

TRANSBOUNDARY ELEPHANT MOVEMENTS ARE AFFECTED BY LANDUSE, ROADS, WATER AND FENCES

CUSHMAN, SAMUEL, Michael Chase, Curtice Griffin

We used movement cost modeling in GIS to test the influence of roads, settlements, fences and water on the seasonal movements of elephants in Botswana-Namibia-Angola. We used a factorial modeling approach to test the scale and strength of influence of each factor across a range of effects. Our results suggest that fences, roads and settlements all act as barriers, but to different degrees and scales. The influence of settlements acts at an appreciable distance, while that of fences is much more severe but localized. By comparing over 10,000 alternative models we identify the factors that most strongly influence elephant movement. We apply this knowledge to produce a movement resistance map that may be useful to prioritize conservation and management of this wide-ranging species.

USE OF NON-INVASIVE GENETIC METHODS TO CONFIRM DUIKER SPECIES IDENTIFICATION MADE IN THE FIELD DURING DUNG COUNT SURVEYS

VAN VLIET, NATHALIE, Mathieu Bourgarel, François Feer, Christian Miquel, Pierre Taberlet, Stéphanie Zundel, Robert Nasi, Jean Charles Filleron

Duikers (*Cephalophus* sp.) are among the most hunted species for food and income in African forests. The knowledge of their abundance or trend is essential to the estimation of hunting sustainability. Because of the low rate of sightings, dung counts have been more widely used than other survey methods to estimate duikers' abundance. However, given the fact that up to seven species can coexist in the same region, the difficulty in identifying duiker species from their dung is a major problem related to the use of this method. Currently, there is no study that tests the reliability of field identification of duiker dung. Many authors have lumped together different duiker species (e.g. red duikers) and even other non duiker species such as the Suni antelope (*Neotragus moschatus*). Thus researchers and managers have to cope with unreliable estimations on duiker population. In this study, we suggest a method based on non-invasive genetic methods to identify duiker species from DNA present on fresh dung, collected from the field and conserved in silica tubes until extraction and sequencing. We compare identification of dung made by field experts with the results given by a phylogenetic tree based on the 12S mitochondrial DNA sequences. Our results show that field identification is only reliable to distinguish *C. sylvicultor* but can not be used to distinguish the blue duiker from the red duikers, and even less among red duiker species. We suggest the use of non invasive genetic methods to ensure reliable species identification when dung counts are carried out. This methodological input will probably strengthen the dung count technique in areas where several ungulate species coexist and make it the most practical and reliable method for duiker population estimations.

POPULATION DYNAMICS OF THE RAGGEDTOOTH SHARK (*CARCHARIAS TAURUS*) ALONG THE EAST COAST OF SOUTH AFRICA

DICKEN, MATTHEW, Anthony Booth, Malcolm Smale, Jeremy Cliff

Understanding the population dynamics of raggedtooth sharks (*Carcharias taurus*) is crucial in defining abundance, habitat use and evaluating the effects of exploitation and anthropogenic activities. Between 1984 and 2004, a total of 1107 juvenile (1.8 m TL) *C. taurus* were tagged and released along the east coast of South Africa. A total of 125 juvenile and 178 maturing and adult *C. taurus* were recaptured, representing recapture rates of 11.2% and 7.5%, respectively. A Cormack-Jolly-Seber model was developed to estimate abundance, survival and probability of capture for both size classes of shark. The mean annual abundance of juvenile sharks, unadjusted for bias, was 6 794 (95% C.I. = 5 031 – 9 724) and adult sharks 21 790 (95% C.I. = 17 158 – 30 745). The accumulated effect of tag specific tag loss, non-reporting and post-release mortality were to reduce the overall estimate of juvenile and adult abundance by approximately 50%. The population size of juvenile sharks remained relatively constant over the 20-year study period, whereas the abundance of adult sharks has significantly increased ($P = 0.019$). This is one of the first applications of an open population model to any shark species worldwide.

INSIGHTS INTO ELEPHANT INFLUENCE ON OTHER LARGE HERBIVORES

VALEIX, MARION, Hervé Fritz

Concerns have arisen about the influence of locally high elephant numbers on other large herbivores in many African protected areas. For instance, in Hwange National Park, Zimbabwe, large herbivore populations have declined since the mid 1980s while the elephant population has increased strongly. This study investigated whether elephants are responsible for the decline in other herbivore populations through two mechanisms. We studied microhabitat selection by other herbivores to test for consequences on other herbivores of elephant-induced vegetation changes. We found that most herbivores selected sites where elephant-induced changes had occurred. Because surface water is scarce, we also studied the role of elephants in water access by other herbivores. We monitored waterholes for 3744 hours and we found that some species adjusted their behaviour to elephant presence (e.g. temporal niche shift). However, it is unlikely that these behavioural changes influenced population dynamics. This study therefore demonstrated that our hypotheses based on effects of elephant-induced vegetation changes and on interference competition for water cannot explain the declines observed in populations of other herbivores. Hypotheses about competition for key-resources and indirect effects on predator-prey relationships of vegetation changes are raised and remain to be explored. These results are crucial given the recent debate on the necessity to control elephant populations in southern Africa.

FERNS, FROGS, LIZARDS, BIRDS AND BATS IN FOREST FRAGMENTS AND SHADE CACAO PLANTATIONS IN TWO CONTRASTING LANDSCAPES IN THE ATLANTIC FOREST, BRAZIL

FARIA, DEBORAH, Mateus Paciencia, Marianna Dixo, Rudi Laps, Julio Baumgarten

Agroforests, like the traditional shade cacao plantations (cabruças) of southern Bahia, Brazil are biologically rich habitats. However, a critical question for the conservation management of this specific region and, more generally, to all the highly fragmented Atlantic Forest, is to what extent the conservation value of cabruças relies on the presence of primary forest habitat in the landscape. We selected five diverse biological groups (ferns, frogs, lizards, birds and bats) and investigated their response to the relative importance of cabruças and forests in two contrasting landscapes in southern Bahia, one dominated by forest with some interspersed cabruças and one dominated by cabruças with dispersed forest fragments. For all biological groups, community structure in cabruças changed relatively to forests, but there were pronounced differences between the two landscapes with regard to the ability of cabruças to maintain species richness. A greater representation of native forest in the landscape positively influences the species richness reported in cabruças. Landscape context also influenced the spatial variability of species composition, stressing the importance, and the vulnerability, of the small forest patches remaining in the landscapes dominated by shade plantations. These results point to the need to preserve sufficient areas of primary habitat even in landscapes where land use practices are generally favorable to the conservation of biodiversity.

ARE PARKS WORKING? A SUMMARY OF THE RESULTS AND CHALLENGES OF EVALUATING ECOLOGICAL AND SOCIO-CULTURAL EFFECTIVENESS IN CASE STUDY NATIONAL PARKS

TIMKO, JOLEEN

Many national parks worldwide have been accused of being ecologically unsustainable, socially unjust, or both. This presentation presents the results of a comparative effectiveness evaluation carried out in national parks in Canada and South Africa which assessed whether case study parks were simultaneously effective in both ecological and socio-cultural terms. Key criteria within both these realms were evaluated using park-specific management plan objectives as indicators. Park ecological monitoring data was used to evaluate the following criteria: conservation of biological diversity and ecosystem processes, and adaptation to and mitigation of stressors and

threats. Information from semi-structured interviews with park managers and members of park co-management boards were used to evaluate the following socio-cultural criteria: resolution of land claims, designation of resource access rights and livelihood opportunities, and participation in park governance. Results show that few parks are effective either ecologically or socio-culturally, and the general effectiveness assessment for each case study park will be presented. The status and trend and outcomes-focused, ordinal evaluation scales used in the study will be compared, and broader study findings such as the move toward targets and/or thresholds in park management and key social factors deemed necessary for success in achieving socio-culturally effective parks will be presented.

SEA DUCKS CONSERVATION: LINKING FRESHWATER, MARINE AND TERRESTRIAL HABITATS

SAVARD, JEAN-PIERRE, Scott Gilliland

Sea Ducks present a peculiar conservation challenge as most spend their lives in coastal waters but breed on land and raise their young on freshwater lakes. Examples of terrestrial and freshwater habitat conservation are numerous; conservation of marine areas in relation to sea ducks is rare. Non breeding scoters and eiders feed on mollusks, a very localized and predictable food resource and are philopatric to their molting and wintering sites where flocks of thousands individuals are not uncommon. Behavior observations of flightless molting scoters and eiders indicate that birds can cover several kilometers in a single day in relation to tides and disturbance. Eiders are generally associated with large mussel beds whereas scoters are associated with clam beds. Preferred marine habitats are usually less than 10 m deep and may include intertidal flats. Special marine protected areas are a potential tool to protect these sites. In Canada legislative tools include the Migratory Bird Convention Act, the Canadian Wildlife Act, the National Parks Act, and the Canada Oceans Act. However they have yet to be used. It is urgent that we initiate protection of the most important molting and wintering sites.

FISHES, FRESHWATER AND A TALE OF TWO ESTUARIES

WHITFIELD, ALAN

The biotic and abiotic factors that determine the distribution and abundance of fishes in southern African estuaries are strongly driven by riverine inputs. Freshwater flow interacts directly and indirectly with the fishes that inhabit estuaries, e.g. river floods directly influence estuarine water temperature, salinity, pH, turbidity, nutrient status, organic inputs, dissolved oxygen concentrations and olfactory cues; and indirectly affect mouth state, tidal prism, habitat diversity, productivity, fish recruitment, food availability and competition. The increasing abstraction of fresh water from both large and small river catchments in southern Africa has had the effect of forcing some estuaries into artificial cycles, i.e. natural successions now have human imposed trajectories that are changing estuarine variability and forcing these systems into extreme states. An understanding of this variability and the impact of reduced river flow is vital if estuarine conservation efforts are to succeed. In this presentation two systems, the Kariega Estuary in the Eastern Cape Province and Lake St Lucia in KwaZulu-Natal, are used as examples to illustrate how fish assemblages have responded to major alterations in freshwater flow regimes.

EXTRACTING CONSERVATION: A STUDY OF COOPTATION AND COMPROMISE BETWEEN INDIGENOUS COMMUNITIES, INDUSTRIES AND ENVIRONMENTALISTS

ALI, SALEEM

This paper analyzes some of the recent critique of environmentalism offered by anthropologists in the context of partnerships between industry and conservationists for environmental planning, particularly for oil and mining projects. Using comparative case analysis and standard ethnographic methods, the paper analyzes the approach of IUCN, Conservation International, The Worldwide Fund for Nature (WWF), The Nature Conservancy (TNC) and Earthworks. While Conservation International and IUCN have established formal programs of partnership with the extractive industries, WWF and TNC have been more cautious and approached partnerships on

an ad hoc basis for projects. Earthworks is on the other end of the spectrum with more confrontational approaches and partnering with human development organizations such as Oxfam to shame industry into compliance. The paper proposes that the success of partnerships is often dependent on a sequence of more strident and confrontational approaches that provide industry a comparative frame for compromise on conservation. Once this frame is provided conciliatory processes can prevail. At the same time the anthropologists critique of conservation groups misses the fact that their mandate is often at odds with indigenous interests. Further such groups are formed on the basis of changing attitudes about the environment at all levels -- and indigenous communities might be considered no exception to this imperative for change.

MITOCHONDRIA AND NUCLEAR DNA PHYLOGEOGRAPHY SUGGEST SEVEN
PHYLOGENETIC SPECIES OF PSEUDOALCIPPE IN AFRICA
NJABO, KEVIN, Rauri Bowie, Michael Sorenson

The African Hill babblers have a wide but discontinuous distribution in tropical Africa. Restricted to montane forests, hill babblers have a patchy distribution and show appreciable morphological variation between allopatric populations, which have often been treated as a single species. At least seven "subspecies" are described, although their monophyly and phylogenetic relationships are untested. We surveyed sequence variation in six nuclear introns and a mitochondrial protein coding gene from different sub specific populations in Africa, and compared the phylogeographic structure of genetic diversity with described patterns of variation in morphology and vocalization. The results reveal relatively deep divergence and reciprocal monophyly among several different mitochondrial clades largely corresponding to forms previously described as subspecies based on morphology. The phylogenetic relationships among these clades suggests a complex geographic history of dispersal and/or range expansion and vicariance during the history of the genus. Our results suggest at least two dispersal events from East to West Africa as well as movement in the opposite direction. Long-term historical isolation and perhaps adaptation to different local conditions has resulted in divergence of morphology as well as songs, which are not shared between subspecific groups. The magnitude of molecular divergence combined with concordance of patterns in mitochondrial, nuclear, morphological and behavioral variation, we recommend the recognition of up to seven hill babbler species.

CROSSING BOUNDARIES: ALIEN SPECIES IN THE ANTARCTIC
LEE, JENNIFER, Steven Chown

Invasive alien species are a global issue. As elsewhere in the world, alien species in the Antarctic have a profound effect on the communities which they inhabit. Clearly there is a need to halt these invasions, but where to start? We propose that to manage alien invasions in the Antarctic we first need to gain a better understanding of how many propagules and of what type are transported into and around the region. Using the logistics operations of the South African National Antarctic Programme as a model system, we undertook systematic surveys of several classes of cargo and personal equipment with the aim of identifying the equipment types which pose the greatest biosecurity threat to the region. A total of 188 cargo/personal units were surveyed revealing that despite strict quarantine and control measures substantial numbers of propagules are being transported to the region. Although it will be a considerable challenge to reduce this propagule load, our work provides vital information as to where resources should be targeted to give the greatest conservation benefits.

ECOLOGY AND INTERACTIONS OF CAPE FOXES, BAT-EARED FOXES, AND BLACK-
BACKED JACKALS: CONSERVATION IMPLICATIONS FOR SMALL CARNIVORES IN
SOUTHERN AFRICA
KAMLER, JAN, David W MacDonald

Interference competition usually occurs within canid communities in northern temperate regions, although this has not been studied among African canids. Although cape foxes are widely distributed in southern Africa, their numbers have been declining in recent years, and current

densities appear to be low everywhere. To investigate if competition with larger canids negatively affects cape foxes, populations were studied in two adjacent areas that differed greatly in jackal densities. Bat-eared foxes also were studied on both sites to determine their relationships with other canids. Since May 2005, 16 cape foxes, 40 bat-eared foxes, and 15 black-backed jackals have been captured, radio-collared, and monitored on a weekly basis on both sites. Predation from jackals was the largest cause of mortality for cape (60% of deaths) and bat-eared (67%) foxes. High jackal numbers caused home ranges to increase from 8.6 to 29.1 km² for cape foxes, and from 3.3 to 9.1 km² for bat-eared foxes. Both fox species clearly avoided jackal core areas, thus foxes had to range over larger areas to safely find food in areas with high jackal densities. High jackal numbers also caused cape fox densities to decrease >70%, while doubling group sizes of bat-eared foxes. In the absence of large carnivores (e.g., lions, hyenas, leopards), black-backed jackals can attain relatively high densities, which results in severe negative impacts on cape foxes, and possibly other small carnivores.

EVALUATING THE PERFORMANCE OF A DECADE OF SAVE THE TIGER FUND'S INVESTMENTS TO SAVE THE WORLD'S LAST WILD TIGERS GRATWICKE, BRIAN, John Seidensticker, Mahendra Shreatha, Karin Vermilye, Matthew Birnbaum

Given the lack of resources for conservation, it is increasingly important that conservation funds are spent wisely in a way that results in real conservation outcomes such as increased animal or plant populations or habitats protected. Conservation donors are in a unique position to provide leadership on this issue because they have access to a range of different organizations and can provide a 'bigger picture' in terms of analyzing conservation success and failure, and to disseminate best conservation practices, but few make the effort to perform meta-evaluations of their grant portfolios. This is the first attempt to analyze the performance of \$12.6 million invested by Save The Tiger Fund (STF) in more than 250 tiger conservation grants. We have devised a simple evaluation method and use it to take stock of successes and failures of different conservation methods that were classified into the following categories: understanding, education, anti-poaching, sustainable development, habitat protection and restoration, leadership development and trafficking reduction. We found that there were many successes and some failures, but that overall, STF grantees project outputs exceeded their original objectives but that there are often so many confounding variables it is often difficult to determine the direct effects of grantees actions on tiger or prey populations. Even in those places where tiger populations have stabilized, it is difficult to determine to what extent STF funding was responsible for the positive conservation outcome, because on average, STF supplied about 25% of the all the funding available to the conservation of wild tigers. Places like the Russian Far East and the Terai Arc Landscape that achieved landscape-level conservation outcomes were guided by clearly articulated conservation visions for the landscape that attracted and coordinated long-term donor funding, had buy in from governments and other stakeholders, and ensured the cooperation and lack of duplication of the activities of multiple conservation organizations. Limited funds are seldom congruent with global conservation needs, so donors should facilitate collaborative problem solving methods and the sharing of lessons learned and best practices to inform conservation actions elsewhere to maximize the 'bang for our conservation buck'.

WHERE DO WE ACT TO GET THE BIGGEST BANG FOR OUR CONSERVATION BUCK? A SYSTEMATIC SPATIAL PRIORITISATION APPROACH FOR AUSTRALIA KLEIN, CARISSA, Kerrie Wilson, Josie Carwardine, Matthew Watts, Hugh Possingham

The global conservation community is charged with finding the best places to invest limited conservation funds to prevent the most biodiversity loss. The conventional mandate is to meet biodiversity conservation targets within the smallest possible area of land or sea. This implies a cost minimisation objective, but ignores spatial variability in the cost of different conservation actions. Explicit economic factors must then be considered post-hoc. It is more efficient to consider spatially-explicit costs of conservation actions a priori. We prove this by prioritising areas according to both site-specific measures of biodiversity value and the cost of the planned

conservation action. We demonstrate our approach by conducting the first comprehensive, spatial prioritisation analysis at a fine resolution for Australia. Our analysis includes the full range of Australia's biodiversity (where data exists), captures certain ecological processes, minimizes threats to biodiversity, and incorporates spatially explicit data of the cost of different actions. We discover remarkable increases in financial efficiency when using appropriate surrogates for the costs of two conservation actions: reservation and stewardship. Our study proves that a poorly posed conservation problem that ignores costs can lead to very expensive mistakes. We also demonstrate novel methods for considering ecological processes and threats to biodiversity in a systematic conservation planning framework.

QUANTIFYING AND MANAGING THE LOSS OF GENETIC DIVERSITY IN A FREE-RANGING POPULATION OF TAKAHE USING PEDIGREES

GRUEBER, CATHERINE E., Ian G. Jamieson

Pedigree analysis has benefits for the genetic management of threatened populations through the evaluation of inbreeding, population structure and genetic diversity. As good pedigree data are difficult to collect, few examples exist of using pedigrees exclusively to manage free-ranging populations. One such example is the management of the takahe (*Porphyrio hochstetteri*), a highly endangered flightless New Zealand rail. As part of the takahe recovery program, birds were translocated from the sole remnant population in Fiordland to four offshore islands from which introduced predators had been eradicated. This "island" population, now numbering 83 and at carrying capacity, has been closely monitored since founding, providing an accurate pedigree that is 7 generations deep in parts (genetic founders = 31). Modelling this pedigree revealed that 7.5% of genetic diversity (GD) present in the founding population had been lost over the relatively short timeframe since founding, due mainly to a failure to equalise founder representation (founder genome equivalents = 6.6). These results are supported by ongoing microsatellite work which indicates that island takahe have lost both allelic diversity and heterozygosity relative to the Fiordland birds. Our results underscore the usefulness of maintaining pedigrees for the genetic management of free-ranging populations, and the importance of managing genetic diversity from the outset of translocation activities.

CONSERVING SOUTH EAST ASIAN MAMMALS: WHAT TO DO WHERE?

WILSON, KERRIE, Luigi Boitani, Federica Chiozza, Gianluca Catullo, Ian Dutton, Alessandra Falcucci, Hedley Grantham, Erik Meijaard, Luigi Maiorano, Hugh Possingham, Carlo Rondinini, Valeria Salvatori, Will Turner, Matthew Watts

Alternative land uses make different contributions to the conservation of mammals, and each land use has different costs associated with its implementation and management. We apply a spatially-explicit, systematic framework for prioritizing conservation investments that accounts for the costs and benefits of multiple land uses. For a small region in Kalimantan, we obtained data on land use, land cover, and the costs of converting current land uses to alternative uses. We also obtained data on the distribution of mammals that are sensitive to forest conversion (and their conservation targets) and the relative contribution of each land use type to achieving the targets for each species. We then modified the potential contribution of each land use type to target achievement by the probability that investment in each land use actually achieves the desired conservation outcomes. This enabled us to account for enabling conditions and socio-economic factors that determine the likelihood of success of conservation investments. We prioritised investments in alternative land uses in order to achieve the conservation targets in a cost-effective manner. The application of our framework tells us not only where to act, but how to act in order to effectively and efficiently conserve South East Asian mammals.

INTEGRATING MULTI-STAKEHOLDER VIEWS IN THE DESIGN AND IMPLEMENTATION IN A WILDLIFE CONSERVANCY ON KUKU RANCH NEAR AMBOSELI, KENYA OKELLO, MOSES

Historically, the communal land ownership and pastoralism lifestyle allowed Maasai to sustainably and harmoniously use and share with wildlife. On the Kuku group ranch this mutual co-existence is now threatened by an increasing population and land use changes. Consequently, human-wildlife conflicts and competition are increasing, and the conservation of migrating wildlife threatened. One proposed solution in Kuku is to create a wildlife sanctuary that will increase wildlife range and also provide economic benefit to the otherwise not benefiting Maasai. But multi-stakeholder support is important for implementation and success of such an enterprise. I investigated such support and aspirations through interviews and discussion with two major stakeholders—the local Maasai community and the Kenya Wildlife Service. Both the Maasai and the KWS supported the establishment of the conservation area. For the Maasai community, the support was dependent on perceived economic benefits that would potential offset wildlife-related damages, as well as access to land and its resources. A majority of the Maasai also supported agricultural expansion and group ranch sub-division; even though they acknowledged potential negative impacts to wildlife and pastoralism. It is therefore clear that the proposed wildlife sanctuary can only succeed if established as a multi-use area that incorporates the resource needs of stakeholders while also promoting wildlife conservation through ecotourism. This would accrue revenue from tourists, and allow Maasai access to critical resources (such as pasture and water) in times of scarcity.

HUMAN IMPACT ON TROPICAL ECOSYSTEMS: SHOULD WE OR SHOULD WE NOT INTERVENE? TREYDTE, ANNA

Today, almost half of the earth's land surface has been transformed by humans, leading to drastic changes in biodiversity. The ecosystems' resilience to changes depends on the spatial and temporal scale of interactions. We present three examples on humans influencing plant-herbivore interactions: (1) Protected areas provide limited resources, and often inhabit "surreal" animal species assemblages and population sizes that need to be regulated. (2) Livestock farming alters natural ecosystems, particularly in savanna habitats, and high grazing densities leave behind habitats difficult to recolonize by wildlife. (3) A rapid decline in large tree densities through logging affects associated plant and animal communities as sub-canopy vegetation of elevated nutrient contents in savanna ecosystems, an important food source for selective grazers, will be lost. Based on these examples we recommend adequate intervention strategies: In fenced reserves, regulative measures for plant and animal systems are needed to maintain a high biodiversity and sustainability. Livestock-impacted areas can still be attractive habitats if restoration management can ensure long-time resettlement through wildlife. In dry and nutrient poor savannas trees need to be strictly protected as grass nutrient improvers, essential for grazers in otherwise nutrient-poor savanna systems. We propose that management needs to follow once we understand ecosystem processes to prevent future imbalances and species losses.

PROTECTING NATURE WHERE WE LIVE: SMALL MAMMALS IN THE NEW YORK METROPOLITAN AREA BURNS, CATHERINE, David Burg

Urbanization is swiftly occurring around the world, and will continue to increase steadily in the coming decades. Understanding wildlife responses to increasing human population density and associated land-use changes is therefore critical to the conservation of flora and fauna across the planet. WildMetro, a small non-profit organization dedicated to protecting nature in metropolitan regions, has conducted three years of field research in the New York metropolitan area to assess the impacts of increasing urbanization on a suite of nocturnal small mammal species. We have used a combination of mark-recapture live-trapping and tracking methods to survey mammal

communities in protected areas across the region, spanning the gradient from extremely urban to suburban to rural. Habitat type and patch size both have significant influences on diversity and abundance of the small mammal community, with smaller patches supporting higher densities of small mammals but with a lower overall diversity. Small mammal communities additionally appear to be strongly negatively impacted by the density of white-tailed deer. This research allows us to begin to identify specific habitat types and other characteristics of protected areas that are essential to the conservation of small mammal communities in urban areas, and to identify thresholds of urbanization beyond which small mammals are critically negatively impacted.

COMPATIBILITY OF LIVESTOCK GRAZING WITH FOREST REGENERATION IN MEDITERRANEAN HOLM OAK PARKLANDS PLIENINGER, TOBIAS

Successful regeneration of holm oaks is the key to the conservation of the outstanding biodiversity levels in Spanish dehesa parklands. However, low densities of regeneration were measured in this study. The threshold for livestock stocking levels supporting regeneration was below all figures presently found in the dehesas. In the analysis of stand structure, a positive relationship between tree age and the age of agro-silvo-pastoral use of the dehesas was detected. This suggests that the forest cycle has been disrupted, and stands may dissolve gradually. Regeneration failure is an implicit component of this agroforestry system. An analysis of long-term abandoned dehesas situated at roadsides showed that holm oak stands are able to recover if grazing and cultivation are set aside. In a mail survey managers of private large landholdings highly appreciated having holm oaks on their land, both for income- and non-income-related motivations, e.g. for the preservation of real estate value or family tradition. Land managers identified over-maturity of stands and regeneration failure among the top five problems of dehesas. Conservation policy should be directed towards incentive schemes, environmental education, and technical assistance.

NATURAL WETLAND SIZE AND TIDAL CREEK SHAPE MATTER FOR SOUTHERN CALIFORNIA COASTAL WATER QUALITY MYERS, MONIQUE, Richard Ambrose

In Southern California over 90% of our coastal wetlands have been destroyed. Recently the paradigm that wetlands act as filters for urban runoff, removing contaminants before they enter the ocean, was challenged when researchers found that a small Southern California wetland increased fecal indicator bacteria (FIB) populations. This wetland's size, however, had been reduced to less than 1/100 of its natural size. Our research indicates that larger natural wetlands can provide important bacterial attenuation functions. We measured FIB populations during dry and wet weather at all inlet sites, where water entered the wetland, and at the one outlet site, where water drained into the ocean, of a 93 ha Southern California wetland. We also measured water FIB concentrations at different distances along tidal creeks. This natural wetland attenuated FIB during all but the largest rain event of the year. Bacterial populations were reduced as they travelled along naturally shaped, sinuous tidal creek channels. This work suggests natural wetlands provide important ecosystem services and that conservation of wetlands in their natural condition has important water quality implications for near-shore marine environments.

PREDICTIVE HABITAT AND POPULATION VIABILITY MODELS FOR JAGUARS (*PANTHERA ONCA*) IN THE SIERRA MADRE ORIENTAL, MEXICO BRAVO, OSVALDO ERIC RAMIREZ, Carlos Alberto Lopez Gonzalez

Due to habitat loss, it is necessary to identify areas with potential viability for endangered species. In the case of jaguar (*Panthera onca*) little is known for extreme distributional areas, making it necessary to create conservation strategies to assure long term survival. For this purpose, a spatial dynamic model (PATCH) was used to determine priority areas in the Sierra Madre Oriental, México. It was developed, with a static model created estimating mortality (human population density and paved road density) and survival (vegetation index and physiographic

aspects) probability. Demographic information used, was previously published. Three scenarios were considered: actual conditions, human population growth in 15 years, and paved road density increase in 15 years. Results show that actual conditions provide sufficient habitat for jaguar survival in a 200 year span. However, increase in human population and road density will result in species extinction in a 50 year span with an increase in possible conflicts. The results of this model will help to concentrate resources into certain areas to assure long term survival for jaguar populations.

MARK-RECAPTURE STUDIES OF LARVAL DISPERSAL IN MARINE FISHES:
UNDERSTANDING THE SPATIAL SCALE OF MARINE CONSERVATION
ALMANY, GLENN, Michael Berumen, Simon Thorrold, Geoffrey Jones, Serge Planes

Most marine organisms have a planktonic larval phase lasting days to weeks, and larval dispersal is the primary mechanism connecting populations. Understanding the scale of dispersal is critical to the design of marine protected area (MPA) networks. Mark-recapture studies can provide direct estimates of ecologically-relevant dispersal, but these have proven difficult. We developed a new tagging method in which rare barium isotopes are maternally-transmitted to embryos prior to spawning and subsequently incorporated into larval otoliths (ear bones). After dispersal, juveniles are collected and their otoliths are analyzed for barium tags with mass spectrometry. In Kimbe Bay, Papua New Guinea, we tagged the larvae of two species of coral reef fish representing the two dominant modes of reproduction in fishes: a pelagic-spawning butterflyfish with a long planktonic phase (~38 d) and a demersal-spawning anemonefish with a short planktonic phase (~11 d). We tagged approximately 17% and 100% of butterflyfish and anemonefish larvae, respectively, produced from 0.3 km² of reefs surrounding Kimbe Island. Analysis of juveniles collected from these reefs in February 2005 revealed that ~60% of both species were produced by the resident adults. This suggests that the spatial scale of management is much smaller than previously imagined and that relatively small MPAs may be capable of ensuring the persistence of some marine species.

SOCIO-ECONOMICS AND POTENTIAL FOR COMMUNITY-BASED CONSERVATION OF THE
EDIBLE STINK BUG, *ENCOSTERNUM DELEGORGUEI* (HEMIPTERA: TESSARATOMIDAE),
IN SOUTHERN AFRICA
DZEREFO, CATHY, Rob Toms, Ed Witkowski

Encosternum delegorguei, the edible stink bug, is a coveted and nutritious delicacy in north eastern South Africa and southern Zimbabwe. Various methods to ameliorate the "chilli" or bitter taste were recorded in structured interviews with 72 harvesters. Of these 66% eat and sell them, 33% only sell them and 19% collect solely for own use. Rural families can earn an average income of R 3 015 (S.D = R 1 864) (\$1 = R7) per annum by selling for between R 50 (cooked and dried) to R150 (living) per kg. In its local context, this is a high price commodity. Insects harvested at Modjadji and Zimbabwe are transported over 200 km's to the Thohoyandou area, where local supply is insufficient. Sixty-four percent of interviewees perceived the resource to be in decline. This was attributed to reduced rainfall (51%), loss of indigenous vegetation (15%) and fires (1%), while one person mentioned over harvesting as a factor. Flagship species for ecosystems and as tourism draw cards are needed to lobby public support for community driven conservation. *E. delegorguei* is a traditional African food and medicine species suitable for motivating in situ protection of Sour Lowveld Bushveld occurring on the eastern slopes and foothills of the Drakensberg and Soutpansberg ranges. This vegetation type is about 76% transformed and loss of vegetation coupled with steep topography and high rainfall can contribute to erosion problems. As part of a conservation plan the insect's biology and habitat requirements must be known and communicated to the stewards of its habitat.

ELEPHANT FEEDING BEHAVIOUR AND CONSERVATION IMPLICATIONS: QUANTIFYING THE FEEDING IMPACTS OF A KEYSTONE SPECIES

LESSING, JOAN, Graham I H Kerley, Sharon L. Wilson

Elephants are hypothesized to function as keystone species in African ecosystems, but the mechanisms have rarely been elucidated. We measured elephant preferred feeding height and ability to harvest branches in Subtropical Thicket, South Africa. Elephant feed over the greatest height range of thicket browsers, accessing forage from the ground up to 5.5 m, higher than the 1.8 m achieved by kudu and black rhinoceros. Furthermore, elephant can break off larger branches (up to 48 mm on *Schotia afra*) than cropped by other browsers, with a resultant larger biomass available. They can therefore access more forage biomass than other browsers. This, together with their ability to assimilate poor quality forage, allows them to access forage resources from ecosystems beyond the ability of co-existing herbivores. We show that elephants' unique feeding with their trunk allows them to access more resources than predicted by body size. This confirms their potential to alter ecosystems through direct foraging, and their potential to exclude co-existing herbivores. The conservation of elephants can therefore place other herbivores and plants at risk. These findings provide a mechanistic understanding of these impacts, and provide the basis for developing monitoring tools focussing on elephant specific feeding behaviour.

THE DIVERSITY AND THREATS OF MARINE MAMMALS IN WEST AFRICAN COASTAL WATERS AND THEIR PROTECTION NEEDS: THE SCENARIO IN GHANA

KWABENA, PATRICK OFORI-DANSON

There is paucity of information about the West African manatee (*Trichechus senegalensis* Link 1795) which is one of the three species of manatees of the world. Available information from literature and surveys undertaken in the Volta basin since 1994 confirm the occurrence of two groups of the mammal in the basin – one group in the Lower Volta and another group in the upper reaches of major tributaries of the lake which are physically separated from each other by the Akosombo dam. Large group sizes of the manatee is not encountered indicating that the two groups could be too depleted to support any large-scale removal. Mortality is mainly through direct hunting and entanglement in fishing gears. Manatee/human conflicts therefore occur where they damage fishing nets. For cetaceans, at least 13 species of dolphins have been recorded in the coastal waters of Ghana indicating high diversity of these mammals. The dominant species include, the clymene dolphin (*Stenella clymene*), Pantropical spotted dolphin (*Stenella attenuata*), Atlantic spotted dolphin (*Stenella frontalis*), Risso's dolphin (*Grampus griseus*) and the bottlenose dolphin (*Tursiops truncatus*). In absence of enforcement rules and regulations for protecting the manatee and the diverse cetaceans in the West Africa sub-region, hunting and fishing continue to pose as major threats to the survival of marine mammals. The exploitation of dolphins is gradually becoming a source of revenue many local communities, both directly and indirectly because the carcasses are cut into small portions, smoked and retailed locally for food; and some are also used as baits for catching local sharks, whose fins are becoming scarce foreign exchange earner. The protection needs for these mammals are discussed to facilitate the urgent need for the adoption and enforcement of conservation strategies to save the remaining stocks. It is considered that any conservation strategy should identify, educate and involve traditional manatee hunters or cetacean fishers in the sub-region.

THE FUNCTION-AREA RELATIONSHIP AND ITS RELEVANCE FOR CONSERVATION PLANNING

CUMMING, GRAEME, Matthew Child

While the species-area relationship (SAR) is one of the most widely accepted generalities in ecology, little attention has been paid to patterns of spatial variation in functional diversity. Functional perspectives on patterns of species occurrences may offer new and interesting insights into a range of spatially explicit problems in ecology and conservation. We first derived a general form for the function-area relationship (FAR). We then used beak morphology to classify

a subset of 153 South African bird species into 18 functional groups, and calculated both the SAR and the FAR for these data at quarter-degree resolution for the whole of South Africa. As predicted, the FAR followed the same general form as the SAR, but with a lower asymptote. The relationship between functional and taxonomic richness by quarter-degree grid cell was quadratic rather than linear, with considerable scatter around the curve. Our results demonstrate that while the FAR is predictable and follows a similar form to the SAR, taxonomic richness is not always a good surrogate for functional richness. The difference in areas under the FAR and the SAR offers a quantitative measure of the resilience of the ecosystem to species loss. Process-oriented conservation plans and assessments would benefit from considering local variations in the relationship between taxonomic and functional diversity when areas are prioritised for conservation.

DROUGHT, SNAILS, AND LARGE SCALE DIE OFF OF U.S. SOUTHERN SALT MARSHES SILLIMAN, BRIAN, Johan van de Koppel, Mark Bertness, Lee Staunton, Irv Mendenhallsson

Salt marshes in the southeastern U.S. have recently experienced massive die-off, one of many examples of widespread degradation in marine and coastal ecosystems. Although intense drought is thought to be the primary driver of this die-off, we found snail grazing to be a major contributing factor. Survey of marsh die-off areas in three states revealed high-density fronts of snails on die-off edges at 11 of 12 sites. Exclusion experiments demonstrated snails actively converted marshes to exposed mudflats. Salt addition and comparative field studies suggest that drought-induced stress and grazers acted synergistically and to varying degrees to cause initial plant death. Following these disturbances, snail fronts formed on die-off edges and subsequently propagated through healthy marsh, leading to cascading vegetation loss. These results, combined with model analyses, reveal strong interactions between increasing climatic stress and grazer pressure, both potentially related to human environmental impacts, which amplify the likelihood and intensity of runaway collapse in these coastal systems.

DIVERSITY OF DWARF CHAMELEONS IN SOUTH AFRICA: PATTERNS AND PROCESSES TOLLEY, KRYSTAL, Brian Chase, Felix Forest

Much of the diversity observed today in the three South African biodiversity hotspots (Cape Floristic Region, Maputaland, & Pondoland) has been attributed to climate change as a mechanism for triggering speciation events. The timing of a number of species-rich clade radiations in the region seem to correspond with global paleoclimatic trends, with a marked cooling trend since the mid-Miocene being considered a major factor igniting radiation and speciation events in a wide range of taxa. However, linking major diversification events to palaeoclimatic trends with any degree of confidence has been speculative. Here we show, using a complete species phylogeny of dwarf chameleons (genus *Bradypodion*), that radiation events are spatio-temporally distinct, and are associated with precise events in the climatological and geological history of southern Africa. Geographic areas showing high chameleon diversity were identified by species richness (SR) and phylogenetic diversity (PD). These areas correspond with known hotspots of biodiversity based on floral endemism and SR. The dated phylogeny suggests that several major radiation events correspond with major climatic shifts, first in the mid-Miocene and later in the Pliocene and Pleistocene. Optimizations show that closed habitat (i.e. forest) is an ancestral state in dwarf chameleons, with a shift to more open habitats occurring as forests became fragmented and open habitats began to dominate southern Africa in the Pliocene.

COMMUNITY MANAGEMENT OF SACRED FORESTS IN GHANA ORMSBY, ALISON

Sacred forests are areas that have cultural significance to the people who live around them. Because sacred forests tend to be small, they are often isolated habitat fragments surrounded by agricultural lands. These fragments sometimes represent the last locations in certain regions with potential for biodiversity conservation. Ghana has a long history of community protection of sacred sites. Research at Tafi Atome Monkey Sanctuary and Boabeng-Fiema Monkey Sanctuary

revealed contrasting histories of resource management and cultural traditions. A qualitative, ethnographic research methodology was used, including semi-structured, open-ended interviews. The history of each site, rationale for its protection, taboos relating to natural resource use, and ecological management techniques were investigated. Results indicate that management approach, level of community involvement, and ecotourism profit sharing are linked to effectiveness of site protection and community attitudes. Both sites have a long history of resource protection associated with beliefs that local monkeys are sacred, with related taboos on hunting. Both sites have faced erosion of traditional resource protection customs due to missionary influences. Long-term government involvement at one site and community conservation at the other present contrasting challenges for the future viability of each forest in terms of tourism, local participation, and biodiversity preservation.

CONSEQUENCES OF NOT REALIZING ONE'S (DISPERSAL) POTENTIAL:
PHYLOGEOGRAPHY AND CONSERVATION OF A WIDE SPREAD CORAL REEF FISH,
HALICHOERES HORTULANUS
DREW, JOSHUA, Paul Barber

Understanding larval connectivity in marine taxa is an important component to elucidating their evolutionary history, ecological connections and in developing effective management strategies. Here we investigate the phylogeography of a common widespread reef fish, *Halichoeres hortulanus*. Using information from the mitochondrial and nuclear genomes we demonstrate that there are clear differences between Pacific Ocean and Indian Ocean fish. These differences appear to be centered around the Flores sea. We show that this biogeographic boundary appears to act as a near complete one-way filter with haplotypes moving from the Pacific to the Indian, but not in the other direction. Similarly we demonstrate a signal of rapid population expansion in the Indian Ocean samples suggesting that there has been a recent invasion from East to West. Our results indicate that while the fish has the potential for long distance dispersal, several factors, including paleohistory and modern day ocean currents serve to restrict this dispersal capability. This study implies that despite the broad geographic range of this species, effective management must incorporate biogeographic data, and that stocks in Indonesia represent two separate evolutionary lineages.

PAST, PRESENT AND FUTURE: THE USE OF PALEOECOLOGY AND BIOCLIMATIC
ENVELOPE MODELING TO HELP CONSERVE ENDANGERED GARRY OAK ECOSYSTEMS
IN SOUTHWEST CANADA
PELLATT, MARLOW, Karin Bodtker

Under the Canadian Species at Risk Act (SARA) Garry oak ecosystems are listed as "at-risk" and act as an umbrella for over one hundred species that are endangered to some degree. In order to effectively recover or allow these species to persist where possible, it is critical to understand the ecological process essential for their ongoing survival. The project I will discuss is a multi-disciplinary research project that examines the paleoecology, modern ecology, ethnobotany, and fire history of selected Garry oak ecosystems. Understanding mean fire return intervals, ecosystem dynamics over time, and the role of people in this ecosystem structure is critical to the long-term survival of these communities. We develop bioclimatic envelope models to display future scenarios for Garry oak distribution in order to consider climate change in the potential persistence and recovery of Garry oak ecosystems at a spatial scale relevant to land managers. We are synthesizing the results of this project and proposing management actions to assist protected area managers, scientists, and recovery teams in the task of ecosystem management and restoration. The restoration of ecosystem processes may help in the long-term conservation of these systems and achieve ecological integrity in Garry oak ecosystems.

THE CONSERVATION CONSEQUENCES OF PROMISCUITY IN PLANTS POLLINATED BY NECTAR-FEEDING BIRDS

KRAUSS, SIEGY, TianHua He, Luke Barrett, Byron Lamont, Neal Enright, Ben Miller

In plants, pollen dispersal is characteristically leptokurtic, with significant consequences for population genetic structure and nearest-neighbour mating dynamics. However, most studies have been on wind- or insect-pollinated plants from the northern hemisphere. Here, we quantify realised pollen dispersal, and examine its effect on fine scale spatial genetic structure and mating dynamics, within an Australian vertebrate pollinated shrub, *Banksia hookeriana* (Proteaceae). We assigned paternity using AFLP markers to 274 seeds from 5 families within a natural population of 112 plants. Realized pollen dispersal departed from nearest-neighbour pollination, with a distribution corresponding to the spatial distribution of plants. We found an equal probability of paternity for more than 90 potential mates, at a distance of up to 50 m, from a maternal plant. This near panmixis is facilitated by highly mobile nectar feeding birds such as honeyeaters in the family Meliphagidae. With 15% of the Australian flora pollinated by nectar-feeding birds, our results have broad and novel evolutionary significance for many species of Gondwanan lineages. We suggest that the consequences of reduced pollen dispersal caused by habitat fragmentation, declining pollinators, and non-native pollinators such as European honeybees, are of particular conservation concern for these promiscuous plants with native pollinators facilitating near random mating.

RAPID ASSESSMENT OF SPECIES RESPONSES TO HABITAT LOSS USING BASIC BIOLOGICAL INFORMATION

HOCKEY, PHILIP, Odette Curtis

Much research has focused on identifying traits that can act as useful indicators of how habitat loss affects species' extinction risks, with mixed results. In this study, we develop two simple, rapid-assessment models of species' susceptibility to habitat loss. Both are based on an index of range size, but one is based on an index of body mass, the other on an index combining habitat and dietary specialisation. We apply the models to samples of birds in the families Accipitridae (raptors) and Bucerotidae (hornbills), and also to the lemurs of Madagascar, and compare the models' classifications of risk with the IUCN's global threat status of each species. The model based on ecological attributes was much more robust than the one based on body mass, identifying threatened birds and lemurs with an average of 80% accuracy, and Endangered and Critically Endangered species with 100% accuracy. This model also identifies some species not currently listed as threatened that almost certainly warrant conservation consideration. We conclude that appropriate analysis of even fairly crude biological information can assist in raising early warning flags for species' relative susceptibilities to habitat loss, thus providing a useful and rapid technique for developing conservation 'straw dogs' for further refinement.

LONGEVITY IN CHEETAHS: THE INHERITABLE KEY TO SUCCESS?

PETTORELLI, NATHALIE, Sarah Durant

An understanding of the factors governing reproductive success has fundamental implications for population demography, conservation, selection and adaptation. In this study we show (1) that lifetime reproductive success is positively but non linearly linked to longevity in cheetahs, (2) that experience and the quality of the mother, as indexed by longevity, influence annual reproductive success, (3) that the success of the last breeding occasion in cheetahs is lower than the reproductive success of previous years but increased with females' longevity, (4) that time, experience and the correlation between longevity and the quality of the mother are factors that all contribute to the positive relationship between longevity and lifetime reproductive success, and (5) that there are significant maternal effects on longevity in cheetahs, with long-lived females successfully rearing to independence females that live longer than average. We suggest that learned or innate mechanisms such as differences in hunting abilities or differences in the ability to avoid predators might explain the strong maternal effect in determining longevity. Our results demonstrate the importance of long term studies that follow multiple generations in gaining a full

understanding of the factors affecting reproductive success, and hence population dynamics and ultimately adaptation and evolution.

OTTER DIET AND DISTRIBUTION; POINTERS TO PRIORITIES IN FRESHWATER
CONSERVATION IN KENYA
OGADA, MORDECAI

Research over the last 3 years has shown that the diet of otters (*Aonyx capensis*, *Lutra maculicollis*) is an accurate indicator of aquatic community structure and dynamics. Otters have a high energy requirement and are restricted to aquatic habitats, so their diet is highly influenced by what is available. Analysis of *A. capensis* diet in the Ewaso ng'iro river from 2003-2005 clearly indicated the geographical extent and temporal dynamics of the Louisiana crayfish invasion in the area. Crayfish antennule bases and fish preopercle bones have significant linear relationships ($Y = -36.891 + 58.87 * X$; $R^2 = .902$ and $Y = 29.313 + 25.05 * X$; $R^2 = .725$ respectively) to the live weights of the prey items. Both of the above are retrievable intact from otter faeces and are paired, so they are also accurate indicators of the number of prey items consumed. Water quality, quantity and fish tonnage have been the foci of freshwater system monitoring in Kenya thus far, though population and community structure of aquatic fauna is a more sensitive variable and should be the priority. This method is still under refinement, but has been found to give valuable information on both the abundance and population structure of prey species. Once important indicator species have been identified, this is a cheap, useful and sustainable monitoring tool/technique for freshwater ecosystems.

INTERACTION OF INDO-PACIFIC BOTTLENOSE DOLPHINS (*TURSIOPS ADUNCUS*) AND
GILLNET FISHERIES IN ZANZIBAR, TANZANIA
AMIR, OMAR, Per Berggren, Eva Stensland, Anna Särnblad, Narriman Jiddawi

The Indo-Pacific bottlenose dolphin, *Tursiops aduncus*, is the cetacean species most impacted by gillnet fisheries in the coastal waters of Tanzania. Between January 2000 and December 2005, 70 bottlenose dolphins were caught incidentally in gillnet fisheries. There were 36 (51%) males, 32 (44%) females and 3 (4%) of unknown sex. Most of the bycatch took place from February to April and from August to November with a maximum in August. To assess the impact of drift gillnet fishery on bottlenose dolphins, observer programmes were conducted onboard fishing boats to estimate the bycatch of bottlenose dolphins in the drift gillnet fishery operating off the south coast of Zanzibar. The total annual bycatch was estimated to 13 bottlenose dolphins. This estimate represents annual mortality of 9.6% for the bottlenose dolphins in the area. The relatively large numbers of bycatch dolphins recorded indicate that bycatch may be a potential threat to local population that need to be addressed in future conservation and management efforts in the area.

PLANNING FOR RESERVE IMPLEMENTATION IN A COMPLEX WORLD
HOLNESS, STEPHEN, Mike Knight

Systemic conservation plans have tended to become more complicated and comprehensive over time, with each new plan striving for innovation in identifying biodiversity priorities. Ironically, this tends to make the plans less useful for reserve implementation. Although primarily driven by biodiversity issues, most reserve expansion problems also involve complex interactions with economic and social systems, both of which are frequently ignored by conservation planners. Further, implementing a reserve network may involve a number of stages, multiple agencies, political fickleness, interactions within free market economies, unexpected difficulties and improbable windfalls. This invariably occurs in the context of limited resources for land acquisition and subsequent management. This paper examines, using examples from recent park planning and expansion activities within national parks in South Africa, the requirements that systematic conservation plans need to meet in order to be useful for agencies involved in reserve expansion. Key elements include real-time answers, a strong adaptive approach with efficient feedback loops, a broader range of input variables, clear prioritization, frequent updates and flexible

products. Further, we argue that strong links between planners and implementers is a prerequisite, and ideally that implementing agencies should have internal planning capacity.

EFFECTS OF HABITAT FRAGMENTATION ON THE POLLEN DISPERSAL AND GENETIC DIVERSITY OF *D. PANAMENSIS*, A KEYSTONE RAINFOREST TREE
HANSON, THOR, Steve Brunsfeld, Bryan Finegan, Lisette Waits

In the face of widespread deforestation, the conservation of rainforest trees relies increasingly on their ability to maintain reproductive processes in fragmented landscapes. *Dipteryx panamensis* is considered a keystone tree in the Atlantic lowland forests of Central America, providing critical habitat for the endangered great green macaw (*Ara ambiguus*). Here we used molecular genetic paternity analysis to determine pollen dispersal distances for *D. panamensis* in protected forest, forest fragments, pastures adjacent to fragments and isolated pastures. We found the shortest pollen dispersal distances among protected forest trees, moderate distances for fragment and adjacent pasture populations, and distances of up to 2.3 km in isolated pastures. Outcrossing rates were lower in pasture and isolated pasture populations, and spatial autocorrelation was greater among their progeny. We found no significant difference in genetic diversity between adult and progeny generations, but trends pointed to lower diversity and increased structure for pasture and isolated pasture progeny. Changes in the community or behavior of pollinators may account for the longer pollen dispersal distances in fragmented landscapes, bolstering gene flow and expanding genetic neighborhoods. Pasture and isolated pasture populations, however, appear to still be at risk from long-term genetic erosion.

THE INTERACTIVE EFFECTS OF DEFORESTATION AND SIZE ON THE STRUCTURE AND CHEMISTRY OF SMALL, AMAZONIAN STREAMS IN RONDONIA, BRAZIL
DE MOOR, EMILY, Chris Neill, Alex Krusche, Victoria Ballester

Large areas of the Amazon Basin are being cleared for cattle pasture, but the consequences of this land-use change on the health of small streams has received little attention. We examined how deforestation for pasture interacts with stream size to alter the structure and chemistry of small streams in the lowland Brazilian Amazon. We surveyed 31 first- to third-order forest and pasture streams, and documented benthic substrate, cation and anion concentrations, dissolved oxygen, pH, alkalinity and conductivity. Whereas the benthic cover of small, forest stream channels was predominantly characterized by leaf detritus, grass dominated the channels of first- and second-order pasture streams. First- and second-order pasture streams had significantly lower nitrate (NO₃⁻) and dissolved oxygen (DO) concentrations than their forest counterparts. Third-order pasture streams had little grass cover and comparable NO₃⁻ and DO concentrations to first- and second-order forest streams, demonstrating that the effects of deforestation on stream structure and chemistry vary substantially with scale. This study suggests that the structural and chemical alterations to small, lowland, Amazonian streams caused by deforestation are occurring over a large land area, potentially impacting both the community structure of the streams themselves, as well as the structure and function of downstream ecosystems.

A SPATIAL AND TEMPORAL APPROACH TO INVESTIGATING SOCIO-ECOLOGICAL RESILIENCE IN THE LITTLE KAROO, SOUTH AFRICA
OFARRELL, PATRIC, Timm Hoffman, David le Maitre, Caroline Gelderblom, Daniela Bonora, Greg Forsyth

The Little Karoo is characterised by high levels of ecological degradation attributed to overgrazing and cultivation. There are also a variety of socio-economic factors affecting the area. This study investigated the interconnectivity of these social ecological systems focussing on land-use practices and their ecological consequences. Cause-and-effect analysis enabled us to identify possible socio-ecological thresholds from which we draw conclusions regarding the resilience and trajectory of the system. We documented the history and land-use practices of the area by conducting archival studies and interviewing farmers. To establish ecological trends we analysed a time series of aerial and fixed point photographs and examined rainfall, river flow and livestock

records. We found evidence of substantial ecological degradation occurring prior to 1920s. Farmers generally perceive the 1940s as the time when the greatest degradation took place. Stocking activities, coupled with major rainfall and flooding events post the 1940s appear to have triggered large scale erosional processes. Ecological indicators show signs of improvement in the natural vegetation in the last 40 years, however the area under cultivation also increased. These effects are attributed to state subsidies provided during the period 1970-1990. Identifying resilience thresholds is essential if a sustainable trajectory is to be plotted for this complex socio-ecological system.

DO MIXED LAND USE PRACTICES BENEFIT POLLINATOR DIVERSITY? – EXAMPLES FROM SOUTH AFRICA

VELDTMAN, RUAN, Simon van Noort, Hamish Robertson, Denis Brothers, Connal Eardley, Fred Gess, John Donaldson

Several studies have now documented negative effects of intensive human-mediated land management practices on pollinator diversity, with an anticipated concomitant decline in pollination ecosystem services in natural and managed areas alike. Currently, such a pollinator decline has not been measured in South Africa. As a preliminary step in addressing this gap in our knowledge, Aculeata were sampled in agro-ecosystems within three biomes within South Africa, namely the Fynbos, Nama Karoo and Grassland Biomes. This insect assemblage includes highly efficient pollinators such as bees, as well as other wasps that are likely to contribute to the pollination of indigenous plants. During a quantified inventory, wasps and bees were sampled using Malaise traps, yellow pan traps, pitfall traps, and sweeping. Aculeata families analysed included Bethyridae, Chrysididae, Plumariidae, Tiphidae, Pompilidae, Bradynobaenidae, Mutillidae, Vespidae, Sphecidae, Apidae, Colletidae, Halictidae, and Megachilidae. We quantified species richness and abundance of Aculeata fauna across four to seven land-use-type regimes per single locality within each biome. Generally diversity was greater in untransformed areas, confirming the importance of natural areas in acting as biodiversity reservoirs. However, the importance and uniqueness of the biodiversity maintained in transformed (current or historic) landscapes varied greatly, adding between 16 to 57% of the total species richness. Also, the portion of species shared between natural and transformed areas ranged between 28 to 30%. This illustrates the importance of conservation of insect pollinators in the agro-ecosystem matrix.

EFFECTS OF HABITAT DEGRADATION ON LEECH PARASITISM IN AQUATIC TURTLES

READEL, ANNE, Christopher Phillips, Mark Wetzel

Turtles are experiencing global declines, primarily due to habitat degradation. While the impacts of habitat degradation on turtle demographics and behavior have been investigated, comparably little is known about the impacts on turtle health. The aim of this investigation was to use a turtle assemblage to examine how terrestrial habitat degradation (agriculture) and pond type (natural/man-made) alter parasite infection dynamics, using leeches (*Placobdella* sp.) as a study system. Leeches prevalence and intensity on turtles were higher in natural ponds compared to man-made ponds, but did not vary from agricultural development adjacent to ponds or with any other pond characteristics. Leech loads varied among turtle species with *Chelydra serpentina* and *Chrysemys picta* being the most parasitized and *Apalone spinifer* being the least parasitized. There were no differences in leech loads between sexes or reproductive stages (mature/immature) but when turtles were parasitized, larger turtles had more leeches. Finally, leech loads on turtles also varied throughout the season, peaking in July. These results demonstrate that pond type appears more important than terrestrial habitat degradation in determining leech infections, but other host and environmental characteristics also influence leech dynamics. Because health is generally a major determinant of fitness, incorporating health-related outcomes into studies of turtle conservation should improve population management efforts.

USING BIRD MIGRATORY PATTERNS AND COMMUNITY PARAMETERS TO SET
CONSERVATION PRIORITIES FOR PANTANAL WETLANDS IN BRAZIL
Pinho, João Batista, MIGUEL ÂNGELO MARINI

The Pantanal of Brazil, one of the largest wetlands of the World, is under threats, such as deforestation of the savanna dominated surrounding plateau, habitat conversion for cattle ranching and large developmental projects. Bird migratory patterns and community parameters in four forest types were used to propose conservation and forest conversion priorities for the Pantanal. Extensive point counts and mist-net captures of 215 bird species revealed that flooded forests ("cambarazal" and "landi") had higher estimates of bird richness and abundance than non-flooded forests ("carvoeiro" and "cordilheira"). Flooded forests also had more species exclusive to them and were more similar to each other than the non-flooded forests. Thus, the selection of forests to be converted into pasturelands should give priority to the drier non-flooded forests than to the flooded forests. Also, several bird species apparently perform either seasonal or occasional movements between the Pantanal and the surrounding plateau indicating the importance of large scale regional planning for the conservation of forest birds. If the Pantanal inundation cycle is altered by the construction of hydroelectric dams or the Paraguay-Paraná waterway, some forests may not become flooded anymore and decrease species richness. If the cerrado (savanna) of the surrounding plateau is destroyed, important migratory patterns may be disrupted and also loose species.

AVIAN DISPERSAL AND LANDSCAPE PERMEABILITY: HOW MANY LOGS WOULD A
LOGRUNNER RUN IF A LOGRUNNER COULD LOG RUNS?
PAVLACKY, DAVID, Anne Goldizen, Andrew Lowe

The disruption of dispersal due to habitat loss and fragmentation is a critical mechanism leading to local extinction. However, quantifying critical levels of dispersal for mobile vertebrates is notoriously difficult. Recent advances in ecological genetics allow some inference to dispersal events, but non-independent data and potential sampling artefacts limit the analytic power of isolation-by-distance models. Here we introduce a mixed-modelling approach for estimating variance components and predicting the effects of landscape structure on gene flow. Our research question focuses on the role of historic and contemporary landscapes in predicting dispersal for a terrestrial rainforest bird, the logrunner (*Orthonyx temminkii*). In this study, 220 birds sampled from 11 locations separated by different proportions of native vegetation and cleared land, were genotyped for 10 microsatellite loci. Information-theoretic model selection showed equal support for historic and contemporary effects. The percentage of dry eucalypt forest (*Eucalyptus* spp.) in the historic landscape and the number of edge boundaries km⁻¹ in the current landscape were the best predictors of gene flow (FST/1-FST). Our results suggest current genetic structure, and therefore dispersal amongst logrunner populations, was shaped by historic processes such as the prevalence of wildfire as well as contemporary land clearing and the creation of edges.

HIGH ECOLOGICAL VALUE BUT LOW ECONOMIC INCENTIVES FOR SMALL FOREST
FRAGMENT PROTECTION IN COSTA RICA'S CARIBBEAN LOWLANDS
ROBERTS, DINA, Wayde Morse, Celia Harvey

In lowland Costa Rica, forest clearing for cattle and dairy production, and exotic crop cultivation have replaced once large expanses of forest. Remnant forest patches of varying sizes are often the dominate natural habitats remaining in otherwise highly modified landscapes. The complementary nature of small reserves can maintain biodiversity in areas where few alternative management options exists. Ignoring the value of small reserves, or undervaluing their contribution to ecosystems services, could lessen the likelihood that these features will remain on the landscape. We present results from our research studying the value of small fragments to a declining migrant songbird, the Wood Thrush, *Hylocichla mustelina*, as a case study and review results of published studies from the region for forest-dependent organisms from a variety of taxonomic groups. We summarize results from a sociological study of private landowner

participation in an environmental service payment scheme within the same region of Costa Rica. We present data showing small landowners are not participating in payment schemes in proportion to the number of small and medium-sized fragments within the landscape. Finally, we provide recommendations for improving protection of small fragments by increasing participation of small landholders in payment programs.

SURFACE-WATER CONTROLS THE DYNAMICS OF A LARGE ELEPHANT POPULATION CHAMAILLE-JAMMES, SIMON, Hervé Fritz

Elephant management is a major conservation issue in Africa. The justification and tools to control local elephant overabundance remain highly controversial, while we surprisingly know very little about the environmental factors naturally limiting elephant populations. Here, using long-term (> 20 years) aerial and waterhole census data, we assessed how dry season surface-water availability constrained the dynamics of one of the world's largest elephant population, the population of Hwange National Park, released from culling regulation in 1986. Local elephant densities increased asymptotically with surface-water availability, indicating that high surface-water availability is a pre-requisite to reach high elephant abundance, although additional factors further limit elephant densities. When the number of elephant per waterhole increased, either due to population increase or reduced surface-water availability, elephant distributed themselves more evenly across waterholes, suggesting the avoidance of increased intra-specific competition. Since culling stopped, elephant numbers did not increase at the initially crowded waterholes, and similarly elephant numbers did not increase in areas of the park where surface-water availability was low. Overall our study suggest that surface-water availability determines both elephant distribution and abundance, and that surface-water availability should be taken into account when planning elephant management policies.

VARIATIONS IN ESTUARINE LIFE HISTORY DIVERSITY OF JUVENILE CHINOOK SALMON BASED ON STABLE ISOTOPE ANALYSIS OF FOOD WEB LINKAGES ANDERSON, GREER, Charles Simenstad

In the U.S., major recovery efforts have been enacted to restore diminishing salmon populations in the Columbia River. The effects of flow regulation and habitat alteration in the estuary have been widely understudied yet represent what is thought to be a critical aspect of salmon recovery. The goal of this study was to describe the trophic linkages supporting juvenile Chinook (*Oncorhynchus tshawytscha*) in the lower Columbia River, the patterns of their use, and their correspondence with various life history traits such as movement, residence time, and origin. Food web pathways were established through the use of stable isotopes ratios ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{34}\text{S}$) in liver and muscle tissues. We used trophic linkages of individual fish along with otolith microchemistry and stock-of-origin estimates to characterize migratory patterns and trends in habitat use. Our results indicate that juveniles are associated with a variety of fluvial, anthropogenic, estuarine, and marine organic matter sources. Many life histories were strongly linked to marsh production despite the diminishment of these food webs in the estuary. Evaluation of life history diversity of populations indicates that there is considerable heterogeneity in habitat use and movement. Due to the importance of marsh production, environmental change in the estuary could ultimately affect the long-term stability of food webs and the overall ability of the system to support juvenile salmon.

THE DEMISE OF A "SYMBIOSIS": INDIGENOUS PEOPLE AND WETLAND ECOSYSTEMS IN THE SHORELINES OF LAKE TANA, ETHIOPIA ABERRA, YOHANNES

As the pressure of the agrarian population in the shoreline plains of Lake Tana increased, the indigenous tribal societies (known as Woito) were unable to retain their ancestral homelands (the wetlands) with which they lived in harmony for centuries. In the hands of the cultivators the wetlands were converted to various uses, in the main, for the growing of food crops. The Woitos were forced either to shift to cultivation or leave the area for good. Now the area of the Lake Tana

shoreline wetlands has dwindled into few patches. The impact has not only been the loss of beneficial plant and animals species in the wetland ecosystems, but also the hydrological imbalance that has become worrisome in the Lake and its shoreline. Freshwater ecosystems in the Lake are being adversely affected because of accelerated sedimentation. Shoreline flooding has also had a boomerang effect on the cultivators who are responsible for the demise of the protective wetlands. This paper discusses the historical processes of social transformations in the shoreline wetlands; the societal and environmental effects of the transformations; the social and economic possibilities of restoration of the status quo ante; and the political will to that end.

CAN BORNEAN OIL PALM PLANTATIONS BE MADE MORE HOSPITABLE FOR BIODIVERSITY?

PIN KOH, LIAN, David S. Wilcove

There have been growing concerns about the biological impacts of rapid oil palm (*Elaeis guineensis*) expansion in Southeast Asia. Our objective was to identify biodiversity-friendly management practices by determining factors affecting the diversity of two key bio-indicator taxa in oil palm plantations. We sampled butterflies and birds in 22 500 ha of oil palm plantations in Sabah, Malaysian Borneo. We related vegetation measures and land cover variables to butterfly and bird diversity at two spatial scales – across sampling sites (site diversity; n=98) and across entire oil palm estates (estate diversity; n=10). Vegetation measures did not affect the site diversity of butterflies. Percent ground cover of weeds had a significant positive effect on the site diversity of birds. The percent cover of surrounding natural forests had significant negative effects on the site diversity of butterflies but had significant positive effects on the site diversity of birds. The percent cover of natural forests within and surrounding oil palm estates had no significant effect on the estate diversity of butterflies but had significant positive effects on the estate diversity of birds. We conclude that 1) altering vegetation and land cover characteristics within or around estates would not increase the site or estate diversity of butterflies; and 2) increasing percent ground cover of weeds and percent cover of surrounding natural forests could enhance the site and estate diversity of birds.

COMMUNITY ATTITUDES TOWARDS ELEPHANTS IN THE AMBOSELI ECOSYSTEM, KENYA

KIOKO, JOHN, Simon Seno, Geoffrey Wahungu

Most elephant populations in Africa depend on privately owned land adjacent to protected areas. In order to enhance their conservation without compromising human welfare, it is imperative that the socio-economic implication of the relationship between humans and elephants is clearly understood. Structured interviews with inhabitants who live between Amboseli and Tsavo West National Parks in Kenya showed that their perceptions on elephants were highly negative. The patterns of attitudes were depended on respondent's ethnic origin, gender, type of land use, level of wildlife benefits, level of elephant crop damage, wildlife authority responses to problem elephant reports and the resident's future economic plans. The attitudes were not associated with the respondent's level of education and age. Recent socio-economic transformation in the Amboseli Ecosystem characterized by increased agriculture and influx of immigrant from other parts of Kenya and Tanzania has largely contributed to the negative attitudes towards elephants. Interventions should incorporate land use planning and community education so as to improve the adverse relationship between humans and elephants in the Amboseli ecosystem.

THE EFFECTS OF LIVESTOCK GRAZING AND CONTROLLED FIRE ON BIRD COMMUNITIES IN EAST AFRICAN SAVANNAS

GREGORY, NATHAN, Ryan Sensenig, David Wilcove

African savanna ecosystems are sustained by two key disturbance processes: grazing by domestic and wild ungulates and fire. Since European settlement, wild ungulates and traditional pastoralists have been displaced, and fires have largely been suppressed. In the Laikipia District of Kenya, bomas, traditional thorn-scrub corrals, serve as a major landscape modifier in the absence of fires. We measured avian abundance and species richness, vegetation

characteristics, seed production, and arthropod biomass on controlled, replicated burns of three sizes (1, 9, and 81 hectares) and on recently-abandoned bomas. Most of the commonly observed species show strong affinities for disturbed habitats. Recently burned plots host greater densities of birds than controls, and these effects are most pronounced in 9 ha plots, but densities return to preburn levels after one year. However, Palearctic migrants are found almost exclusively in burned plots during the northern winter. Bomas also host significantly greater densities of birds than control sites. While fewer birds are found in bomas than recent burns, species richness is higher, and some species prefer bomas to burns. However, the effects of bomas are longer lived. Disturbance in the form of either fire or bomas appears to be critical to the maintenance of avian diversity in this part of East Africa. Effective bird conservation in savannas will require the incorporation of both types of disturbance into management.

GLOBAL NETWORKING TO IMPROVE URBAN BIODIVERSITY CONSERVATION

MADER, ANDRE, Shona Young, Kate Berrisford, Stephen Granger, Monika Zimmermann, Gregg Oelofse, George Davis, Debra Roberts, Sebastian Winkler, James Murombedzi

It is estimated that by 2007 most of the world's population will be urban. Cities are heavily dependent on natural resources, most of which are sourced countrywide or worldwide. Already, cities utilise 75% of the planet's resources, though they cover only 2% of its land surface. These resource-hungry centres of civilisation therefore have severe negative effects on global biodiversity. Paradoxically cities are also of central importance in biodiversity conservation due to the disproportionate wealth and power of their inhabitants, and therefore their effect on decisions that impact the planet. Local Action for Biodiversity (LAB) is an ICLEI - Local Governments for Sustainability - initiative that recognizes the importance of city governments as drivers of biodiversity conservation within and beyond the urban context. The first phase of LAB involved surveys of biodiversity and its management from participating cities around the world. Collation of the subsequent city biodiversity reports has provided unique insight into the range of perceptions, experiences and approaches resulting from participating cities' varied backgrounds and circumstances. This information will be fed back to participating cities along with published versions of their own reports. Further steps in the LAB process will advance this foundation with declarations of commitment toward biodiversity conservation, action plans and applied projects.

RECOVERY OF THE CRITICALLY ENDANGERED PHILIPPINE CROCODILE *CROCODYLUS MINDORENSIS* THROUGH COMMUNITY-BASED CONSERVATION

VAN WEERD, MERLIJN, Jan van der Ploeg

The endemic Philippine crocodile *Crocodylus mindorensis* is one of three critically endangered Asian crocodilian species. Its numbers and distribution have dramatically declined to a point where many conservationists have given up hope for survival of the species in the wild. Killing of crocodiles and conversion of wetland habitat by local people are the causes of the decline. We discovered a remnant population in northern Philippines in 1999 and have set up a conservation project here with strong participation by local government and communities. Community awareness programs have changed attitudes towards the species from hostility to pride. Empowerment of farmers, fishermen and local government has resulted in protection of crocodiles and wetlands. Increased wetland resources provide benefits to communities. A local nest protection, hatchling head-start and reintroduction program greatly enhances survival chances of new-born crocodiles. As a result, the Philippine crocodile population in northern Luzon has been recovering from just 12 individuals in 2000 to more than 70 now and is currently the only known remaining reproducing population in the wild. The approach we used is of interest to recovery programs for other threatened crocodilians. Our positive experiences with localized participative conservation also hold promise for more effective conservation in the Philippines, one of the hottest of the conservation hotspots.

LESSONS LEARNT FOR MARINE SPATIAL PLANNING - A COMPARISON OF THREE
MARINE PROTECTED AREA PROCESSES
OSMOND, MIKE, Satie Airame, Jon Day

Different approaches have been used to establish marine protected areas (MPAs) in different countries. In this paper we compare and review three processes to establish MPAs within the United States and Australia. These two countries share many similarities but their approaches to managing marine resources differ considerably. Each of these efforts to establish MPA's was motivated by public concern about declines of targeted marine species and habitats. However, the responses varied because of differences in the structure of governance, strength of legislation, available funding, level of participation of stakeholders, role of scientists, and the level of public and political support. Comparison of these processes provides insight into the most effective approaches for restoring and protecting marine ecosystems and gaining public support.

OCCURRENCE OF *BATRACHOCHYTRIUM DENDROBATIDIS* AT BREEDING SITES OF
BUFO BOREAS IN THE ROCKY MOUNTAINS
MUTHS, ERIN, David Pilliod, Lauren Livo

The amphibian chytrid fungus (*Batrachochytrium dendrobatidis*, *Bd*) is extirpating amphibian populations in several world regions. We analyzed the distribution of *Bd* across an 110 latitudinal gradient in the Rocky Mountains, sampling 202 historic and extant boreal toad (*Bufo boreas*) breeding sites in 97 geographical clusters. We sampled boreal toads or amphibian surrogates. *Bd* was detected at 64% of the clusters tested in this region. The Southern Rocky Mountains has experienced the greatest declines in *Bufo boreas* in the region but had the lowest percentage of sites with this fungus. This pattern may indicate differences in susceptibility to chytridiomycosis; or effects of sublethal stressors, including environmental and anthropogenic variables. We evaluated potential relationships between landscape (latitude and elevation) and anthropogenic attributes (mining and herbicide use) and the prevalence of *Bd* at infected sites.

THE THEORY OF BIOTIC REGULATION OF THE ENVIRONMENT AND ITS IMPLICATIONS
FOR CONSERVATION POLICIES
EFREMENKO, DMITRY

The paper discusses political aspects of the theory of biotic regulation of the environment (BRET). The theory may be formulated with the following propositions: - Undisturbed natural ecosystems create and control their environment. They maintain it in a state optimal for the whole environmental community and, up to a certain threshold, compensate for all deviations from that optimum. Such biotic regulation occurs on both local and global scales. - Biotic regulation is performed by the complex co-ordinated functioning of all species in the natural ecological community. Anthropogenic pressure destroys the regulatory potential of the ecological communities on a local scale and continually weakens the global power of biotic regulation. Without the stabilising impact of natural biota both the global environment and climate would rapidly degrade to a state prohibiting human existence. On the one hand, the analysis of political implications of the theory shows that BRET can be used as a framework concept for integrated environmental policy on both national and international levels. BRET offers additional opportunities to harmonize policies of biodiversity conservation and prevention of global warming. On the other hand, its political implementation requires a new model of supranational environmental governance and additional limitations to the principle of sovereignty. That is why the Russian government does not support this theory as a political guiding vision.

IMPACTS OF NON-NATIVE FOREST PESTS AND PATHOGENS: USING ECONOMIC
ANALYSES TO INFORM POLICY RESPONSES
AUKEMA, JULIANN

Worldwide, introduced pathogens and insect pests of trees threaten forests and the native species, ecosystem services, and economic values they provide. In North America, numerous

introduced forest pests have had substantial environmental and economic impacts, including billions of dollars in lost revenue and ecological restoration expenses. Here we examine three scenarios of future pressure from invaders of North American forests, and to each we attribute an expected economic cost over the next fifty years. Given the economic costs of different intensities of invasion, we make arguments for the value of alternative policies that could make it more likely that the “reduced” invasion pressure scenario becomes the future we actually see. This research is intended to feed into a parallel economic assessment of the costs of policy responses, so that a cost: benefit analysis can be conducted.

MODELLING SEX RATIO AND NUMBERS FOR TRANSLOCATION IN METAPOPOPULATION MANAGEMENT LAW, PETER

Translocation of individuals between subpopulations of a metapopulation is practiced, or envisaged, for a variety of reasons and requires careful consideration. When the genders of a polygynous species manifest different reproductive performance, Linklater (Con. Bio. 17, 906 – 909, 2003) proposed that the number of individuals of each sex translocated into a target population for the purpose of maintaining genetic diversity in isolated subpopulations of a metapopulation could be chosen on the basis of parental investment theory. Adapting basic ideas in the parental investment literature, I describe a model which captures Linklater's proposal for polygynous species: each gender is characterized by a function which models reproductive returns as a function of management resource-investment. Summing the return functions over the individuals of each gender to be translocated, with males weighted by the female:male ratio of the post-translocation target population, yields a (nonlinear) total return function which can be maximized subject to the resource constraints. The model is solvable analytically for certain return functions and numerically for quite general biologically plausible return functions. Granted the necessary species-specific biological information required to determine the model parameters in any instance of application, a practical algorithm can be constructed to generate the models predictions for the optimal translocation.

WECHIAU COMMUNITY HIPPO SANCTUARY: MEASURING SUCCESS IN TERMS OF SOCIAL, NATURAL, AND PHYSICAL CAPITAL BEIER, PAUL, John J. Mason, Patrick Adjewodah

The Wechiau Community Hippopotamus Sanctuary (WCHS) was created in 1999 to protect one of Ghana's two remaining hippo populations. Is it a success? Using a 2005 assessment, we report success in three dimensions. (1) Natural Capital: WCHS protects hippos, 30 other mammals, 230 birds, and 210 plants in 190km². Livestock grazing and farms have been removed from the core area. (2) Social Capital: Traditional chiefs and earth priests support the project, but are undemocratic, so WCHS created a new institution that includes women, fishermen, and less-empowered ethnic groups. Illiterate communities are involved by local workshops, advisory councils, picture books, and primary school presentations. Conservation education reaches many Ghanaian tourists and secondary school students. (3) Physical Capital: Tourism revenues and new roads, schools, boreholes, and scholarships benefit 22 villages. Revenues now cover operating costs, allowing WCHS to end two subsidies and target remaining subsidies on new infrastructure. There are also failures in each dimension. (1) Bushfires remain unnaturally frequent. (2) Some stakeholders do not fully participate due to illiteracy, inability to hear about meetings in time to attend, and ethnic bias. (3) Unsecured loans of WCHS funds are risky, and could undermine public support. So... Is this a success? Can success in one dimension compensate for failure in others? How do you create fair, transparent institutions while working with autocratic traditional authorities?

A STUDY ON THE HABITAT UTILIZATION PATTERN BY THE INDIAN RHINO IN THE WORLD FAMOUS KAZIRANGA NATIONAL PARK, ASSAM (INDIA)

HAZARIKA, ARUP KUMAR, Amalesh Dutta, Binoy Kumar Deka, Prakash Chetry

Kaziranga National Park, Assam (India) is the home of the highest population of the Indian rhino (*Rhinoceros unicornis*) in the world. The park is located in the flood plains of the river Brahmaputra which results suitable habitat for the Indian rhino. Unfortunately, no study has been conducted on the habitat utilization pattern of Indian rhino till date. So, a study was carried out at the Kaziranga National Park, to understand the habitat utilization pattern of the Indian rhino. The study was carried out during 2005-2006. For this, scan animal sampling method was followed and data was collected on habitat use after 10 minutes interval covering four seasons (Pre -monsoon, monsoon, retreating monsoon and winter). The study showed that the Indian rhino mostly preferred the tall grassland habitat. So, special emphasis should be given to manage the tall grassland habitat and its pattern of growth etc in order to conserve the Indian rhino. An immediate clearance of water hyacinth, lantana and mimosa, which are destructing the suitable habitat for the rhino, should be done for conservation of rhino. This research can help to inform future land use and conservation planning and will assist with priority setting for habitat protection and restoration.

THRESHOLDS OF POTENTIAL CONCERN AS BENCHMARKS IN THE MANAGEMENT OF AFRICAN SAVANNAS

GILLSON, LINDSEY, Kristina Duffin

In the Kruger National Park, South Africa, ecosystem managers use a series of monitoring endpoints, known as Thresholds of Potential Concern (TPCs), to define the upper and lower levels of accepted variation in ecosystems. For woody vegetation, the current TPC suggests that woody cover should not drop by more than 80% of its "highest ever" value. In this paper, we explore the utility of palaeoecological data in informing TPCs. We use calibrated fossil pollen data to explore variability in vegetation at two sites over the past 5000 years, to provide a long-term record of changes in woody vegetation cover and a context for interpreting more recent vegetation change. The fossil pollen data is calibrated using studies of modern pollen and vegetation from the Kruger National Park; arboreal pollen percentage was simulated using pollen-landscape modelling software for savanna landscapes of varying woody vegetation cover, and the relationship between vegetation and pollen data was quantified using non-linear regression. This quadratic equation was then applied to fossil pollen data in order to estimate woody vegetation cover from arboreal pollen percentages. Our results suggest that the TPCs have not been exceeded during the period represented in the pollen record, because estimated woody vegetation cover has remained above 20% of its highest ever value. By comparing fossil pollen data with TPCs, our study demonstrates how palaeoecological data can be presented in a form that is directly relevant to management objectives.

CHANGING PASTORAL LAND MANAGEMENT: CHARCOAL EXTRACTION IN TROPICAL OPEN WOODLANDS OF NORTHERN TANZANIA

BUTZ, RAMONA

Challenging economic and environmental conditions, coupled with increasing population, have led to changes in the priorities and activities of rural Africans. In Tanzania's open woodlands a growing dependency on non-farm extractive activities such as firewood supply and charcoal production, are placing increasing pressure on local resources. Although pastoralists have used fuelwood in this region for 3,000 years, recent changes have led to major shifts in resource management and use. This study investigates land use conflicts associated with historical management practices and contemporary shifts in the extraction of fuelwood for charcoal production in the Maasai village of Engikareti in northern Tanzania. I used a suite of randomly stratified, semi-structured interviews, unstructured group interviews, shadowing of charcoal producers, and voucher specimen collection to investigate changes in local resource use. Charcoal serves as a cash crop for a growing number of women. In 2005, more than 200 women

removed an estimated 4000 trees to provide subsistence income for their families. Population growth, drought, social and economic marginalization, and a lack of other marketable resources are leading to rapidly increasing rates of extraction. While demand for fuelwood is unlikely to deplete forest cover on a large scale, imbalances between the patterns of demand and availability imply potential localized scarcities, degradation of savanna vegetation, and onset of desertification.

WHAT CAN HOME RANGE ANALYSIS CONTRIBUTE TO CONSERVATION? A CASE STUDY OF THE WHITE RHINOCEROS (*CERATOTHERIUM SIMUM*)

WHITE, ANGELA M., Ronald R. Swaisgood, Nancy Czekala

How animals use space has important consequences for feeding ecology, social organization, and mating strategies, and figures prominently in conservation of many species. For instance, knowledge of home range size, overlap, and seasonal movement patterns are used to estimate the number of animals that are sustainable within an area. However, the genetic health of populations is determined as much by the patterns of mating as by the population size. In a 3-year study we investigated how habitat variables and male territories influence female white rhinoceros (*Ceratotherium simum*) movement patterns and reproductive behavior. Females used grassland habitat preferentially, utilizing these areas significantly more than expected based on availability. Females spent more time in some territories than predicted, but we found no evidence that females, in general, shared the same preference for particular male territories. The amount of grassland in a male's territory predicted female use of the territory and the amount of time a female spent in a male's territory was a significant predictor of reproductive activity with the male. Therefore, males with more grassland habitat in their territories may be contributing disproportionately more to future generations. Turnover in territory ownership and the distribution of preferred habitat may alleviate reproductive skew. This study demonstrates how spatial data can be used to elucidate mate preferences and possible genetic consequences.

THE DISTRIBUTION AND HABITAT REQUIREMENTS OF THE CRITICALLY ENDANGERED ADERS' DUIKER WITHIN THE ARABUKO-SOKOKE FOREST, KENYA

DE VERE, NATASHA, Franziska Schrod, Catherine Jackson, Amrita Neelakantan, Amy Plowman, Erustus Kanga

Aders' duiker *Cephalophus adersi* is a critically endangered antelope with confirmed sightings from only two coastal forests in Kenya and on Zanzibar. This study aims to investigate the distribution and habitat requirements of Aders' duiker within the Arabuko-Sokoke forest, Kenya. In 2005 duiker signs (pellet piles and tracks) were quantified along with sightings of Aders' duiker in 40 plots throughout the forest. These were related to vegetation measures including canopy cover, visibility and plant species along with measures of human and elephant disturbance. This revealed positive relationships between duiker signs and low visibility and high number of duiker food plants. A negative relationship was seen between duiker signs and elephant disturbance. Aders' duiker sightings were greater in areas with more canopy cover. In 2006, 10 camera traps were set up within the forest. During a 2 month sampling period 10 pictures of Aders' duiker were taken. These results are beginning to build a picture of the habitat requirements for Aders' duiker and the success of the camera trapping suggests that this technique may be valuable for surveying forests for this species. The long term aim of this research is to survey other coastal forest fragments within Kenya and to inform conservation actions.

PLANNING FOR THE FUTURE: BUILDING A GENERIC FRAMEWORK TO INTEGRATE CONSERVATION PLANNING APPROACHES

BOTTRILL, MADELEINE, Bob Pressey

Diverse conservation planning approaches are being developed across different environments at a range of scales. This has led to uncertainty, within the conservation science community and among governments and donors, about the application of seemingly competing approaches by organizations and agencies. With the IUCN and a steering group, we are working to articulate the

similarities and differences between these approaches. Firstly, we are reviewing published and unpublished literature on current approaches to produce a generic framework which constitutes a series of steps for consideration by all conservation planning teams. Secondly, we are identifying the importance attributed to each step by these teams and defining the nuances which characterise their respective methods. Thirdly, we are examining how approaches used by selected organizations incorporate steps from the framework. One outcome will be a profile of each approach, illustrating how it complements or differs from other approaches, and identifying reasons for these differences. In broadening knowledge of various conservation planning approaches, a generic framework can promote more effective conservation for the future.

CAPACITY BUILDING FOR BIODIVERSITY CONSERVATION KIRSCH-JUNG, KARL P.

The temporary wetlands of Eastern Mauritania provide habitats for a wide range of animal and plant species and support livelihoods through multiple land use in the arid environment of the northern Sahel of West Africa. The recent increase in environmental degradation is caused by a number of factors related to, amongst others, social, organisational and legal aspects. The increase in population and in their needs combined with the loss of influence of the traditional institutions result in an open access to natural resources. The key aspect of a new approach to ecosystem conservation is decentralization, which means, the transfer of decision-making and/or executive power to stakeholders outside the state administration. The particularity of the approach lies in the way in which it rethinks responsibility for the management of common property resources. While being based on the hierarchy of rights of access to existing resources (that is, recognition of the prior rights as well as rights of third parties), the approach puts into place very strict conditions in the social and organizational realm. It is all about supporting managers of collectively used resources to organize themselves and to identify and implement sustainable modes of exploitation. The key stage of the legal and institutional feasibility of setting up local management organizations has been achieved successfully. These organizations recognize and accept responsibility, which involves the setting up and control of conservation and management rules and the investment in protective measures.

FORMERLY ENDANGERED SPECIES AS RESEARCH TOOLS IN POPULATION BIOLOGY – THE CASE OF THE MAURITIUS KESTREL BURGESS, MALCOLM, Malcolm Nicoll, Carl Jones, Ken Norris

Recovering populations of endangered species that are intensively monitored provide an opportunity to understand the mechanisms that regulate populations as they grow from low abundance levels. This can have important management implications, but also provide broader insights to fundamental ecological questions. Here, we use a restored population of the Mauritius kestrel that has been intensively monitored for 19 years since reintroduction to explore how spatial variation in habitat quality might affect territory occupancy, density-dependence and ultimately population dynamics. We created a habitat map of our study area, and have used this to explore the relationship between habitat and territory quality (in terms of bird fitness), how territories have been occupied as the population has grown, and the implications for patterns of density-dependence. We have also radio tracked juvenile kestrels to explore habitat selection decisions at a crucial life history stage. Our results show that spatial heterogeneity in habitat quality can be an important mechanism in population regulation, and illustrates the value of using recovering populations to explore these issues.

ANT DIVERSITY PATTERNS IN THE CAPE FLORISTIC REGION BRASCHLER, BRIGITTE, Kirsten Mahood, Natasha Kruger, Kevin J. Gaston, Steven L. Chown

South Africa's Cape Floristic Region (CFR) is known for its extraordinary plant diversity but less is known about its invertebrate diversity. The CFR is under pressure from land-use change, and climate change will have major effects in the near future. We examine species diversity patterns in a long-term monitoring program covering several biomes of the CFR and disturbed and

transformed areas. We focus on ants, a group which plays a major role in the CFR as seed distributors. Ants are collected bi-annually using pitfall traps in 30 sites within the Western Cape Province. In addition, environmental parameters are assessed. Here we present the results from the first year of the program. Species richness and abundance differed widely between habitats. High vegetation cover reduced ant abundance but increased species richness. Similarly the effect of soil chemical composition and soil structure on species richness and abundance differed. Turnover among sites and seasons was large in natural habitats; with many rare and spatially restricted species. Species composition was more similar between the nama karoo and succulent karoo than between them and the fynbos biome. However, some abundant species occurred across biomes and some major seed distributors occurred even in transformed areas invaded by Argentine ants. Our results show the high complexity of ant distribution patterns in the CFR and will contribute to understanding its development under ongoing environmental change.

FIRE AS A CONSERVATION ISSUE IN LATIN AMERICA MYERS, RONALD

Recent global assessments have focused on the impact of altered fire regimes, i.e. too much fire, too little fire, or the wrong kind of fire, on the conservation of biodiversity. Fire as an ecological process determines the characteristics of many ecosystems. Fire also impacts some ecosystems very negatively. There are three broad categories of ecosystems that are determined by their overall response to fire: 1) fire-dependent ecosystems--those that need a specific regime of fire and are characterized by species with adaptations to fire, 2) fire-sensitive ecosystems--those that are negatively impacted by most fires and species are intolerant of fire, and 3) fire-independent ecosystems--those where fire normally plays no role. In Latin America, over half of the ecosystems are fire-dependent, yet public policies and management strategies generally do not recognize the role of fire, leading to inappropriate management actions. Compounding the failure to recognize the beneficial role of fire in many ecosystems is a failure to identify the underlying socio-economic aspects of fire use to people's livelihoods. Novel approaches to dealing with fire-related conservation problems involve integrating the technical aspects of fire management with appropriate ecological constraints and the socio-economic necessities of using fire. The Latin America & Caribbean Fire Learning Network is providing a forum for promoting this integrated approach to fire management in the region.

SPECIES RICHNESS AND HUMAN DENSITY: EXPLANATIONS FOR A POSITIVE SPATIAL CORRELATION HUGO, SANET, Berndt Van Rensburg

Despite the negative human impact, a positive spatial correlation between species richness and human population density persists. Three suggested explanations were investigated: species persist in natural habitat patches, undetected at coarse resolutions, so that a unimodal or negative relationship exists at finer resolutions; the form of the relationship depends on the conservation measures in an area; the negative human impact occurs over the full range of the correlation, so that the slope is lowered. South African bird species richness – human density relationships, were compared between coarse and fine resolutions and between regions with different amounts of land transformation. Further, the slopes of the species richness – productivity relationship, estimated before and after taking human density into account, were compared. Substantial support was found for the second explanation only (the positive relationship breaks down at higher transformation levels), though common species respond to lower levels of transformation than rare species. Rare species are highly dependent on specific areas with high productivity levels where they have to contend with high human densities and transformation levels. Common species appear to be more flexible in response to transformation, by either benefiting from it or dispersing. In conclusion, the reasons for the persistence of the positive relationship seem to depend on the species' dynamics and their response to land transformation.

OPTIMAL CONSERVATION OF MIGRATORY SPECIES

MARTIN, TARA, Iadine Chades, Peter Arcese, Peter Marra, Hugh Possingham, Ryan Norris

Designing effective conservation strategies for migratory animals presents a unique challenge because population abundance is influenced by events that occur throughout the annual cycle. We use a decision theoretic approach to address the problem of how to conserve habitat for a Neotropical-Nearctic migratory bird across its tropical wintering range. We first identified a conservation strategy to maximize abundance on the wintering grounds based on relative density, rate of habitat loss, and the cost of winter habitat. Using information on how wintering populations are geographically connected to temperate breeding populations, as estimated from stable-hydrogen isotopes in feathers, we then added the objective of maintaining a minimum percentage of each breeding population. We show how the optimal conservation strategy dramatically changes when we include this additional objective. Our results demonstrate how optimal conservation strategies for migratory species depend critically upon knowledge of how populations are geographically linked between different periods of the annual cycle; information that is relatively easy and inexpensive to collect yet exists for only a small percentage of species.

KILL, WATCH, AND WALK AWAY - OPTIMAL ERADICATION OF INVASIVE SPECIES

WILCOX, CHRIS, Marc Mangel

Invasive mammals on islands are responsible for most vertebrate extinctions. This threat is highly relevant for ongoing biodiversity losses, rats alone have been introduced to 82% of the world's islands. Encouragingly, restoration efforts hold significant promise – feral cats and rats have been removed from over 250 islands. However, as larger and more diverse islands are targeted, efficiency has become an issue. While there have been a number of efforts to estimate the costs of eradications, there has been little attention to formal methods for determining optimal (i.e. minimum cost) eradication strategies. In addition, for larger islands it may not be possible to determine unambiguously when eradication has been achieved, so not only do analyses need to consider how to optimize the kill rate, but also when to declare success and stop the eradication campaign. We present the optimal culling strategy for a population that is observed imperfectly, and demonstrate that it may be optimal to cease efforts prior to eradication, depending on the population dynamics of the target species. While we illustrate our results with data from a recent eradication of feral goats in the Galapagos, the results can be generalized to other feral animals and invasive weeds.

HUMAN LAND USE PRACTICES CAN HIDE NATURAL PATTERNS

BALDI, ANDRAS, Tibor Magura, Robert Horvath

The species area relationship, when number of species increases as sampled area increases, is a basic pattern of ecology. This relationship was described for oceanic islands first, then it was applied for habitat islands as well. While the first system is natural, the second is usually due to human habitat modifications. In this presentation we will show by two examples that for regions largely modified by humans the application of such basic relationship may need precaution. We studied the distribution of 4000 arthropod species in 16 nature reserves in Central-Hungary, and find a lack of increase in species number with increase of reserve area. This was a consequence of the wrong reserve selection practice: large reserves were unproductive, homogeneous areas, while small reserves were productive, heterogeneous, usually forested areas. In the other study we compared bird communities in two groups of forest fragments: one with native tree species, the other with exotic tree species. We found that species-area relationship is present only in the native tree species group and for forest specialist bird species and lacking for exotic tree species fragments and generalist bird species. Therefore, it seems that human activities, like wrong reserve selection and widespread application of exotic species may hide natural patterns. The application of species-area relationship thus needs precaution when used in conservation of human dominated landscapes.

POLICY FRAMEWORK FOR UTILIZATION AND CONSERVATION OF BELOW-GROUND BIODIVERSITY IN KENYA

ACHIENG, CELLINE, Peter Okoth

Soil organisms or Below-ground biodiversity (BGBD) have not been given a specific schedule in the policy and legal framework of Kenya. This study found out that this lack of inclusion was mainly due to lack of awareness and appreciation among stakeholders. Currently, there is no specific policy and legislation in Kenya that governs the use and conservation of BGBD. The sectoral laws in place that are supposed to outline the use of BGBD have no such provisions. Such laws are the Agriculture Act, the Plant protection Act, the Forest Act, the Pesticides Control Act, the Mining Act and even the most recently enacted umbrella biodiversity Act: the Environmental Management Coordination Act (EMCA). The goal of the study was to contribute to the enhancement of soil biological diversity and sustained utilization of its components in Kenya through an improved policy framework. Two main themes addressed by the study included land use change and intensities and appropriate policy framework for utilization and conservation of soil organisms. 120 farmers, 30 scientists and 12 research and private institutions dealing with BGBD were issued with questionnaires about their experiences with BGBD. Lack of awareness and appreciation of the importance of BGBD among farmers was found to be a dominant factor. It is therefore, important that such farmers are first of all educated before a policy is formulated. Scientists and institutions dealing with soil organisms did not strictly adhere to any guidelines. Even those scientists and institutions that had Material Transfer Agreements and Material Acquisition Agreements did not use them regularly. Most institutions had various articles of the Convention on Biological Diversity to adhere to but were not implementing such guidelines. This was mainly because there were no clear directives on how to implement the same at national and sectoral levels.

CONSERVATION OF THE ENDANGERED GREVY'S ZEBRA (*EQUUS GREVYI*) IN THE SAMBURU LANDSCAPE, KENYA

MUORIA, PAUL, Nicholas Ogue, Hassan Boru, Caroline Bosire, Fiesta Warinwa, Philip Muruthi

Having declined by an estimated 87% over the last 40 years, Grevy's zebra is one of the most endangered equids in the world. Currently, it is near endemic to Kenya where it lacks legal protection as it is considered a Game Animal instead of a Protected Animal. Since 2002, we have been monitoring this species with the aim of contributing towards the conservation of a viable population. Our study is in the Samburu landscape, Grevy's zebras' last bastion where they share pastoral lands with local communities. In this paper we examine their population status, seasonal distribution, movements and threats to survival. We show that adult sex ratio is biased towards mares in the community areas but towards stallions in the protected areas (Samburu and Buffalo Springs National Reserves). In addition, there are more immature individuals on community lands than protected areas. Protected areas are important dry season refuges particularly during drought. Anthrax outbreaks and predation by lions appear to be major causes of mortality for this species. We argue that the long term conservation of this equid will depend on local community participation, upgrading its legal status from a game animal to a protected one, disease surveillance and monitoring the impact of other wild animals particularly lions.

A REVIEW OF RESEARCH ON LION ECOLOGY IN WEST AND CENTRAL AFRICA

DE IONGH, HANS, Hans Bauer, Barbara Croes, Peter Hamling

The African Lion Working Group (ALWG) has concluded that there is a lack of research data on lion populations in Central and West Africa. The number of free ranging lions in West and Central Africa is now estimated at 1700 individuals according to the African lion database. The present research review intends to contribute to a better knowledge of lion populations in this region. Research in selected National parks in West and Central Africa (Benin, Guinea Conakry, Cameroon, Tchad) has focused on livestock depredation, pride structure and movements and home ranges. Research methodology included the use of VHF radio telemetry, the use of calling stations, measurement of lion tracks, direct field observations and regular reports by tourists and

guides. Group size of lions in West and Central Africa is on average 1.7 lions and seems much lower compared with group size in East and South Africa. Lion populations have declined during the past decades and populations are scattered and isolated. Wild prey biomass per kg of predator is low, when compared with national parks in East and South Africa. In addition lion density in West and Central Africa is low (max 5 animals per 100 km²), much lower than in East and South Africa National Parks. The review of current research indicates large wet season home ranges of pride members and seasonal movements of individual lions outside the park during the wet season. Current research also has identified the presence of male problem animals. Main threats to the lion populations in the selected case studies from West and Central Africa are a) habitat fragmentation and isolation b) lion livestock conflicts and retaliatory killing and c) poaching.

FROM LANDSCAPE TO GRASS SPECIES: DOES THE FORAGING BEHAVIOUR OF SABLE ANTELOPE EXPLAIN THEIR DECLINE IN SOUTHERN AFRICA? PARRINI, FRANCESCA, Norman Owen-Smith

Sable antelope progressively declined in the Kruger National Park but still occur in small reserves. Clear conservation guidelines are important for this valuable species. The aim of our study was to determine whether sable foraging patterns could explain why this species is more vulnerable to local extinction than abundant grazers. Based on these findings we provide managers with habitat and nutritional requirements for sable, important when considering reintroductions or managing existing populations. We undertook the study in the Kgaswane Mountain Reserve, South Africa, an area free of predators where sable were doing well. We compared habitat and resource use of two herds occupying distinct landscapes. Sable were not restricted to wooded savanna as previously documented but used a marshy area and burnt grasslands as key resource areas during the dry season. For each breeding herd, there needs to be between 10-20 km² of woodland-grassland matrix. The results also suggest that sable were doing well despite high numbers of other grazers. At the grass level, sable depended largely on two staple grass species of high forage value, but were also able to exploit tall stemmy species generally avoided by other ungulates. These findings do not indicate that sable are narrowly specialized and therefore it is unlikely that foraging can explain their decline. As a precaution, we suggest choosing reserves with few or no predators when reintroducing sable.

TOWARD TERROIR: SOCIOCULTURAL AND ECOLOGICAL SALIENCE IN LANDSCAPE CONSERVATION IN THE CONGO BASIN RUSSELL, DIANE

Conservation models based in management of 'landscapes' designed by conservation biologists dominate in the central African countries making up the 'Congo Basin'. In delineating and designing these landscapes, scientists used only biological data appropriate for initial conservation priority setting. These landscapes are now enshrined in multi-million dollar investments in nine countries with a mandate to zone these territories for different uses. Management of wildlife, forests and other natural resources requires more than large spaces: it necessitates viable social institutions at all levels to govern common property resources and maintain ecosystem services. Management also requires an understanding of political-economic flows among social and ecological units. This paper shows how to add historical, sociopolitical, cultural and ecological salience to a landscape approach in the Congo Basin to create an appropriate framework for management. Adding in cultural, social and ecological dimensions means adjusting conservation strategies toward building local constituencies, meeting livelihood needs and maintaining ecosystem services. These aims can be achieved through strengthening national institutions, rights and assets-based approaches, attention to common property resource management and most critically, the refiguration of landscapes as terroirs.

THE EFFECT OF URBANIZATION ON BIODIVERSITY CONSERVATION

McDONALD, ROBERT, Peter Kareiva, Richard Forman

A majority of humanity now lives in cities, and by 2030 some 75% of people are expected to live there. We will focus on the direct expansion of urban area, and present a quantitative global analysis of the impact of urbanization on biodiversity and protected areas. We utilized demographic data from the Global Rural/Urban Mapping Project (CIESIN) and the United Nations Population Division to construct spatially-explicit scenarios of urban area expansion. These scenarios were compared with ecoregional data on vertebrate species and vascular plant richness (WWF), as well as the World Protected Area Database (UNEP-WCMC), filtered to include only terrestrial parks of greater than 1 km². While many ecoregions, representing 62.4% of the terrestrial surface, have less than 1% of their area urbanized, some are highly impacted: more than 10% of vertebrate species are in ecoregions that have more than 50% of their area urbanized. The median distance from a protected area to a city will dramatically decrease, particularly in Eastern Asia (from 43.1 km to 23.0 km), with potential implications for the integrity of the protected areas. Most urban-impacted parks (90%) will be located in countries with limited income to spend on park protection (< \$15,000 per-capita PPP GDP).

WHY DO FISHERS FISH WHERE THEY FISH? USING THE IDEAL FREE DISTRIBUTION TO UNDERSTAND THE BEHAVIOUR OF ARTISANAL REEF FISHERS

ABERNETHY, KIRSTEN, Edward Allison, Phil Molloy, Isabelle Côté

The complex dynamics of small-scale fisheries have often been ignored when designing management initiatives, contributing to management failure. This study used the ideal free distribution (IFD) as a framework to understand mechanisms underlying fishing site-selection by Anguillian fishers exploiting shallow-water reefs. It used an interdisciplinary approach, combining fish abundance/catch surveys with fisher behaviour data collected through interviews. Contrary to the predictions of IFD, we found that fishers did not distribute themselves so that average reward was equal among fishers. Also, fishing pressure did not increase with resource availability. Key assumptions of the IFD were not met. Lack of 'ideal' knowledge of the reef prevented fishers from choosing fishing grounds with the greatest rewards. Neither were all fishers seeking to maximise profit. Fishers were not 'free' to distribute themselves among reefs owing to variation in social, economic and physical characteristics that constrained their movements and ability to extract resources. The IFD, as a null model, is useful to frame studies designed to rapidly gain detailed insights into the complexity and dynamics of a small-scale fishery, as well as identify the level of resource use spatially. This framework may inform efficient and effective development of stakeholder-sensitive reef and fishery management practice.

ADAPTIVE DIVERGENCE IN RESPONSE TO ANTHROPOGENIC HABITAT DISTURBANCE IN A LONG-LIVED RAINFOREST CYCAD

LOPEZ-GALLEGO, CRISTINA

Drastic environmental changes in disturbed habitats may promote rapid evolution in populations, as strong directional selection may result in genetic differentiation in populations exposed to modified environments. I tested the hypothesis that populations of the Cycad *Zamia fairchildiana* have the potential for adaptive genetic differentiation between its native and disturbed habitats in Costa Rica. Phenotypic selection analyses showed that leaf production and the number of leaves are under selection in the disturbed habitat, but not in the native habitat. These traits can respond to selection, as they showed significant additive genetic variance in heritability estimations. A reciprocal-transplant experiment showed population genetic divergence between habitats for germination and seedling survival. Greenhouse experiments suggested that differences in light availability between habitats might play an important role in population differentiation in this species. Taken together, these results suggest that recent environmental changes after anthropogenic disturbances are promoting adaptive genetic differentiation in populations of *Zamia fairchildiana* from native and disturbed habitats. This has consequences for the spatial genetic structure of the species, and for the evolutionary potential of populations for further environmental

changes (e.g. global warming), and therefore it is an important issue to be considered for conservation purposes.

SOCIAL MARKETING AS A TOOL TO APPLY CONSERVATION PSYCHOLOGY FOR THE IMPLEMENTATION OF SYSTEMATIC CONSERVATION PLANS IN THE EASTERN CAPE, SOUTH AFRICA

WILHELM-RECHMANN, ANGELIKA, Richard Cowling

A number of systematic conservation plans (SCPs) encompass the Eastern Cape Province. However, local municipalities rarely integrate the SCP-products in their land use planning and decision making processes. To enhance the implementation of the SCPs, social marketing is used to persuade local land use planners to meaningfully integrate the maps in their work processes. Social Marketing is a tool that explicitly targets the voluntary behavior of individuals and groups. It relies on techniques developed by commercial marketing and switches the perspective from the conservationist's to the one of the land use planner. Based on psychological and sociological instruments, the various barriers to as well as possible benefits of the desired behavior are investigated and subsequently strategically addressed. Social Marketing has been used successfully in the health domain and for environmental behaviors like recycling. The ongoing project presents an instance of applying conservation psychology to enhance conservation implementation where the legal and cultural contexts have proven insufficient to address biodiversity loss.

IS THE SUPPLY OF TROPHY ELEPHANTS TO THE BOTSWANA HUNTING MARKET SUSTAINABLE?

OWEN, CHERYL-SAMANTHA, Phil Hockey

Botswana hosts the world's largest population of African elephants *Loxodonta africana*, and in northern Botswana, populations are increasing at a rate of 6% per annum. The greatest cash return on a single elephant is from trophy hunting, and hunting is an important foreign income generator. Hunting does, however, risk the sustainability of both the elephant population and the supply of males with trophy-quality tusks. A model utilising a Leslie matrix was developed to simulate the population dynamics of the elephants in northern Botswana under different levels of hunting pressure, with different calf survival rates and with or without a carrying capacity imposed. The age structure of a pristine population, and the proportion of elephants of each age with trophy-quality tusks was developed from tusk measurements and ages of elephants culled over 25 years from Kruger National Park. The model suggests that the current level of hunting pressure is sustainable and unlikely to threaten the availability of trophy-quality tusks in the future. Simulations of increased hunting pressures indicated that doubling the current hunting take-off would result in very few large trophy animals, but would not compromise the supply of males suitable for trophy hunting. A decrease in the current survival rate of calves in their first year of life would, however, greatly reduce the supply of trophy-quality elephants.

SPIRIT OR SPECIES? - WHY MANY CONSERVATION PROJECTS FAIL

SINCLAIR, J ROSS

Many conservation and research projects in the developing world appear to place local communities at the centre of their design and implementation. Despite this, many such projects fail due to conflicts with these communities. I discuss possible reasons why conservation projects fail in terms of their design (site-selection biased to biodiversity over community, inadequate understanding of human societies, commodification of nature, differing objectives and expectations, bias to biological science over social science) and implementation (differences in the understanding of exchange, failure to demonstrate the usefulness of science, poor communication). I illustrate these points using projects from Melanesia and then propose an approach to address some of the problems identified. Until conservationists acknowledge and address their limited understanding of the communities they work in, more projects will fail and opportunities to conserve biodiversity will be lost.

ARTIFICIAL WATERPOINTS AND MANAGEMENT OBJECTIVES IN SOUTHERN AFRICAN SAVANNA

FARMER, HELEN, Ed T.F. Witkowski, Mike J.S. Peel

Supplementation of water resources in savannas can increase population sizes and ranges of water dependent large herbivores, increasing economic returns from a property. However, long-term supplementation can lead to detrimental effects on ecosystem processes. This study used a management intensity gradient within the Great Limpopo Transfrontier Park (southern African savanna) to investigate effects of management objectives on artificial waterpoint density and positioning. Spatially explicit waterpoint databases from six South African private reserves (high intensity management), Kruger National Park (South Africa; medium intensity management) and Limpopo National Park (Mozambique; low intensity management) were analysed using GIS. High intensity management areas had higher density artificial water provision (0.150 waterpoints/km²) than medium intensity areas (0.009 waterpoints/km²) whilst low intensity areas had no artificial water provision. Preliminary results indicate naturally drier areas within properties have higher artificial water provision, although waterpoints are primarily located within drainage lines. Locating artificial waterpoints in naturally drier areas leads to a greater risk of degradation as surrounding vegetation and soils have not evolved with the higher herbivore densities associated with waterpoints. Within the transfrontier conservation area it is important to understand how management objectives affect the naturalness of artificial water provision.

MARINE PROTECTED AREAS FOR ENDEMIC SEABIRDS IN THE BENGUELA

PICHEGRU, LORIEN, Peter Ryan, Sue Lewis, Giacomo Dell'Omo, Samantha Petersen, Céline Le Bohec, David Grémillet

The Benguela is one of the four major upwelling systems in the world, characterized by very high productivity. These favourable conditions allowed the evolution of numerous endemic species, including seven seabird species. However, during the 20th century most seabird populations have decreased dramatically, due to the combined effects of human disturbance, over-fishing, and climate change, threatening some species with extinction. In particular, the three endemic species reliant on pelagic fish stocks, Cape gannets (*Morus capensis*), African penguins (*Spheniscus demersus*) and Cape cormorants (*Phalacrocorax capensis*) are all classified as vulnerable or near-threatened, after the decrease of their populations following the collapse of the sardine *Sardinops sagax* stocks in the 1970s. All three species breed colonially, mainly at offshore islands, and these breeding sites are protected as nature reserves. However, there is growing evidence that their feeding sites also deserve special protection, since seabird foraging success ultimately influences the reproductive output and the size of the colonies. We used GPS-tracking to determine feeding hotspots of those seabirds and model their energetic demands to estimate the amount of prey necessary to sustain populations at current levels. GPS tracks obtained from Cape gannets, African penguins and Cape cormorants at 10 colonies over 5 years are used to define key foraging areas for possible considerations as Marine Protected Areas.

ASSESSING THE THREAT STATUS OF ECOLOGICAL COMMUNITIES: SCALE, VIABILITY AND ECOLOGICAL THEORY

NICHOLSON, EMILY, David S. Wilcove

Government and non-government agencies are increasingly interested in assessing the threat status of ecological communities as a key part of conservation planning. Such assessments have proved difficult, however, due to a lack of agreed-upon criteria. We review currently available methods for assessing the status of communities, and compare them with species assessment systems such as IUCN's Red List. We then evaluate the community approaches in the context of ecological theory, including species-area relationships and ecological thresholds. We find that virtually all of the current approaches make it harder to list ecological communities as threatened than is the case for species. This raises an obvious paradox: multiple species within a community are likely to be classified as threatened long before the community itself is recognized as such.

The greatest problems in assessing community status lie in defining both the appropriate scale of assessment and appropriate measures of viability that can be applied across a range of communities. Moreover, the ways in which ecological communities are defined are highly scale-dependant and can be arbitrary, rendering threat assessment even more difficult. We conclude with recommendations for criteria and thresholds based on ecological theory, and apply them to ecological communities in the Florida Peninsula Ecoregion in the U.S.A.

INTEGRATING BIODIVERSITY CONSERVATION AND POVERTY ALLEVIATION THROUGH ADAPTIVE MANAGEMENT OF GORONGOSA NP

BEILFUSS, RICHARD, Roberto Zolho, Marc Stalmans, Jeremy Anderson

Gorongosa NP has an iconic status for its legendary concentrations of wildlife, but warfare decimated 99% of large herbivore populations and impoverished surrounding communities. The Carr Foundation and Mozambique Government have teamed to (1) restore the structure, function, and processes of the Gorongosa ecosystem and (2) alleviate poverty through local investments, revenue sharing, and community-based ecotourism businesses. The thirty-year, \$100 million project is guided by a Sustainable Business Model and a Conceptual Model for Adaptive Management. Restoration target conditions are not defined as a return to historical conditions. Grasslands were over-grazed in the past, with bulk grazers in poor condition nine months of the year and extirpation of rare antelope. Key ecosystem drivers, including fire, grazing, and hydrology, have changed with settlement patterns and developments. The adaptive management system integrates a range of target conditions, evaluated at multiple scales, for biodiversity conservation (landscape-ecosystem-populations-genes) and human development (households-communities-institutions). We elucidate the complex linkages between factors affecting target conditions—e.g., ecosystem services vs. resource-use restrictions—and monitoring indicators to test assumptions such as the efficacy of investments to both reduce poverty and promote pro-conservation behavior change. “Thresholds of Potential Concern” provide upper and lower limits of desirable change.

CAN PROTOCOLS FOR RED-LISTING THREATENED SPECIES FORECAST EXTINCTIONS?

KEITH, DAVID, Michael McCarthy, Helen Regan, Tracey Regan, Burgman Mark, NCEAS
Extinction Risk Working Group

Risk-ranking protocols are used widely to classify the conservation status of the world's species. Here we report on the first empirical assessment of their reliability by using a retrospective study of 18 pairs of bird and mammal species (one species extinct and the other extant) with eight different assessors. The performance of individual assessors varied substantially, but performance was improved by incorporating uncertainty in parameter estimates and consensus among the assessors. When this was done, the ranks from the protocols correctly predicted the extinction outcome in 70-80% of pairs and there were mismatches in only 10-20% of cases. This performance was similar to the subjective judgements of the assessors after they had estimated the range and population parameters required by the protocols, and better than any single parameter. When used to inform subjective judgement, the protocols therefore offer a means of reducing unpredictable biases that may be associated with expert input and have the advantage of making the logic behind assessments explicit. We conclude that the protocols are useful for forecasting extinctions, although they are prone to some errors that have implications for conservation. Continued testing and refinement of the protocols may help to provide better absolute estimates of risk.

IS THE ESTABLISHMENT OF A FUNCTIONING ECOSYSTEM SUFFICIENT TO RESTORE REPTILE COMMUNITIES IN SITES REHABILITATED AFTER BAUXITE MINING?

CRAIG, MICHAEL, Richard Hobbs, Andrew Grigg, Mark Garkaklis, Carl Grant, Patricia Fleming, Giles Hardy

Patterns of reptile succession in restored sites are poorly known in most ecosystems. However, understanding how reptile succession proceeds may be critical in evaluating restoration success

because reptiles are typically the vertebrate group that is slowest to recolonise restored areas, probably because of their lower mobility and the specific habitat requirements of some species. We installed trapping grids to sample reptile communities in four ages (4, 8, 12 and 17-year old) of restoration after bauxite mining and unmined forest. We then used this information to determine whether restored sites were providing adequate habitat for all reptile species and whether the reptile community was proceeding towards the unmined state. Not surprisingly, individual species responses differed. Generalist, late successional, open habitat and closed habitat species were identified, but no early successional species. Late successional species were those that required mature habitat features, such as logs or decorticated bark. At the community level, the system did not appear to be returning towards the unmined forest, with 17-year old restored sites being most different from unmined forest sites. This suggests that, despite the establishment of a functioning ecosystem, some active management of restored sites will be required if the reptile community is to return to its pre-mining state.

LANDSCAPE LEVEL PROCESSES THAT LEAD TO THE COLLAPSE OF FRESHWATER RECREATIONAL FISHERIES POST, JOHN

Evidence is accumulating that recreational fishing is capable of collapsing fisheries. Recreational angling opportunities in freshwater are distributed across landscapes and attract effort based on the combination of angling quality, travel distance and availability of facilities, analogous to a predator-prey numerical response. We quantified this numerical response of anglers to across a large lake district in Canada. We linked this spatial numerical response to a logistic population growth model and simulated spatial patterns of effort and catch rates over the landscape. At locations distant from urban centres, effort is low and catch rates near pristine, at intermediate distances, effort and catch rates approximate maximum sustainable levels, and at short distances, fishing effort is sufficiently high to harvest to collapse. Landscape scale spatial patterns differed quantitatively for species varying in rates r and K , but the qualitative patterns were consistent among species, demonstrating the pervasive impacts of the numerical response. Traditional regulations that limit effort by individual anglers are ineffectual where any benefit of restriction on individuals is overwhelmed by the numerical response. Control of total effort, rather than individual effort is necessary to ensure sustainable recreational fisheries across landscapes. A change in management perspective is necessary, from that of individual fisheries to one of dynamic harvest processes across landscapes.

THE IMPORTANCE OF INVOLVING LOCAL COMMUNITIES IN LION CONSERVATION: A CASE STUDY FROM TANZANIA LICHTENFELD, LALY

Over the last two decades, the African lion (*Panthera leo*) population is estimated to have declined by 30-50%. African lion experts have identified the availability of wild prey and the indiscriminate killing of lions as primary factors influencing the viability of remaining lion populations where lion range overlaps with human habitation. Tanzania contains over a quarter of the remaining wild lion population and extensive lion range outside of national parks and game reserves. Ecological and sociological research conducted among Maasai communities in the Tarangire ecosystem of northern Tanzania indicated nearly 40 lions are killed annually by the Maasai living in seven villages outside the eastern boundary of Tarangire National Park. The primary motive for killing lions was retaliation for livestock killing. In addition, negative attitudes toward lions were influenced by the perception of risk of living alongside a dangerous carnivore, insecure property rights and a perceived lack of benefits from wildlife tourism. Livestock-lion conflicts are expected to increase as Maasai populations grow, net livestock density increases and prey availability declines. Future lion management priorities in the Tarangire ecosystem should emphasize the development of locally appropriate and participatory measures for mitigating livestock-lion conflicts in the short-term, while ensuring the Maasai recognize increased wildlife benefits from their lion populations over the long-term.

CONSERVING BIODIVERSITY THROUGH THREAT ABATEMENT: TURNING THEORY INTO REALITY DOWNEY, PAUL

The recognition that alien plants are a major cause of biodiversity loss has not led to a greater understanding of which species are at risk, or the development of on-ground conservation management strategies. To turn the theory of biodiversity loss due to alien plant invasions into an on-ground management reality, an 11-step process was developed using the alien shrub *Chrysanthemoides monilifera* (L.) Norl. Several new processes were needed to achieve these 11 steps, for example, the Weed Impacts to Native Species assessment tool was developed to assess the biodiversity at risk. This led to a significant increase in the number of the native plant species known to be at risk (from six to 160+). Sites were then assessed based on the alien plant and the biodiversity at risk, which led to 169 priority sites for control. Coordinated implementation and monitoring are crucial steps to ensure that all the stakeholders (government and community) are undertaking control in a manner that ensures conservation outcomes are achieved and reported. While this process is gaining wide acceptance in Australia, it requires considerable resources and commitment both in the planning and implementation phases (i.e. all steps). Irrespective, the benefits to date have outweighed the costs, resulting from a better understanding of impacts, longer term commitment to restoring sites, wide community support and significant new funds. These 11 steps could be applied to abate other threats to biodiversity.

ECONOMIC GROWTH, HUMAN PREFERENCES AND BIODIVERSITY MARCELINO, FUENTES

Economic growth does not cause biodiversity losses. To understand the root causes of biodiversity loss we must first acknowledge that people differ in their preference for biodiversity. Many people under many circumstances prefer non-environmental goods, and are willing to sacrifice biodiversity in order to get them. This preference increasingly conflicts with the opposite preference for biodiversity, and with the further provision of non-environmental goods. In principle, a good way to solve preference conflicts and inter-temporal inefficiencies is a free market where everybody can bid for different goods. In current markets biodiversity is often at a disadvantage because biodiversity is not adequately protected, and sometimes cannot be protected, by property rights. Solutions to this problem should respect people's preferences, including preferences for non-biological goods, and specifically address those cases where property right issues result in an inefficiently low present or future provision of biodiversity goods. This should consist of expanding property rights over biodiversity and wild habitats, eliminating government policies that needlessly harm the environment and, where a careful cost-benefit analysis indicates so, implementing government interventions to protect biodiversity. A policy of steady state economy does none of those things.

INTERACTIONS BETWEEN POPULATION DYNAMICS AND HUNTING: A CASE STUDY OF THE RED GROUSE (*LAGOPUS LAGOPUS SCOTICUS*) BUNNEFELD, NILS, David Baines, E.J. Milner-Gulland

Interactions between human activity, especially harvesting, and demography are under-represented in conservation science despite theoretical studies demonstrating their potential importance. In this study we compared the age and sex structure of ten red grouse populations before shooting with the age and sex of hunted individuals in the same locations over two years. We showed that the composition of red grouse harvests was not a true reflection of the population structure: more young than old grouse, and within the old age class more males, were shot when offtakes were high and vice versa when offtakes were low. The susceptibility of young grouse and old females increased with shooting pressure. This has important implications for understanding red grouse population dynamics, particularly because population dynamics are strongly influenced by parasite loads. Grouse with higher parasite burdens have reduced fecundity. Shooting and parasites might interact at high density such that the parasite load of the population increases after the shooting season, given that old grouse show a higher parasite

burden but are less likely to be shot. The findings from this case study are relevant to conservation more generally, because they examine the relationship between wider ecological processes such as host-parasite dynamics, harvest rate and selectivity and population fluctuations. These interactions are vital for sustainability, but are rarely explored.

EMPOWERING THE PEASANTS TO BE THE CUSTODIAN OF AN ENDANGERED ECOSYSTEM: THE CASE OF YALA SWAMP IN KENYA

MWAURA, FRANCIS, Esther Kagure, Milka Ngugi, Lucy Wanjohi, Magdalene Makara, Jacton Otieno, Jane Mbuthia

Threatened ecosystems in Kenya face a conflict in whether to be protected or to be left under management of the peasants. The priority of development agencies is to have management options that will entail exploitation of resources for quick returns. Yet the end result of this management option is a phenomena where the poor degrade the resource and hence they became more impoverished as the resources potential is ruined. Yala Swamp is an example of such a resource. Although its ecological importance has been recognized, intervention strategies that would ensure sustainable development and biodiversity conservation are lacking. Participatory approach where local communities, resources' experts and conservationists collaborated in resources inventory, ranking the sustainability and conservation potential of various management options, educating the community and policy makers on findings resulted to the locals appreciating the worth of the resource and a sense of ownership. They are advocating for sustainable utilization through awareness meetings, petitioning developers and government on austere environment undertakings and formed development groups engaging in poverty reduction through management option that are compatible with conservation. Efforts to strengthen these groups through training and boosting their income status through linking products of sustainable management to the market are needed.

MODELLING OF POTENTIAL EUROPEAN WETLAND SITES FOR BIODIVERSITY CONSERVATION SCHLEUPNER, CHRISTINE

In our study we are primarily focussing on the biotope-complexes of natural freshwater wetlands. During the last century European wetlands have dramatically decreased in number and size. Only 30-40% of the wetlands that existed at the beginning of the 20th century remained today. As result not only valuable biotopes are lost but also fragmentation of the remaining wetlands takes place. This research study is integrated in the EU-financed NEEDS-Project, which, besides others, aims to evaluate the full costs and benefits (direct + external) of energy policies and of future energy systems as well as to improve the estimation of the average and marginal avoidance costs of greenhouse gas emissions, with particular emphasis on European land use. The base is the economic FASOM-model that optimizes land allocation by combining agriculture, forestry and biotope conservation modules. This spatial analysis study contributes to that model by evaluating potentials to preserve existing habitats, to restore formerly native habitats, as well as to create non-native managed habitats with respect to European wetlands. It locates existing wetland habitats and models potential convertible wetland sites that are further rated after connectivity and positional relationships. Hereby, GIS provides an appropriate tool to fulfil the aim of this assessment. The optimization model integrates also data of the technical and economic potential of habitat establishment. The results are visualized in wetland suitability maps that might be able to give an overview of valuable wetland areas of Europe concerning biodiversity as well as economic land use options. Furthermore, it will be possible to illustrate these results under different Climate Change scenarios.

PEOPLE CHOOSE, ALGORITHMS DON'T: PRIVATE LANDS AS AN EXAMPLE OF THE NEED FOR USING SOCIAL FEATURES IN CONSERVATION PLANNING
PASQUINI, LORENA

Conservation on private lands requires the sustainable involvement of the landowners. These landowners hold their own sets of beliefs, knowledges and practices regarding nature, conservation, their role in the landscape and that of others. These beliefs and practices influence the use, perception and control of the landscape and its biodiversity, and thus need to be taken into account to enable effective implementation of conservation planning outputs. This paper draws on in-depth interviews and questionnaires conducted with Private Conservation Area (PCA) landowners in the Little Karoo, South Africa, to identify critical social features of the system. These include landowner motivations and capacity to conserve, landowner management strategies, and social capital. The significance of these social characteristics for the successful implementation of ecologically-driven conservation planning is then examined. The presence or absence of these features can differentially affect the performance of conservation areas chosen solely on the basis of their ecological characteristics. Thus, to enable effective implementation of conservation action, conservation planning procedures critically need to include and account for the social dynamics of a system, by compiling data on social patterns and setting targets for both social and ecological features through a process here termed Adaptive Conservation Planning. Ecological criteria should be used to determine potential sites for conservation, consequently refined according to social criteria.

BUSH MEAT CRISIS IN WILDLIFE DISPERSAL AREAS OF TSAVO WEST, CHYULU AND AMBOSELI NATIONAL PARKS OF SOUTH WESTERN KENYA
KIRINGE, JOHN, John Kioko

Wildlife poaching for bush meat has emerged as a major threat to wildlife conservation in Kenya. Historically, wildlife hunting was done in a sustainable manner but this has collapsed due to changes in traditional lifestyles of local communities. We assessed the prevalence of bush-meat poaching in the Tsavo-Amboseli ecosystem using structured and semi-structured questionnaires. Results showed that bush meat poaching was prevalent and was primarily carried out by migrant tribes (Kamba, Kikuyu and Chagga). However, the Maasai people who traditionally abhorred eating or killing wildlife were also involved. Twelve large mammal species were poached for bush meat with Thomson's gazelle, Grant's gazelle, Maasai giraffe and Plains zebra being the most frequently sought. The meat was consumed locally or sold in markets mainly along the Kenya-Tanzania border. Most respondents (85%) did not support bush meat poaching while 67% felt that the local community had no responsibility in mitigating bush meat poaching. The mitigation measures against bush meat poaching were ineffective in curbing poaching due to inadequate funding and weak legal framework. Results suggest that bush meat poaching is a threat to wildlife conservation efforts in the Tsavo-Amboseli ecosystem and if mitigation measures are to be effective, they must enlist the support of local communities.

INTEGRATING FARMLAND INTO CONSERVATION PLANNING: A SYSTEMATIC REVIEW OF WETLAND BIRD USE OF INTENSIVE ROW CROP AGRICULTURE
ELPHICK, CHRIS, Oriane Taft, Patrick Bukowski, Tess Present

Agricultural land dominates the world's land surface, with arable land occupying 12% of the Earth's land surface (1.4 billion ha). Given human population growth and issues of food security, increases in agricultural land conversion and intensification are unlikely to cease. A major challenge, therefore, is to identify ways that farmland can contribute to meeting conservation goals. We conducted a systematic review of the literature, focusing on 146 wetland-associated bird species, and documenting their patterns of use of major row crops in North America (rice, spring wheat, winter wheat, corn, soy, sorghum, cotton, peanut, tobacco). Our search process found 561 published papers. Most studies were conducted in corn, rice, or wheat, and almost half concerned waterfowl. 120 (82%) focal species, including 36 "conservation priority" species, occurred in at least one crop. Rice was used by the most species (105), but over 30 species also

used corn, sorghum, soy and wheat. Use of different crops was highly nested, rather than different subsets of species being found in different crops. Crops were used primarily for foraging, with most use during nonbreeding periods. Compared to other crops, more species forage in rice fields and more species nest in wheat and rice. Overall, use patterns indicate great potential for row crops to benefit a wide variety of wetland birds if the land is farmed with conservation in mind.

AN APPRAISAL OF WOMEN ROLE IN THE EXPLOITATION OF NON-TIMBER FOREST PRODUCTS IN CAMEROON: IMPLICATION FOR RURAL LIVELIHOOD AND RESOURCE SUSTAINABILITY FONJONG, LOTSMART

Little importance was given to non-timber forest products (NTFPs) and to the role of women in economic development before the advent of the economic crisis in the late 1980s in most of Africa. The harsh socio-economic environments created by both the crisis and the adjustment measures put in place there after, pushed most households to seek additional sources of livelihood in the NTFPs. With the aid of case study analysis, this paper describes the diversity and exploitation of NTFPs in Southern Cameroon by women and its role in fighting rural poverty. While acknowledging the socio-economic contribution of the activities of these women in all facets of livelihood, particularly in augmenting household income, the paper highlights the difficulties of these women in the extraction, preservation and commercialization of NTFPs. It argues that these problems do not only reduce the efforts of women in fighting poverty but they also undermine potentials of NTFPs as important sources of revenue and survival. The exploitation of NTFPs, the paper underscores, has both positive and negative consequences on the sustainable management of natural resources and requires concerted efforts from the state and other stakeholders to create an enabling environment for better exploitation of these resources by women. It maintains that although the benefits from women's participation in the exploitation of NTFPs is not enough to fight poverty, it nevertheless, provides a springboard for poverty alleviation and an opportunity for women to be implicated in the management of natural resources.

PATTERNS OF LOSS AND REGENERATION OF TROPICAL HOT SPOT FORESTS IN SOUTHERN MADAGASCAR: THE SOCIAL INSTITUTIONAL CONTEXT ELMQVIST, THOMAS, M Pyykönen, Maria Tengö, Elisabeth Rabakonandrianina

In Madagascar deforestation rates have been estimated to be very high and viewed as primarily a result of a rapidly growing population. Recent research has challenged both the dramatic deforestation rates and proposed a more complex set of drivers of land-cover change. Here we analyzed population density, climate change and institutional changes as factors driving deforestation in high endemism dry forests in southern Madagascar. We used three Landsat images from 1984, 1993 and 2000 respectively, and based on ecological and institutional field analyses we made a time-series analysis of changes in forest cover. Population density did not correlate with forest cover change. An area of 16 000 ha had been degraded by 2000, but an area of 13 000 ha, not classified as forest in 1984, had spontaneously regenerated. The net result was a marginal decrease of 7% of total forest cover during the period 1984-2000. An analysis of institutions revealed that degradation of forests occurred in areas with insecure property rights, while areas with well-defined property rights had either regenerating or stable forest cover. The large-scale regeneration appears to be a result of a combination of climatic changes, migration and decreased human population and livestock grazing pressure, but under conditions of well-defined property rights. This study points to the importance of local, place-based studies with simultaneous analyses of local drivers and institutional characteristics for understanding land-cover change. Our study also emphasizes the large capacity of a semi-arid system to spontaneously regenerate given a window triggered by a changing climate and decreased grazing pressure, but where social institutions mitigate drivers of deforestation.

QUANTIFYING THE BIODIVERSITY VALUE OF TROPICAL SECONDARY AND PLANTATION FORESTS

BARLOW, JOS, Toby Gardner, Carlos Peres

Biodiversity loss from deforestation may in part be offset by the increased coverage of secondary forests and plantation forestry in the humid tropics. However, our current knowledge of the value of these habitats is limited to few taxa, and the majority of existing studies are confounded by methodological shortcomings. We examined the value of tropical primary, secondary and plantation forests for 15 different taxa using a replicated design that minimized spill-over effects. Different taxa exhibited a wide range of responses to changes in land-use, and only three of the 15 taxa separated all three habitat types both in terms of species richness and community structure. Congruence between taxa was very low based on abundance or species richness data, but much higher using metrics based upon community structure and species composition. Commonly sampled taxa such as birds, lizards and butterflies shared similar responses to habitat change. Taxa with the most distinct responses were those characterized by unique resource requirements, such as bats and amphibians, or highly vagile groups such as orchid bees, or those that are difficult to sample, such as small mammals. Our results demonstrate the necessity of using response metrics other than species richness, and show how the consequences of ongoing tropical land-use change can be highly idiosyncratic for some taxa.

THE COMMUNITY IMPACTS OF A FRESHWATER FISH INVADER

LOWE, STEVEN, Dean Impson, Jenny Day, Paul Skelton

The biota of rivers in the Cape Floristic Region is characterised by high endemism. Most of the indigenous fish in the region (>80% endemic) are threatened with extinction, but the conservation status of aquatic invertebrates (>2/3rds endemic) is largely unknown. All major rivers of the region are invaded by introduced fish, with smallmouth bass (*Micropterus dolomieu*) currently the most widespread. In this study we investigate the patterns and mechanisms of the impacts of *M. dolomieu* invasion on a river community. We studied fish, aquatic invertebrates, algae and physical characteristics on the Witte River, Bain's Kloof, in adjacent reaches containing either bass or indigenous fish separated by a waterfall barrier. Sites invaded by *M. dolomieu* show a loss of indigenous fish and a four-fold reduction of fish biomass; an increased abundance of some indigenous fish prey taxa (Baetidae and Simuliidae); an altered invertebrate community composition and a reduced diversity (H'); increased drift and feeding behaviour of baetidae; alteration of the size-class composition of some invertebrate populations; a reduction of algal density (up to 20-fold). The impacts are seasonally dependent and differences between sites are not due to the environmental factors measured. We report the novel finding that invasion by *M. dolomieu* on the Witte River causes a trophic cascade by eradicating indigenous fish, reducing predation pressure on their invertebrate prey, thereby altering the invertebrate community composition leading to seasonally reduced standing algal biomass.

EVALUATING BIODIVERSITY CONSERVATION IN THE TROPICS

LINKIE, MATTHEW, Robert Smith, Deborah Martyr, Elizabeth Suedmeyer, Joko Pramono, Nigel Leader-Williams

Many large, donor-funded community-based conservation projects in the tropics have been unsuccessful, so there is a critical need for quantitative analyses to identify the reasons why. Here we analyse the effectiveness of an Integrated Conservation and Development Project (ICDP), which sought to reduce biodiversity loss through the development of villages bordering Kerinci Seblat National Park (KSNP) in Indonesia. We evaluated the success of a US\$1.5 million development grant disbursed to 66 villages in return for their commitment to stop illegally clearing the forest. First, we identified the landscape factors that best explained regional deforestation patterns and found that protected area status, elevation, slope, distance to settlements and distance to public roads were important. These factors were then used to construct a deforestation risk model, which showed that forest around ICDP villages was at no greater risk than forest around other similar non-ICDP villages. Finally, we investigated observed

deforestation rates around both the ICDP and non-ICDP villages and found no difference. Instead, we found deforestation was highest in accessible areas where village land-tenure had been undermined by the designation of selective logging concessions. Our quantitative approach highlights the importance of strengthening law enforcement inside KSNP and local property rights outside KSNP.

THE COMBINED EFFECTS OF HARVESTING AND HABITAT FRAGMENTATION ON BLUE CRAB POPULATION PERSISTENCE

MIZEREK, TONI, Helen Regan, Kevin Hovel

Marine biodiversity is increasingly threatened by multiple processes with cumulative effects. To determine optimal management options, the synergies between threats need to be explicitly considered. Chesapeake Bay blue crabs (*Callinectes sapidus*) are a species subjected to multiple threats. Management strategies have focused primarily on reducing fishing mortality because blue crabs support the largest fishery in the Bay but other threats likely contribute to the population decline. There has been a drastic loss and severe fragmentation of seagrass beds, the primary habitat. We used a stochastic stage-based meta-population model to assess the cumulative effects of habitat fragmentation and harvesting of blue crabs and suggest management options to promote population persistence. The population response varied among four fragmentation types and the optimal habitat type depended on whether harvesting was considered. Crab introductions were more beneficial to populations than harvest reduction in isolated patches of seagrass, irrespective of patch size. The opposite was true for continuous or clustered patches of seagrass. Due to apparent synergies between habitat fragmentation and harvesting, optimal management strategies for blue crab populations will depend on where management is administered. Management strategies must consider limiting all threats and should be focused on a combination of options.

COLLABORATIVE PROTECTED AREA MANAGEMENT: PROSPECTS AND LIMITATIONS FOR BIODIVERSITY CONSERVATION

DUGELBY, BARBARA

Protected areas worldwide are often established with little or no recognition of local rights and traditions, and many “conventional parks” are, at least in theory, kept largely free from human impacts. The problem of viewing local communities and others as separate from parks has had profound negative impacts on these groups. In particular, lack of attention to historical resource use patterns and tenure rights associated with the exclusive park model has resulted in conflicts and increased pressures on natural systems. In recognition of the conflicts and failures associated with the exclusive approach, as well an increasing concern for local rights, the conservation community has shifted in recent decades towards more “inclusive” approaches to protected areas. Inclusive approaches provide local stakeholders some form of consultation or “collaboration” in planning and management, seeking to more effectively integrate parks with the socioeconomic fabric of the surrounding region. Nonetheless, protected area co-management is a relatively new approach, widely viewed as a “work in progress”, with few documented success stories or mature working models. In this presentation I examine the concept of collaborative protected area management, review successes and failures from the field, and discuss the implications for both community development and biodiversity conservation goals.

COMPLEX PATTERNS OF GENETIC VARIATION IN FRESHWATER MUSSELS (BIVALVIA: UNIONIDAE) OF THE UNITED STATES: IMPLICATIONS FOR CONSERVATION GENETIC STUDIES

JONES, JESS, Paul Grobler, Richard Neves, Eric Hallerman

Effective conservation planning for freshwater mussels requires an understanding of genetic variation within and among populations. Patterns of unionid genetic variation can be complex, and may be influenced by interspecific introgression, genetic drift, secondary contact and different divergence times. We studied genetic variation in three federally endangered mussel species

using nuclear DNA microsatellites and mitochondrial DNA (mtDNA) sequences. Populations of fanshell (*Cyprogenia stegaria*) maintain highly divergent mtDNA lineages in sympatry; however, these matrilineages are panmictic based on analysis of DNA microsatellites. These patterns are best explained by past introgression with other species, and perhaps recent mixing of historically separated populations. The Cumberlandian combshell (*Epioblasma brevidens*) exhibits decreased genetic diversity due to long-term small population size, and contains divergent lineages indicative of secondary contact. The oyster mussel (*Epioblasma capsaeformis*), member of a recently diverged species complex, shows extremely low levels of mtDNA sequence divergence (uncorrected p-distances ranged from 0.00053-0.00795) among sibling species but high levels of divergence at DNA microsatellites (RST values ranged from 0.15-0.71) and morphological characters. Genetic analyses that include only a limited number of genetic markers, such as mtDNA, may risk making erroneous conclusions on genetic structure of unionid populations. These studies indicate the need to comprehensively understand genetic variation for molecular markers and phenotypic traits to implement conservation planning.

CALIFORNIA'S SALTON SEA-POLICY, SCIENCE AND REHABILITATION OPTIONS FOR A
GLOBALLY SIGNIFICANT SALINE DESERT ECOSYSTEM
CAGLE PA PHD, FRED, David Younkman

The Salton Sea, a hyper-eutrophic saline desert ecosystem, is the largest inland lake in California. The sea is increasing in salinity and produces decreasing water quality, extensive algal blooms and toxic gases. It has been allowed to exist as an agricultural sump to prevent salinization of 426,000 acres of farmland. Recent demands for water by the urban coastal cities will decrease the amount of water to preserve the current sea. It has also become critical habitat for 400+ species of birds along the Pacific flyway. Various stakeholders over the past twenty years have spent over \$75 million in research to determine the future design of the sea. Competing demands of development and habitat have compelled the state to narrow the 225 alternatives proposed to 8 possible approaches. The bureaucracy and decision approaches which have made the decisions difficult provide many lessons for other saline lake ecosystems. Research leading to the 8 alternatives resulted in the selection of a preferred alternative. The limits of our knowledge to complete the preferred alternative under predicted costs, time frames, and in view of global climate change have applications to human-impacted and managed ecosystems around the world.

PREDICTING GLOBAL PATTERNS OF BIODIVERSITY LOSS IN PRIMATES DEPENDS ON
ASSUMPTIONS ABOUT RELATIVE SPECIES VULNERABILITY
CARDILLO, MARCEL, Andy Purvis

Continuing environmental degradation will very likely lead to the decline and possible extinction of many mammal species in coming decades. Can we predict these declines and identify which species are most likely to disappear soonest, so that pre-emptive conservation action can be taken? We use data for the world's primates to compare different ways of quantifying the relative vulnerability of species, based on (1) current Red List categorization, (2) current geographic range size, (3) multivariate comparative models, and (4) comparative models combined with projected human population growth. We find that the global patterns of predicted loss of species and phylogenetic diversity differ substantially among these scenarios. The exception is Madagascar, where loss of primate biodiversity is predicted to be high under all scenarios. Species responses to human impact are complex and variable, and simplistic assumptions about relative vulnerability of species may be misleading. We conclude that multivariate comparative models that incorporate as much biological, phylogenetic and geographic information as possible will give the most accurate picture of where future biodiversity loss will be greatest.

THE IMPORTANCE OF THE IMPACT-DENSITY RELATIONSHIP FOR OPTIMAL MANAGEMENT OF INVASIVE SPECIES

YOKOMIZO, HIROYUKI, Matthew Thomas, Hugh Possingham, Yvonne Buckley

We present optimal management strategies for an invasive population which has a large economic impact. The level of optimal management effort depends on the relationship between the population density of the invader and the cost of impact caused by the invasive population. In management studies this relationship is often assumed to be linear; however, we have little empirical knowledge of this relationship and it could plausibly take several different non-linear forms. We examine how the optimal management effort level varies based on four functional forms of the cost of impact. The optimal management effort minimizes a total cost which is a sum of the cost of impact and an economic cost of management effort. If we apply an inaccurate cost of impact curve, the invested management effort is smaller or larger than the optimal level based on an accurate cost of impact curve. We calculated the increase of the total costs due to this over- or under-investment in management which indicates the value of information of the cost of impact curve. The value increases with time scope of management and it also depends on what kind of inaccurate cost of impact curve is applied. Knowing the correct form of the cost of impact curve will enable managers to better prioritize species for control and make more efficient budget allocation decisions.

PROTECTION IN HIGH PLACES: GAP ANALYSIS OF MONTANE ECOSYSTEMS FOR CONSERVING CENTERS OF ENDEMISM

Sherpa, Mingm, ERIC WIKRAMANAYAKE, Colby Loucks, Gokarna Thapa

Montane ecosystems usually harbor high levels of endemism due to the complex topography and biogeographic history that has isolated species for long periods. We undertook a global analysis of montane biomes to assess gaps in protected areas coverages. We overlaid the WDPA protected areas on the remaining natural habitats above 1000 m elevation, as defined by the combination of land cover from the GLC2000 and SRTM DEM datasets, to assess the extent of protection in montane biomes, and used the AZE database of sites with threatened endemic species and Endemic Bird Areas to assess the extent of protection of centers of montane endemism. The results indicate that several centers of endemism in the Tropical and Subtropical Moist Forest biomes in montane regions of all biogeographic realms are unprotected. The Montane Grasslands biomes in four of five biogeographic realms lack adequate protection; the Desert and Xeric Shrublands in four of six realms; and the Temperate Broadleaf and Mixed Forests in two of five realms. Centers of endemism in the other montane biomes are better represented by the current protected areas networks. The analysis also indicates there is considerable habitat remaining in most montane biomes for additional protection to benefit montane endemic species.

FRUIT BAT POLLINATORS LINK TERRESTRIAL AND MARINE CONSERVATION IN MADAGASCAR

Andriafidison, Daudet, Radosoa Andrianaivoarivelo, Paul Racey, RICHARD JENKINS, Olga Ramilijaona

Madagascar's three endemic and threatened fruit bat species of fruit bat play a potentially vital role as seed dispersers and pollinators. In Kirindy-Mitea National Park in western Madagascar, we studied the visits of mammal pollinators to endangered baobab trees *Adansonia grandidieri*. Nocturnal observations of fruit bats and lemurs were made at 35 flowering trees in intact forest (13), degraded forest (13) and agricultural land (9). The large fruit bat *Pteropus rufus* was the most common mammal visitor and highest visitation rates were recorded on baobabs in agricultural land. Small lemurs were not recorded from this habitat, and visited baobabs in degraded forest more often than in intact forest. We located two *P. rufus* roosts in mangrove forest 8-10 km from the baobab forest. Lemur pollination appeared to be far less important than *P. rufus* and for the fruit bats to be conserved the mangrove roost sites need to be incorporated into conservation plans. At other sites in Madagascar *P. rufus* roosts in small offshore islands.

Fruit bat roost sites need to be conserved to maintain the ecological services provided by these bats even when feeding areas and roosting sites are physically separated.

CONSERVATION VALUE OF LINEAR FOREST REMNANTS FOR UNDERSTOREY BIRDS IN AMAZONIA

HAWES, JOSEPH, Jos Barlow, Toby Gardner, Carlos Peres

Linear forest remnants are frequently proposed as valuable conservation tools but evidence is currently lacking to show whether such structural connectivity provides functional connectivity for fauna and ecological processes. The influences of habitat type and remnant length are particularly poorly known. We examined the value of riparian and terra firme primary forest remnants within a silvicultural landscape in the north-east Brazilian Amazon, where the matrix is dominated by *Eucalyptus* plantations. We conducted mist-netting for understorey birds in 8 linear remnants connected to continuous forest, with a total of 24 sites located near to, far from, and within undisturbed forest controls. We found that riparian linear remnants were more successful than terra firme remnants in maintaining high species richness and the disturbance-sensitive species characteristic of continuous primary forest. Bird communities in both remnant types changed with increasing distance along remnants into the matrix, to include more birds typical of secondary growth forest but not of the *Eucalyptus* dominated matrix. All linear remnants are shown to be valuable, at least as refuges, for some species normally intolerant of conditions outside continuous forest, and we conclude that improving connectivity through linear remnants has the potential to maximise biodiversity conservation efforts in disturbed landscapes, where increasing habitat area is often not possible.

ECONOMIC ANALYSIS OF CROP DEPREDATION BY ELEPHANTS AT THAILAND'S KAENG KRACHAN NATIONAL PARK SUGGESTS LANDUSE CHANGE NOT CROP GUARDING IS THE SOLUTION

PATTANAKAEW, PUNTIPA, Simon Hedges, Chumpon Kaewket

From November 2004 to September 2006, we measured the extent of crop depredations by elephants in a 50 km² agricultural enclave in Kaeng Krachan National Park (KKNP). We estimated that the maximum market value of the crops damaged (mainly fruits and vegetables) was USD131,765/year. Our tests of labor-intensive paid crop-guarding methods suggest effective protection will cost USD150,656-197,433/year. High-quality electric fencing would cost approximately USD90,000 to build and USD9000-18,000/year to maintain. Changing to crop types unpalatable to elephants or switching to activities such as raising cattle would appear to make better economic sense than trying to protect vulnerable crop types. Relocating people is not feasible at KKNP (although it could be a solution elsewhere). Our data show that farmers affected by elephant depredations are willing to change and some farmers have already changed to less vulnerable crops. Willingness to change is likely high because the farmers are already in a market agricultural system, not a subsistence system. Obstacles to more widespread adoption of alternative landuses include high start-up costs. In the past this has been addressed through assistance from the government. Such landuse changes could provide a permanent solution to human-elephant conflict at KKNP, benefiting both people and elephants, and is potentially a model for other sites.

CRISIS IN FOREST MANAGEMENT SCHEME IN BURKINA FASO: SPLITTED WOOD PRACTICES IN TWO VILLAGES

ZOUGOURI, SITA

This socio-anthropological study focuses on how rural actors exit the externally induced but locally accepted creation of a "protected forest" as a common resource. It deals with the case of a forest management scheme, created on this "protected forest", in two villages in Burkina Faso. Rural communities, in particular the local actors involved in this forest management scheme, have their proper understandings and perceptions of what it means to be linked to a common resource as managers, as "owners" and as workers producing economic benefits for themselves

and for others (State, wood merchants). We will mainly focus through this practice of splitted wood on the logics and strategies of local actors and their understanding of government policy with respect to renewable natural resource management. Local practices, around the already put in place and very well organized forest management scheme, will also be described in this study. The main activities of the forest management scheme in Bounounou administrative district are big wood cutting and selling through a wood market chain. The splitted wood is an activity developed besides the big wood market since 5 years (in terms of increasing). The splitted wood is defined as the rest of big wood (branches of trees) which stay and which have a diameter lower than 10 centimeters. But in practice it is all wood cutting in pieces and selling by stack inside the village on the main roads. Through concrete cases, we will firstly underline the perceptions that the local actors have of the creation and the organization of this new forest; and secondly on the relationships between the actors (members and woodcutters) and the direction (management) of the project and finally on the relationships between the members of cooperatives and the wood market.

USING A SOCIAL MARKETING FRAMEWORK TO SYSTEMATICALLY EVALUATE AND DESIGN A CONSERVATION POLICY INSTRUMENT PRIOR TO IMPLEMENTATION JEPSON, PAUL, Richard Ladle

Evidence-based conservation needs to embrace systematic evaluation of strategic policy options prior to implementation, as well as post-hoc evaluation of conservation interventions. We employed a social marketing framework, involving strategic use of social survey tools, to assess the efficacy of a regulatory vs. market-based approach to reduce the conservation impacts of the wild bird trade in Java and Bali. In the six cities surveyed, we found that 1-in-3 households keep a bird, nearly 1.5 million of the birds kept are wild-caught, and that the hobby contributes US\$93 million annually to the economies of the six cities and generates significant employment among poorer sectors of society. The scale of bird-keeping indicates that a regulatory approach might be impractical and undesirable on economic, social and political grounds. In contrast, key conditions needed for a market-based approach (consumer demand, captive-bred supply, political support etc) are in place. Insight from the social surveys inspired the design of social change strategy to support the introduction of a market-based policy instrument with a strong collective action component. We conclude that social marketing frameworks have the potential to strengthen adaptive management and innovation early-on in the project cycle thereby improving the performance of conservation interventions.

BUILDING A HEALTHY MEGA-CITY. TOOLS FOR CONSERVING BIODIVERSITY IN A RAPIDLY URBANIZING PROVINCE PFAB, MICHÈLE

As the economic centre of South Africa, the province of Gauteng is experiencing rapid urban and industrial development. The resulting impacts on biodiversity are managed predominantly by means of the Environmental Impact Assessment Regulations (2006) promulgated in terms of the National Environmental Management Act (1998), with the ultimate objective to develop a city that is conducive to human wellbeing. The implementation of these Regulations in relation to biodiversity is facilitated by a conservation plan developed for the province by the implementing agency, the Gauteng Department of Agriculture, Conservation and Environment. Designed in line with the systematic conservation planning protocol, the plan identifies areas essential for the support and maintenance of biodiversity. The conservation plan and associated biodiversity data are delivered to environmental officers via an internal GIS server and decisions are informed by a decision tree that integrates relevant biodiversity information, minimum requirements for specialist studies, sensitivity mapping rules and standard mitigation measures. In addition, legislative protection through the EIA Regulations is currently being strengthened through the publication of supplementation maps as well as the listing of Threatened and Protected Ecosystems in terms of the Biodiversity Act (2004). The application of this decision support system will be illustrated by means of an appropriate case study.

GASTROINTESTINAL BACTERIAL EXCHANGE AMONG PEOPLE, MOUNTAIN GORILLAS
AND DOMESTIC ANIMALS IN BWINDI IMPENETRABLE NATIONAL PARK, UGANDA
RWEGO, INNOCENT, Tony Goldberg, Thomas Gillespie, Gilbert Isabiry-Basuta

Infectious diseases pose a significant and growing threat to the health, well-being and long term viability of wild primate populations. This study was carried out in Bwindi Impenetrable National Park, southwestern Uganda. The common gastrointestinal bacterium *Escherichia coli* was used as a model microbial system for studying disease transmission. Fecal samples were collected from mountain gorillas (n=67), gorilla guides (n=22), field assistants employed in gorilla research (n=8) and people from the local community (n=34) and their domestic animals (n=42). *E. coli* bacteria were isolated from fecal samples, and Rep-PCR was used to generate unique fingerprints for bacterial isolates, from which epidemiological relationships were inferred. People, domestic animals, and gorillas tended to share similar *E. coli* genotypes with individuals from the same group or location. People working with gorillas tended to harbour *E. coli* bacteria genetically more similar to the bacteria of the gorillas with which they work than to the bacteria of gorillas with which they don't work. Domestic animals living in close proximity to gorilla groups tended to harbour bacterial isolates genetically similar to the gorillas. Overall, these results suggest that spatial and behavioural overlap between people, domestic animals, and gorillas can lead to the exchange of gastrointestinal bacteria. Strategies to limit such exchange would benefit both gorilla conservation and human and animal health.

HISTORICAL GLOBAL PATTERNS OF HABITAT CONVERSION
BOAKES, ELIZABET, Richard Fuller, Philip McGowan, Georgina Mace

Habitat change has been implicated in the decline of over 85% of threatened vertebrate species and is a key driver of observed change in species ranges. Significant large scale anthropogenic habitat conversion has occurred continuously for hundreds of years, disrupting analyses using present-day distributions of habitats to investigate drivers of decline in species ranges. We used a global projection of the distribution of major habitat types (based on the HYDE dataset) at half-degree resolution and over seven time periods since 1700 to investigate spatial patterns of habitat change. The likelihood of anthropogenic conversion of habitat within a grid cell increased with the proportion of habitat in the surrounding area that had already been converted. While generally implying an accelerating rate of habitat fragmentation over time, the strength of this relationship varied among habitats, as well as regionally and temporally. Whilst there is a clear overall trend for habitat conversion to be concentrated in areas where some disruption has already occurred, regional and temporal effects must be taken into consideration when exploring the relationship between habitat conversion and species range dynamics. A better understanding of the relationship between habitat change and range change is crucial when assessing the additional explanatory power of more diffuse decline drivers such as climate change and exploitation.

A SIMPLE INDICATOR FOR ASSESSING CURRENT AND FUTURE STATUS OF
TERRESTRIAL ECOSYSTEMS
JONAS, ZUZIWE, Mathieu Rouget, Timm Hoffman

Simple ecosystem-based indicators are needed for monitoring biodiversity change. Here, we develop an indicator describing current and future ecosystem status to provide advice to conservation planners. This approach identifies currently threatened ecosystems and predicts future changes in the status of 202 ecosystems in the Succulent Karoo biome, one of thirty-two internationally recognized biodiversity hotspot. Current status was determined based on species composition, turnover, and current habitat loss per ecosystem type. We predicted future habitat loss based on mining and crop potential in the area. Logistic regression models were used to determine the probabilities that natural remnants will be either converted or will remain in its natural state in the next 20 years. We predicted an increase in the number of threatened ecosystems. Results showed that large remnants of natural vegetation are endangered and the trend will continue in the future. Fourteen currently endangered ecosystems could become

critically endangered in the future. Twenty-eight ecosystems out of the 174 that are currently least threatened will eventually be denoted as vulnerable in the future. Priority should be given to the conservation and ecological management of these threatened ecosystems. Such approach is useful in targeting and prioritizing ecosystems where future habitat loss is expected.

ASSESSMENT OF TWO ECOLOGICAL NICHE MODELLING ALGORITHMS FOR TWO ENDANGERED AFRICAN FISH SPECIES, *SANDELIA BAINSI* (ANABANTIDAE) AND *BARBUS TREVELYANI* (CYPRINIDAE)

Coetzer, Willem, JIM CAMBRAY, Ernst Swartz

Two ecological niche, namely Desktop GARP (Genetic Algorithm for Rule-set Production) and Maxent (Maximum Entropy Species Distribution Modelling) were applied to two endemic, South African freshwater fish species. *Sandelia bainsii* (Anabantidae) and *Barbus trevelyani* (Cyprinidae) have been assessed as Endangered (IUCN, 2006) because of habitat destruction and alien fish introductions. *Sandelia bainsii* inhabits the middle to upper reaches of rivers with rocky substrata, while *B. trevelyani* prefers upper tributary streams which have a good perennial flow. Ecological niche modelling has been used successfully to predict freshwater fish distributions, and to aid conservation efforts by indicating where new populations may be found. The environmental layers used in the modelling algorithms broadly fell into the categories of topography (elevation, slope and aspect), substratum (surface stratigraphy, broad soil type, average soil depth and average clay content), climate (air temperature and rainfall) and river size and flow. While the modelling algorithms predicted wider distribution ranges compared to current knowledge, we found the ecological niche models of *S. bainsii* and *B. trevelyani* to be realistic according to our knowledge of the habitat requirements and distribution ranges of these species. This methodology could assist us in predicting areas of historical occurrence and could lead to the discovery of new populations. Sanctuary areas and government-backed and implemented management plans are urgently required for both species. Areas of special concern should be those in which both species occur together such as in the Amatola mountains which are under threat from developments for alien trout.

IMPACTS OF INVASIVE ALIEN PLANT CLEARING ON RIPARIAN VEGETATION RECOVERY ALONG RIVERINE CORRIDORS IN MPUMALANGA, SOUTH AFRICA

BEATER, MARGARET, Edward Witkowski

The aim of this study was to measure the ecosystem repair of the Sabie River riparian environment in Mpumalanga, South Africa, in response to the clearing of alien plants by the Working for Water (WfW) alien plant clearing programme. This was achieved by studying the long term impacts of this programme and the invasion of alien plants, on the plant species composition, diversity and vegetation structure of riparian ecosystems on the Sabie River. Over time, the mean species richness increased significantly (24.1 ± 1.0 in 1996 and 44.4 ± 1.5 in 2005; $P < 0.001$). The greatest increase over time was for weed species, which increased by 50%. Beta diversity over time was relatively low, indicating a small change in species composition, despite the increase in species richness. It is concluded that the WfW clearing along the Sabie River has been partially successful, as there has been a significant decrease in the invasion intensity of large alien trees (which tend to have the highest transpiration rates) over time. However, the WfW programme was not effective in terms of ecosystem repair, as the invasion intensity increased slightly from 1996 to 2005, largely as a result of the significant increase in the aerial cover of smaller alien shrubs. Furthermore, the growth form composition remained relatively unchanged over time, and more than half of the alien species found in 2005 were tree and shrub species. Therefore, little or no ecosystem repair has occurred along the Sabie River.

FERAL CATS ON ISLANDS : GLOBAL PATTERNS IN THE DIET OF AN INVASIVE PREDATOR
BONNAUD, ELSA, Eric Vidal, Erika Zavaleta, Josh Donlan, Felix Manuel Medina, Manuel Nogales, Bernie Tershy, Bradford Keitt, Matthieu le Corre

The feral cat is among the most cosmopolitan introduced predator on islands, and is responsible for a suite of direct and indirect negative impacts on insular biodiversity worldwide. The success and spread of this opportunistic predator is generally attributed to its trophic adaptability and generalist diet. Here we synthesize diet patterns and trophic impacts of feral cats to elucidate general biogeographical and ecological patterns. We address a number of questions using a world-wide dataset with a meta-analyses framework: Are there general trends in the diet of feral cats on islands? How do abiotic and biotic factors influence diet composition and diversity? Are feral cats more successful or have greater impacts in certain biogeographical provinces? Does the presence of certain abundant prey species, native or non-native, influence the dynamics and overall diet of feral cats? The feral cat appears adaptable to most insular environments, irrespective of biogeographical factors. In contrast, its impact on native species varied principally according to the prey composition present. Our meta-analyses and similar approaches could aid in the prioritization of invasive mammal eradications on islands worldwide.

CARNIVORE HEALTH AND CONSERVATION RISKS RELATED TO HUMAN ACTIVITIES IN A PROTECTED AREA OF THE BRAZILIAN AMAZON TROPICAL FOREST
WIPPICH WHITEMAN, CHRISTINA, Ulisses Eugênio Cavalcanti Confalonieri, Maria das Dores Correia Palha, Eliana Reiko Matushima, Vanessa Conceição Monteiro, Alanna do Socorro Lima da Silva, Jamile da Costa Araújo

Human encroachment in protected areas has been a longstanding source of social conflict and a threat to wildlife conservation in the Brazilian Amazon. In fragmented landscapes, risks may become even greater. In our study, such issues are addressed at the Zones of Wildlife Protection (ZWP) of the Tucuruí Lake Protected Area, Eastern Brazilian Amazon. In order to assess these risks, interviews were conducted with the local riparian communities. Domestic and wild carnivore, as well as marsupial species, have been sampled for infectious disease investigation. The interviews revealed the practice of hunting with dogs and close contact between wild carnivores and the local people as conservation and disease transmission threats. The domestic dog disease survey (n=100) showed positive serological results for Canine Distemper (27%), Toxoplasmosis (80%), Leishmaniasis (9.4%), Leptospirosis (10%), Brucellosis (2%) and Neosporosis (10.6%), and negative for Rabies. Two ocelots (*Leopardus pardalis*) have been tested and resulted positive for Toxoplasmosis and negative to the Immunodeficiency and Feline Leukemia viruses. Marsupial samples (n=34) were positive for Toxoplasmosis (17.6%), and negative for Leishmaniasis. Distemper represents a threat to wild carnivores in the area, and the zoonotic agents identified have potential impact on the local wildlife, domestic animal and human populations.

THE PERSISTENCE OF SUMATRAN MAMMALS IN HUMAN-DOMINATED LANDSCAPES:
WHICH SPECIES, WHERE AND WHY?
SMITH, JOSEPH, Tim Coulson, Chris Carbone, Tom Maddox

Sumatra's increasingly pervasive population has created an urgent need to understand the effects of human activities on the persistence of remnant wildlife. Much of Sumatra's landscape is now dominated by a matrix of oil palm, degraded forest and rural settlement. Our objective was to identify the anthropogenic and environmental factors associated with species persistence within these habitats. Repeated detection/non-detection surveys of 73 randomly distributed cells, within a 900 km² study site identified 25 medium/large mammals from 1752 hrs of search effort and 1760 camera trap-nights. Logistic regression analysis identified key landscape factors associated with the probability of species occurrence. Mammalian diversity differed between major habitat classes with highest overall diversity recorded in areas dominated by degraded forest rather than oil palm or rural settlements. Preliminary data for the Sumatran tiger *Panthera tigris sumatrae* indicate use of more remote forest habitats, characterized by closed canopies and low levels of

human activity. In contrast, the Malayan sun bear *Helarctos malayanus* and tapir *Tapirus indicus* occurred in more disturbed forest with higher levels of human activity. Our results provide a basis for collaborative Sumatran-wide surveys of terrestrial mammal distributions and associated threats, which will underpin future landscape conservation measures.

WALK THE LINE: BENEFITS AND CONSEQUENCES OF ROADS AND TRAILS TO EASTERN WOLVES (*CANIS LUPUS LYCAON*) WITHIN AND ADJACENT TO A LARGE PROTECTED AREA

MACKENZIE, ALISTAIR, Marie-Josée Fortin, Brent Patterson, Dennis Murray

Roads and trails within protected areas may affect intra- and inter-specific relationships of wildlife; such interactions may in turn affect population level processes and long term viability. Previous studies on wolves have reported conflicting evidence that wolves show both affinity for and avoidance of roads. This conflict may arise due to the nature and conditions of the features; circumstances of low human activity may allow animals to derive benefit from linear features. Using location data (50,464 points) from 27 GPS collared wolves collected over 4 years we tested for wolf affinity or avoidance of primary, secondary and tertiary roads as well as trails during different seasonal periods. We employed randomization procedures on individual telemetry points, temporally sequential paths and empirical estimates of home ranges. Individual wolf points were significantly closer to linear features than randomly generated points. Wolf home ranges and sequential paths contained or intersected significantly more linear features than other areas of the landscape. Thus, conservation initiatives within protected areas should focus on the quantity and configuration of linear features; exploitation of roads and trails by top predators may have cascading effects upon prey species and interspecific competitors in terms of capture efficiency, home range size and territorial defense.

CONTRASTING POTENTIAL IMPACTS OF CLIMATE CHANGE ON THE RANGES AND MIGRATORY REQUIREMENTS OF EUROPEAN *SYLVIA* WARBLERS

DOSWALD, NATHALIE, Yvonne C. Collingham, Brian Huntley, Debbie Pain, Rhys E. Green, Steve G. Willis

Little work has been done examining the potential effects of climate change on both the breeding and wintering ranges of migrant species and the consequent implications to migratory distances and pathways. Here we model both the breeding and wintering ranges of 15 species of European/North African breeding birds of the genus *Sylvia* across Europe and Africa using climate response surface models and show that wintering and breeding range can both be modelled well. Simulations of range extents under three future climate change scenarios highlight that, for all species, range shifts on the breeding grounds will have greater consequences on future migration distances, compared to shifts in the wintering ranges. We simulate that short distance migrants will have a significantly increased relative migration distance in future and also simulate an increased suitability for over-wintering in Europe for several species, as has already been observed for the blackcap, *Sylvia atricapilla*, over recent decades. Our results highlight the individualistic responses of species, with few species simulated to have consistent range size changes on both breeding and wintering grounds. Neither climate change effects on the breeding or wintering grounds are individually likely to be the dominant climatic factor in changing populations of European migrant species in the future. Instead both should be considered in parallel.

CORRELATES OF RAPID DECLINE IN ANURANS: SPOTTING TRENDS TO DIRECT CONSERVATION EFFORTS

BIELBY, JON, Natalie Cooper, Andrew A Cunningham, Andy Purvis

The 2004 Global Amphibian Assessment outlined 398 anuran species that have recently moved a step closer to extinction. A number of threatening processes have been implicated in these declines, including emerging infectious diseases. Diseases, in particular chytridiomycosis, are a serious threat to amphibian biodiversity having been responsible for severe declines and the

possible extinction of several species of anurans. Species-specific intensive management has been suggested as an action plan for species conservation in the face of chytridiomycosis. If such remedies are to be effective, it is essential that we have a robust method for identifying those species most at risk of decline in the future. Using a dataset including species from six continents, we conducted multivariate comparative analyses to investigate the relationship between chytrid related changes in Red List status and a variety of biological, environmental and climatic predictor variables. We found that freshwater dependent, restricted range, low fecundity montane species were more susceptible to chytrid linked declines. Such species represent high priority conservation targets. Further, we found that widespread species in temperate climates were more likely to have been recorded as suffering from chytrid infection. While there may be a biological explanation for this pattern, it possibly underlines biases in our knowledge of chytrid distribution.

HABITAT VALUE OF REMNANT RIPARIAN FOREST CORRIDORS FOR WILDLIFE LEES, ALEXANDER

Protected areas are crucial but wholly insufficient to ensure the persistence of the tropical forest biota worldwide, the fate of which depends primarily on private landholdings. Brazilian forestry legislation requires that all riparian zones on private landholdings should be maintained as reserves, and sets the minimum width of riparian forest to be retained alongside rivers and perennial streams. The width of these forest corridors should be proportional to that of the watercourse. We investigated the effects of width and degradation status of 37 riparian forest sites, including 24 corridors connected to large forest patches, 8 unconnected forest corridors, and 5 control riparian zones embedded within continuous forest patches on bird and mammal richness in a hyper-fragmented forest landscape surrounding Alta Floresta, Mato Grosso, Brazil. Vertebrate use of corridors was highly species-specific but broad trends emerged dependent on species life histories and their sensitivity to disturbance. Narrow and/or highly disturbed riparian corridors retained only a depauperate vertebrate assemblage that was typical of non-forest habitats, whereas wide, well-preserved corridors retained a near complete species assemblage. Restriction of livestock movement along riparian buffers by targeted fencing, and excluding key areas alongside deforested streams would allow regeneration and facilitate connectivity restoration.

PROMISCUITY AND PROTECTED AREAS – INSIGHTS INTO CHEETAH MATING STRATEGIES IN THE SERENGETI

GOTELLI, DADA, Jinliang Wang, Sultana Bahir, Sarah Durant

Cheetahs live at low density and need large home ranges, which makes them vulnerable to population declines. Understanding the parameters that affect their reproductive success is crucial for cheetah conservation. In this study we made use of a long term behavioural and genetic dataset comprising cheetah mothers, their cubs and putative fathers to infer the mating system of the Serengeti cheetah population. A statistical analysis programme was adapted to infer paternity from the analysis of thirteen microsatellite loci. Our data showed a high rate of multiple paternity in the population; 43% of litters were fathered by more than one male. The results also demonstrated that female fidelity was low, and provided some evidence that females chose to mate with unrelated males. This pattern indicates that pre-copulatory male manipulation of females was counterbalanced by polyandry. Although almost 65% of resident adult males were sampled, paternity assignment was low, indicating that males living outside the park boundaries may contribute substantially to cheetah reproduction. This finding reinforces the role that cheetah's high mobility of plays in their ecology, and should be taken into consideration in any management programmes aimed at the conservation of this species.

CONDITION-DEPENDENT HABITAT SELECTION BEHAVIOUR IN REINTRODUCTIONS:
CONSEQUENCES FOR POPULATION SETTLEMENT AND VIABILITY
BAPTISTE MIHOUB, JEAN, Pascaline Le Gouar, François Sarrazin

Despite their growing use, reintroductions still have a high failure rate. The success of reintroduction programs depends largely on release strategies and, as in extant populations, on habitat quality and dispersal patterns. To address the role of habitat choice in reintroduced populations, we integrated three explicit condition-dependent habitat selection strategies – based on intrinsic habitat quality, presence or reproductive success of conspecific- and one fixed random strategy in a demographic model. We analyzed the influence of behaviour on (i) establishment and (ii) viability of reintroduced populations in short and long-lived species. We also compared population dynamics under several release designs differing with respect to age ratio of the released groups and release frequency. Our results suggest that, depending on habitat selection strategies, initial environmental conditions and release methods greatly affect settlement in all types of species, regardless of life cycle. In addition, random or conspecific attraction-based strategies can be unviable strategies, e.g. ecological trap, when selection criterion and environmental quality are unrelated. Consequently, these results stress the importance to assess species dispersal behaviour patterns before reintroduction. Integrating habitat selection behaviour in reintroduction models to avoid incorrect predictions is thus of primary importance and implies the need of more behavioural ecology studies.

CAPACITY BUILDING IN MAMMAL MANAGEMENT FOR WESTERN CAPE NATURE
RESERVES: MONITORING THE ENDANGERED CAPE MOUNTAIN ZEBRA
SMITH, REBECCA, Russell Hill

Effective monitoring and management of the endangered Cape mountain zebra *Equus zebra zebra* (CMZ) is essential for its long-term survival. The CMZ population at De Hoop Nature Reserve is the most genetically diverse in existence and vital for the long-term stability of the subspecies, but monitoring had almost ceased by the end of 1999. Our project aimed to develop rigorous methodologies for monitoring CMZ and other large mammals in Western Cape Nature Reserves where the focus has traditionally been on the sensitive flora of the region. We re-established population monitoring for CMZ at De Hoop in 2005 by training field rangers to use CyberTracker. During the first year, 99 individuals were identified indicating a decline in annual population growth since 1999. A male biased sex ratio may have contributed to this decline. This bias, in conjunction with results from a study of habitat use, which indicate a preference for grasslands (3% of the area), suggests that 'excess' males should be translocated in order to maximise reproductive potential of the population. Our work highlights the importance of effective monitoring for the development of management strategies and thus for the long-term stability of threatened species.

TRACKING THE PULSE OF LIFE: A GLOBAL FRAMEWORK FOR MONITORING AND
UNDERSTANDING BIODIVERSITY IN THE FACE OF CLIMATE AND LAND COVER CHANGE
ANDELMAN, SANDY, Jorge Ahumada

Global change and direct human actions threaten biodiversity at local to global scales and compromise the essential services that human societies derive from nature. Although biodiversity is one of our planet's most precious assets, we do not have a consistent way of measuring biodiversity change that allows us to make comparisons among different geographic scales and among different taxonomic and trophic levels in a way that is statistically robust. The Convention on Biological Diversity set a target to reduce current rates of biodiversity loss by 2010. This creates the need for a monitoring program that not only produces detailed and reliable information about rates of biodiversity loss, but that also will provide insights into the underlying mechanisms of change at the relevant scales. We present a site selection and sampling framework for a global network of sites that will enable us to quantify and forecast changes in biodiversity in response to climate change and land cover. This unprecedented effort fills a critical

data gap in conservation science by providing the first public domain, reliable time series data on a range of biodiversity attributes at local, regional and global scales.

CONSERVATION OF LONG-LIVED PLANTS SHOULD CAPITALISE ON SYNERGIES BETWEEN THREATS

REGAN, HELEN, David Keith, Mark Tozer, Tracey Regan, Naomi Tootell

As threats to biodiversity increase there is a growing need to investigate interactions between multiple threats and manage populations accordingly. The current management paradigm is to address threats separately without understanding their synergistic effects on population dynamics. We use a long-term data set for *Xanthorrhoea resinifera* to parameterise an individual-based population model to investigate the cumulative effects of altered fire regime and disease on risk of decline. This species is representative of a functional group of plants found in all Mediterranean climates: long-lived resprouters. We show that over a 150 year horizon altered fire regime does not have a noticeable impact on population persistence in the absence of disease. However, when the full impacts of disease are considered the best fire regime is complete fire suppression. This option performs better than 50% disease reduction with wildfires: fire causes some mortality not offset by post-fire recruitment over the time horizon. We consider additional time horizons relevant to the population dynamics of the species, the threatening processes and the practicalities of management. For long-lived species these time scales are incommensurate but reveal different feedback effects and provide different strategies for management. We show that consideration of synergies between threats can reveal counterintuitive solutions. Such consideration is critical to providing effective conservation management.

BIASED DATA REDUCE EFFICIENCY AND EFFECTIVENESS OF CONSERVATION RESERVE NETWORKS

Grand, Joanna, Michael P. Cummings, Anthony G. Rebelo, Taylor H. Ricketts, MAILE C. NEEL

Complementarity-based reserve selection algorithms efficiently prioritize sites for biodiversity conservation, but they are data-intensive and most regions lack complete species inventories. We explored the implications of basing conservation planning decisions on incomplete and biased data using occurrence records of the plant family Proteaceae in South Africa. Treating this high-quality database as “complete”, we introduced three realistic biases characteristic of biodiversity databases: a detectability bias and two forms of roads bias. We then compared reserve networks constructed using complete, biased, and randomly-sampled data. All forms of biased sampling performed worse than both the complete dataset and equal-effort random sampling. On average, biased sampling failed to detect 1-5% of species, and resulted in reserve networks that were 9-17% larger than those designed with complete data. Spatial congruence and the correlation of irreplaceability scores between reserve networks selected with biased and complete data were low. Thus, reserve networks based on biased data require more area to protect fewer species and are spatially distinct from those selected with randomly sampled or complete data.

LONG TERM DEMOGRAPHIC CHANGES IN THE TARANGIRE ELEPHANT POPULATION: A 13 YEAR STUDY

FOLEY, CHARLES A.H., Lisa J. Faust

Since the introduction of the international trade ban on ivory in 1989 many elephant populations in East Africa have staged a rapid recovery. The population of elephants of Tarangire National Park, Tanzania, has been monitored nearly continuously since 1993, and demographic data have been collected from 667 individually known female and infant elephants in 27 family groups. During this period the population has increased by 6.3% per annum. Demographic variables have reached what is probably the biological minima for this species: average interbirth intervals are 3.3 years (median 3.1 years), age of first birth is 10.9 years, while infant first year mortality averages 2% per annum for females and 4% for males. 3% of infants born have been twins. This rapid population growth is a likely result of an abundance of forage and a release from the reproductively suppressive effects of poaching. The population growth rate is now slowing; it is

unclear whether this is a consequence of below average rainfall in the past three years or of negative density dependence impacting the population.

THE IMPACT OF SALMON FARMING ON THE HOST PARASITE RELATIONSHIP BETWEEN SEA LICE AND JUVENILE SALMON: IMPLICATIONS FOR THE HEALTH OF WILD SALMON POPULATIONS

PEET, COREY R., John Volpe, Asit Mazumder, Alexandra Morton,

Amplification of the ectoparasitic salmon louse (*Lepeoptheirus salmonis*) and subsequent large scale transfer to wild fish is a growing conservation concern associated with open-net salmon farming. Recently, salmon lice outbreaks resulting in high levels of mortality of wild juvenile salmon have been documented in coastal areas of British Columbia (BC), Canada where salmon farming activities are concentrated. Concern is mounting as to what effect increased lice densities may have on affected salmon populations. Key to the debate has been a lack of data on ambient sea lice infection levels on juvenile salmon. We empirically examined the natural interactions between sea lice and juvenile salmon in an area that allowed simultaneous assessment of ambient lice infection levels and the influence of salmon farms. Results show salmon farms increase lice densities on wild juvenile salmon up to 150 times above ambient levels. These results coupled with the species specific risk factors of some Pacific salmonids suggest industrial scale salmon farming poses a significant threat to sympatric salmon populations.

CAN CARBON SEQUESTRATION IN REGENERATING EASTERN ARC MOUNTAIN FORESTS ENHANCE CONSERVATION EFFORTS AND IMPROVE LIVELIHOODS?

MWAMPAMBA, TUYENI HEITA

Carbon sequestration in tropical forests is increasingly being considered as an ecosystem service that can meet the dual goals of conservation and improvement of livelihoods. Vegetation and soil sampling of more than 50 belt transects was conducted in the Eastern Arc Mountains, Tanzania, to determine the rate of above and below-ground C sequestration in regenerating forests and to investigate the effects of land use history on sequestration. The results make possible a preliminary sequestration model for the Eastern Arcs based on land use history, elevation and aspect and identify the tree species most significant to carbon accumulation. Given current C prices, an assessment is made as to whether C accumulation in forests is sufficient to improve local livelihoods in the area.

ACTIVITY-SPECIFIC HABITAT PREFERENCE IN AMERICAN BADGERS: IMPLICATIONS FOR CONSERVATION PLANNING

QUINN, JESSICA

Mapping the availability of suitable habitat for species often serves as a foundation for developing conservation plans. In many species, different habitats may be used for different activities, which should also factor into conservation planning efforts. In this study, I investigated habitat use in the American badger *Taxidea taxus*, a semi-fossorial grassland carnivore. 10 radio-implanted badgers, 6 females and 4 males, were tracked for up to 18 months in Monterey County, California, U.S.A. Using compositional analysis, I examined whether badger preference for vegetation type, road proximity, or trail proximity for daytime denning differed from that preferred for nocturnal foraging and traveling. Analysis was conducted at the scale of both the study site and home range. At the study site scale, badgers preferred grasslands and areas more distant from roads for all types of activity. Within their home range, badgers showed no preference for vegetation type or trail proximity for foraging and traveling, but did prefer to use areas further from roads for these activities. For denning within their home range, badgers preferred scrub and riparian habitat; and den sites further from trails as well as roads. Grassland conservation efforts that use badgers as a focal species should consider these different types of habitat use when determining the configuration of both core and corridor habitat.

PATTERNS OF SEED RAIN AND REGENERATION IN ABANDONED AGRICULTURAL
CLEARINGS IN A TROPICAL DECIDUOUS FOREST IN INDIA
TEEGALAPALLI, KARTHIK, Ankila Hiremath, Devcharan Jathanna

Forest recovery in human-abandoned pastures and agricultural fields has been shown to be particularly slow. We examined seed arrival and regeneration of trees at different distances from the forest and investigated if introducing bird-perches improves seed arrival, in five abandoned clearings nested within a seasonally dry forest in India. Seeds of the invasive shrub *Chromolaena odorata* arrived abundantly into the clearings. Relative to animal-dispersed seeds, wind-dispersed seeds were over-represented and declined steeply in numbers farther from the forest. Introduction of bird-perches increased seed numbers 20-fold and species richness by 50%. Considerable regeneration was recorded in the clearings, but seedling and juvenile numbers declined linearly into the clearings. Competition with existing vegetation was found to play a secondary role in limiting regeneration. Our data indicate that although slowly, the clearings are likely to revert to forests over time. Clearing of *Chromolaena* thickets and planting of native trees—especially species that attract frugivorous seed dispersers—may foster regeneration. However, if management objectives of the park are to maintain high densities of large mammals, interventions such as clearing or burning may be required. Continued monitoring of these clearings will be invaluable in understanding the dynamics of forest recovery in seasonally dry tropical forests.

MAIN THREATS TO AVIFAUNA IN “SERRANIA DE LAS MINAS” (TROPICAL ANDES
HOTSPOT): AN ANALYTICAL SURVEY
GALLO-CAJIAO, EDUARDO, Carlos Julian Idrobo-Medina, Luis Alfonso Ortega-Fernandez

In spite of fragmentation being one of the main harms to birds in tropical forests, few studies have concerned the underlying mechanisms of its causes. During 2004-2005 we surveyed in Serrania de las Minas, Southwestern Colombia, the main threats to avifauna implementing an integral approach that included environmental, social, economical and political perspectives. We conducted this analysis through open-ended interviews, participant observations, incorporating satellite images analysis and literature revision. We identified indirect and direct threats, as follows: expansion of the agricultural frontier, timber-use crops, high biocide-use crops, illicit-use crops, road construction, hunting and commercial and local aimed logging. We propose that expansion of the agricultural frontier could be considered as a pivotal threat, because when this occurs the rest almost inevitably happen too. This keystone threat is maybe caused by a lack of a land ownership reformation in Colombia, human population increasing, low-income human population, land's speculative interests and global political and economical dynamics. We found, according to previous studies, that the identified threats potentially affect birds at life-history level, as well as population dynamic level. We concluded that such threats operate in a synergistic way and that their deleterious effects are multidimensional in birds.

CAN “NET PRESENT VALUE” (NPV) BE USED AS DECISION TOOL TO DIVERT FOREST
LAND TO NON-FOREST USES? – THE INDIAN EXPERIENCE
CHAKRABARTI, MILINDO

The extent to which conversion of forest land to other non-forest uses should be allowed in India is an important policy question today. Environmentalists, development practioners, activists, academics, industrial enterprises have been involved in the debate, which is being intensively monitored and supervised by the Apex Court of the country, suggesting the strong interlinkage existing between social and ecological systems. There has been more or less a consensus among the different stakeholders on allowing conversion of forest land to non-forest uses on upfront payment of the net present value (NPV) of the stream of benefits – both tangible and intangible – that would have been derived from the forest land diverted, with some well spelt out restrictive clauses. Incidentally, India appears to be the first country in the world to have initiated such an effort at settling the disputed issue and consequently, have been suffering from considerable teething problems. The present paper a) Chronicles the efforts made so far in

reconciling the differing interests through an NPV regime; b) Charts the existing difficulties – both conceptual and practical – in implementing a suitable NPV regime and c) Suggests possible ways out to arrive at a meaningful consensus among the stakeholders. Indian experiences so far may be used as a suitable reference point in other developing countries to balance the tension between development and conservation.

ECOLOGICAL LINKAGES FOR URBAN BIRD POPULATIONS

DAVIS, ROBERT, Lesley Brooker, J Dale Roberts

The conservation of urban fauna populations is an imperative and timely goal in an expanding world of concrete and steel. Perth, Western Australia's capital, is experiencing strong growth and rapid urban development on a small and bio-diverse coastal strip of 50 km north-south by 25 km east-west. The objective of our research was to identify fauna species most at threat in the Perth metropolitan region and determine the parameters most affecting population viability, with a focus on the importance of corridors. An extensive literature review and Delphi survey of 15 experts identified several bird taxa at risk especially Splendid Fairy-wren, Thornbills, Scarlet Robin and Grey Shrike Thrush. We analysed a database of 1500 repeat bird surveys from 121 urban remnants. Pattern Analysis identified three major categories; bushland-dependent specialists, bushland-dependent generalists and urban generalists. Preliminary pattern analysis supported species chosen under the Delphi process (Thornbills and Fairy-wrens) as most at risk and a GLM identified the primary factors affecting population viability as dispersal, remnant area, isolation and fire. Field studies on corridor use by at risk species revealed a strong preference for dense cover and a strong negative correlation with fire frequency. The practical on-ground actions arising from this project will be outlined to show how landscape connections in urban areas can increase the long-term viability of remnant faunal populations.

USING EXISTING FORESTRY AND ECOLOGICAL DATA TO INFORM FOREST CONSERVATION – THE NEED FOR DATA TO SERVE MULTIPLE FUNCTIONS

McPHERSON, TSITSI

What are the biotic affinities of native tropical species that would facilitate their conservation or use in reforestation? Answers to this question are not easily obtained from the current literature. Using floristic data from the 18, 0.5 ha CARBONO plots at La Selva, Costa Rica, 51 economically important species were analysed to evaluate the explanatory power of nutrients and topography relative to species abundance, dominance and importance. A literature search of the 51 species in all major science search engines was completed to compare published nutrient/slope associations with those obtained in this study. Species were analysed using the multivariate techniques Redundancy Analysis (RDA) and Canonical Correspondence Analysis (CCA). Published nutrient/slope associations were available for 8 of the 51 species, with little similarity between published accounts and from this study. Although 20% variation in species abundance, dominance, and importance were cumulatively explained by nutrients and slope, RDA analyses suggest the importance of other environmental factors. Published records reported nutrient quantities in plant parts while this study considered nutrient levels in the soil. This study points to the need for greater communication between foresters, ecologists, and policy writers. Conservation driven by research requires data to serve multiple functions from management to policy creation.

SPATIAL CONFLICTS BETWEEN FORAGING SEABIRDS AND TRAWL FISHERIES IN THE PROPOSED MARINE PROTECTED AREA OF GOLFO SAN JORGE, ARGENTINA

YORIO, PABLO, Flavio Quintana, Patricia Dell'Arciprete, Diego González-Zevallos

The north of Golfo San Jorge holds a significant proportion of the Patagonian breeding population of Magellanic Penguins *Spheniscus magellanicus* and Imperial Cormorants *Phalacrocorax atriceps*. These are important targets for ecotourism and guano production, respectively. Its waters are also used by over 100 trawlers targeting for hake and shrimp. This area has been recently proposed as a Marine National Park, and thus information is needed for spatial planning.

We studied the use of feeding areas by penguins (n = 5) and cormorants (n = 13) during the 2006 breeding season using GPS, and assessed its relationship with fisheries based on fishery statistics and on-board observations. Foraging distances from the colony varied between 25.8 and 44.3 km (mean = 37.4) for Magellanic Penguins and 2.0 and 17.9 km (mean = 8.9) for Imperial Cormorants. Foraging areas overlapped extensively with trawlers operating in the area. Ten of the cormorants spent on average 53% (range = 26-87%) of their time at sea within the area used by the fishing fleets. Incidental mortality evaluated during the height of the fishing season between 2003 and 2006 reached a maximum of 1382 and 1855 cormorants and penguins, respectively. Our results suggest the urgent need for developing spatial and temporal zoning schemes to minimize conflicts between seabird populations and commercial fisheries.

RETHINKING THE FUTURE OF BIODIVERSITY CONSERVATION IN MADAGASCAR ANDRIANARIMISA, ARISTIDE, Helen Crowley, Lisa Gaylord, James Mackinnon

At the 2002 World Summit on Sustainable Development Madagascar agreed to triple the acreage of its protected areas in order to achieve a significant reduction in the current rate of loss of biological diversity by 2008. With its current 15-year National Environmental Action Plan, which was enacted in 1995, the island was protected by new conservation strategies. Reviews of published and unpublished data were undertaken to evaluate the impact of this program both on biodiversity conservation and people welfare. As results, deforestation rates have since declined from over 400,000 ha a year in 1975-1985 to around 100,000–200,000 ha a year during the 1990s. Nearly 1.6 million ha were recognized as reserves in the National Network of Protected areas, and 1.8 million ha have been recently created under the new IUCN paradigm which focuses on benefiting the local people to alleviate poverty, reengineering protected areas, and highlighting the interaction between humans and nature. Now, landscapes to conserve the majority of endangered vertebrate species are identified as highly prioritised zones for conservation. Considerable progress has been made in legal protections and the government's commitment to conservation. But there are areas where more work needs to be done; among these are freshwater ecosystems, illegal trade, insuring the effectiveness of various management initiatives, and long term funds to support the conservation programs.

PEST CONTROL AS AN INCENTIVE FOR BIRD CONSERVATION IN COFFEE PLANTATIONS JOHNSON, MATTHEW, Jherime Kellermann, Amy Stercho, Steve Hackett, Dwight Robinson

Ecological services provided by native species can offer incentives for conservation in agricultural regions. Birds in diverse coffee farms suppress insect abundance, but to date there is no evidence that these reductions directly benefit crop production or farm income. We hypothesized that (1) birds suppress the coffee berry borer (*Hypothenemus hampei*), the world's most destructive coffee pest, (2) this service translates to increased income for farmers, and (3) the benefit of birds is positively associated with vegetative complexity and farm heterogeneity. Using experimental bird exclosures, we tested these hypotheses in one low and four high elevation farms in Jamaica. Coffee berry borer were more abundant inside than outside exclosures across all farms, though the differences were greatest at low elevation. The market value of increased saleable berries attributable to suppression of coffee berry borer by birds ranged from US\$17 to over US\$80 per acre, but there was little evidence that this ecological service provided by birds was dependent on farm complexity. Our results are the first to demonstrate a strong direct economic incentive to conserve bird populations in coffee farms. We hypothesize that landscape heterogeneity may enable the spread of birds from diverse to homogenous farms. Future work should investigate landscape composition to identify conditions under which the ecological services of birds and other organisms can be maintained.

THE SPATIAL ECOLOGY OF A SEMI-URBAN CHACMA BABOON (*PAPIO H. URSINUS*)
TROOP: A CASE STUDY IN THE CAPE PENINSULA, SOUTH AFRICA
HOFFMAN, TALI, Justin Oriain

A quarter of the world's 230 primate species are currently threatened by the direct and indirect activities of humans. The Cape Peninsula in South Africa is a classic example of this trend, with urban sprawl greatly reducing the availability of suitable habitat to the local baboon *Papio h. ursinus* population. In this study we perform a spatial analysis on a semi-urban baboon troop using GPS and behavioural data. Spatial analyses are considered to be a critical component of organismal and system ecology and the quantification of spatial patterns makes inference about the causation of behaviour possible. GIS analyses were performed to relate the extent of the home range to spatial and temporal distributions of critical resources and the effects of habitat, altitude and seasonality on area usage and movement patterns. Area use correlated positively with alien vegetation and negatively with indigenous vegetation and altitude. The most intensively utilised areas of the home range were comprised of pine plantations, vineyards and urban habitats. The most favoured food items were alien grasses, seeds/corns and pine cones. A seasonal home range shift from high to low altitudes was attributed to high primary production (e.g. grasses) following the onset of winter rains. Semi-urban troops may thus benefit from anthropogenic disturbances, exhibiting reduced home range size and daily distances travelled. The implications of these findings for short-term and long-term management of the baboons in the Cape Peninsula are discussed.

KLEE: THE FIRST 12 YEARS OF AN EXPERIMENTAL APPROACH LIVESTOCK-
BIODIVERSITY INTERACTIONS

YOUNG, TRUMAN P., Charles Warui, Bell Okello, Robert M. Pringle, Kari E. Veblen, Corinna Riginos, Charles Warui, Frederick Erii

Most African savanna wildlife occurs on rangeland managed for livestock, and the conservation of savanna biodiversity will depend on coexistence with livestock on multiple-use lands. However, there are virtually no controlled replicated studies that simultaneously manipulate both domestic and wild herbivores. In Laikipia, Kenya, we have been excluding combinations of a) cattle, b) wildlife, and c) megaherbivores from replicated plots in bushy grassland since 1995. I provide an overview of the first 12 years of the Kenya Long-term Exclosure Experiment (KLEE). We have revealed strong competitive interactions and compensatory responses. Most vertebrate and invertebrate herbivores respond positively to the exclusion of competitors, although these interact in complicated ways. These effects cascade through the system, affecting birds, snakes, lizards, and spiders. Cattle foraging behavior is positively affected by the exclusion of wildlife, but only during dry periods. Cattle fully compensate for the absence of wildlife, but wildlife do not fully compensate for the absence of cattle, perhaps because cattle far outnumber large native herbivores in this system. Complete exclusion of large herbivores set the savanna on a pathological trajectory that includes increased mortality of grasses and increases in forb abundances. Together, these results suggest a highly interdependent web of interactions among wild and domestic savanna species.

SPATIALLY EXPLICIT MODELS FOR PREDICTING THE RESPONSES OF RIVER
COMMUNITIES TO ENVIRONMENTAL CHANGE

ANDERSON, KURT, Roger Nisbet, Edward McCauley, Sebastian Diehl

Managers have traditionally used simple hydrological and habitat-association methods to predict how disturbances to river environments affect viability of instream biota. An emerging consensus advocates shifting the focus of management away from habitat provisions for target species and towards preserving viability of the larger river environment. Progress in this area has been hampered by the lack of modeling tools for understanding how river communities respond to spatially variable environmental disturbances such as nutrient inputs and changes to the flow regime. We use population models to identify a characteristic length scale, the response length, which identifies the spatial scale over which communities respond to environmental disturbances.

Due to the effects of dispersal, communities that exhibit longer response lengths will often show more limited responses to disturbances occurring over spatial scales smaller than the response length, and will typically return to their pre-disturbance state faster. Response lengths can be approximated as the average lifetime dispersal distance of the most dispersive member of small, tightly linked foodwebs, and are highly dependent on flow conditions. We illustrate the utility of response lengths using data collected from the Bow River south of Calgary, Canada. We conclude by identifying future research needs, such as the integration of spatially explicit population dynamic models with hydrological and nutrient processing models.

POPULATION AND CONSERVATION STATUS OF CRITICALLY ENDANGERED SPECIES: TONKIN SNUB-NOSED MONKEYS (*RHINOPITHECUS AVUNCULUS*) IN VIETNAM DONG, HAI

The Tonkin snub-nosed monkey (*Rhinopithecus avunculus*) is a slender-bodied, sexually dimorphic, arboreal, critically endangered primate and endemic to northern Vietnam. It belongs to the subfamily Colobinae. Global population for *R. avunculus* has remained unclear and is largely based on local reports and short surveys. The most recent estimate for total population of *R. avunculus* is 250 individuals. This was the first long term study on the population and conservation status of the species. Systematical observations were carried out at the three known sites of *R. avunculus* between 2004 and 2006 and found that 1) the population size of *R. avunculus* is decreasing (less than 130 individuals); 2) Hunting pressure is still high and a major threat to the survival of *R. avunculus* in their range; 3) Although conservation activities have been carried out at the langur's habitats, some have proved unsuccessful. These results are contrastive to previous reports. Tat Ke Sector, Na Hang Nature Reserve, for example, has been reported to be home of a population of 80 individuals and hunting pressure has been successfully controlled, but an eleven-month study revealed that population size is only 22 individuals and team members would hear from three to five gunshots on daily basis.

A COMPARISON OF THE EFFECT OF HERBIVORES AND MAN ON THE VEGETATION OF NORTHERN MAPUTALAND, KWAZULU NATAL, SOUTH AFRICA GAUGRIS, JEROME, Margaretha van Rooyen

We evaluated the influence of herbivores and man on five woodland and three forest vegetation communities of the Maputaland Biodiversity hotspot. Abundance and distribution surveys were conducted on three sites. Tembe Elephant Park (TEP), where herbivore populations densities have grown since 1989 and are thought to shape the vegetation is the herbivore influence site, the village area of the rural community of Manqakulane (MRC), populated since 1992 serves as a human influence site, while Tshanini Game Reserve (TGR), a recently declared conservation area run by the above rural community has been relatively free from herbivore and human influence since 1992 serves as control site, it is expected to be representative of "pristine" vegetation in the sub region. The vegetation community density was calculated in each of 12 diameter size classes and eight height size classes deemed representative of the regions vegetation structure. Linear regressions were calculated to best fit ($r^2 > 80\%$) the population structure described by the diameter and height based curves. Mean diameter and height for vegetation communities were calculated. The three sites were compared. The TGR site differs from the other two, and shows that vegetation communities have reached a climax state, whereas the other two sites show signs of disturbance for TEP and near collapse of ecological processes for MRC. Herbivores and man have influenced the vegetation significantly and raise concern for the hotspot's biodiversity conservation.

COMPATIBLE LANDSCAPE MANAGEMENT PRACTICES WITHIN AND BEYOND KEY
BIODIVERSITY AREAS FOR THE CONSERVATION OF GLOBALLY THREATENED SPECIES
VILLEGAS, KAR, Grace Ambal, Charlotte Boyd, Thomas Brooks, Oliver Coroza, Naamal De
Silva, Liza Duya, Rodel Lasco, Goetz Schroth, Grace Villamor

The Philippines hotspot is on the brink of an extinction crisis. Only about seven percent of its original, old growth forest persists, and many species are currently confined to the remaining fragments. The most effective way to prevent species extinction is by identifying and safeguarding sites of globally threatened or geographically restricted species, known as Key Biodiversity Areas (KBAs, Eken et al. 2004). However, some globally threatened species and KBAs urgently require additional conservation action beyond these site boundaries. These include area-demanding species for which site protection is essential, but insufficient to secure their conservation over the short- to medium-term, and those which are threatened by changes in broad-scale ecological processes, such as hydrological processes. To ensure the persistence of these species and sites, landscape-scale planning must explore opportunities to integrate conservation objectives into meeting the basic needs of the human communities through the development of land uses integrating agroforestry, agriculture and other land uses. In this study, the Philippine globally threatened species and KBAs that require urgent conservation action at the landscape scale were reviewed and compatible agroforestry/agricultural land uses and management practices were identified. The species include: 11 amphibian and two bird species threatened by changing hydrological flows and quality; four mammals, six birds, and one reptile species that require large home ranges and are threatened by hunting; and two species of mammals declining through hybridization. The area and connectivity requirements for these species beyond KBAs were mapped out using GIS and overlaid with land use, forest cover and hydrological data to assess how conservation targets may be best achieved.

CAN LIFE-HISTORY CHARACTERISTICS BE USED TO PREDICT THE RESPONSES OF
BIRDS TO HABITAT CHANGE?
OKES, NICOLA, Phillip Hockey, Graeme Cumming

The consideration of life-history characteristics should provide a way of making predictive generalizations about the responses of different species to environmental modification. To test the hypothesis that birds with similar life-histories and/or ecological attributes will respond in similar ways to environmental change, we compared the life-history and ecology of water bird species that have either expanded or contracted their ranges in the last 40 years in southern Africa. We found that life-history traits provided an inadequate explanation of whether species would be range expansionists or contractionists. However, ecological attributes of species that related to habitat use correlated well with range changes. Species that inhabit endorheic pans seem to be 'pre-adapted' to using man-made dams and impoundments. The ability of many species to use artificial wetlands has aided the westward range expansion into the arid regions of southern Africa. Species relying on vegetated wetlands and reeds for nesting are predisposed to range contraction as their habitats have been severely impacted by agricultural development. Most range contractions have been from west to east, reflecting the high level of wetland degradation in the eastern lowlands of South Africa. Based on analysis of ecological attributes of regional contractionists, several additional species are identified as being of potential conservation concern, although such concern may not as yet have been expressed.

ADAPTABILITY, LINKAGES AND SELF ORGANISATION: THE KEYS TO CO-MANAGEMENT
IN SOUTH AFRICA'S COMMUNAL AREAS?
CUNDILL, GEORGINA

A legacy of impoverishment, lack of capacity and erosion of local institutions in South Africa's communal areas pose unique challenges for conservation. The capacity of local institutional structures to self-organise, adapt to social and ecological change, and to create and maintain linkages with institutions at broader scales, might be the key to co-management in these areas. To test this hypothesis, in-depth institutional analyses were combined with on-going monitoring of

changes in institutional capacity to manage natural resources in four study sites in South Africa, where community based conservation interventions are currently underway. The results show that although national government departments and community based organizations are actively seeking to develop co-management structures, linking institutions such as local and district municipalities are absent across the board. While communities in the early stages of co-management prefer single, powerful but vulnerable institutions, more 'mature' communities have learnt to diversify their institutions to cope with ecosystem management, thereby building institutional resilience. Therefore, although conventional wisdom suggests that the major challenge for co-management in South Africa lies in the ability of communities to self-organise and adapt to change, this research suggests that the capacity of local government departments to take on the challenge of collaborative governance is in fact the key constraining factor.

POWER, KNOWLEDGE AND LEGITIMACY IN WETLAND RESOURCE CONSERVATION IN SOUTH BENIN: LESSONS FROM INDIGENOUS INSTITUTIONS
MONGBO, ROCH L., Anne Floquet, Peggy Tohinlo

The debate on natural resource management has gone a long way, from the tragedy of the common paradigms to the rights-based approaches that advocate a post-modern rehabilitation of endogenous institutions. The latter is conducted in modern states context, with laic and science-based conceptions of ecosystems, where participatory schemes reify folkloric indigenized institutions with obscured conception of power relations and doubtful results in resource management. This paper discusses a success case of autonomous endogenous management of the Azili water complex, a wetlands Ramsar 118 site in South Benin. Quantitative investigations indicate sustained ecosystem productivity over decades and substantial maintenance of biodiversity, despite an intensive use by increasing populations. These combined with anthropological data allow us argue that the key to such performance lays in the embeddedness of managing institutions in the broader society context. Unlike disarticulated state-led management set-ups, the regulations and actual functioning of institutions and strategic actors are woven in people's livelihood, resources regimes and local knowledge systems, all embedded in local ideologies, power struggles and belief systems. We conclude on the symbolic and material assets and power-web on which endogenous managing institutions establish their legitimacy, instrumental in winning people's compliance to sustained uses of resources.

POPULATION STRUCTURE AND REGENERATION PATTERN OF MULTIPLE-USE TREE SPECIES IN A FLAGSHIP PRIMATE CONSERVATION FOREST, NW UGANDA
MWAVU, EDWARD, Ed Witkowski

Chimpanzee conservation in tropical forests is threatened by unsustainable exploitation of timber and agricultural encroachment, resulting in the loss of primate food trees. The population structures of 15 tree species that are both timber and primate food sources were examined in Budongo Forest Reserve (BFR) with a view to assess regeneration patterns and implications for sustainable management. Nine of the 15 species, namely *Lasiodiscus mildbraedii*, *Celtis mildbraedii*, *Pouteria altissima*, *Chrysophyllum albidum*, *Cynometra alexandri*, *Diospyros abyssinica*, *Funtumia elastica*, *Chrysophyllum perpulchrum* and *Antiaris toxicaria* had highly negative size-class distribution (SCD) slopes, ranging from -2.47 to -1.1, and juvenile:adult ratios ranging from 34.86 to 2.33. Hence, clearly exhibiting 'inverse J' type curves with continuous representation of individuals in all diameter classes, suggesting successful or healthy regeneration. In contrast, *Alstonia boonei* and *Cordia millenii* had weakly negative SCD slopes of -0.25 for both and juvenile:adult ratios of 0.33 and 0.70 respectively, and hence a pulsed regeneration pattern. Juvenile:adult ratios of $<<1$ would indicate species with low recruitment. Logging of trees for timber by local people (both legally and illegally) to earn an income also appears to affect the SCDs of *C. millenii* and *A. boonei*. Of the 15 species, *Raphia farinifera* and *Cordia millenii* were found not to be resprouting from damaged stumps or roots. Leaving behind standing mature fruiting trees in logged areas would be of great importance to both timber and wildlife conservation to provide food for primates and birds which will consequently disperse the seeds to other areas.

A SYSTEMATIC PLAN FOR THE CONSERVATION OF SOUTHEAST ASIAN MAMMALS
RONDININI, CARLO, Luigi Boitani, Gianluca Catullo, Federica Chiozza, Alessandra Falcucci,
Hedley Grantham, Luigi Maiorano, Hugh Possingham, Bob Pressey, Valeria Salvatori, Will
Turner, Kerrie Wilson

Southeast Asia is a frontier of the world biodiversity crisis. The rising number of species at risk of extinction must be conserved using insufficient existing resources while allowing an expanding human population to fulfil its social and economic needs. This requires conservation plans that explicitly aim at minimise conflicts. We modelled the potential distributions of 1084 Southeast Asian mammals based on their geographic ranges and habitat relationships, as assessed in six workshops with regional experts, and a set of four environmental maps: GLC2000 land cover, GTOPO30 elevation, LandScan 2002 population, and Digital Chart of the World hydrological features. We estimated the value of land and the potential for conflicting land uses based on the maps by the FAO Global Agro-Ecological Assessment and the FAO Gridded Livestock of the World. We identified the areas of predicted expansion of human population using the maps of projected population (2000 to 2015) by the Global Rural-Urban Mapping Project. Using these pieces of information we produced a systematic plan for mammal conservation. Even with the plan that explicitly attempted to minimise conflict between biodiversity conservation and economic development, many of the areas identified as irreplaceable to achieve the conservation goals overlap areas of predicted expansion of human population. Effective conservation strategies other than reservation are needed if we are to succeed in conserving Southeast Asian mammals.

TRAFFIC DISTURBANCE TO MIGRATION OF TIBETAN ANTELOPES ALONG QINGHAI-TIBET
RAILWAY AND HIGHWAY
XIA, LIN, Qisen Yang

The Qinghai-Tibet Highway and the accompanied newly built railway are major passages between Tibet and hinterland, which is on the main migration route of the Tibetan Antelopes. To protect the animals, railway bridges and 33 wildlife passages were built and put into use, but still no wildlife crossing structures on highway. From 2004, we continued monitoring the migration of chiru population along the railway and highway, recorded all chiru passes and the traffic disturbance to them. In 2004, the main structure of wildlife corridors was finished but the rail bed was still in construction. We recorded 1660 individuals moved to Hoh Xil for calving, and 2303 in return migration, about 56% using crossing structures. The human activities in construction period of the railway and road traffic both had great impact on migration of Tibetan Antelopes. In 2005, all wildlife passages were put into use. From May 31st to August 30th, 1509 chiru individuals were detected at Wubei Bridge to the calving ground and 2182 individuals back, among which 88.5% used wildlife corridors. The efficiency of wildlife passages increased. On July 1st, 2006, the Qinghai-Tibet railway began trial operations. In our fieldwork of this migration season, we recorded 2122 chiru moved from their winter ground to their summer calving ground and 2854 individuals back, the corridor use increased to 98.63%, and more bridges and corridors were used than 2004-2005.

ENVIRONMENTAL SECURITY IN AGROECOSYSTEMS – INTERACTIONS BETWEEN
FARMERS' MINDSCAPE AND LANDSCAPE
MARZALL, KATIA

Agroecosystem's environmental security is central for the promotion of rural communities' the sustainability. The complexity of ecosystems structure and processes, as well as its intrinsic uncertainty, only increases the challenge to find effective approaches to tackle environmental security. The framework I propose to observe environmental security discusses possible determinants of agroecosystems environmental security and argues for the centrality of farmers' attitudes and motivations in the definition of the interaction with their environment, influencing ecosystems structure and functions, hence agroecosystem's sustainability. The methodology

considers the system's resilience, integrating the analysis of the agroecosystems landscape and mindscape. Resilience considers the capacity of a system to continue to evolve in its dynamic life cycle, in spite of external stresses. Landscape represents the actual security of the system, considering ecological resilience. Mindscape considers the social resilience of the system, involving mainly the capacity to ask 'what if...?' and 'what then...?' These aspects were observed and analyzed in a rural community in South Brazil exploring the feasibility of the methodology. The outcomes highlight the possibility of combining several components and the importance of a complex approach to the environmental issue, if actions need to be undertaken to maintain or promote environmental security.

REDUCING HUMAN-ELEPHANT CONFLICT: DO CHILIES REALLY DETER ELEPHANTS FROM ENTERING CROP FIELDS?

HEDGES, SIMO, Donny Gunaryadi

Human-elephant conflict (HEC) is one of the most serious threats to elephants in Asia and Africa and can result in significant economic losses for farmers. Chili (capsaicin) based elephant deterrents have been promoted widely as tools for reducing HEC but have been little-tested. From October 2005 to April 2006, we tested a coordinated crop guarding system at HEC "hotspots" around Way Kambas National Park (WKNP) in Indonesia. We evaluated the effectiveness of coordinated guarding plus traditional tools at one site (the "traditional site") and coordinated guarding plus novel chili-grease fences and trip-wire triggered sirens at an adjacent site (the "chili+sirens site"). We also monitored HEC rates around WKNP in order to assess the effectiveness of our mitigation trials. Over the trial period there were 34 attempts by elephants to enter crop fields at the chili+sirens site, of which only 3 (8.82%) were successful, and 57 attempts to enter fields at the traditional site, of which only 5 (8.77%) were successful. Over the same period, there were 401 crop-raiding incidents elsewhere around WKNP. We conclude that coordinated guarding is the key to successfully keeping elephants out of crop areas (e.g., coordinated guarding successfully repelled >90% of elephant raids in our trial) and that chili-based methods do not add any significant deterrent effect but do add expense and create additional work. Chilies may however have value as elephant-resistant cash crops.

THREATENED TROPICAL HERPETOFAUNA OF NORTHEAST INDIA AND THEIR CONSERVATION STATUS

DAS, ABHIJIT, Firoz Ahmed

Northeast India situated at the confluence of Tibeto-Yunnanese, Indo-Malayan and Indian Biogeographic region sprawling over an area of 2,62,379km². The region is an important part of Eastern Himalayan and the Indo-Myanmar global biodiversity hotspot. As many as 180 species of reptiles and over 100 species of amphibians are known from this poorly explored region. Such a large diversity is considered due to diversity in habitat, altitude and varying climatic conditions. However, this rich herpetofaunal assemblage is poorly documented both taxonomically and biologically and their conservation status remains unknown. Among the known species, except some of the turtles, present status of other reptiles and amphibians are not evaluated. Most of the endemic species are also considered data deficient in the RDB of the IUCN, yet they are losing their habitat and population at an alarming rate. Further, the wildlife Protection Act of India also poorly recognizes and protects these smaller animals and their habitats. Killing, habitat loss and local trade and consumption of reptiles and amphibians are at very high rate and needs proper attention from conservation authorities to save them from extinction. The Gharial has already disappeared from the region while new species are being described. Hence, it is feared that many of these herpetological diversity will be lost forever before they are documented and evaluated, if the present rate of threat persists for a decade.

LAND USE AND TENURE ARRANGEMENTS IN THE IBERA WETLAND RESERVE dARC, NADINE RENAUDEAU, Sofia Heinonen

Land tenure is usually considered one of the key factors that define patterns and change in land-use systems. This paper argues that the relationship between land tenure and use is often more complex than expected responding to changing ecological and socio-economic conditions. The study draws on empirical evidence from three rural populations, namely Ñupi, Uguay and the islands located within the Iberá Reserve, a wetland area located in Corrientes province, northeast corner of Argentina. Results show that where formal and informal land tenure arrangements overlap, issues of ownership and access arise affecting land use patterns, such as access to shared rangeland in Nupi; to family plots in Uguay, or to natural resources in the islands. These results highlights the importance to manage and monitor information about access to land and property in conservation projects. This study derives in recommendations and a number of criteria and indicators that can help zonification and the design of the protected areas.

SPATIAL ECOLOGY OF ANDEAN CATS: MAPS AS TOOLS FOR TRANSFRONTIER CONSERVATION

MARINO, JORGELINA, Magdalena Bennett, Agustin Iriarte, Mauro Lucherini, Constanza Napolitano, Pablo Perovic, Juan I. Reppucci, Claudio Sillero-Zubiri, Lilian Villalba, María Viscarra

The spatial ecology of species with restricted distribution and/or highly specialized habits can inform conservation actions, even when details of the ecology and behaviour of populations are largely unknown. The Andean cat (*Oreailurus jacobita*), a High Andes endemic, is a suitable model species for the application of concepts of spatial ecology to the conservation of rare populations. In a transfrontier collaboration, we constructed a predictive map of the distribution of habitats with varying degree of suitability for Andean cats around the triple frontier between Argentina, Chile and Bolivia. Our map aimed at representing the environmental factors that seem to impose a limit to the distribution of this rare cat, namely the high altitude rodents they depend on (chiefly *Lagidium viscacha*) and the presence of rocky outcrops with suitable shelter. Our proxy variables were: vegetation types (particularly 'vegas', small marshes that concentrate most of the productivity in an otherwise barren landscape), altitude and slope. In this way we predicted the potential spatial structure of Andean cat populations across boundaries, their connectivity and location of hotspots for conservation. We used a set of Andean cat distribution data to test the validity of our predictions and offer recommendations for coordinated range-wide research and conservation.

COMMUNITY BASED CONSERVATION OF MEDICINAL PLANTS AMONG LUO-SUBA COMMUNITIES IN KENYA

KIBET, STALINE, Peris Kariuki, Walter Nyamolo, Simon Kangethe, Samuel Onyango, Samuel Matheka

A study was carried out in February 2005 to determine commonly utilized medicinal plants and the level of community involvement in ensuring their sustainable utilization among the Luo and Suba communities in Kenya. The study done through a semi-structured questionnaire, sampling of target plants species using random transect lines and participant's observation focus on traditional health practitioners. Thirty six traditional health practitioners were interviewed, 47 transects laid out and sampled and 4 markets surveys carried out. Harvesting techniques, frequency of harvesting and ailments treated as well as distribution of targets species were noted. Up to 25 species were confirmed as popular medicinal plants in the region three of which have been domesticated. Three other species were exclusively sourced from outside the region. Over 65% of the respondents have tried to cultivate one or more of the target species with few cases of success. Poor harvesting methods were noted, users of the medicine largely determine the form in which the medicine is sold in the markets. The growing demand for traditional medicine in the region due to increase in terminal illnesses particularly HIV/AIDs related illnesses has provided opportunities as well as threats to the conservation of medicinal plants in the region.

GREAT WHITE PELICAN (*PELECANUS ONOCROTALUS*) PREDATION ON SOUTH AFRICAN WEST COAST ISLANDS AND ITS IMPACT ON SEABIRD POPULATIONS
DE PONTE MACHADO, MARTA, Martin Musangu Mwema , Lorien Pichegru

Great White Pelicans feed mainly on fish and other aquatic organisms. In the Western Cape an unusual behaviour has become increasingly common: feeding on seabird chicks, mainly Cape Cormorants (CC) and Kelp Gulls (KG). Cultural transmission of behaviour is suspected. Diminishing artificial food sources have intensified predation pressure on seabirds. A monitoring programme was established in 2006 breeding season on 4 West Coast islands to assess impact on breeding success. Number of pelicans involved in predation, size of foraging groups, and number, size and energetic content of chicks eaten were recorded. Pelican activity budget, predation rate and energy requirements (FMR) were calculated. Pelicans caused almost complete breeding failure of CC and KG on Jutten and Schaapen Islands. Of 7400 and 2560 CC pairs, only 42 (0.56%) and ca.15 (0.58%) chicks fledged. 50 KG chicks fledged on Jutten from 2528 nests (1.97%). On Malgas pelicans were kept away from some colonies, fledgling 341 chicks from 2206 nests (15%). An average of 45 pelicans visited Malgas [5-104], eating 2-3 Cape Gannet chicks/pelican/day. Crown Cormorants were only targeted extensively on Dassen, due to their choice of breeding sites. Different hunting strategies for different prey species were observed. Pelican predation could have detrimental mid-term effects for local seabird populations. This work will provide scientific advice on different management options, after some trials were carried out this year.

REPRODUCTIVE TIMING IN RELATION TO NDVI VARIABILITY AMONG FREE-RANGING AFRICAN ELEPHANTS
WITTEMYER, GEORGE, Henrik Rasmussen, Iain Douglas-Hamilton

The phenology of reproduction is often correlated with resource availability and is hypothesized to be shaped by selective forces in order to maximize lifetime reproductive success. African elephants have the distinctive life history traits of a 22 month gestation and extended offspring investment, necessitating a long-term strategy of energy acquisition and reproductive expenditure to ensure successful offspring recruitment. We investigated the relationship between the reproductive phenology of a wild elephant population and resource availability using remotely sensed Normalized Differential Vegetation Index (NDVI) data as a measure of time-specific primary productivity and hence forage quality. The initiation of female elephants' 3+ year reproductive bout was dependent on conditions during the season of conception but timed so parturition occurred during the most likely periods of high primary productivity 22 months later. Juvenile mortality was not significantly correlated with ecological variability. Extreme climatic events, such as those associated with the El Niño-Southern-Oscillation (ENSO), acted to synchronize female fecundity in the population. This study suggests that the relationship between fecundity and ecological variability instigates the characteristic demographic fluctuations in elephant populations, rather than the mortality-driven fluctuations observed in many ungulate populations.

QUESTIONING CONSERVATION: SOCIAL SURVEYS IN CONSERVATION BIOLOGY AS TOOLS TO DETERMINE THE POTENTIAL OF COMMUNITY-BASED ECOTOURISM EFFORTS
JONES, NATALIE, Jerry Daday, Michael Stokes, Charles Kimwele

African NGOs and wildlife organizations have cited Kasigau, an area in the Taita Taveta district of southeast Kenya rich in wildlife due to its adjacency with the Tsavo National Park System, as a potential location for new community-based ecotourism (CBE) efforts. Local Kasigau communities are impoverished and snaring is commonplace on their community-owned ranches. This CBE implementation requires knowledge of the attitudes, outlook and current relationship with wildlife of these communities. We conducted surveys of women from the six villages surrounding Mt. Kasigau, with a total of 306 respondents. We designed the surveys to elicit information on the communities' perceptions of tourism, wildlife and conservation as well as the perceived level of human-wildlife conflict in the area. The surveys reveal a high degree of human-wildlife conflict; for

example, 93.8% have had their crops destroyed by wildlife and 42.2% of respondents believe villagers kill wildlife for food. However, responses also demonstrate the realization that tourism and conservation are important for future community development, with 99.9% responding that tourism is important to their village and 89.9% stating that protection of wildlife is important. We evaluated responses within and among the six villages. This study explores a strategy which may be implemented in other regions and provides baseline data to measure changes in community attitudes and behavior as CBE grows in the Kasigau area.

EVALUATING THE EFFECT OF TRADITIONAL VS. LIVELIHOODS-BASED CONSERVATION INTERVENTIONS ON ATTITUDES TOWARDS SAIGA ANTELOPE CONSERVATION IN RUSSIA

HOWE, CAROLINE, Ruslan Medzhidov, Tanya Mudzhaeva, Anna Lushchekina, EJ Milner-Gulland

We compare the impact of public awareness initiatives on attitudes towards the conservation of the critically endangered saiga antelope in the Republic of Kalmykia and Astrakhan province. Different villages in this area had received very different levels of intervention despite living with the same saiga population - traditional "fences-and-fines" conservation, livelihoods enhancement, and low-level media coverage. Using semi-structured interviews on 250 individuals in 8 villages, we found a positive correlation between levels of access to information and both an enthusiastic opinion of saiga and greater knowledge of conservation initiatives. In villages where livelihoods enhancement and targeted public awareness campaigns had been instigated, knowledge of saiga ecology and conservation was significantly greater than in villages experiencing traditional conservation or media coverage only. Willingness-to-pay (WTP) was used as a proxy for behaviour and, after controlling for wealth, was significantly correlated with a positive opinion of saiga and increased knowledge of saiga ecology and conservation. Wealth and ethnicity were the two greatest background influences on attitudes and behaviour. This study is unusual in being able to study the effect of conservation interventions while controlling for other factors, and gives support for the view that livelihood improvement interventions lead to more positive attitudes to conservation than more traditional methods.

LONG-TERM PARTNERSHIPS IN CONSERVATION: A CASE-STUDY FROM NORTH LUANGWA, ZAMBIA

van der Westhuizen, Hugo Francois, Lewis Saiwana, ELSABE VAN DER WESTHUIZEN

Many wildlife authorities from African countries have struggled to meet their conservation targets given the often severe financial constraints, and/or low institutional capacity they face. International partners may step in to offer financial or technical support, under varying agreements and levels of input or time periods for which the support is forthcoming. Results of these interventions or partnerships are varied, and difficult to quantify. Given that these support projects can prove vital to achieve conservation goals, it is important that lessons learnt from existing partnership agreements be more widely disseminated. One such partnership is the long-term collaboration between the Zambia Wildlife Authority and Frankfurt Zoological Society in the North Luangwa National Park in Zambia. This partnership is now almost 20 years old, and has evolved over time to respond to the specific needs and challenges faced. This is reflected in the changing levels and type of inputs made by both partners over the years. One measure of success of a conservation initiative is obviously how the status of endangered or threatened taxa has improved during the time-period of the initiative. Elephant populations in the area have shown a steady increase in number since the early 1990s, and in 2003 black rhino was successfully reintroduced to the Park, and in effect to the country. The length of this conservation collaboration gives ample opportunity to investigate lessons learnt.

AGE, MUSTH AND PATERNITY SUCCESS IN MALE AFRICAN ELEPHANTS

BARNER RASMUSSEN, HENRIK, John Okello, George Wittemyer, Hans Siegismund, Peter Arctander, Fritz Vollrath, Iain Douglas-Hamilton

Information on age and tactic related paternity success is essential to understand the lifetime reproductive strategy of males and the evolutionary processes that shape the life history traits of a species. The degree of reproductive skew between individuals has profound implications on population genetics and should be considered in long-term strategies for conserving small populations of threatened species. Likewise the genetic structure and behaviour of species with large reproductive skew may be disproportionately affected by anthropogenic actions affecting the reproductively dominant individuals. Our results on age and tactic specific paternity success in male African elephants are the first from a free ranging population and demonstrate that paternity success increases dramatically with age, with the small number of older bulls in the competitive state of musth being the most successful sires. Reproduction, however, was not monopolised by musth bulls, with 20% of calves sired by non-musth bulls. We found that 60% of mature bulls (>20 years old) in the population sired offspring during the 5-year study period. Hence reproduction was less skewed than predicted from behaviour and life history traits. These results have implications for behavioural and genetic effects of trophy hunting and ivory poaching, both of which target older bulls. In addition these results are critical to the current debate on methods for managing and controlling increasing populations.

USING DNA FORENSICS TO FIGHT THE SOARING IVORY TRADE

WASSER, SAMUEL, Bill Clark, Celia Mailand, Matthew Stephens

The illegal ivory trade has recently intensified to the highest levels in history. The trade is being driven by organized crime, taking advantage of demand from powerful economies in the Far East and an associated soaring increase in the price of high quality ivory. Moreover, virtually none of the major perpetrators are being prosecuted for these crimes, inside or outside Africa. Under these circumstances, the best way to combat such trade is to keep the ivory in Africa. This precludes the existence of any legal trade into which smuggled contraband can be laundered. A massive infusion of law enforcement, on the scale that worked in 1989, is needed to achieve this. We describe genetic techniques that can greatly assist such law enforcement efforts by assigning large seizures of contraband ivory to its source. Identifying these poaching hot spots also helps identify potential trade routes, as well as refute claims from countries falsely denying poaching problems. We determined the geographic origin of 532 tusks in the largest ivory seizure since the 1989 ivory trade ban. That seizure also contained 42,120 "hankos," solid thumb-sized ivory cylinders used to make signature stamps. Here we use similar DNA analyses to determine the origin of those hankos, as well as origin of other large ivory seizures. Combining this approach more broadly with law enforcement could help thwart an illegal trade that is once again threatening extinction of many African elephant populations.

LONG-TERM CONSEQUENCES OF POACHING ON RELATEDNESS AND PHYSIOLOGICAL HEALTH OF AFRICAN ELEPHANTS

GOBUSH, KATHLEEN SCHUYLER, Benezeth M. Mutayoba, Samuel K. Wasser

Widespread poaching in the 1980's altered the demographic structure of matrilineal elephant groups in many populations by decreasing the number of old, adult female kin (Barnes and Kapela, 1991, Poole, 1989). We investigated long-term genetic, physiologic and reproductive consequences of a poaching-related disturbed social structure among African elephants (*Loxodonta africana*) using non-invasive endocrine, genetic and observational techniques. Dung samples were collected from adult female elephants from 93 family groups during a 25-month period in Mikumi National Park, Tanzania. This region experienced heavy poaching prior to the ban on the international sale of ivory but that pressure has relaxed considerably over the last decade (Douglas-Hamilton, 1986, Balozi, 1987, Poole, 1989, TWCM 1998 & 2000). Corticosterone and progesterone fecal metabolite levels were quantified using radio-immuno-assay (Wasser et al. 1996 & 2000). Genetic relatedness of adult female elephants in family groups was

determined using fecal microsatellite DNA analysis (Wasser et al. 2004). Relatedness among adult females within family groups was compared to those expected from a simulated non-poached population via gene-drop analysis (Thompson, 2005). Findings suggest that loss of kin has long-term effects, over a decade later, on females of this long-lived, socially complex species, influencing group composition and genetic relatedness of family groups, with associated impacts on stress hormone levels and reproductive output.

PHYLLOSTOMIDAE BATS AND THE STRUCTURE OF NEOTROPICAL FORESTS: WHAT CAN BATS TELL ABOUT HABITAT QUALITY?

BAUMGARTEN, JULIO, Deborah Faria

Phyllostomidae bats and particularly those from the subfamily Phyllostominae have been recognized as good indicators of habitat quality. We investigated the relationship of bat community structure and forest disturbance in the Brazilian Atlantic Forest at southern Bahia. We used forest structure parameters often related with disturbance and correlated them with bat species richness and abundance. We sampled bats and forest structure in 30 sites encompassing five different habitat categories: interiors and edges of both continuous forests and fragments, and secondary forests. Multivariate analysis revealed the existence of a gradient increasing from interiors to edges and secondary forests. We found a negative, significant association between bat community parameters and the forest disturbance gradient, with lower values of richness and abundance in more disturbed forest categories. We then added to the analysis sites of shade cacao plantations, a highly disturbed managed system. Regardless the overall level of habitat disturbance, bat community parameters were still positively influenced by forest structural attributes. Phyllostomidae species richness and abundance significantly were higher in shade plantations compared with the remaining forest categories. These results indicate that high species richness and abundance are not always related with pristine habitats. Therefore bats may not be necessarily indicating the habitat quality for other biological groups.

SOCIAL STABILITY AND GEOGRAPHIC FIDELITY OF HUMPBACK DOLPHINS DIFFER WITH HABITAT: DOES THAT MATTER FOR CONSERVATION?

KARCZMARSKI, LESZEK, Almeida Guissamulo, Victor Cockcroft

Humpback dolphins (*Sousa chinensis*) inhabit shallow coastal waters of Indo-Pacific. In East Africa, the continued survival of a number of populations remains uncertain; habitat loss and incidental mortality represent the greatest threats. Here we compare findings of two photo-identification mark-recapture studies, conducted in Algoa Bay, South Africa, and in Maputo Bay, Mozambique; using population modelling and multivariate techniques we investigate population structure and social dynamics of humpback dolphins in differing coastal habitats. Off the exposed Eastern Cape coast humpback dolphins live in small dynamic groups, while less than 1300 km to the north, in the relatively sheltered Maputo Bay, they form considerably larger and more stable units of association. Along the Eastern Cape coast both males and females range over long distances, presumably in search of food, while the Maputo Bay population shows significantly stronger geographic fidelity. It seems that the abundance of resources and intra-group scramble competition determine group size and stability, while the distribution of foraging grounds and other critical resources determine individual ranging patterns and effective availability of mates. All the above factors and the apparently habitat-driven differences have serious implications in determining population vulnerability; their incorporation into demographic models as part of population viability analysis could lead to better management practices.

CATS, COWS AND COMMUNITIES: INVESTIGATING HUMAN-LARGE CARNIVORE CONFLICT AROUND RUAHA NATIONAL PARK, TANZANIA

DICKMAN, AMY, Sarah Durant

Human-wildlife conflict is an issue of pressing conservation concern, particularly when it involves threatened species, and accurately identifying the causes of conflict is fundamental to developing effective resolution strategies. This study investigated pastoralists' attitudes towards wildlife,

particularly large carnivores, in the area around Ruaha National Park in Tanzania, a globally important area for biodiversity. Pastoralists reported intense conflict with wildlife, especially carnivores, and were largely hostile towards the nearby Park, as wild animals cross the boundary and cause problems on village land. Although the level of retaliatory wildlife killing was low, this was mainly due to circumstantial constraints rather than innate tolerance, highlighting a likely conservation concern for the future. A range of factors affected the severity of respondents' conflict with carnivores, including ethnic group, wealth, income sources, social status and levels of livestock loss experienced. Successful conflict mitigation will depend upon reducing depredation through better husbandry, and upon improving the cost-benefit ratio of wildlife presence to ensure that local people receive direct, relevant benefits from conservation, particularly from the Park. Identifying the main factors influencing conflict, and therefore developing the most appropriate mitigation schemes, will have significant benefits both for human and wildlife populations in this important area.

STATUS OF THE BLACK BEAR IN THE NORTHWESTERN LOWER PENINSULA OF MICHIGAN: A NON-INVASIVE MARK-RECAPTURE POPULATION ESTIMATE STUDY RIGNEY, TODD, Mark Knee, Bradley Swanson

Hair-snares and microsatellite genetic markers have become increasingly more common in mark-recapture studies on large mammals. Since no direct personal contact with organisms is made the use of non-invasive hair-snares in black bear studies offer advantages over traditional methods since the dangers to both the bear and handler are avoided. Open- and closed-population models may offer differing estimates of population size due to the different assumptions of each. Hair-snares non-invasively collected black bear hair samples (June-July 2005/2006) in order to estimate population size. Sample collection occurred in 9 counties in the Northwestern Lower Peninsula of Michigan where hair-snares were distributed in a grid-like fashion. Follicular DNA was extracted and amplified at 7 microsatellite loci using PCR. Open-population models in program MARK were used to analyze data and yield a population size of 52 individuals (95% C.I. 7-141). Closed-population models in previous population estimates including the entire Northern Lower Peninsula of Michigan offered population estimates of 1,882 black bears (95% C.I. 1,389-2,551). The results from the open-population model indicate that black bears are not equally distributed throughout the Northern Lower Peninsula of Michigan which may be attributable to urban development and lack of usable habitat. Closed-population models estimating black bear population size will not work in relation to open-population models.

DUGONGS (*DUGONG DUGON*) OF THE BAZARUTO ARCHIPELAGO, MOZAMBIQUE: POPULATION ESTIMATES AND CONSERVATION STATUS GUISSAMULO, ALMEIDA, Leszek Karczmarski, Henrique Balidy, Selma Sambane, Valera Lucena Dias, Mizeque Mafambissa

Dugongs (*Dugong dugon*) are endangered throughout the western Indian Ocean; the Bazaruto Archipelago region, Mozambique, is believed to harbour the last viable population in Africa. This project, conducted in 2003-2006, was part of a larger effort of integrating management planning for the region. Aerial surveys with DISTANCE sampling assessed dugong numbers and distribution. Landstad ETM7+ satellite images were used for mapping seagrass beds with GIS techniques, and 17 seagrass beds were sampled across the Bazaruto Bay (BB). Dugong numbers were estimated at 235 (CV=15%) within BB, and 89 (CV= 47%) in the offshore waters (OW) north of BB. Dugong density within BB (0.162/km²) was double the density in OW. These estimates are considerably greater than previously suggested, and likely indicate higher precision of current survey techniques compared to early 1990s. However, large aggregations (several tens of dugongs) reported in '90s were never seen during this study, suggesting that actual dugong numbers decreased over the past decade. Seagrasses occupy currently 15% (88.21 km²) of BB; but the species favoured by dugongs represents < 15% of the total seagrass cover and is scattered in shallow areas of the Bay where it is exposed to destructive fishing practices. As anthropogenic mortality and habitat deterioration continues, the future of the Bazaruto dugongs

remains uncertain; prospects of gas and oil exploitation in the region pose new threats to dugongs' offshore refuge areas.

LEVERAGING SUPPORT FOR LOW PROFILE REGIONS BY MEANS OF GEOGRAPHICALLY BROAD-BASED CAMPAIGNS FOR PROTECTION JOHNS, DAVID

Many areas determined by conservation scientists to be important to conservation lack the political support needed to gain protection. This obtains even though it has been demonstrated that the areas lacking support are essential to the integrity of a larger region or system with support. Climate change is emerging as another scientific argument for connectivity across large landscapes, but science does not easily translate into political mobilization. In North America an important political justification is emerging for continental level "wildways"—a system of connected reserves that stretch e.g. from the mountains of northern Mexico to Alaska. By advocating for a wildway as a whole, the hypothesis is that higher profile areas such as Banff, Yellowstone, or Yosemite NPs, can carry along the lower profile areas. One such wildway campaign, The Spine of the Continent, has shown early promise by attracting broad support and enthusiasm from conservationists. A geographically large-scale campaign is also attractive because it is creating opportunities for enhancing capacity: its boldness is attracting new constituencies and other resources. At the same time conservationists still have much to learn from the successes and failures of other movements.

REGULATION OF SUMMER HOME RANGE SIZE OF AMPHIBIANS (*BUFO BUFO*, *BUFO VIRIDIS*) IN A BRAIDED FLOODPLAIN MOSAIC INDERMAUR, LUKAS, Marianne Gehring, Thomas Winzeler, Wendelin Wehrle, Beat Naef-Daenzer, Klement Tockner

Home range size (HRS) reflects the performance of animals because it integrates their behavioural and physiological requirements. Previous home range studies mostly focused on single factors affecting HRS and on one core area. However, many factors act in concert and their importance may shift when considering core areas with and without excursive activities. Moreover inference for conservation planning is more extensive when based on the ecology of multiple species. We studied the HRS of two toad species (*Bufo bufo*, *Bufo viridis*) in their natural habitat, a dynamic floodplain ecosystem. The objective was to identify multiple factors determining summer HRS in core areas with and without excursive activities. Therefore we gathered 6000 radiolocations of 114 individuals over a two-year period in the floodplain mosaic of the Tagliamento River (NE Italy), a reference system of European importance. Model selection was done using an information theoretic approach. Both species had multi-nuclear home ranges and differed significantly in HRS. Although differences in the ecology of the species were reflected in their HRS, the same factors (habitat richness; availability of large wood deposits=LW) explained HRS of both species and core areas best. Hence, to conserve amphibians in their natural environment, a natural flow regime, an unconstrained river corridor, as well as the delivery and retention of LW need to be maintained and restored.

USING CONSERVATION PRESSURE POINTS TO STEM ECOLOGICAL HEMORRHAGE: MANAGING AVIAN PREDATORS ON THREATENED SALMONIDS IN THE COLUMBIA RIVER ESTUARY ROBY, DANIEL D., Donald E. Lyons, Ken Collis, Yasuko Suzuki, Allen Evans, Jessica Y. Adkins

The Columbia River Basin in North America, about the size of France, formerly produced billions of anadromous salmonids (*Oncorhynchus* spp.) annually, all of which reach the Pacific Ocean via the Columbia River estuary. Currently, 13 of 20 Evolutionarily Significant Units (ESUs) of salmonids from the Basin are threatened or endangered under the U.S. Endangered Species Act, due primarily to over-harvest, degraded habitat, hydropower dams, and hatcheries. The largest breeding colonies of Caspian terns (*Hydroprogne caspia*) and double-crested cormorants (*Phalacrocorax auritus*) in the world recently formed on an island in the Columbia River estuary.

These colonies of native, protected waterbirds are products of (1) creation of artificial nesting islands, (2) reliable food supply produced by salmon hatcheries, and (3) loss of secure nesting sites and food resources elsewhere. Using bioenergetics models and recovery of smolt PIT tags on the bird colonies, we estimate losses of salmonid smolts to terns and cormorants are ca. 10% of those that survive to the estuary. Fisheries managers view avian predation as one of several significant impediments to restoring threatened Columbia Basin salmonids. This knotty problem, which has pitted salmon conservationists against bird conservationists, cannot be resolved without active habitat restoration for both birds and fish. Our research group advocates an innovative approach to predator control that reduces avian predation rates without negatively affecting recovering waterbird populations. This involves dispersing and shifting colonies of piscivorous birds to alternative colony sites where threatened fishes are less prevalent in the food supply.

PHYSIOLOGICAL STRESS AND INDIVIDUAL MOVEMENTS OF AFRICAN FOREST ELEPHANTS (*LOXODONTA AFRICANA*) IN RELATION TO ANTHROPOGENIC DISTURBANCE IN GABON

MUNSHI-SOUTH, JASON, Landry Tchignoumba, Janine Brown, Nicole Abbondanza, Jesus Maldonado, Ann Henderson, Alfonso Alonso

Human activities are major determinants of forest elephant distribution in Gabon, but the types and intensity of disturbance that elephants can tolerate are not known. Noninvasive fecal technologies hold great promise for studying elusive forest elephant populations. We conducted a dung survey within the Gamba Complex of Protected Areas in SW Gabon to examine individual movements and physiological stress of forest elephants in relation to disturbance. The Gamba Complex consists of two national parks that are longitudinally divided by an "industrial corridor" dominated by petroleum operations. We are using multi-locus microsatellite genotypes amplified from dung samples to estimate the minimum number of elephants, their sex ratio, and movements of individuals across the industrial corridor. We are also measuring fecal concentrations of glucocorticoid stress hormones for elephants subject to different levels of disturbance: 1) Loango National Park, 2) the industrial corridor, and 3) a nearby area of substantial elephant-human conflict. The emerging field of "conservation physiology" seeks to understand the physiological responses of animals to environments altered by human disturbance, of which field endocrinology is a crucial component. This study is the first large-scale examination (>300 dung samples) of physiological stress in wild forest elephants.

EFFECTS OF CLIMATE CHANGE ON PRIMATE POPULATIONS: A REVIEW OF HYPOTHESIS AND PREDICTIONS FOR CONSERVATION

AHUMADA, JORGE, Sandy Andelman

Despite the overwhelming evidence for climate change, there are no systematic reviews of its possible effects on the long-term population dynamics and persistence of many taxa, in particular, those with strategic conservation value such as primates. Given the many roles that primates play in the functioning of tropical ecosystems, changes in their population dynamics might trickle down to primary producers and other trophic guilds accelerating ecosystem change in unpredictable ways. In this talk we propose several hypothesis for the effects of climate change on the long-term persistence and dynamics of primate populations, mainly through the effects of climate change on primary producer phenology and dynamics. For each hypothesis we propose a particular associated conservation action designed to mitigate the effect. We refine our predictions for different primate functional groups to increase the resolution and scope of the effects. Based on these predictions, we assess the susceptibility of these various primate functional groups to climate change as an initial conservation assessment for primates as a whole. Finally, we stress the need and importance of long-term monitoring programs for primates in order to test and differentiate among these various hypothesis and take appropriate conservation actions.

CONSERVATION IN SEASONAL SOCIAL-ECOLOGICAL SYSTEMS: A CASE STUDY ON THE UPTAKE OF SNAKE HUNTING BY TONLE SAP FISHERS IN CAMBODIA
BROOKS, SHARON, John Reynolds, Jennifer Gill, Edward Allison

Seasonal systems provide an array of resources of fluctuating availability, upon which diversified livelihoods are built. One such form of diversification that has arisen in Cambodia's Great Tonle Sap Lake in the last 10-15 years is snake hunting. This single activity represents the world's largest snake hunt and there are fears that it may severely threaten a unique assemblage of snake species. Through stakeholder interviews and participatory workshops with hunters, we show how the uptake of snake hunting is an adaptive response to ecosystem degradation driven by new forms of economic activity, increasing human population pressure and poor policy choices. Within our study communities, snake hunting provides a crucial income source that is of increasing importance to the less well-off. Following a lean period with low fish catches, fishers switched to exploiting snakes, and we argue that this strategy, although detrimental to the snake populations, may contribute to ecosystem and livelihood sustainability through raising household incomes and preventing further degradation of other resources. We advocate a pro-poor conservation response that does not erode the resilience of the social-ecological system but builds on these adaptive strengths. Conservation of this threatened community of snakes requires not only an understanding of the complex nature of all livelihood activities, but also needs to address the underlying threats to equitable and sustainable resource use.

PERMEATING THE PALMS; THE POTENTIAL AND FEASIBILITY FOR MAMMALS WITHING OIL PALM PLANTATION LANDSCAPES
FITZHERBERT, EMILY, Ian Bateman, Chris Carbone, Andrew Watkinson, Tom Maddox

Oil palm is rapidly dominating land usage throughout Southeast Asia; exotic monoculture replacing high biodiversity forest. Limited quantitative research indicates that this switch precipitates marked declines in species diversity across a range of taxonomic groups, where large areas of oil palm create a barrier to wildlife movement. In a unique collaboration between a Sumatran oil palm plantation and a conservation NGO, we determined patterns of abundance and habitat usage of medium to large mammals across the plantation landscape using direct and indirect sampling methods. Only three, of the 44 species recorded within neighbouring forest, were found within the oil palm areas. However a further 10 species, including two IUCN red-list species, Malayan Tapir (*Tapirus indicus*) and Sun Bear (*Helarctos malayanus*), were recorded within riparian bufferzone habitats and small fragments of native vegetation surrounded by oil palm. These results were incorporated into a cost-surface analysis to evaluate the economic impact to plantation management incurred by supporting these habitats and tolerating mammalian pest species. This analysis reveals not only the potential for mammalian movement across the oil palm /forest boundary but also the economic implications and feasibility of conserving remnant patches and corridors of native habitat, thus exposing the potential to increase the permeability of oil palm landscapes and their value for mammalian biodiversity.

NEGATIVE IMPACTS OF A NON-NATIVE, AGRICULTURAL PEST, THE DIAMONDBACK MOTH, ON TWO RARE AND ENDANGERED BRASSICACEAE SPECIES
SQUIRES, SUSAN, Luise Hermanutz, Peggy Dixon

Agro-ecosystems support a huge diversity and biomass of non-native insects, but the ability of these insects to invade and degrade natural ecosystems is ignored. The Diamondback moth, *Plutella xylostella*, is a problematic non-native, agricultural pest worldwide. It feeds on members of the Brassicaceae family, including the endangered Long's braya, *Braya longii* and threatened Fernald's braya, *B. fernaldii*. These globally rare plants are endemic to the Limestone Barrens of Newfoundland, Canada. The immigration of the Diamondback moth from U.S. overwintering sites to this natural ecosystem has been monitored with pheromone traps since 2003. After a mass immigration of the moths in July, females lay eggs on 30% of the Long's braya and 16% of the Fernald's braya population. Larval feeding decreases seed output from 11 to 4 seeds/fruit and damages 40% of leaves. Survival is correlated to the number of eggs/plant the previous year

($p=0.02$, $F=1.94$) and leaf damage ($p=0.001$, $F=9.29$). In 2004 and 2005, summer air temperatures were 44% and 55% warmer than the 30-year climatic normal, allowing this pest to survive for multiple generations and resulting in added damage to braya. In an effort to manage the Diamondback moth mass trapping was initiated in 2006. This study supports the need for the agricultural industry to organize pest management on a global scale in order to control highly distributed pests and support the long-term survival of rare host plants.

A TOOL FOR IMPROVING CONSERVATION PLANNING AND PRIORITIZATION: - MAPPING BIODIVERSITY USING QDGC

LARSEN, RAGNVALD, Thomas Holmern, Eivind Røskaft, Honori Maliti, Sarah Durant

Information on the distribution of animals is essential for conservation planning and management, and there are currently a number of initiatives in the process of gathering such data. Geocoding standards have often had a local focus, and the lack of proper naming conventions has been a central hindrance to synergetic use of regional, national and continent wide data. A widely used geocoding standard in African countries is Quarter Degree Grid Cells (QDGC) which provides the basis for major biodiversity atlases in the region. The current definition of the QDGC standard failed to support unique references across geographical quadrants. This made its use across the prime meridian or equator problematic. TAWIRI has together with NTNU further developed the QDGC. The nomenclature has been extended and now supports unique references on an African scale. The updated QDGC now provides a vehicle for sharing biodiversity data where laws, regulations or other formal considerations deny sharing of raw data. The paper makes recommendations on how QDGC can be used as a standard for exchange of data where raw data can compromise research project integrity, management authorities or wildlife security. QDGC therefore offers through tools of for conversion and presentation of biodiversity data using web mapping systems or desktop systems like ArcGIS, a crucially important alternative to existing approaches that may help plan and prioritize conservation resources more efficiently.

BRIDGING THE KNOWING-DOING GAP: PLANNING FOR IMPLEMENTATION IN THE ALBANY-MAPUTULAND-PONDOLAND HOTSPOT, EASTERN CAPE, SOUTH AFRICA KNIGHT, ANDREW, Richard M Cowling, Bruce M. Campbell

The number of systematic conservation assessments (i.e., area selection studies) published in the peer-reviewed literature has grown exponentially recently. The majority of these assessments are never implemented as conservation action on-the-ground. This situation manifests the "knowing-doing gap, where knowledge developed and accrued by a scientific discipline fails to be usefully applied in the real-world. If conservation assessments are to have societal relevance then they must be a part of a broader conservation planning process which, 1) structures the systematic conservation assessment around the concept of "conservation opportunities", not simply conservation priorities, 2) complements the systematic conservation assessment with an implementation strategy, 3) pro-actively and meaningfully collaborates with stakeholders, and 4) focuses upon the establishment of social learning institutions, not simply the identification of priority areas. We have developed a conservation planning approach we call "planning for implementation" which embodies these principles, and are currently applying it in the Albany-Matputuland-Pondoland hotspot in South Africa. We outline how we've operationalised the concept of "conservation opportunities"; in doing so, linking the systematic conservation assessment directly to the stakeholder collaboration process, which encourages the mainstreaming of conservation knowledge and action into stakeholders day-to-day land management activities.

DEMOGRAPHIC IMPACTS OF TASMANIAN DEVIL FACIAL TUMOUR DISEASE AND IMPLICATIONS FOR MANAGEMENT

McCALLUM, HAMISH, Shelly Lachish, Menna Jones

Since its detection in 1996, a transmissible facial tumour has spread through most of the geographic range of the largest surviving marsupial carnivore, the Tasmanian Devil (*Sarcophilus*

harisii). This emerging disease has led to population declines of up to 90%. We have conducted mark-recapture studies at two sites following disease arrival, and have been able to compare demographic parameters with those obtained from before the disease arrived. Estimated survival of adult devils has declined dramatically following disease arrival, to a point where it is now close to zero. Similarly, the age structure of the affected populations has changed such that virtually no animals older than three years are present, in contrast with the situation before disease arrival. There is some evidence of increased reproduction of first-year females in infected populations. However, Pradel models, closed population estimates and demographic models all concur that rapid population declines are occurring, which are likely to lead to local extinction. Although we have some encouraging results from a single-site trial in which we are removing infected animals, the best management strategy currently available is establishing disease-free populations on offshore islands.

TREE DENSITY AFFECTS WILD UNGULATE HABITAT PREFERENCES IN A KENYAN SAVANNA

RIGINOS, CORINNA, James Grace

African savannas vary widely in tree cover. Land management practices such as fire suppression, cattle grazing, fuelwood harvesting, and elephant protection are dramatically altering natural patterns of tree density. African savannas support a wide diversity of wild ungulates. Few studies, however, have explicitly addressed the consequences of variation in tree density for these herbivores. Wild herbivores likely prefer habitats that optimize predator visibility and forage quality and quantity, all of which may be affected by woody cover. To examine the effects of tree density on wild herbivores, I quantified herbaceous cover, species composition, and wild herbivore use across a 10-fold range of tree densities in an *Acacia drepanolobium* savanna in Laikipia, Kenya. The dominant ungulates in this system are zebras, Grant's gazelles, hartebeests, giraffes, elephants, and oryx. All species except elephants were found to prefer areas with fewer trees, likely due to higher visibility rather than differences in herbaceous species composition. Elephants, in contrast, preferred areas with a high density of trees and damaged proportionally more trees in these areas. By damaging trees in high density areas, elephants may have a negative feedback on woody cover in the landscape. To further test these relationships, I am manipulating tree densities in a large-scale experiment. My results show how human modifications of savanna structure impact the habitats available to wild ungulates.

THE CONSERVATION OF KARST ECOLOGY IN SOUTH AFRICA

DURAND, FRANCOIS

Gauteng is the smallest province with the largest and fastest growing population in South Africa. Fast-growing urbanisation is accompanied with growing pressure on the existing water supply, sanitation and waste management infrastructure. Research done shows that the abstraction of groundwater poses a serious threat to the structure of karst and karst ecology in the dolomitic regions of South Africa. In addition, several anthropogenic factors such as mining activities, poor waste management principles, certain farming practices, urbanisation and pollution threaten not only karst ecology but also the potability of surface and groundwater in Gauteng. These anthropogenic disturbances pose a serious threat to aquatic ecosystems in this region. The development of the Cradle of Humankind World Heritage Site as a major tourism attraction puts additional pressure on this fragile ecosystem. Most of the caves and associated groundwater in the dolomitic regions of South Africa are occupied by organisms, including numerous indigenous bat species and endemic invertebrate species, which form an intricate food web. The proposed management plan for karst ecosystems in Gauteng is the first step towards the conservation of this sensitive and unique part of the biodiversity and natural heritage of South Africa.

IMPACT OF INVASIVE GRASSES ON DETRITAL FOOD WEBS IN A SEMI-ARID SYSTEM
WOLKOVICH, ELIZABETH M., Kathryn L. Cottingham, Douglas T. Bolger **WITHDRAWN**

THE EFFECTS OF CLIMATE CHANGE ON BIRD COMMUNITY COMPOSITION IN THE U.S.
HOOKER, JOSH

Climate change is expected to effect biodiversity in many ways. Species are typically modeled individually to investigate the effects of changing climate. However, species do not occur individually, they occur in communities. How will these communities change in response to changing climate? Constrained ordination is applied to a dataset of 608 (breeding) bird species in the U.S. and current climate to investigate how current climate relates to current community variation. Climate is shown to explain 25% of the bird community variation. Future climate scenarios are then used to predict the future distributions of these communities. Using constrained ordination in this way makes it possible to quantify how much individual bird communities are expected to change. Furthermore, the communities most at risk from climate change as well as those most likely to persist can be identified and mapped.

DEVELOPING ROBUST QUANTITATIVE CRITERIA FOR LISTING SPECIES UNDER THE U.S. ENDANGERED SPECIES ACT USING PERFORMANCE TESTING
REGAN, TRACEY, Barbara Taylor

Developing robust quantitative criteria for listing species under the U.S. Endangered Species Act requires considering not only the population dynamics of the species' concerned but also the uncertainties in the process. These include uncertainty in our data, how we use the data to make inferences or predictions about the real system, and uncertainties in the system itself, such as environmental and demographic variation. We use performance testing to evaluate the performance of alternative listing criteria under uncertainty. Performance testing allows the exploration of the consequences of alternative listing criteria and evaluates them against a set of performance requirements. We simulate species where we know their fate, generate data and estimate parameters using Bayesian inference. A two-stage Monte Carlo population model is developed, incorporating parameter uncertainty directly into extinction risk estimates. The listing decision given the species' true fate is compared with the listing decision given the estimated model to determine if the species is correctly classified or not. This process is repeated for all possibilities to determine if the performance requirement is met. We show that while performance testing does not guarantee robustness, it provides a useful process for exploring the circumstances when listing criteria perform well and when they perform badly.

HABITAT LOSS AND FRAGMENTATION EFFECTS ON ASIAN ELEPHANT DENSITY AND DISTRIBUTION IN THE LEUSER ECOSYSTEM OF SUMATRA, INDONESIA
AUGERI, DAVE

Asian elephants are declining and *Elephas maximus sumatranus* is critical for the global population. This study occurred in Gunung Leuser National Park (GLNP), Indonesia in 2005–2006 and was the first study in the region using the MIKE S Class system. Other endangered species were studied. Methods used MIKE Survey Standards and DISTANCE protocols and included a dung decay and RECCE survey and 77.5 km of line-transects in primary and secondary forest in a 400 km² study area. Dung disappearance rate was 188.9 days (df=133, SE \pm 6.1) and we used a production rate of 18.15 (df=11, SE=0.055). Habitat type and forest age and health were the most significant effects ($r^2=0.202$, df=15, $F=3.79$, $P=0.0001$) interactively on elephant distribution. Elephant, tiger, sun bear, argus, and primates were limited to primary forests and secondary forests >26 years old that retained primary forest traits. Density was $D=0.167$ elephants/km² (95%CI=0.106–0.262). Occupancy rate was $\Psi=0.8754$. Abundance was $N=67$ elephants (95%CI=42.5–104.8) in the study area and $N=563$ (95% CI=357.6–883.9) for lowland forest 25 years old is advised and should be led by a multi-interest Advisory Board.

QUANTIFYING PLANT POPULATION PERSISTENCE IN HUMAN DOMINATED LANDSCAPES LAWSON, DAWN, Cerina Lamar, Mark Schwartz

We assess population performance of rare plants across a gradient from rural to urban landscapes and evaluate two hypotheses central to strategic conservation planning: 1) that population performance declines with increasing human dominance and 2) that small populations perform poorly. We use Natural Heritage data from California for our assessment. We found that population performance does not decrease with association to urban settings or smaller initial population. Our results are consistent with a pattern of few species extinctions within these landscapes over the past several decades. We conclude that these populations within compromised landscapes can contribute to overall biodiversity conservation.

WILDLIFE LAW ENFORCEMENT: THE CONTRARY IMPACTS ON LIVELIHOODS AND CONSERVATION IN CENTRAL AFRICA WIELAND, MICHELLE

Unsustainable hunting of wildlife for food is an immediate threat to many animal species in protected areas. Demand by urban consumers is, in some places, an important driver of unsustainable harvest by rural hunters. Law enforcement in and around protected areas is one approach to reducing trade in wildlife to sustainable levels. Results of a twelve month study in the Republic of Congo are used to better understand contrary livelihood and conservation impacts of enforcing wildlife laws to curb the bushmeat trade. Data show that law enforcement adversely impacts the livelihoods of rural families by reducing income, increasing woman and child labor, and reducing access to social services such as hospitals and schooling. On the other hand, law enforcement may well be positive in improving aspects of household nutrition by increasing local consumption of protein. For conservation, this law enforcement is effective at significantly reducing hunting and bushmeat trafficking, but in the process it weakens local stakeholders and greatly increases their animosity towards conservation initiatives. Bushmeat law enforcement is a double edge sword, but it is a critical tool for the protection of endangered and threatened species. To reduce the negative effects, conservationists must improve dialogue with stakeholders such as local communities and cultivate partnerships with organizations to develop alternative economic activities for hunters.

POPULATION UTILIZATION DISTRIBUTION AS A PREDICTOR IN MODELING BLACK RHINO (*DICEROS BICORNIS*) HABITAT IN AFRICA'S SOUTHERN RIFT VALLEY VAN DER HEIDEN, CRAIG, John Volin

Identifying habitat preferences to predict suitable habitat for reintroduction of endangered fauna is a challenge to conservationists and resource managers. An innovative technique to evaluate resource selection for black rhino (*Diceros bicornis*) was used to assess the population utilization distribution (PUD) within a rhino sanctuary in Liwonde National Park, Malawi. By assessing the height of kernel densities in their home range generated by home range software, we analyzed PUD for the rhino enabling us to classify responses to habitat variables over a spatial gradient of resource selection. The measured variables included vegetation, satellite imagery, browse availability, roads, rivers, water holes, and distance to permanent water. We incorporated each variable into a geographic information system. To predict rhino habitat across the sanctuary, we applied a linear conditional autoregression model to quantify habitat variables, associated with the PUD. The model was calibrated in a known core area ($R^2 = 0.60$, $p^2 = 0.58$, $p=0.002$), we then applied the model to an area unoccupied by rhino. Modeling PUD can prove to be a powerful conservation tool in determining suitable habitat for reintroduction and management of black rhino or other endangered wildlife species.

AIDING THE HABITAT CHARACTERISATION OF PELAGIC PREDATORS USING EXPERT OPINION

DELL, JAMES, Chris Wilcox

The decline of large pelagic fish populations is a growing concern as international fishing fleets continue to increase their effort levels and vessel range to provide for an increasing global market. Future conservation of large mobile fish species, such as the tuna and billfish, will require accurate habitat characterisations to inform effective and sustainable management decisions. Our work uses location information from catch records combined with oceanographic data and the expert opinion of fishers to inform a Bayesian general linear model of yellowfin tuna availability in the Tasman Sea. We conclude that Bayesian frameworks allow the inclusion expert opinion as a valuable data source otherwise ignored in traditional methods.

INTEGRATED POLICIES FOR SUSTAINABLE INDIGENOUS LIVELIHOODS IN NATURAL RESOURCE MANAGEMENT

DAVIES, JOCELYN, MICHAEL LaFLAMME

Indigenous groups argue for investment in integrated outcomes from natural resource management (NRM) to enable sustainable livelihoods. Integrated outcomes include improvements in health, family wellbeing, biodiversity, adult and youth NRM skills, traditional knowledge transmission, and income. They are naturally integrated in traditional practices, but rarely in government practices. We will present an international and Australian overview of research that: establishes a weight of evidence for policies to support integrated outcomes; provides examples of indigenous NRM programs that focus on integrated outcomes; and reviews benefits to Australian government of policies that integrate outcomes across sectors. We will then present a participatory research approach to develop partnerships. This approach uses data generated by local stories to develop models that indigenous groups can use: to demonstrate the benefits for investing in integrated outcomes; to compare indigenous and government worldviews; and to build understanding and partnerships for increased investment in indigenous livelihoods.

THE EVOLUTION OF LAND USE PLANNING IN ZAMBIA TO DEVELOP LONG TERM CONSERVATION STRATEGIES IN PROTECTED AREA BUFFER ZONES

LYNOS, ANDREW, Gabriel Mushinge, Austin Mwakywamba

While the most immediate threat facing wildlife in developing countries is often unsustainable or illegal offtake, permanent conversion of critical habitat through unplanned and unmanaged land use presents a greater and more permanent challenge in the medium and long term. Zambia's protected area system includes semi-protected game management areas buffering the major national parks. To address the increasing pressures in these areas for competing land uses, the Zambia Wildlife Authority is spearheading the development of land use plans in partnership with a wide range of institutions, including traditional authorities, government departments, and NGOs. This paper draws upon case studies from Kafue National Park to explore the evolution of land use planning in Zambia, including the strategies for soliciting participation, methodologies for identifying conservation targets, and mechanisms for regulation. Challenges include a rather weak policy and institutional context, the speed at which change is occurring, and a broader political economy which creates nodes of pressure far flung from the affected areas. The study highlights the importance of institution building at the local level, prioritization of conservation goals, understanding micro-macro linkages, and identifying thresholds of change. Land use planning offers the hope of preserving future opportunities for wildlife use, but will only be effective if consistent with the broader institutional and economic context.

FLEXIBILITY IN DISPERSAL BEHAVIOUR INCREASES THE POTENTIAL FOR
SUCCESSFULLY INTEGRATING NATURAL AND AGRICULTURAL SYSTEMS
DOERR, VERONICA, Erik Doerr, Micah Davies

With increasing agricultural expansion and intensification worldwide and the known threats they pose to natural systems, one of the key debates in conservation biology is whether it is possible to integrate conservation of natural systems within agricultural landscapes, or whether set-aside reserves are the only real solution. To be successful, integration must ensure that natural ecosystems retain ecosystem functions, such as dispersal and gene flow, but we currently know little about how flexible these processes might be. We evaluated plasticity in dispersal by comparing the natal dispersal movements of brown treecreepers (*Climacteris picumnus*) in a continuous woodland and in two fragmented agricultural landscapes that differed in the degree and type of connectivity between patches. We found that birds in the agricultural landscapes adjusted their dispersal search behaviour by making more frequent exploratory movements and moving through more diverse types of connectivity, resulting in similar search areas and settlement success as birds in continuous woodland. Such behavioural plasticity is rarely studied, but it suggests that integrating natural ecosystems and agriculture may be a successful strategy for conservation, and landscape planners would benefit from understanding flexibility in ecosystem processes and its limits.

MAKING GOOD MANAGEMENT DECISIONS FOR THE COST EFFECTIVE CONSERVATION
OF NEW ZEALAND'S THREATENED SPECIES
JOSEPH, LIANA, Richard Maloney, Shaun O'Connor, Theo Stephens, Hugh Possingham

Effective management of threatened species is usually limited by the lack of a framework for planning management strategies and prioritising actions. Currently, New Zealand's Department of Conservation's process of determining priorities for threatened species is inconsistent, and there is little transparency or logic in decisions on why species are managed or not. The academic literature dedicated to prioritising management usually recommends ranking species on threat, phylogenetic distinctiveness, or social significance. These approaches make the unrealistic assumptions that all species cost the same to manage and actions have the same likelihood of succeeding. These assumptions will result in the misallocation of scarce conservation resources and, potentially, unnecessary losses. Here, we present a formal and systematic framework to optimise resource allocation to New Zealand threatened species where cost of management, the technical capacity to manage, and potential for species' recovery are considered. We provide examples of elicitation of expert opinion on objective setting and estimates of framework parameters, including of management costs and benefits. We demonstrate prioritising species based on threat status, social significance or any other measure is only one step in the prioritisation process. We show that efficiency in spending is substantially improved through incorporating management costs and, hence, the number of species managed is increased remarkably.

THE IMPORTANCE OF TRADITIONAL SACRED FORESTS OF GAMO PEOPLE FOR
BIODIVERSITY CONSERVATION IN GAMOGOFA ZONE, SOUTHERN ETHIOPIA
DAYE, DESALEGN DESSISA

A natural forest ecosystem in Ethiopia is degraded to secondary formation and many of them have been converted to forest plantation. The original forests represent dry afro-montane forest type and restricted to the sacred forests associated with deities and sacred burial ground, on top of hills as well as along streams and/or creeks as isolated forest pocket. The study of the importance of traditional sacred forests for biodiversity conservation in Gamo highland has started in 2005. Field studies have been carried out to examine the local beliefs, regulations and practices that have successfully protected the biodiversity. The data-collection methodology included site visits with custodians of sacred forests. They include local traditional priest, king and community chief, administration of questionnaires, and carry out discussions with them and other knowledgeable elders, individuals and groups. In each of the sacred forests and burial grounds

biodiversity assessment was carried out and all woody plant species were identified and categorized into threat categories. Coordinates of sacred forests were taken using a GPS. The size and shape of the sacred places and forest cover were digitized to produce a distribution map of the sacred forests. There are about 250 sacred forests distributed all over the Gamo highland, ranging in size from 0.5-20 hectares. The forests are classified as dry afro-montane forest. All plant species found in sacred forests were investigated and identified. A total of 531 plant species belonging to 108 families have been identified, and the species richness varied from 20-70 per forest. Sacred forests are storehouses of endemic or rare species which are otherwise absent or rare in the rest of the region. Four of these plants are nationally protected species. These include *Hagenia abyssinica*, *Cordia africana*, *Juniperus procera* and *Podocarpus falcatus*, and some species such as *Maytenus addata*, *Erythrina brucei*, *Achanthus sennii* are endemic to Ethiopia. There is high diversity of sacred places in Gamo highlands that are used as important reservoirs of biodiversity, preserving unique species of plants, insects and animals. They are the last refugia for Gamo indigenous culture and belief system and biological diversity. Many sacred forests contain a wide variety of biodiversity, including endemic species and relict populations of more ancient forest types.

SAVE, SURVEY OR SURRENDER: OPTIMAL MANAGEMENT OF A CRYPTIC THREATENED SPECIES

MCDONALD-MADDEN, EVE, Michael McCarthy, Iadine Chades, Brendan Wintle, Hugh Possingham

Many of our most threatened species are cryptic and failure to detect them in a location in any year does not mean they are actually absent. The persistence of even large animals, like the Sumatran tiger (*Panthera tigris sumatrae*), may be uncertain especially where parks are large and/or inaccessible and limited survey resources are available. Thus managers of threatened species face several dilemmas: if I am not sure the species is present should I continue to manage for that species, should I invest my limited resources trying to find out if it is present or should I allocate my money elsewhere? We have developed a vigorous decision framework for allocating resources between management, monitoring and doing nothing for an endangered species. We discover that managing a park for a cryptic threatened species can be optimal even if we are not sure the species is present. The more valuable the species is relative to costs of monitoring and management, and the more we believe a species is present, the more likely we are to manage without monitoring. As our belief in the presence of a species declines we shift resources from saving the species to surveying the species, and finally, when surveys lead to a sufficiently low belief that the species is extant, we surrender resources to other species or conservation actions. We illustrate our findings with a case study using parameters for the Sumatran Tiger.

SHOULD WE PROMOTE CONNECTIVITY? A BEHAVIOURAL ECOLOGY APPROACH TO ESTIMATE GENE FLOW

MARIETTE, MYLENE, Constantino Macías García

Considerable effort has been dedicated to counteract the effects of habitat fragmentation on species persistence. In particular, connecting populations by individual translocation or habitat management (e.g. corridors) was suggested to maintain genetic diversity. However, other positive and negative effects of connectivity on population genetics and dynamics have now been identified. Our review highlights that their relative importance remains highly debated, and that no consensus has yet been reached on whether connectivity reduces extinction risk. Importantly, the main effect of gene flow depends on the level of gene flow. This is well recognized in population genetics and the optimal gene flow to maintain genetic diversity has been established and tentatively applied in translocation programs. However, this optimal gene flow does not consider non-genetic factors. Moreover, the relationship between gene flow and dispersal rate is not as straightforward as previously stated because gene flow depends not only on the number of immigrants but also on their reproductive success. We suggest that behavioural ecology can help predict the effects of connectivity. In particular, we can predict dispersal behaviour under different

habitat configurations and immigrant reproductive success under different mating systems. We can then predict how the resultant level of gene flow affects the genetic and demographic structure and ultimately the probability of extinction of a metapopulation.

SEASONAL VEGETATION PREFERENCES DRIVE AFRICAN ELEPHANT MIGRATIONS
ACROSS SEVEN SOUTHERN AFRICAN COUNTRIES
LOARIE, SCOTT, Rudi van Aarde, Stuart Pimm

African elephants (*Loxodonta africana*) are the flagship species of southern African savannahs. Elephant's wide-ranging, seasonal ecology complicates their management. With increasing human activity, elephant populations are declining on a continental scale. Locally, densities often increase in remaining habitat, and human-elephant conflict arises where both species compete for resources. Mitigating human-elephant conflict and designing protected areas that accommodate elephants requires a better understanding of elephant movements across seasonal and geographic gradients. We placed satellite collars on 73 elephants across 7 southern African countries and tracked each an average of 400 days. We combined these data with remotely sensed MODIS images collected at 16-day intervals. We found that elephant movements are influenced by strong seasonal vegetation preferences. In the dry seasons, elephants prefer wooded areas with high mean greenness and minimal seasonal variance. In the wet season, elephants enter areas that are less green on average and more seasonally variable. These areas are marginal in the dry season, but produce abundant growths of seasonal grasses in the wet season. These resources are spatially and temporally disjoint and elephants often must make large seasonal movements to access both resources. Protected areas should strive to include both resources to minimize seasonal contact with humans.

EFFICIENT AND ROBUST POPULATION MANAGEMENT UNDER SEVERE UNCERTAINTY
BAXTER, PETER, Colin Thompson, Michael McCarthy, Hugh Possingham

Uncertainty and financial constraints can both greatly affect the success of conservation actions. Economic cost functions can be included in population models to find optimal management strategies, but these recommendations ignore severe uncertainty in the underlying processes. We combine two recent advances in decision theory (information-gap theory and matrix efficiency analysis) to show how uncertainty affects which strategies are preferred. We investigate the joint effects of management costs and uncertainty on population management decisions for the Helmeted Honeyeater (an endangered Australian bird), and the koala. To increase Helmeted Honeyeater populations with greatest cost-efficiency, a manager should invest exclusively in nest protection, but the suitability of this approach deteriorates as uncertainty gets very high. A more risk-averse strategy should include a degree of bet-hedging by purchasing extra habitat. In the case of koala population management we discover that the recommendation of matrix efficiency analysis – to invest in fecundity and survival management in roughly equal proportions – is very robust indeed to uncertainty. Our approach allows consideration of two factors to which conservation is often subjected: economic constraints and high uncertainty. It produces robust recommendations for efficient management that allow a transparent trade-off between performance expectation and risk avoidance.

CONSERVATION OF NEPALESE WETLANDS FOR LIVELIHOOD: AN INDIGENOUS
APPROACH
KHANIYA, GANESH, Isha Sharma, Kamal Rai

Wetland ecosystems in various parts of Nepal are getting vulnerable thus threatening the biodiversity and causing imbalance in ecosystem. This paper addresses the correlation and interdependence between the use of wetlands for sustainable livelihood and indigenous conservation practices, prominently based on some wetlands from different ecological niches in Nepal. Nepalese wetlands carry huge cultural significance upon which the livelihood of different ethnic communities, specially, marginal ones is relied on. Yet they had remained long neglected as wastelands in Nepal and currently are under serious threat of encroachment owing to

urbanization and declining indigenous knowledge. Human encroachment of wetlands for immediate benefit has caused threat to the very survival of these precious water heritages which subsequently lead to desertification and biodiversity loss. This paper concludes that with the concerted effort of different stakeholders bringing the community in the forefront, livelihood of marginal community can be ensured and conservation of these entities can be sustained. Wetland management, thus, should be intertwined with livelihood and cultural aspects for the sustainable conservation and environmental protection.

THE DRY AND EARLY WET SEASON IMPORTANCE OF HIPPO LAWNS AND BURNT SAVANNA FOR BUFFON'S KOB IN A WEST AFRICAN SAVANNA BUIJ, RALPH, Hans de longh, Paul Loth

Recent studies in Cameroon indicate that grass swards kept short by hippopotami are essential for daily subsistence of mesoherbivores during the wet season. The 2006 upgrading of the IUCN Red List status of *Hippopotamus amphibious* and its vulnerability in West Africa in particular, merit further research into its role in habitat structuring. To investigate the importance of hippolawns for Buffon's kob during the dry and early wet season, an experiment to assess grass biomass production was performed next to a transect survey to determine kob distribution. Vegetation characteristics were recorded to determine profitability and grass samples collected for chemical analyses. Results show that burnt savanna and salt licks are important determinants of kob distribution during the mid dry season. Profitability and nutrient content are important factors underlying preference for young growth on burnt savanna. Hippolawns were not preferred by kob at this time, despite a relatively high nutrient content and comparable biomass production to burnt savanna. Hippolawns become more profitable from the early wet season. The results support the specific role of hippopotamus grazing and fire in providing nutrient resources for medium-sized herbivores during different parts of the year, and underline their importance to park management.

NATURAL RESOURCE EXPORTS FROM DELAGOA BAY AND ITS HINTERLAND 1845-1907 SHAFFER, L. JEN

While previous investigation of historic East African export records has focused on the social, political, and economic changes generated by the slave and ivory trade in this region, these same records could be used to document regional long-term ecological change. This study analyzes available export records for Delagoa Bay (now Maputo Bay, Mozambique) and its hinterland from 1845 to 1907 in order to understand the potential ecological impacts of historic natural resource extraction on this region. Types, amounts, and values of exported biological, non-agricultural resources were collected from the alfândega registers held at the Arquivo Histórico Ultramarino in Lisbon, Portugal. Published accounts of nineteenth century explorers were used to identify unusual items and the extent of Delagoa Bay's hinterland. Information on the ecological niche of identifiable exports was drawn from the literature to determine potential ecosystem impacts. Elephant ivory, rhinoceros horn, and hippopotamus teeth comprise the top three exports from 1845-1907. Other listed exports include various wild animal pelts, skins, bones, and horn, sea turtle shells, cowry and conch shells, whale oil and ambergris, fresh and dried fish, specialized timbers (*Diospyros kirkii*, *Spirostachys africana*, *Dalbergia melanoxylon*), mangrove tree bark, rubber (*Landolphia kirkii*), and a lichen (*Roccella montagnei*).

ASSESSING RESERVE DESIGN STRATEGIES IN TERMS OF SPECIES PERSISTENCE GORDON, ASCELIN, Bill Langford, Sarah Bekessy, Lucy Bastin

Recent developments in reserve design algorithms have resulted in a large number of methodologies for selecting conservation reserves, though little work has been done to compare these strategies in a general way. This study compares conservation strategies in terms of the persistence of species within a given reserve configuration. Specifically, it examines how the ranking of different conservation strategies is affected by the following factors: the structure of a landscape and the distribution of species; the type of population model used to calculate the

persistence measures and the method used to aggregate individual species persistence measures to a multi-species measure. We take several reserve selection strategies, including simple heuristics and more complex spatially explicit selection algorithms, and assess their performance with a range of species population models, from a simple patch occupancy model to stage structured metapopulation models. Using both real and simulated data with various landscape configurations, this framework allows us to investigate when a given reserve selection strategy is appropriate for a particular conservation scenario. This study demonstrates the difficulty in generalising about the use of conservation strategies due to the sensitivity of results to landscape structure, species distributions and the type of population model used to calculate persistence measures.

REGIONAL SCALE ANALYSIS OF REEF FISH ASSEMBLAGES ON TEMPERATE WESTERN AUSTRALIAN REEFS: EVIDENCE FOR INDIRECT EFFECTS OF FISHING DELACY, CAINE, Euan Harvey, Howard Choat, Russ Babcock

The compensatory increase of lower order species following the removal of higher order competitors and predators is expected given the top-down control of higher order members on the community. Through the use of underwater video transects, a broad scale analysis of temperate reef fish assemblages was conducted along approximately 1500 kms of coast of the west and south west coast of Australia. The coast was segmented into seven regions and each zone contained 4 locations and 4 sites within each location. At each site twelve 25x5 m transects were conducted using underwater video. Four higher order targeted species showed marked difference in abundance along the coast, with each species tending towards higher abundances in areas of low fishing pressure on the south coast. Conversely, two non-targeted species showed an increasing trend in abundance at Perth and Jurien bay, where the highest level of fishing are maintained. *Coris auriculalis* showed a three fold increase in abundance at Perth and 5 fold at Jurien bay compared to any other region. Similarly, *Notolabrus parilus* were nearly five times more abundant at regions Perth and Jurien Bay, compared to their two neighbouring regions. This study highlights the need for assemblage based research on the effects of fishing.

DIVERSITY AND CHANGE IN SETTLED SAVANNAH WOODLANDS: AN ECOLOGICAL HISTORY OF RESILIENCE IN SOUTHERN ZIMBABWE Mukamuri, Billiards B., KENNETH B. WILSON

Arising from a broader study of ecological history, this paper explores the nature and causes of dramatic changes in the savannah woodlands of Mazvihwa a semi-arid area in Southern Zimbabwe over a century of intense but changing human utilization. Tracing precise changes in the extent, density and species composition of mopane and miombo woodlands in a densely settled communal area adjacent to a series of mining towns, the study demonstrates that anthropogenic impact has had much more varied and subtle impacts than are usually considered. Complex changing local woodland management traditions and practices interact with the ecological dynamics of these savannahs to lead to greater than expected stability in some cases, and more rapid shifts in others, as seen over different temporal and spatial scales. Overall, and despite largely inappropriate governmental interventions in the name of conservation, both woodland diversity and the environmental services provided by trees have proven remarkably resilient, reflecting how dynamic and adaptive are both African savannahs and African communities.

WHICH MATTERS MOST IN RESERVE OPTIMIZATION: THE GOAL OR HOW WE GET THERE? LANGFORD, BILL, Ascelin Gordon

Quantitative methods for the design and selection of reserve networks are an important research topic in biodiversity conservation. However, predicting the performance of a method on a particular problem or on a broad range of problems is difficult. Part of the difficulty comes from the fact that reserve selection methods are composed of at least three integrated parts: biological

models, objective functions with constraints (containing terms such as representation targets, boundary length, cost, etc.), and optimizers (algorithms such as simulated annealing). For example, it is difficult to determine whether one method performs better because it has an irreplaceability term in its objective function or because it uses simulated annealing instead of a greedy search, or both. In this paper we use our recently developed evaluation framework to separate and quantify the relative contributions of the objective functions and the optimizers to species persistence. We do this across a variety of landscapes and real-world complications to look for results that are generalizable beyond the usual single case study in a single geographic location. We show the variety of conditions under which the objective function controls performance with respect to species persistence vs. conditions where the optimizer controls performance. These results demonstrate the need for conservation biology to more rigorously test the outcomes of reserve selection methods.

BIODIVERSITY CONSERVATION MONITORING IN MADAGASCAR: PROGRESS IN SAFEGUARDING THE MOST IMPORTANT BIODIVERSITY AREAS

RAKOTOBE, ZO LALAINA, Luciano Andriamaro, David Knox, Will Crosse, Harison Rabarison, Harison Hanitriniaina Randrianasolo, Rollande Finoana, Leanne Miller

A systematic monitoring framework consisting of three state indicators and one response indicator is applied to measure and analyze progress in safeguarding species, sites and landscapes of global biodiversity significance in Madagascar. These indicators include the Red List Index, and indices of habitat change in key biodiversity areas and fragmentation and changing protection status of Key Biodiversity Areas. The results yield negative trends over the last two decades for all three state indicators, while the response indicator, by contrast, shows a positive trend over the last few years. This first analysis of trends in these indicators paints a clear and broad picture of changes in the status of Madagascar's biodiversity. This in turn both delivers reliable messages for building awareness and informing decision making and generates detailed information to direct more in-depth analysis and more strategically targeted conservation actions. The far-reaching biodiversity conservation reforms currently being implemented in Madagascar may be set to significantly reduce the nation's biodiversity loss. Yet to provide a definitive answer to whether this is indeed the case, long-term tracking of the indicators tested here is necessary. This will not only gauge the nation's level of commitment to biodiversity conservation, but will also assess Madagascar's contribution to measuring progress towards the 2010 target of significantly reducing the rate of biodiversity loss.

FERAL CAT IMPACT ON SOOTY TERNS (*STERNA FUSCATA*) AT JUAN DE NOVA ISLAND, MOZAMBIQUE CHANNEL

PECK, DARREN, Lucie FAULQUIER, Patrick PINET, Sebastien JAQUEMET, Matthieu LE CORRE

Feral cat (*Felis catus*) predation on seabirds has been documented; however details regarding shifts in diet relative to seabird availability, predation rates and the impact on population dynamics are scarce. We present here data documenting a seasonal shift in feral cat diet, at Juan de Nova Island, Mozambique Channel. We also quantify sooty tern (*Sterna fuscata*) predation by feral cats and examine their impact on sooty terns over both the short-term (by removing cats from sub-colonies), and over the longer-term by highlighting their influence on population growth rate (?) using a matrix model approach. Cat diet shifted from insects, rats and mice outside the tern-breeding season to primarily terns during the tern-breeding season. The predation rate of sooty terns at Juan de Nova was 5.94 terns cat⁻¹ day⁻¹, with a proportion of these (22%) being killed without being consumed ('surplus kills'). When only one cat was removed from each sub-colony, tern predation dropped tenfold. From our model, the annual growth rate for sooty terns was 1.010 in the absence of cat predation. It remained above 1 until a predation impact equivalent to approximately three times the estimated cat density (12.04 per km²) was incorporated. Results demonstrate that cats preferentially predate and have acute impacts on breeding sooty terns at Juan de Nova, and that even a modest increase in cat density could lead to negative effects on population growth, despite a large breeding tern population.

FACTORS PREDICTING DEN USE BY MATERNAL GIANT PANDAS

ZHANG, ZEJUN, RONALD R. SWAISGOOD, HUA WU, Ming LI, Yange Yong, Jinchu HU, FUWEN WEI

As a highly k-selected species, giant panda cub (*Ailuropoda melanoleuca*) survival can have a significant effect on population persistence. Extremely altricial at birth, survival of panda cubs—like their ursid kin—is dependent on suitable dens. We studied the denning ecology of giant pandas to provide data for informed conservation management of this endangered species. Using records from years of monitoring in the Foping Nature Reserve, China, we identified 17 used and 21 unused den sites, and measured several variables potentially affecting their suitability. Principle components analysis, combined with traditional univariate tests, indicated that maternal females prefer deeper cavities with a high interior to entrance ratio for height and width, suggesting a preference for narrow entrances and roomy chambers. We suggest that these factors are related to thermal buffering, predator deterrence, and minimizing the risk of accidentally crushing the cub. Microhabitat features, including slope and distance to water, were also useful in predicting den use by maternal females. These maternal preferences are likely correlated with cub viability in selected dens, suggesting that the availability of suitable dens may limit population size, especially in areas where tree dens have been eliminated by logging of old growth forests. Our data can be used to help define characteristics of suitable dens when surveying protected areas to determine if den sites may be limiting.

THE INTEGRATION OF LIVELIHOOD NEEDS AND HUMAN WELFARE IN THE MANAGEMENT OF PROTECTED AREAS

SUNDERLAND, TERRY, Jacqueline Sunderland-Groves, Roger Fotso, Anthony Nchanji, Aaron Nicholas, Eberhard Goetz, Frank Stenmanns

The Takamanda Forest Reserve (TFR) in SW Cameroon is not only highly diverse but is also one of the last refuges of the Cross River gorilla (*Gorilla gorilla deihi*), a taxon of critical conservation importance. Recent initiatives in the region have focussed not only the direct conservation of the biological resources of the area but have also taken into consideration issues of basic human welfare. The TFR is soon to be upgraded to a National Park, but based on a sound scientific baseline, an integrated management approach based has been developed that will support the sustainable use of certain high-value forest products integral to rural livelihoods strategies. The integration of a wider range of management objectives has been made possible by the formalisation of a close partnership between the Government of Cameroon and international conservation (WCS) and development agencies (GTZ and DED) and a reinterpretation of the national law on the creation of Class IV protected areas which supports legislative changes to the National Park legal framework if they are accepted and adopted by all stakeholders. It is hoped the integration of human activities that do not compromise conservation objectives into the management of the proposed National Park will avoid the problems of conflict and non-compliance that characterise the creation and management of protected areas elsewhere.

GENETIC DIVERSITY IN SOUTH AFRICAN IMPALA (*AEPYCEROS MELAMPUS*)

SCHWAB, PATRICK, Thorsten Witt, Günther Hartl, Paul Grobler

Genetic differentiation between geographically distant conspecific populations, and possible adaptation to different habitats, may justify management as separate evolutionary lineages. Several authors have suggested that such distinct populations or evolutionary significant units (ESUs) should not be mixed. Phylogeographic information is lacking for many southern African antelope species. It is still not known whether genetic structuring exists within most species, and whether structuring results from vicariance or have adaptive significance. Most antelopes affected by possible genetic structuring are scarce and it is difficult to obtain meaningful sample sizes for genetic analysis. The use of a commonly available species as a model may provide useful insight into processes and patterns of genetic diversity in antelope populations without the complications of sampling valuable animals. The impala occurs over a wide distribution range in South Africa

and is easily sampled, thus providing an ideal model-species. In this study we sampled nine populations in the Limpopo Province and two in KwaZulu-Natal. Sequencing of the mitochondrial DNA control region (346bp, n=130) showed minor differentiation between certain populations. Microsatellite genotyping (seven loci, n=130) revealed more significant genetic structuring among populations. In terms of conservation implications, translocations between the Limpopo and Kwa Zulu Natal provinces are probably not advisable.

COMBATING POVERTY AND BIODIVERSITY LOSS IN THE GUINEA SAVANNAH LANDS OF THE MOLE NATIONAL PARK, GHANA

BOSU, DARYL EBENEZER, Moses Kofi Sam, William Simonson

The savannah lands surrounding the Mole National Park of northern Ghana have been severely degraded by many years of unsustainable land management practices. The village communities which depend on these areas lack many basic services and infrastructure, and their fight for survival drives them to indiscriminate game hunting and wild honey hunting, leading to damaging bush fires and declines in endangered mammal populations, within the protected area and in off-reserve areas. Working with two communities, a combined approach of empowerment in community resource management, and introduction of simple technologies to improve income generation, was adopted. Community liaison officers worked with the villages to agree and delineate a 62 square kilometer Community Resource Management Area (CREMA), which was then surveyed for its fauna, flora and resource utilization potential. A management constitution was established, and district bye-laws are being developed to devolve full responsibility for the management of the land to the communities. Concurrently, 98 actors were identified, trained and resourced in bee-keeping, and 30 actors in dry season gardening. Gari processing and Shea-nut processing facilities were provided to women's groups to make the production and marketing of these products a viable enterprise. An ongoing biological monitoring programme in the CREMA and National Park will help determine the environmental benefits of this approach in the longer term.

MAKING CONSERVATION EFFECTIVE THROUGH PAYMENTS FOR BIODIVERSITY PROTECTION IN KALAHAN RESERVE PHILIPPINES

VILLAMOR, GRACE, Delbert Rice

Rewarding Upland Poor for Environmental Services (RUPES) is developing ecotourism as one of the payment mechanisms to bolster the biodiversity conservation in the Kalahan Reserve in the mountainous region of the Philippines. The Ikalahans are indigenous people living in the Reserve. With their indigenous knowledge and practices the Ikalahans were able to maintain two sanctuaries of high plant and animal diversity (with 20 new unrecorded species of birds, 1150 of native plants and more than 150 endangered species of birds, orchids, trees, wild animals and insects), while setting aside areas for their food production. The Ikalahans are known for their indigenous knowledge practice systems that are environmentally sustainable. With these, thousands of hectares of forestlands were preserved from further land conversion and benefits derived from the forest were increased while improving the forest biodiversity.

THE ROLE OF ABANDONED AGRICULTURE FIELDS AS BEE HABITAT: LOCAL- AND LANDSCAPE-SCALE LAND USE EFFECTS

MANDELIK, Yael, Rachael Winfree, Neal Williams, Claire Kremen

Abandoned agriculture fields (old fields) are a prominent feature in arable landscapes. These habitats provide essential foraging resources for wild bees, which are important pollinators of many crops and wild plants. Little is known about how management of old fields affects their role as wild bee habitat. Old field typically contain many non-native plants, making them a good system for investigating interactions between native and non-native plants and pollinators. We studied bee communities and floral resources in old fields of different ages that also differed in management (mowed versus un-mowed). The study was conducted in New Jersey, U.S.A., in 20 half-hectare plots spanning a gradient in age, local management practice, and land use intensity

in the surrounding landscape. At each site we sampled wild bees, honey bees and flower abundance 5 times from late spring till autumn. Neither old-field age nor mowing regime significantly affected the number of wild bee species or their aggregate abundance. The abundance of wild bees, but not honey bees, was strongly correlated with the proportion of forest cover in the surrounding landscape. Wild bees and honey bees used different components of the floral community, with honey bees making significantly more visits to exotic plants. We conclude that mowing and age since abandonment have no significant effect on bee communities inhabiting old fields, but honey bees may be facilitating the spread of exotic flowers in these habitats.

ARE ELEPHANT CORRIDORS WILDLIFE HIGHWAYS? AN EMPIRICAL TEST OF THE FOCAL SPECIES APPROACH IN TANZANIA

EPPS, CLINTON, Lauren Gwin, Benezeth M. Mutayoba, Bakari N. Mbano, Peter Coppolillo, Justin Brashares

The “landscape species concept” uses a single species as a surrogate for planning, managing and monitoring the conservation of whole communities. However, this approach has received little empirical evaluation, particularly when applied to conserving landscape connectivity. The African elephant *Loxodonta africana* has often been proposed as a focal species for large mammal communities in east Africa. However, it is not known whether other species preferentially inhabit or disperse through elephant corridors. To evaluate the presence of mammal species across a suspected elephant corridor, we conducted 35 walking transects (8.5 km average length) across a largely unprotected region (~10,000 km²) between two Tanzanian national parks. Most transects were placed according to a randomly-initiated systematic grid to avoid biases associated with roads and trails. We recorded dung, tracks, and direct sightings of large mammal species (>1 kg). We also recorded human activities and other habitat-related variables. Elephant activity was strongly correlated with the number of ungulate, carnivore, and total large mammal species detected. Farming and grazing were negatively correlated with elephant presence, species richness, and relative abundance of large mammal sign. Although these data may reflect habitat value rather than potential for dispersal, they suggest that empirically-validated landscape and focal species approaches may be valuable tools for conserving connectivity.

EVALUATION OF THE CONTRIBUTION OF GROUNDWATER DISCHARGES TO RIVERS FOR RIVER ECOSYSTEM SERVICE ASSESSMENTS AND CONSERVATION PLANNING

LE MAITRE, DAVID, Christine Colvin

River flows are an important ecosystem service and groundwater contributes significantly to these services by sustaining river flows. This paper uses river flow statistics and broad, lithological aquifer types to gauge the contribution of groundwater to river flow regimes in southern Africa. The approach involves defining the nature of the physical template, namely, the principal aquifer type, and assessing the nature of the groundwater contribution to surface flows using flow statistics. This analysis focuses on seasonal variation rather than annual flow indexes. Weak relationships between annual river flow indexes and the seasonality or concentration statistics ($r < 0.20$), imply that catchment storage characteristics are an important source of variation between catchments. Catchment storage, particularly subsurface storage and discharge, plays a key role where the flow concentration indexes are lower than the corresponding rainfall concentrations. The lowest total flow concentrations (< 25%) occur in a few isolated groups of catchments on carbonate dominated aquifers and in some fractured sedimentary aquifers. The baseflow index and groundwater-fed baseflow are useful and ecologically meaningful variables but do not relate directly to potentially significant differences in river flow patterns, for example perennial versus seasonal rivers. Flow concentrations also are useful and potentially ecologically important variables and should be used in assessments.

THE DEMOGRAPHIC CONUNDRUM OF MANAGING ELEPHANTS FERREIRA, SAM, Rudi van Aarde

Growing African elephant populations influence other species. Even though the link between elephant numbers and their effects is tenuous, much debate focuses on how to manage numbers and the damage caused by elephants. Management options such as birth control, translocation and culling may negate density-dependence and boost population growth. In addition, the fencing and isolation of conservation areas may enclose populations and hinder dispersal. Management such as the control of fires, burning and water supplementation may influence elephant dynamics. Our study showed that elephant density affected population growth through birth rates that decreased when densities increased. Increased variability in rainfall reduced survival rates. The interplay between births and density, and that of survival and rainfall may explain temporal changes and spatial variation in numbers. However, inter-population dispersal may modulate such heterogeneity. Actions to reduce densities can increase birth rates, while water provisioning may improve survival and hinder seasonal movements, and fencing could hamper dispersal. This will stimulate growth rate and increase impact. We should thus be cautious to reduce elephant numbers and to introduce elephants into systems that do not provide for the spatial needs of elephants or the management of spatial heterogeneity. Ultimately, the restoration of elephant spatial use may reduce impact, even at relatively high local densities.

THE RESILIENCE OF TROPICAL DRY FORESTS TO DISTURBANCE AND CLIMATIC VARIABILITY: A 16-YEAR STUDY OF A LARGE-SCALE PLOT AT MUDUMALAI, SOUTHERN INDIA SUKUMAR, RAMAN, H.S. Dattaraja, H.S. Suresh

The structure and stability of tropical forests and their role in the carbon cycle are being investigated, especially in the context of future climate change. We have been studying forest structure and dynamics in a 50 ha permanent plot in a tropical dry forest at Mudumalai, southern India. During the period 1988-2004, this site has witnessed six ground fires, a severe drought during 2001-03, and significant mortality in understory trees because of fire and herbivory by elephants. Recruitment, mortality and population size of woody stems ($> 1\text{ cm dbh}$) have fluctuated widely, depending mainly on occurrence of fire. Basal area increased overall from 24.4 m^2/ha in 1988 to 25.3 m^2/ha during 2004, though there were marginal declines during periods of deficient rainfall. Interestingly, there has been a monotonous increase in above-ground biomass (and carbon stocks) from 174 tons/ha in 1988 to 193 tons/ha in 2004, mainly because of a shift in biomass from species with low wood density to those with high wood density, suggesting that this dry forest has sequestered carbon in spite of disturbance and extreme climate. We suggest that tropical dry forests subject to a regime of disturbance and high environmental variability have adapted through a variety of life-historical traits, and thus show high resilience, an important consideration in assessing future climate change impacts on tropical ecosystems.

CHALLENGES AND SUCCESSES IN CONSERVING THE EVOLUTIONARY HISTORY OF REDFIN MINNOWS IN SOUTH AFRICA AND LESOTHO SWARTZ, ERNST

Lower sea levels than at present, most notably a – 130 m sea level during the last glacial maximum about 18 000 years ago, seems to have played an important role in allowing currently isolated river systems on the south coast of South Africa to share common confluences before reaching the sea. Molecular studies suggest that possibly only a few palaeoriver systems existed. However, other opportunities for dispersal has been limited resulting in isolation-type processes dominating the evolution of redfin populations. Many of the isolated populations are declining, mainly as a result of alien fish species, necessitating prioritisation of populations that are critical to the conservation of unique evolutionary lineages. As part of a comprehensive IUCN re-assessment of the conservation status of southern African freshwater fishes, 16 evolutionary lineages in seven species were formally included. The 13 lineages that occur in South Africa will now receive individual protection as unique conservation entities. In Lesotho, the Mohale

population of the Maloti minnow is under severe threat because of the Lesotho Highlands Development Plan to deliver water to South Africa through several large reservoirs and connecting tunnels. Prioritisation of the Mohale population based on distribution and molecular studies resulted in a comprehensive conservation and translocation plan to save this unique evolutionary lineage, a first for conservation of fishes in Africa.

CONSIDERING EXPLANATORY FACTORS SIMULTANEOUSLY WHEN EXPLAINING SPECIES RICHNESS PATTERNS

WILSON, JOHNNY, Berndt van Rensburg, Willem Ferguson, Mark Keith

Large scale biodiversity patterns are often spatially autocorrelated and covary mainly with environmental variables and anthropogenic activities. Nonetheless, few studies consider the potential additive or counteractive effects these predictor groups may have towards each other. Neglecting such effects could jeopardise our understanding of the mechanisms that account for altered species richness patterns. We assessed the relative and synergistic effects of environmental, human and spatial influences on species richness patterns using selected South African avifaunal orders. We determined these relationships with variance partitioning techniques by using Generalized Linear Models (GLZ). We found clear differences in the extent to which different avian orders correlated with environmental, human and spatial influences, either combined or exclusively. Although species richness variation correlated best with environmentally structured spatial deviance over most avian orders, pure spatial effects became more apparent in water birds. Charadriiformes (waders) and Anseriformes (ducks & geese) also displayed a particular strong anthropogenic relationship; the latter link has mostly negative conservation consequences.

CONSERVATION MANAGEMENT OF FOREST FRAGMENTS: KEY TO SURVIVAL OF THREATENED WILDLIFE IN CEBU ISLAND, PHILIPPINES

PAGUNTALAN, LISA MARIE

The last few remaining fragments of native forest on Cebu Island support the last few populations of some of the world's most threatened species and subspecies of wildlife. Consequently, Cebu constitutes one of the world's highest conservation priority areas in terms of both numbers of threatened endemic taxa and degrees of threat. Site conservation projects conducted for the last five years have resulted in the protection of the three largest remaining forest fragments, increased local awareness and appreciation on the importance of biodiversity conservation, and involvement of local communities, government units (LGUs), People's Organisations (POs) in the development and implementation of a wide-range of community-based conservation activities. This paper describes the experiences, challenges and strengths of local communities and local government units taking a lead in biodiversity conservation programs in southern Cebu, Philippines. This paper also discussed how local communities, local government units, non-government organization and youth volunteers worked to conserve the endangered Black Shama *Copsychus cebuensis* and other threatened species from extinction.

INTERNATIONAL LAW AND TRANSBOUNDARY MARINE PROTECTED AREAS IN EASTERN AFRICA

RIBEIRO, RAQUEL, Catarina Grilo, José Guerreiro

Eastern African countries share a biological diverse coast with threatened habitats and local communities intensively liaised to natural resources. Setting transboundary networks of marine protected areas (MPAs) between Tanzania and Mozambique, and Mozambique and South Africa is an opportunity to safeguard environmental and social values, and to strengthen bilateral cooperation. This work intends to analyse the role of international law in the implementation of these networks, specifically its ability to facilitate or constrain it, looking into both global (e.g. CBD, UNCLOS) and regional (e.g. Nairobi Convention, African Nature Convention) instruments. 52 instruments were analysed in detail (32 global and 20 regional), 24 of them corresponding to heading legislation and the others to subsidiary one. UNCLOS has a special role as it sets out the

jurisdictional framework regarding maritime zones; Ramsar and World Heritage conventions allow the identification of sites in situ; Ramsar Convention and the Convention on Biological Diversity provide applicable conservation principles. The Nairobi Convention and its protocols are unavoidably the key Eastern African instruments providing for the protection of the marine and coastal environments and the establishment of MPAs. In many of these instruments MPAs are flagged, frameworks for international assistance are set and conservation priority is given to specific habitats in the Eastern African coastal area.

CONSERVATION OF THE PULAI RIVER ESTUARY – AN UPHILL BATTLE CHOO, CHEE KUANG

The Pulai River Estuary boasts the largest (estimated at 38 hectares), contiguous intertidal seagrass bed in Malaysia. It supports rare marine species like the seahorse *Hippocampus kuda*, pipefish *Syngnathoides biaculeatus*, dugong as well as the livelihood of approximately 400 local inshore fishermen. However, the surrounding area has been subjected to port and powerplant development which imposed adverse impacts on the local biodiversity. A public volunteers program was initiated since Sept 2005 to assess changes in the seagrass resources. The volunteers were trained to carry out seagrass mapping, monitoring and survey on the abundance of seagrass macro-invertebrates using transect and quadrat. The population abundance and distribution of *Hippocampus kuda* and *Syngnathoides biaculeatus* were also assessed monthly using a drag net. The data analyzed using the ArcView GIS software showed that the northeastern portion of the seagrass bed had higher seahorse abundance and seagrass percent cover. Nevertheless, it is felt that further studies are needed to investigate the role of population connectivity and that of the keystone species, if any. The preliminary findings from this program were communicated to resource managers and policy makers in the hope that prompt mitigation measures and management plan can be developed. This program has also outreached to the local schools kids who were involved in mangroves, seagrass and water quality monitoring.

SPATIAL MULTI-CRITERIA ASSESSMENT OF DEVELOPMENT AND BIODIVERSITY TRADE-OFFS: AN APPLICATION TO NORTHERN SUMATRA, INDONESIA SUMANTRI, HENDI, Dessy Anggraeni, Iwan Wijayanto, Daniel Juhn, Grace Wong

Northern Sumatra harbors tremendous biodiversity, with over 8,500 plant and 512 faunal species. Most of the large mammalian species are classified as threatened, and twenty six priority conservation areas have been identified in the landscape. The habitats of these species are highly fragmented. A significant portion of the montane forests has been deforested, and majority of the remaining lowland natural habitats are at risk from development pressures and agricultural encroachment, even within the boundaries of existing protected areas. Given that biodiversity conservation must compete with other potential land uses, conservation planning for northern Sumatra must consider local economic and socio-political priorities to be credible. The purpose of this study is to assess key productive assets in the northern Sumatra landscape to inform policy development in land-use planning. We use a collaborative multi-criteria analysis to identify suitable areas for developing commercial agriculture (palm oil and coffee) and timber plantations. Our results indicate there is significant spatial overlap between the biodiversity and economic priorities, and will require difficult decisions on trade-offs between the two priorities. To facilitate biodiversity friendly land use planning, this approach was presented as a platform for negotiation between planning agencies over areas where biodiversity conservation and production conflict.

FISH CONSERVATION OF THE NOSIVOLO WATERSHED, MADAGASCAR LEWIS, RICHARD, Luciano Andriamaro, Noro Raminosoa, Juliette Velosoa, Bellarmin Ramahefasoa

The 120 km long Nosivolo River has the highest diversity of Malagasy fish (19 species, of which four are Critically Endangered, three are Endangered and four are Vulnerable) of any watershed in the country. Three species (two CR, one EN) are endemic just to this watershed. From 2003 Durrell, University of Antananarivo and Conservation International began work in the watershed.

The major threats we identified are sedimentation (from deforestation), mining, over-fishing, and the introduction of exotic fish species. Since 2005 we have been working with the local human communities to develop conservation strategies and improve the livelihoods of the communities dependent on the river. All have shown strong interest in developing strategies to protect the fish, the river and the surrounding watershed. The approach is also strongly supported by national and regional government and by regional politicians. Durrell has already assisted the fishermen to organise themselves into Associations. They have proposed and implemented closed season (during fish spawning), larger mesh sizes, and permanent no-catch zones. Participatory monitoring will indicate whether these measures are impacting the fish populations. Agricultural solutions are being proposed to try and limit land erosion and subsequent water sedimentation. This is the first fish conservation project in Madagascar.

ELEPHANTS AND THEIR IMPACT GULDEMOND, ROB, Rudi van Aarde

Elephant management is often motivated by the damage they inflict on woody vegetation. However, factors associated with rainfall and fences may complicate the interpretation of the response of vegetation to elephants. We reviewed 238 studies published over a period of 45 years and did a meta-analysis based on 21 studies that provided sufficient information of vegetation responses. For each study, we considered elephant density, savanna type (based on rainfall per year), whether elephants were fenced or not, and the responses of the plant variables. There exists a bias towards the citations of 20 studies in our database. Of these, 15 showed that the vegetation responded negatively to elephants - only half of the remaining 218 studies showed a similar pattern. Our analysis indicated that vegetation responded negatively at high elephant densities. Savanna type and fences influenced these responses. In arid savannas (784 mm), vegetation responded negatively to elephants living at higher densities, but were recorded at lower densities under fenced than unfenced conditions. Management should consider savanna type and the presence of fences when evaluating elephant impact.

MODELLING THE EFFECTS OF CONTRACEPTION IN THE AFRICAN ELEPHANT POPULATION IN THE ADDO ELEPHANT NATIONAL PARK, SOUTH AFRICA CASTLEY, J. GUY, Graham, I.H. Kerley, Michael H. Knight

Managing burgeoning elephant populations in southern Africa remains a dilemma. The Addo Elephant National Park provides a unique opportunity to assess the options for implementing a contraceptive strategy as the demographics and dynamics of this elephant population have been well documented. Our analysis tested the efficacy of contraceptive treatments using a simple spreadsheet model to identify potential future outcomes. All cows capable of breeding were exposed to contraceptive treatments of 25%, 50%, 75%, 100% and combinations of these. Population reduction was achieved in just three years under a continuous contraception regime (100% treatment), while a 77% continuous treatment effectively stabilised the population over the long term. Changes to the age- and sex-specific structure of the population were noted and there was a progressive shift from a population dominated by younger individuals to one where older age classes prevailed. Extinction of age cohorts is observed under a 100% contraception scenario. It is possible to limit population growth while maintaining age and sex structure by manipulating the frequency (variable three year cycles) and intensity (25%-100%) of treatments. A contraception study will be implemented on a portion of the Addo elephant population allowing these predictions to be tested. Despite contraception providing a potential management reprieve, continued efforts should be made to expand habitats for confined elephant populations.

DECLINE OF NATIVE TREE DIVERSITY UNDER ALIEN SPECIES INVASION IN NATIVE FORESTS OF MAURITIUS BAIDER, CLAUDIA, F. B. Vincent Florens, Dominique Strasberg

The flora of Mauritius is one of most threatened in the world, yet little is known about how this biodiversity is maintaining itself in the face of alien species invasion. We surveyed trees ≥ 10 cm

in dbh in an alien weed invaded wet forest first surveyed in 1937 to document the changes, and to compare with an adjacent area which was first weeded of alien plants in the 1930's. We also determined recruitment, growth and mortality of woody native plants ≥ 1.3 m tall between 2002 and 2006 in 10 plots of 100 m². Our findings indicated a 50 percent decline of native trees ≥ 10 cm dbh since 1937. This decline was much higher than in the forest area weeded of alien plants. Native tree recruitment over the period 2002 to 2006 was low (0.9 percent) while tree mortality during the same period reached 5.2 percent. Susceptibility of native species to the invaders varied significantly. We conclude that the remnants of wet tropical forest of Mauritius are degrading fast and that invasion by alien plants (mainly *Psidium cattleianum*, Myrtaceae) is the major driver of this biodiversity loss. An expansion of the areas being restored through removal of invasive alien weeds from the current mere 60 ha is both crucial and very urgent.

ASSESSING THE CONSEQUENCES OF CLIMATE CHANGE FOR AFRICA'S IMPORTANT BIRD AREA NETWORK

HOLE, DAVID, Brian Huntley, Carsten Rahbek, Debbie Pain, Stephen Willis

Changes in the distributions of birds in response to projected changes in climate over the coming century constitute a principal threat to the conservation of avian biodiversity worldwide and have crucial implications for current conservation strategies. One such strategy, the Important Bird Area (IBA) network, is a region-wide series of sites identified as being critical for the conservation of avian biodiversity. The efficacy of this network in protecting avian biodiversity under projected future climate change however is largely unknown. Focusing on sub-Saharan continental Africa, this project aims to test the assumption that the IBA network will continue to protect avian diversity under a changing climate. Climate envelope models provide an established means of quantitatively estimating changes in species' distributions in response to variation in selected climatic variables. We use this approach to model all 1810 bird species in sub-Saharan Africa. The resulting models are then used to project the spatial distributions of Africa's avifauna in the last quarter of the 21st century under a range of GCM scenarios. Overall, our estimates of the coincidence in area between current and future range projections of the entire avifauna suggest that the ability of the African IBA network to fulfill its remit over the coming century will be much enhanced through a variety of complementary adaptive management strategies.

CONSERVATION OF A RARE FRUIT CHAFER, *ICHNESTOMA STOBBI*, (SCARABAEIDAE: CETONIINAE)

KRYGER, UTE, Vincent van der Merwe, Clarke Henry Scholz

Ichneustoma stobbiai is an endangered fruit chafer (Scarabaeidae: Cetoniinae) that occurs in small habitat fragments within Gauteng province of South Africa. The adults of this species are only active for a few days after the first substantial spring rains and the females are flightless. The adult beetles do not possess functional mouthparts and die shortly after mating. Thus the vagility in this species is extremely low. Prompted by the recent discovery of morphological divergence between populations, this genetic study aimed to assess genetic differentiation within and among the different populations. DNA sequencing of the cytochrome c oxidase subunit I mitochondrial gene was used to determine the genetic composition of the populations. Sequence divergences ranged from 5.7-7.0% among populations and from 0.0-6.5% within populations. Most populations revealed a low haplotype diversity. Phylogenetic analysis of the sequence data resulted in a basal polytomy. Nested Clade analysis inferred allopatric fragmentation for all significant clades. This reconfirms the original hypothesis that the present populations all belong to the same species and represent relicts of a formerly widely distributed species. The alarmingly low haplotype diversities combined with the extremely small habitat patches left dictate immediate conservation management measures. All habitat patches occurring on private farmland have to be protected and a detailed plan for genetic augmentation should be worked out.

THE EXTENT OF UNGULATE TRANSLOCATIONS AT THE GLOBAL AND LOCAL SCALE:
USING SOUTH AFRICA AS A CASE STUDY
SPEAR, DIAN, Steven L. Chown

The ecological benefits of mammalian translocations have increasingly been discussed. Yet, non-indigenous mammals can be detrimental to biodiversity. Ungulate translocations have occurred since historic times for subsistence and continue worldwide for the hunting industry, bringing in big revenues. We examined the homogenisation of ungulates globally and locally and determined the extent of range change of indigenous ungulates in South Africa. Data matrices were compiled for indigenous and non-indigenous ungulate species for countries globally and at a quarter degree square resolution for South Africa. Similarity values between sites were calculated and related to distance between sites. Game sale data was used to calculate the extended area of indigenous ungulate distributions in South Africa. Globally, ungulate biotas have become, on average, more similar, especially for more distant sites. Non-indigenous ungulate introductions have been conducted regardless of indigenous ungulate species richness. However, more introduced species originate from countries with higher indigenous ungulate species richness. Ungulate biotas in South Africa have been changed substantially. There is a significant change in the area of extent of distribution of indigenous ungulates resulting in South Africa's indigenous ungulate communities becoming more similar. Conversely, the introduction of non-indigenous species has resulted in ungulate biotas becoming more different.

ASSESSING HABITAT SUITABILITY FOR TIGER (*PANTHERA TIGRIS*) IN THE TERAJ ARC
LANDSCAPE, INDIA
KANAGARAJ, RAJAPANDIAN, Thorsten Wiegand, Surendraprakash Goyal, Stephanie Kramer-Schadt, Ramesh Krishnamurthy, AJT Johnsingh, Qamar Qureshi, Ashish David

The tiger (*Panthera tigris*), large carnivore of the cat family, needs abundant large wild ungulate prey and undisturbed habitats for its survival. The Indian portion of Terai Arc Landscape spreads along Shivaliks (lower Himalayan foot-hills) and Gangetic plains. This Landscape consists of two distinct zones: (i) *bhabar*, characterized by hilly terrain (ii) *terai*, characterized by fine alluvium with tall grasslands. This Landscape was surveyed twice for tiger and associated species and sampling of foot transects (1001.2 km) and 1530 circular plots were carried out. Habitat Suitability Model (HSM) for tiger was developed using Logistic Regression. This study revealed that this biologically rich habitat, which was contiguous in the past, is fragmented and tiger habitats are in nine blocks connected by 12 potential corridors but it makes only five units when connectivity with Nepal considered. Tiger distribution is linearly related to prey distribution. The HSM shows prey and dense forests are effective predictors in determining tiger presence. Restoring connectivity between fragmented tiger populations is critical to ensure long-term survival of viable population. Habitat blocks and recommended corridors should be strengthened that would yield a largest (ca. 8000 km²) *bhabar* habitat and finest *terai* habitats (ca. 1200 km²) for tiger.

DISCOVERING RESILIENT PATHWAYS FOR SOUTH AFRICAN WATER MANAGEMENT:
TWO FRAMEWORKS AND A VISION
BOHENSKY, ERIN

Two frameworks for understanding sustainability and resilience have maintained a strong presence on the social-ecological research landscape in recent years: 1) the conceptual framework of the Millennium Ecosystem Assessment and 2) the "panarchy" model of the adaptive cycle described by Holling. Despite the popularity of the two frameworks, little comparative analysis has been done of their strengths, weaknesses, and potential utility to managers. I confront these frameworks with the example of water management in South Africa, where a command-and-control approach has been replaced with an overarching vision to balance efficiency, equity, and sustainability, guided by a rigorous water resource classification system. While each framework has a unique focus and purpose, both aid understanding of past and current water management eras, underscoring the increasing connectedness of national management to regional and local processes, and heightened awareness among water

managers of cross-scale dynamics. However, to inform the water management vision and classification, the frameworks require adaptation to allow analysis of trade-offs and the influence of changing societal values over time. Such frameworks could ultimately help water managers achieve a dynamic view of resilience and identify resilient “pathways,” based on a long-term perspective, integration of social and ecological research, and continual learning.

POPULATION ASSESSMENT AND RECOVERY PLANNING FOR THE CRITICALLY
ENDANGERED MEKONG GIANT CATFISH *PANGASIANODON GIGAS*
LORENZEN, KAI, Naruepon Sukumasavin, Hogan Zeb

The Mekong giant catfish (*Pangasianodon gigas*), one of the world's largest freshwater fishes, is classed as critically endangered on the IUCN red list. We conducted a quantitative population assessment in support of recovery planning for the species. Historical information and more detailed data collected over the past 40 years on fishing patterns, catch numbers and size structure were synthesized and analysed using a length-based population model. Results suggest that the species is naturally rare, and was only moderately exploited prior to the 1980s. Demand for spawning stock for initiation of a captive breeding programme and associated public interest in the fishery led to a drastic increase in fishing intensity in the 1980s, resulting in the removal of over 80% of the wild spawning stock within less than a decade. Fishing intensity has since declined to a very low level, due to a combination of economic factors and targeted conservation measures. The spawning population is predicted to recover to its pre-1980 abundance within the next decade. However, the population faces significant new threats in the form of habitat modification by dams and navigational improvements. The captive breeding programme is now operational and provides mitigation against the risk of total extinction from these new threats, but releases of captive-bred fish are not recommended while the wild population is extant and likely to recover naturally.

THE LANDSCAPE CONSERVATION APPROACH AND SAVING LARGE AFRICAN MAMMAL
SPECIES
MURUTHI, PHILLIP, Alfred Kikoti, Bernard Kissui, Benson Lengalen , Rose Mayienda , Paul Muoria, David Williams

Conservation at the landscape level should benefit species by maintaining necessary habitat connectivity all year, protecting individual species and enhancing capacity of stakeholders. In the African Heartlands Program, we examined species' movements across protected areas, corridors, community and private ranches. Protected areas were 'favourite areas' for elephants and lions but not for Grevy's zebra and wild dogs. Overlaps in 'favourite areas' occurred across species but not necessarily around protected areas. Grevy's zebra and wild dogs spent most of their time on community and private lands. Global positioning system (GPS) showed movement corridors clearly for lions and elephants. Mortality of some species seems higher in protected than non-protected dispersal areas. Work on corridors is still nascent; most are inadequately 'secured' in African landscapes. We show this for Kilimanjaro, Samburu, Maasai Steppe Heartlands. AWF is helping secure habitat outside protected areas in different countries, requiring flexibility and use of innovative approaches. Our studies are helping incorporate species interests in landscape conservation planning and implementation to enhance coexistence with humans in their range.

EFFECTS OF LAND USE ON CARNIVORE BIODIVERSITY IN THE TARANGIRE
ECOSYSTEM, TANZANIA
MSUHA, MAURUS, Sarah Durant, Chris Carbone

The presence of unfenced and uncultivated lands outside protected areas is fundamental for future viability of carnivore populations in pastoral dominated landscapes in Africa. Historically, pastoralists have co-existed with wildlife for centuries. However, in recent decades this coexistence has been declining due replacement of pastoral systems with subsistence and commercial cultivation. This paper outlines effects of land use change on carnivore biodiversity in

the Tarangire Ecosystem. We used a grid of camera traps deployed for two and half months in Tarangire National Park and two months in farmlands outside the park. We identified individuals from spots and stripes, estimated abundance using mark-recapture statistical models; and indices of abundance of other species from photographic rates. A total of 18 carnivores were recorded in the park and 6 in farmlands. Density of leopard (*Panthera pardus*) in the park was 8 adult individuals per 100 km², based on four individuals from 9 combined 'capture' and 'recaptures', 1351 trap nights and sample area of 63 km². The method has the potential to be applied for all individually identifiable species in the study sites and can be used for long term monitoring of carnivores.

THE DECLINE OF THE TERRESTRIAL MALACOFAUNA OF MAURITIUS (MASCARENES, INDIAN OCEAN)

FLORENS, F. B. VINCENT, Owen L. Griffiths

Mauritius falls within one of the world's biodiversity hotspots. Only about 2 percent of its native vegetation has survived deforestation in the form of a confetti of fragments increasingly degraded under the assaults of invasive alien species. We sampled the malacofauna over 3,000 person hours in most forest remnants and in a variety of non-native habitats to quantify the effects these human impacts have had on the island's biodiversity. Some 20 new species were discovered and another two species previously thought extinct were relocated. Our main findings revealed that the range of most species declined drastically particularly over the last century or so and that many species disappeared. The extinction rate, among the 81 island endemics, is now 42 percent. This situation is set to worsen as most extant native species are now threatened with extinction when assessed using the IUCN Red List Criteria. Habitat restoration is crucial as a first step in stemming this biodiversity loss. Alien predator control will also be necessary. This study reinforces the view that conservation in Mauritius must at last and resolutely move towards an ecosystem approach as the 60 ha of mainland forest currently being restored is grossly insufficient.

KEY BIODIVERSITY AREAS AS A TOOL FOR IDENTIFYING PRIORITY CONSERVATION SITES OF AMPHIBIANS IN MADAGASCAR

Randrianasolo, Harison, LUCIANO ANDRIAMARO, Rollande Finoana, Harison Rabarison, Zo Lalaina Rakotobe

Key Biodiversity Areas (KBAs) are being used as a tool to support the identification of new protected areas, as well as to support the management of existing protected areas. Based on globally threatened species according to the IUCN Red List, four KBA criteria include: presence of threatened species, restricted range species, and congregatory species. Analyses between threatened species and their habitats were conducted to identify Alliance for Zero Extinction (AZE) sites, which hold the last remaining population of a Critically Endangered (CR) or an Endangered (EN) species. The same criteria were applied for globally threatened amphibian species to define amphibian key biodiversity areas. Findings include 164 identified KBAs covering 8 taxa in Madagascar. Of these, 40 are amphibian KBAs, 18 of which are officially protected. We found that eight critically endangered amphibian species are found within eight KBAs. Only two of these eight sites for critically endangered species are officially protected. Madagascar has 15 AZE sites, currently nine of them are habitat of twelve threatened amphibians species. Five of these sites are already protected; an additional three sites will receive protection under the new protected area system, and one site will not be protected by the current prospectus for new protected areas. Collaboration with the local community may be useful to protect the one remaining unprotected amphibian KBA and implement a management plan that ensures this area's sustainability.

EXPERIMENTING WITH COMMUNITY WILDLIFE MANAGEMENT: DISPATCHES FROM
ZAMBIA
NGWENYAMA, DAVID

Zambia has experimented with different wildlife management designs over the last decade. Zambia has been among the leaders in Southern Africa in implementing community based conservation programmes in wildlife management. Following the 1998 Wildlife Act Zambia introduced a number of innovations in community based wildlife management including Community Resource Boards (CRBs). A framework is presented for assessing and comparing the new community participation in wildlife management regimes. An institutional assessment framework was used to assess the performance community based conservation programmes in three provinces in Zambia. At least 7 "community conservation" institutions in each province were evaluated in terms of performance against set objectives, conservation achievements, community participation and, access and benefit sharing from conservation. Cases included Community Resource Boards (CRBs) under the Zambia Wildlife Authority (ZAWA), local NGOs, producer groups and economic interest groups. Preliminary results indicate that community initiated 'economic interest' groups and local NGOs were better able to meet targets and had on average more inclusive democratic participation. CRBs had better access to financial resources but were also more prone to external influence and manipulation.

DISPERSAL AFFECTS THE SUCCESS OF REINTRODUCTION OF GRIFFON VULTURES
(*GYPS FULVUS*) IN FRANCE
Le Gouar, Pascaline, ALEXANDRE ROBERT, François Sarrazin

The success of reintroduction programs greatly depends on mortality and dispersal of released individuals. However, the role of local environmental pressures in these processes has rarely been investigated, notably because reintroductions are rarely replicated in space or time. Here, we used data on Griffon vultures, which have been released in five sites in France and successfully settled in three of them, to address the role of local environment, survival and dispersal in the success of reintroduction programs. We analysed a 25-year data set encompassing observations of 270 released individuals. Using multistate capture-recapture models to account for tag loss in survival estimates, we estimated dispersal among release sites. In all release sites, adult survival rates were reduced in the first year following their release, regardless of gender. When dispersal was accounted for in survival estimates, we showed that early survival rates were equal among sites, so that the two settlement failures were explained only by differences in dispersal among release sites. Such asymmetrical patterns of dispersal among sites were likely due to conspecific attraction. Our results suggest that post-release mortality can be homogeneous among release sites, whereas dispersal is highly dependent on the matrix of established populations and can have major consequences on population settlement. Dispersal behaviour should thus be incorporated into plans of metapopulation restoration.

INTEGRATING BIODIVERSITY CONSERVATION IN LOCAL GOVERNANCE: THE CEBU,
PHILIPPINES EXPERIENCE
PAGUNTALAN, LISA MARIE

Biological surveys conducted last September to October 2004 confirmed the presence of critically endangered Cebu Flowerpecker *Dicaeum quadricolor* endangered Black Shama *Copsychus cebuensis*, colonies of Large Flying Foxes *Pteropus vampyrus*, Golden-crested Flying Fox *Acerodon jubatus* and Philippine Tube-nosed fruit bat in the forest fragments of Dalaguete and Alcoy, southern Cebu, Philippines. The presence of threatened wildlife was used as a means to engage local government units to develop a biodiversity conservation program. This paper discusses the five years experience, struggles and challenges in influencing local government units in protecting the remaining forest fragments of Cebu and in providing solutions to lessen the use of native trees for charcoal and fuel wood. A strong policy framework, presence of committed staff and community support contributed to the success of the project. However, the ultimate

factor that determines the long-term sustainability of the biodiversity conservation program is the commitment to protection on the part of the stakeholder communities.

REBOUNDED FROM DROUGHT AND FIRE: ARE ENSO-EVENTS BECOMING TOO FREQUENT FOR TROPICAL RAINFOREST RECOVERY?

KINNAIRD, MARGARET, Tim O'Brien, Nurul Winarni, Muhammad Iqbal, Gary Paoli

The interaction of ENSO-related fire and drought can have dramatic impacts on the dynamics of tropical forests. In 1997, ENSO-related fires affected 9.7 million ha, including some 1.7 million ha in Sumatra. We monitored regeneration, mortality and growth rates of trees among 100 vegetation plots (50x10 m) in once-burned, twice-burned and unburned forest in southern Sumatra following the 1997 ENSO event (1997-2006). One year after fires, mortality in unburned plots was 10% while that of once- and twice-burned plots was higher at 13% and 18%, respectively. Mortality returned to background levels (1.5%) in unburned plots one year post-ENSO but remained elevated for 5 years in burned plots. Recruitment equaled or exceeded mortality in all plots post-ENSO and basal area returned to original values after 6 years but is composed of a greater proportion of small stems of fast-growing, low-density timber species. We used these mortality and recruitment data to model forest dynamics over 1000 years. Recurrence of ENSO-related fires at 2/decade results in a 30% and a 97% loss of stems in 100 and 1000 years, respectively. Increasing frequency and severity of ENSO events underscore the urgency for improved fire management in the tropical forests.

THE CONTRIBUTION OF STUDY ABROAD PROGRAMMES TO MONITORING VEGETATION CHANGE: ASSESSING THE IMPACT OF ELEPHANTS ON SAVANNA WOODLANDS

KRUGER, LAURENCE, Julie Coetzee

The Organisation of Tropical Studies conducts two 15 week undergraduate study abroad courses annually in the Kruger National Park. Students conduct field based projects designed to meet the research requirements of the KNP. Elephants, as ecosystem engineers, have the potential to affect change in both composition and structure of savanna woodlands. Examples of our research that may inform the elephant management debate include impact of elephants on vegetation communities in Mapungubwe National Park, baobab demography and on biota associated with woodlands in the Kruger National Park. Elephants differentially impact vegetation communities: Riverine vegetation experienced substantial bark-stripping and canopy-breaking, but the species are fairly resilient (many resprout or regrow bark). *Commiphora* woodlands were deemed more vulnerable as significantly more plants were toppled and many do not resprout. The impact of elephants on baobab demography and distribution was assessed in a comparative study between KNP and Limpopo National Park in Mozambique (few elephants). Little evidence of recruitment was found in KNP, even in Baobab refugia (steep rocky slopes), compared to LNP. Furthermore, significant recent utilization is evident in the KNP. Thus baobab communities are under more pressure in the KNP. Lastly, little support was found for the reduction in diversity with change in woodland vegetation structure.

PHYLOGENY AND GEOGRAPHY PREDICT PATHOGEN HOST RANGE IN WILD PRIMATES AND HUMANS

Davies, T. Jonathan, AMY B. PEDERSEN

Emerging infectious diseases pose a great threat to wildlife and human health. Many of the most virulent diseases, e.g. AIDS and Ebola, are zoonotic – shifting from wildlife to humans. A critical question is what determines when and where a disease first crosses from one species to another. Within primates, we show that infectious diseases are more often shared between species which are closely related and inhabit the same geographic region. A higher frequency of pathogen host shifts between close relatives and neighbours may explain this result. We find that host relatedness is the best overall predictor of whether two host species share the same pathogens. However, geographic overlap among neighbouring hosts is more important in determining the host range for viruses. We suggest this is because rapid evolution within viral lineages allows

host jumps across larger evolutionary distances. We also demonstrate that the pattern of pathogen sharing with humans is the same as that between wild primates. For wild primate conservation, this means the great apes, including chimpanzees and gorillas are most vulnerable to human disease outbreaks, because these species represent our closest relatives. We translate our results into 'hotspot' maps, highlighting regions where the risk of disease transfer between wild primates and humans is greatest. We identify West Africa and SE Asia as hotspots of potential disease emergence in wild primates and humans.

COMMUNITY STRUCTURE AND TEMPORAL DYNAMICS OF LARGE HERBIVORES IN MKHUZE GAME RESERVE NXELE, BEKA

Mkhuze Game Reserve, a medium-sized protected area in KwaZulu-Natal, was proclaimed in 1912. For decades the boundary was not clearly demarcated from the neighboring communal land. The reserve thus experienced inevitable conflicts with communities through a number of factors, mainly poaching and crop damage. The reserve is situated in a semi-arid area and experiences prolonged droughts of 4 to 13 years at approximately 22-year intervals. During these droughts some large herbivore species experience increased mortality due to starvation as well as increased levels of poaching. With regard to communities, livestock deaths increase, the land becomes unlivable and as a result poaching could be intensified on MGR. Furthermore, high unemployment rate and poverty levels faced by the surrounding communities could also have a pivotal role on poaching. Recent fencing of the reserve has largely addressed the boundary conflicts, however poaching is still of great concern as it affects the viability of endangered species such as wild dog and black rhino. To alleviate this, the direct causes of poverty in the communities need to be addressed by both the local and national governments.

THE KNOWING-DOING GAP: TRANSFORMING CONSERVATION SCIENCE INTO CONSERVATION ACTION HAGAN, JOHN, Jeffrey Parrish

The gap between what we know and conservation action that results from what we know is called the "knowing-doing gap." Given the science we have produced over the years, why do so many problems remain? There are many conservation success stories, but a haunting question remains—could we be doing more with what we know? There are many impediments to converting knowledge into action: e.g., science communication and translation problems, institutional impediments, lack of social will to address many conservation issues. A critical analysis of what constrains the conversion of knowledge into action is needed. We have developed a typology that will help conservation scientists better understand how to close the knowing-doing gap. We describe 4 major pathways to converting knowledge into action: (1) legislation/regulation, (2) extension (education), (3) social process, and (4) market-based systems. Which pathway is most appropriate for which problem? We will focus especially on the social process mechanism because we feel it has much growth potential in the next decade. Social process approaches involve scientists integrating into the social fabric of a "place"—becoming responsible, trusted, and respected participants in problem-solving. This is a new approach for many scientists— one which requires skills that need to be developed, or obtained from colleagues in the social sciences sector.

IMPACT OF PARTICIPATORY FOREST MANAGEMENT ON LOCAL FOREST-BASED LIVELIHOODS MESHACK, CHARLES, Kerry Woodcock

Policy objectives of Participatory Forest Management (PFM) in Tanzania, include maintaining and improving forest quality, whilst improving livelihoods. This paper examines the impact of PFM on local forest-based livelihoods in the biodiversity hotspot of the Eastern Arc Mountains of Tanzania. The findings demonstrate that PFM contributes to poverty avoidance, and when combined with support for forest-linked Income Generating Activities (IGAs) and the provision of

transfer payments, has the potential to contribute to poverty elimination. Challenges include: minimizing initial negative impacts and maximizing positive impacts on poorer households; and seeking partnerships to develop forest-based products, and markets for those products.

SPATIAL DISTRIBUTION OF RESTORED AREAS AFFECTS THE EFFICIENCY OF CONSERVATION OF A THREATENED BIRD. THEORETICAL APPROACH USING A MULTI-AGENT SYSTEM

KERBIRIOU, CHRISTIAN, Mathias Rouan, Harold Levrel, Isabelle Le Viol, Helene Dupont, Francoise Gourmelon, Michel Etienne

The spatial distribution of restored areas is likely to influence greatly the success of conservation programs, but is generally little considered. Here, we investigate how spatialization influences conservation efficiency in a threatened chough population of the Iroise Biophere Reserve, France. The dynamics of this population is affected by two main socio-economic changes: (1) abandonment of traditional agriculture, leading to loss of short grasslands, the chough feeding habitat and (2) development of ecotourism on the coast, impacting coastal habitat via trampling, leading to soil erosion or creation of short grassland, and strongly decreasing juvenile survival via disturbance. To define an efficient conservation program based on restoration of grasslands, we developed a Multi-Agent System using a spatially explicit individual-based model for the Chough population. We show that without habitat restoration, and with the observed current increase in tourism pressure, the population is predicted to go extinct quickly. The current program of grassland restoration, ignoring spatial aspects, is predicted to stabilize the population at its current size. However, alternative scenarios with the same management effort but focusing on the spatial distribution of restored areas could double the current chough population size. In addition, such scenarios also incorporate conservation of rare plants, traditional practices or landscape aspects.

ISSUES OF MULTI-DISCIPLINARITY IN CONSERVATION BIOLOGY RESEARCH: LESSONS LEARNED AND CHALLENGES FOR THE FUTURE

MOORE, Susan A., Kate Rodger, David NEWSOME

Researching tourism and its interface with the natural environment can provide important insights into recent critical issues in multi-disciplinarity and its potential contributions to conservation biology. This paper reviews three recent multi-disciplinary research projects, located at the interface between tourism and conservation biology, to describe the lessons learned and challenges associated with such research. These projects were examining the social and environmental impacts of visitors in protected forests in south-western Australia, analysing the interface between tourism and biodiversity, also in this part of Australia and recognised as one of the world's biodiversity hotspots, and describing the reasons why ecologists and biologists may or may not engage in tourism research. Review of these projects suggested at least three important lessons if multi-disciplinarity is to contribute to the science and practice of conservation biology: (1) empirical descriptions of both social and environmental conditions are equally necessary; (2) explicit methodological and analytical linking of these conditions is essential; and (3) peer review and assistance by researchers identified as being able to work across disciplines enhances the research outcomes. Challenges related specifically to the social norms guiding research practice and achieving integration in findings from within and across different paradigms. In terms of social norms, of particular concern is being able to offer the incentives that allow scientists to work effectively over time and through out their careers across disciplines and with those from other disciplines.

MENTAL MODELS IN COMMUNITY-BASED CONSERVATION PROJECTS

BIGGS, DUAN

Mental models are defined as the models people use to interpret the world around them and these are partially culturally derived. Conservation practice in many developing countries operates in a multi-cultural arena and therefore different actors have different mental models in

interpreting a project's, desired objectives, actions and outcomes. This presents a key challenge to conservation scientists and managers. In-depth interviews were used to investigate these issues in community-based birding tourism initiatives in South Africa. The results demonstrate differences in the perceptions and world views of community beneficiaries, project managers and stakeholders with respect to levels of project success and stakeholder conflict. Evidence of differences in mental models is also shown through the differences in the expectations of the roles of the different project actors. Organizational frameworks that operate for five years or more in a transparent, participatory fashion are recommended to bridge these differences over time. This requires a shift away from traditional project business models which are designed for project sustainability over a relatively short period of time to models which embrace the long term commitment required for multi-cultural settings.

ADDING TO THE KRUGER EXPERIENCE: DEVELOPING THRESHOLDS OF POTENTIAL CONCERN FOR TOURISM AND SOCIAL SUSTAINABILITY

MUNRO, JENNIFER K., Susan A. Moore, Stefanie Freitag-Ronaldson

Kruger National Park is one of the world's iconic national parks. It also has a sophisticated adaptive approach to conservation biology management, based on distinct monitoring endpoints. To-date, these thresholds of potential concern have been developed for ecological monitoring, however, recent efforts are shifting to a focus on social, tourism and economic concerns. This paper reports on joint research underway between Murdoch University in Western Australia and staff from Kruger National Park to conceptualise and determine thresholds for tourism and the social and economic sustainability of communities associated with the Park. This paper reports on the first part of this research. Conceptualisation began with the existing approach to ecological monitoring complemented by contributions from complex systems theory, recent theoretical and empirical work in community-based management, and current theorising regarding resilience in ecological and most recently social systems. Results from these associated fields suggest that these social thresholds are likely to be highly context specific. As such, clear descriptions of the current social and economic settings will be essential if meaningful interpretation of the associated monitoring data is to be achieved.

A FRAMEWORK FOR IDENTIFYING THREATENED ECOSYSTEMS

ROUGET, MATHIEU, Tamara Smith, Amanda Driver, Anthony G Rebelo, Richard M Cowling, Zuziwe Jonas, Belinda Reyers, Philip G Desmet

Habitat transformation and fragmentation are major causes of species and ecosystem loss. As a result, a large body of research has focused on the identification and conservation of threatened species. Surprisingly, the identification of threatened ecosystems has received much less attention. Here we present a framework for identifying and classifying threatened ecosystems. The framework is based on five criteria which have a direct impact on ecosystem function or composition. These are irreversible habitat loss, rate of habitat loss, habitat fragmentation, limited geographic extent and imminent threat, and habitat requirement for the persistence of threatened species. An ecosystem can be listed endangered under any of these criteria. We tested and applied the criteria to terrestrial ecosystems in South Africa. Based on criteria A alone (irreversible habitat loss), almost 90 terrestrial ecosystems (out of 438) are endangered with 24 being critically endangered. Such framework will considerably assist conservation planning and implementation of conservation actions for threatened ecosystems. Indeed, threatened ecosystems are legislated by the Biodiversity Act and current land use practices (e.g. new development on virgin land) are restricted where threatened ecosystems occur.

THE PHYLOGENETIC AND GEOGRAPHIC DISTRIBUTION OF EXTINCTION RISK IN THE FLOWERING PLANTS OF THE CAPE

DAVIES, T. JONATHAN, Vincent Savolainen

Biodiversity hotspots are considered to be of critical conservation importance. However, hotspots of species richness do not necessarily coincide with hotspots of extinction risk. To ensure that the

maximum benefits are gained from conservation efforts it is crucial that we understand the processes not only determining patterns of species richness but also species extinctions. Here we examine the distribution of threat using IUCN Red List criteria and geographic data for the Cape flora. We show that the fynbos biome in the western Cape is a hotspot for potential extinctions, but mean threat is less than that found in the northeastern Cape. If we were only interested in protecting the greatest number of threatened species, conservation efforts should focus on the former region. However, regions where an unusually high proportion of species are threatened may also be important. Such areas may represent highly perturbed areas, or they might favour extinction-prone species. Using a comprehensive phylogenetic tree of Cape genera we explore whether extinction hotspots in the Cape are a product of the biological attributes characterising the species that are contained within them, or some factor related to their geography and/or climate.

EVALUATING EFFECTIVENESS OF CONSERVATION INTERVENTIONS USING SYSTEMATIC REVIEW METHODOLOGY, A CASE STUDY: SALMONID ABUNDANCE AND INSTREAM STRUCTURES

STEWART, GAVIN, Helen Bayliss, Dave Showler, William Sutherland, Mark Diamond, Miran Aprahamian, Andrew Pullin

For many years, engineered in-stream structures and natural woody debris have been used in attempts to improve habitat in degraded rivers globally. Considerable debate exists as to the effectiveness of these mitigations, and the implications are significant for conservation managers, policy makers and the aquatic ecosystems themselves. Here we report on the results of a systematic review and meta-analyses that assess the impacts of these structures on salmonid habitat preference and population size. Available evidence indicates that woody debris and man-made in-stream devices both have statistically significant impacts on population abundance but woody debris results in a bigger increase in fish numbers than man-made structures. Species of salmonid and discharge flow rates influence the apparent effectiveness of both interventions. These results suggest that incorporating natural woody debris may often be a more successful method for increasing salmonid abundance, rather than installing engineered devices. This has considerable economic ramifications, suggesting that the higher economic and environmental benefit of woody debris could result in annual savings of millions of dollars globally. This example also illustrates the utility and cost-effectiveness of the evidence-based approach to conservation management.

ENGAGING COMMUNITIES FROM THE "ROOTS-UP": USING A SIMPLE AND PARTICIPATORY PROCESS TO ACHIEVE FOREST CONSERVATION AND SUSTAINABLE USE IN SENEGALESE FORESTS

PIERSON, OLIVER, John G. Heermans

Although threatened by logging, charcoal production and fire, Senegal's forests, which contain important biodiversity, have the potential to be used sustainably to supply resources and income to neighboring communities. Until the early 1990s, Senegal's forests were managed exclusively by the Senegalese Forest Service (SFS) with no legal access for communities. Through the 1996 decentralization law, which transferred various authorities to elected regional and local government bodies, and the 1998 forestry code, which created the framework for communities to enter into forest co-management contracts with the SFS, the government of Senegal has created a process to allow communities to access, in a regulated fashion, the wealth of the forest. These new laws and ensuing regulations aim to meet dual goals of improving forest management and conservation by empowering local stakeholders and facilitating the contribution of forests to rural economic development. In collaboration with USAID and the Senegalese Government, the United States Forest Service has elaborated a methodology for developing simple and participatory forest co-management plans. Community forest management associations are now using this methodology to develop plans and implement management actions. This paper will present the overall principals of the forest co-management methodology and present progress towards

improving forest management, maintaining habitat, and generating revenue for community associations.

AN ASSESSMENT OF THE FRESHWATER ASSETS OF KWAZULU-NATAL FOR
SYSTEMATIC CONSERVATION PLANNING
Rivers-Moore, Nick, Peter Goodman, MNCEDI NKOSI

KwaZulu-Natal is a water-rich province relative to the remaining provinces in South Africa. In preparation for the development of a systematic conservation plan for aquatic ecosystems, we undertook an initial inventory of the dimensions and broad characteristics of the aquatic resources within KwaZulu-Natal. We identified 79 primary (main stem) rivers which empty via an estuary into the sea. At a mapping scale of 1:500 000 we measured 18 392 km of river, of which 1 439 km or 7.82% fall within the boundaries protected areas. Of the 79 rivers, 9 of greater than 100 km in length were free-flowing (un-impounded from source to sea). Freshwater lakes and pans which are rare in KZN are of two broad types, those associated with flood plains and coastal lakes which are generally not connected to the sea. The current state of these aquatic resources was indexed by the degree of land transformation in the catchments, as well as an estimate of the number impoundments weighted by the amount of water impounded. A broad classification of aquatic ecosystems for conservation planning was developed using biogeography at the upper level, and empirical sampling correlated with physical determinants at the lower level. We conclude that in comparison to terrestrial systems, the lack of appropriate freshwater biodiversity information is still a constraint to the development of aquatic conservation plans.

AVIAN DIVERSITY IN AN ELEPHANT IMPACTED WOODLAND ALONG THE CHOBE –
RIVERFRONT, NORTHERN BOTSWANA
JENAMISO, MOTHUSI, Lucas Rutina

The Chobe riverfront vegetation has been transformed from woodland to Shrubland State by elephants. Along this transformation other wild animals have been affected either positively or negatively. We study birds' diversity and species richness in three vegetation states along the Chobe riverfront to test the effects of this transformation on avian distribution and abundance. The results of this study showed that shrubland (high elephant impact) had the least expected number of species (c. 6) while *Baikiaea* woodland (lowest elephant impact) had the highest expected number of species (12). The riverine woodland and mixed woodland (intermediate state between closed woodland and shrubland) had 8 and 9 expected number of species respectively. Similarly, the *Baikiaea* woodland was more diverse ($H' = 1.3$) than the other vegetation states. Contrary to the expected number of species, the intermediate state (Riverine woodland and Mixed woodland) were the least diverse ($H' = 0.63$ and $H' = 0.4$ respectively), with shrubland at $H' = 0.69$. These results show that the Chobe riverfront the conversion from woodland to shrubland was associated with loss of avian diversity. Our result show that if the conversion of woodland to shrubland by elephants continues, the Chobe Riverfront will be dominated by few bird species

'PUBLIC TRUST, TRUSTEESHIP AND CUSTODIANSHIP': THE ROLE OF THE STATE IN
SAFEGUARDING SOUTH AFRICA'S BIODIVERSITY
BLACKMORE, ANDREW

The loss of biodiversity in South Africa is a concern. Whilst there are a multiplicity of causal factors that contribute to the loss of biodiversity, landuse transformation and development are a significant source of this loss. It is this threat to the natural environment that ultimately led to the establishment of list of activities which the State would need to consider in order to ensure that there is sustainable use of the environment. This paper explores the trusteeship invested in an official who is entrusted to decide on land transformation of development applications that may have a negative impact of the country's biodiversity. It is concluded that the South African legal system does not provide adequate protection of biodiversity in the face of economic and humanitarian development. In the light of this, the state is required to consider impacts on biodiversity but is not obligated to safeguard the country's natural heritage in decision making.

The legislation provides scope for tradeoffs that could compromise biodiversity in favour of social or economic sectors. This paper provides an eco-legal interpretation of the principles that drive decision making and the State's trusteeship as provided for in South Africa's environmental legislation.

JUDGING BY APPEARANCES: BEHAVIOURAL AND PHYSIOLOGICAL RESPONSES OF
WANDERING ALBATROSSES TO HUMAN DISTURBANCE
DE VILLIERS, MARIENNE, Andreas Lopata, Albert Eisenbarth

Behavioural responses are often used as measures of the effect of human disturbance on wildlife, but the interpretation of these responses in terms of long-term effects on an animal's fitness is ambiguous. We recorded the behavioural responses of 51 brooding Wandering Albatrosses *Diomedea exulans* on Marion Island to human approaches and handling. Blood samples from these birds were used to measure haematocrit and concentrations of total protein and heat shock proteins (HSP70 and HSP90). Behavioural score was significantly correlated with total protein concentration (negative correlation) and with HSP90 concentration (positive correlation). A preliminary analysis indicated that physiological and behavioural parameters were not related to the age or gender of birds. However, classification of birds according to three breeding areas (close to the research base, far from the base or in a study colony) revealed significant differences in haematocrit and HSP90 concentrations, and a near-significant difference in behavioural scores. Birds nesting far from the base had the lowest mean haematocrit value, while birds nesting in the study colony had elevated HSP90 concentrations and the highest mean behavioural score. These results indicate that the health of chronically stressed Wandering Albatrosses may be compromised, and that such individuals react more intensely to approach and handling than do less stressed individuals.

STEPS TOWARDS A CO-MANAGEMENT ARRANGEMENT FOR THE CONSERVATION OF
MUSSELS IN COFFEE BAY (EASTERN CAPE, SOUTH AFRICA)
CALVO-UGARTEBURU, GURUTZE, Serge Raemaekers

Mussels have traditionally been an important source of protein for coastal communities along the South African coast, particularly in rural areas such as the former Transkei. Exploitation of the marine resources in Transkei has increased in the recent years, resulting on entire areas being depleted of mussels. Natural recovery of these areas is practically impossible. Results from a project aimed at the rehabilitation of over-exploited mussel stocks and the establishment of a co-management plan show that the physical rehabilitation is easy to achieve. A community committee has been elected and trained in co-management; and a community monitoring programme has been implemented. Biological and socio-economic data has been collected and integrated in a GIS database, this has been used to draft a local management plan. The biggest challenge for the sustainability of the project is to put in place management institutions. Current South African legislation promotes co-management, however the following problems exist: both communities' and government's capacity on the ground is low; the working relationship between stakeholders is weak; marine resources are still managed in a centralized way and National government appears to avoid devolution of certain management functions to provincial or local government; and there are no coherent mechanisms to feed community inputs to government. These challenges will be discussed in this paper, as well as steps taken towards overcoming them.

USE OF HERDING TECHNIQUES TO ENCOURAGE MIGRATION IN SEDENTARY ELK
SPAEDTKE, HOLGER, Colleen Cassidy St. Clair

Fescue grasslands comprise one of the most threatened ecosystems in Canada. A nationally-important parcel of fescue occurs on the Ya Ha Tinda Ranch, which is also a traditional and important wintering range for elk (*Cervus elaphus*). Over the past two decades, an increasing number of elk have remained on this range during summer, which may eventually threaten the viability of the grassland and, hence, the elk population itself. We assessed use of aversive

conditioning as a means of reducing grazing pressure and reinstating migratory behaviour in elk. We conditioned elk by herding them daily on horse back in the direction of their historic migratory route. We conducted this herding over two spring seasons while monitoring elk presence on target areas and proximity to the conditioned area by fitting 15 non-migratory elk (determined by earlier studies) with GPS radio collars. By the second summer, elk presence on the targeted grassland had declined by approximately 30%, but this decline was mainly concentrated in daylight hours. Over the same period, the average proximity to the areas targeted for herding increased in these animals by 1800 m, but longer-distance migration did not occur. Our research suggests that aversive conditioning in the form of herding on horse back can temporarily reduce grazing pressure on threatened grasslands, but it is unlikely to reinstate migratory behavior in wild elk.

RE-INTRODUCING NATIVE PERENNIAL SPECIES: RESULTS FROM MULTI-FACTORIAL EXPERIMENTS IN TWO MEDITERRANEAN REGIONS OF THE WORLD (FRANCE, CALIFORNIA)

BUISSON, ELISE, Karen Holl, Sean Anderson, Emmanuel Corcket, Thierry Dutoit

Grasslands were once widespread and species-rich ecosystems which have drastically decreased throughout the world, largely due to changes in land-uses. Remnant grasslands are often highly degraded and disconnected and they require active conservation and restoration to counteract fragmentation. In two dry areas of the world (California and Southern France) where the loss of native perennial species led to increased soil erosion and decreased pasture quality, we looked for the most efficient way to reintroduce formerly dominant perennial species, by testing several treatments: grazing, topsoil removal, stone cover restoration and plant neighbor competition. The ideal combination of treatments generally included: 1) topsoil removal to enhance transplant survival; 2) the exclusion of grazing the first year to optimize establishment; 3) neighbor removal to increase seedling growth; 4) stone cover restoration. When surrounding plants were exotic species with taproots at low density, native perennial transplant survival was higher (hydraulic lift). Plants grown from local seeds had higher survival and growth than plants grown from commercially purchased seeds. Sowing can be an efficient way to reintroduce some of these perennial species to degraded grasslands. Future research looks at the reintroduction of plant communities.

VEGETATION RESPONSES TO INVASIVE ALIEN PLANT CLEARING ALONG THE SABIE RIVER IN AND ADJACENT TO THE KRUGER NATIONAL PARK

MORRIS, TARYN, Edward T. F. Witkowski, Julie A. Coetzee

Working for Water have been clearing invasive alien plants (IAPs) in the Kruger National Park since 1997. However, very little post clearance monitoring has taken place, despite its importance. For although some riparian corridors recover without further management, others often fail to revegetate resulting in further degradation. The aim of this study was to investigate the response of alien and indigenous vegetation to clearing of IAPs, and to understand the factors responsible for varying levels of post clearance recovery. Vegetation composition and structure as well as associated environmental variables were sampled at 12 sites along the Sabie River within and adjacent to the KNP. Relative alien density varied from 4- 97% between sites, and showed a strong negative correlation with both total plant diversity (H' : $r = -0.8474$, $p=0.0005$) and evenness of distribution (Simpson's evenness: $r=-0.8263$, $p=0.0009$). Surprisingly, an increase in the number of clearing treatments showed a similar increase in both the % alien aerial cover ($r=0.8289$, $p=0.0009$) and % alien density ($r=0.7829$, $p=0.0039$), even though sites with the highest number of treatments were not necessarily initially the most invaded ($r=-0.0944$, $p=0.7704$). These results suggest that greater clearing may act as a further disturbance, allowing re-invasion to occur. Further data collection is currently underway to explore the emerging relationships.

CIVIL SOCIETY RISES TO THE CHALLENGE OF CONSERVING THREATENED PLANTS EBRAHIM, ISMAIL, Caitlin von Witt, Domitilla Raimondo

The Custodians of Rare and Endangered Wildflowers (CREW) project involves civil society in the monitoring and conservation of threatened plants in South Africa. Due to the high concentration of threatened plants in the country and the increasing threat to Red Listed plant species it has become an absolute necessity to monitor the status of these plant species. The CREW project has established 16 civil society groups across the country to assist with updating the information on threatened plant species. This information is used for red listing, conservation planning and informing land-use decision making. In addition we have been able to pick up interesting population trends by using historical locality data and herbarium specimen data.

ESTIMATING THE DENSITY OF UNMARKED ANIMALS BY STATIC MONITORING ROWCLIFFE, MARCUS, Juliet Field, Samuel Turvey, Carbone Chris

The use of static monitoring devices to estimate animal density has so far been restricted to capture-recapture analysis of species with individually identifiable markings using camera traps. This paper develops a method that eliminates the requirement for individual recognition of animals by modelling the underlying process of contact between animals and cameras. The model provides a factor that linearly scales observation rate with density, depending on two key biological variables (average animal group size and day range), and two characteristics of the camera sensor (distance and angle of arc within which it detects animals). We tested the approach in a large (200 ha) enclosure with known abundances of four species, obtaining unbiased estimates in three out of four cases. Bias in the fourth species was due to biased placement of cameras with respect to the distribution of this species. Subject to unbiased placement and accurate measurement of model parameters, this method opens the possibility of greatly reduced labour costs for estimating terrestrial animal density, and may make estimation possible where it has previously not been. While the method has been developed with camera trapping in mind, the approach is also applicable in principle to other forms of static monitoring such as acoustic sensors.

INFLUENCE OF HABITAT FRAGMENTATION AND HUMAN PRESENCE ON ASIAN ELEPHANT MOVEMENTS AND BEHAVIOUR IN THE ANAMALAI HILLS, WESTERN GHATS, INDIA MAVATUR, KUMAR ANANDA

Understanding ecological and behavioural responses of elephants to habitat fragmentation is needed for human-elephant conflict mitigation and coexistence. The Valparai plateau in the Western Ghats is a 220 km² landscape of private plantations, rainforest fragments, and human settlements within the Anamalai-Parambikulam Elephant Reserve that contains India's second largest wild Asian elephant (*Elephas maximus*) population. Between 2004-7, I studied movements, conflict with people, and behavioural responses to humans of two elephant herds regularly using the plantation landscape. I tracked elephant herds on foot and vehicle using GPS, assessed property damage on field, and recorded behaviour using scan sampling. Herds differed significantly in the use of natural and plantation habitats. Over one year, herd home ranges (minimum convex polygon method) within plantations were 112.5 km² and 107 km² with an overlap of 87.8 km². With increase in the number of people in close proximity, there was an increase in agitation behaviour and decrease in resting, feeding, and movement in both herds, although feeding in one herd was relatively unaffected. As distance to humans increased over 30 metres, feeding, movement, and resting increased and agitation behaviours decreased. Based on these results, measures are identified to mitigate human-elephant conflict in fragmented regions of the Western Ghats and elsewhere.

BUSHMEAT AND ALTERNATIVES IN URBAN MARKETS IN EQUATORIAL GUINEA:
INDICATORS OF HUNTING SUSTAINABILITY AND DRIVERS OF BUSHMEAT DEMAND
ALLEBONE-WEBB, SOPHIE, Janna Rist, Noelle Kumpel, Bienvenido Ndong Ondó, Guy
Cowlshaw, Marcus Rowcliffe, E.J. Milner-Gulland

Bushmeat hunting is a major threat to biodiversity in central Africa and urban demand for wild meat is growing in many countries. To identify appropriate management strategies, it is necessary to understand both the current sustainability of the trade and likely future demand. Trends in species composition in markets can be an indicator of hunting sustainability, while trends in prices and availability of bushmeat and its alternatives can give some insight into the drivers of bushmeat demand. Data on the price, origin, species and availability of bushmeat, domestic meat and fish appearing in the principal markets in Bata, Equatorial Guinea, were collected over 12 months in 2005 and compared with previous studies. Long-term trends in species composition and origin suggest that hunting is at least locally unsustainable. Black colobus, a vulnerable and easily caught species, was almost entirely sourced from its key stronghold, which may suggest market-driven unsustainable use and near absence in other areas. The prices and availability of fresh fish, domestic meat and bushmeat varied seasonally, whereas the price of frozen foods did not. Fresh meat (wild and domestic) and fish almost always sold out on the day it arrived at market, whereas frozen meat and fish were readily available at all times, suggesting that demand for fresh meat and fish may exceed supply. Effective policies to reduce bushmeat demand should include means to increase the supply of fresh domestic produce.

LES LIAISONS DANGEREUSES: RELATION BETWEEN WILD AND CULTIVATED ACONITES
Le CADRE, SOLENN, Marie-Catherine Boisselier, Jacques Moret, Natalie Machon

Hybridization between wild and cultivated plant species is a widespread phenomenon that can threaten wild populations via massive introgression. Here, we address the role of cultivated ornamental varieties of *Aconitum napellus* in the population dynamics and maintenance of *Aconitum napellus* L. subsp. *lusitanicum*, a rare and protected Ranunculaceae, which occurs in lowland along rivers in the Parisian region. The species can be found only in a few number of remnant populations, threatened by demographic (Allee effect) and genetic (low genetic variability and inbreeding depression) problems. However, surprisingly, new populations were discovered recently. We used a combination of morphological and genetic analyses, as well as control crosses between wild and cultivated aconites, to characterize the new populations and evaluate the possibility of hybridization in natural populations. We showed that the newly discovered populations always consisted of naturalized cultivated varieties. We also demonstrated that crosses between wild and cultivated plants were possible, although they resulted in small seed sets. Finally, we found clear evidence of introgression of cultivated genes in one population. All these results suggest that cultivated aconites may have a dramatic impact on the persistence of small natural populations in the near future and confirm the widespread role of hybridization in species extinction.

CO-CONSTRUCTION OF INTERACTION INDICATORS FOR ADAPTIVE CO-MANAGEMENT:
AN INSTRUMENTAL LEARNING EXPERIMENT IN FOUR WEST AFRICAN BIOSPHERE
RESERVES
LEVREL, HAROLD, Meriem Bouamrane

Co-adaptive management of biodiversity is based, for a large part, on collective learning process. This collective learning concerns "instrumental policy learning", "social policy learning" and "political learning". This communication is focused on an instrumental policy learning that have been launched in four West African biosphere reserves. It is based on a MAB-UNESCO/PNUE-GEF programme concerning the co-construction of interaction (between development and conservation) indicators, inspired by the Integrated Natural Resource Management (INRM) methodology. This process has allowed to test conventional Pressure-State-Response indicators, to highlight their limits and to develop new indicators starting from stakeholders' stories and

perceptions. It has also permitted to test these new indicators through collective restitutions and simulations. Suggestions are formulated concerning: framework from which it is possible to produce interaction indicators that make sense for all the stakeholders and enjoy a certain legitimacy; importance of an ecosystem services approach to support discussions on biodiversity conservation; opportunity to use the indicators in an interactive, decentralized way at an ecosystem scale through simulation models; costs for collecting, processing, and maintaining these interaction indicators, and the means to reduce them from the local knowledge.

ELEPHANTS OF SOUTHEAST ANGOLA IN WAR AND PEACE: THEIR DECLINE, RE-COLONIZATION AND CURRENT STATUS CHASE, MICHAEL, Curt Griffin

Angola's intermittent 25-year civil war displaced over four million people and decimated wildlife populations. During the 1980s, Angola's elephants (*Loxodonta africana*) drew international alarm with reports of up to 100,000 elephants exterminated. Luiana Partial Reserve (PR), a 10,740 km² conservation area in southeast Angola, was the military operations center for UNITA, which used elephant ivory to pay for arms and meat to feed its' soldiers. However, the full impact of the civil war on elephants is uncertain because there are no reliable estimates of Angolan elephant populations. The purpose of this study was to provide historical and current information on the status of elephant populations in Luiana PR. Our three aerial surveys of Luiana PR indicate that elephant populations are increasing rapidly and expanding their range in the Reserve, from 329 in Jan04 to 1,827 in Nov05. Five elephants tagged in Botswana and the Caprivi Strip with satellite collars moved into Luiana PR. To re-establish elephant and other wildlife populations in Luiana PR, it is critical that anti-poaching, effective land use management, and community conservation programs be developed. Further, clearing landmines from large areas of the PR is needed to develop park facilities and encourage ecotourism opportunities. The designation and development of a transfrontier conservation area will provide an economic basis for rural development in the region. Finally, the veterinary fences on the Botswana-Namibia border need to be realigned to increase transboundary movements of elephants and other wildlife.

TREE SPECIES COMPOSITION OF A DYNAMIC FOREST-WOODLAND-SAVANNAH MOSAIC IN UGANDA: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT NANGENDO, GRACE, Frans Bongers, Hans ter Steege

Forest-woodland-savannah mosaics are a common feature in the East African landscape. For the conservation of the woody species that occur in such landscapes, the species patterns and the factors that maintain it need to be understood. We studied the woody species distribution in a forest-woodland-savannah mosaic in Budongo Forest Reserve, Uganda. The existing vegetation gradients were analyzed using data for a total of 591 plots of 400 or 500 m² each. Remotely sensed data was used to explore current vegetation cover and the gradients there in for the whole area. The area shows a clear species gradient ranging from forest, where there is least disturbance, to wooded grassland, where frequent fire disturbance occurs. Most species are not restricted to a specific part of the gradient although many show a maximum abundance at some point along the gradient. Fire and accessibility to the protected area were strongly related to species turnover along the ordination axis with species like *Cynometra alexandri* and *Uvariopsis congensis* occurring at one end of the gradient and *Combretum guenzi* and *Lonchocarpus laxiflorus* at the other. The vegetation cover classes identified in the area were differentiated in terms of diversity, density and, especially, basal area. All vegetation cover classes, except open woodland, had indicator species. Most of the species that occurred in more than one vegetation cover class showed peak abundance in a specific cover class. For conservation of the full range of the species within the mosaic, all existent vegetation types need to be considered. Burning should be managed in such a way that the different vegetation types of the mosaic are maintained.

DOES RIPARIAN CORRIDOR WIDTH INFLUENCE NESTING SUCCESS IN NATIVE CALIFORNIA SONGBIRDS?

MEIKLEJOHN, KATIE, Joshua Ginsberg, Jodi Hilty, Tim O'Brien

Habitat fragmentation caused by human encroachment and agricultural expansion threatens the persistence of biodiversity on a global scale, particularly species that rely on large tracts of undisturbed habitat for survival and reproduction. Habitat corridors have the potential to counteract some of the negative ecological impacts that result from land conversion and habitat fragmentation by improving landscape connectivity. However, the factors that make corridors effective to individual species are not well-understood, and many existing studies lack experimental components or take a single-species approach. This study took advantage of natural conditions to compare the relative abundance and reproductive success of thirty native Californian songbirds across three experimental categories of riparian corridor width. We located and monitored 120 nests to either fledging or failure between April and July 2006 in Sonoma County, CA. Neither observed species abundance nor species diversity is indicative of corridor quality as measured by reproductive success. Most importantly, the results of this study indicate that corridor design must account for both habitat structure within the corridor as well as corridor width, and that these variables may be species specific.

MULTIPLE PATERNITY IN EGG CLUTCHES OF GREEN (*CHELONIA MYDAS*) AND HAWKSBILL (*ERETMOCHELYS IMBRICATA*) TURTLES FROM MALAYSIA

JOSEPH, JUANITA, Paul Shaw

This study analysed genetic paternity in 24 females using five microsatellite DNA markers. Results demonstrated that 20% of hawksbill turtle clutches were sired by multiple males: this represents the first genetic tests of reproductive success in this species. Multiple paternity was more common in the green turtle with 71% of nests being sired by more than one male. Given the high incidence of multiple paternity in green turtles, these may suggest that multiple mating by females is the dominant breeding strategy, and an important factor shaping the mating system of green turtle populations in Malaysia. The same patterns of paternity were also observed across multiple clutches from individual females of both species, consistent with the hypothesis of sperm being stored from mating(s) prior to nesting and being used to fertilize all subsequent clutches of eggs that season, without additional inter-nesting mating by females.

RAPID ASSESSMENT OF MARINE MAMMAL AND SEA TURTLE BYCATCH IN ARTISANAL FISHERIES

MOORE, JEFFREY E., Rebecca L. Lewison, Jeremy Kiszka, Catharine Muir, Andrew J. Read, Tara M. Cox, Larry B. Crowder

Sea turtle and marine mammal populations worldwide are at risk to incidental mortality in marine fisheries. Management to reduce bycatch is impeded by lack of information on the spatial-temporal distribution of fishing effort, and of how many individuals from different taxa are captured in fishing fleets. Data limitation is particularly problematic for artisanal fisheries in developing countries, where even basic data for the number of fishers, types of gear used, and species impacted are unavailable. To address this, Project GloBAL (Global Bycatch Assessment of Long-lived species) has developed rapid assessment protocols to gather information about country fisheries and affected non-target taxa. Our protocols combine boat-counts in major fishing ports with interview data conducted in developing nations. Interview data are collected to allow analyses using: (a) FAST (Fishing Activity Simulation Tool), a GIS tool for mapping the distribution of fishing effort; and (b) Gómez-Muñoz-based models, which were designed to generate fish-catch estimates in artisanal fisheries based on interview data. Here, we describe the rapid assessment protocol and present preliminary results for fishing effort and bycatch assessments conducted in case-study nations of Africa. Our goal is to provide a template that can be readily applied to data-limited fisheries, generating much needed estimates that assist country managers to reduce bycatch while enabling sustainable fisheries.

EFFECTS ON WILDLIFE OF ARTIFICIAL WATERHOLES IN CHOBE NATIONAL PARK,
NORTHERN BOTSWANA
RUTINA, LUCAS, Mothusi Jenamiso

Provision of artificial water supply especially during the dry season and drought periods has become temporary management action in most African savanna conserved areas. In Chobe National Park, Northern Botswana, the argument in providing artificial surface water was two-fold; firstly to spread the use of and impact on vegetation by herbivores along the Chobe Riverfront and secondly to increase the number of wild animal species that can be supported by this new area so as to increase area of tourist attraction thus reducing congestion along the Chobe riverfront. Using a ten-year difference data we tested if the above objectives had been met. We found that there was significant reduction of wildlife biomass along Chobe River between 1994 and 2004, while wildlife biomass has been increasing around artificial waterholes. Similarly elephant female groups (Breeding) and other wild animals biomass were also increasing in areas beyond fifteen (15) kilometers from Chobe River and artificial waterholes, while there was no significant change in elephant male group biomass in these areas. In 1995/6 11 species were recorded using artificial waterholes with elephants constituting 75%. In 2005/6 23 animals species were recorded using the artificial water-holes with elephants constituting 70%. Our results shows that artificial water-holes had assisted in the spread of wildlife there by reducing their pressure along the Chobe Riverfront.

FEEDING ECOLOGY OF THE GREVY'S ZEBRA (*EQUUS GREVYI*, OUSTALET 1882) ON
SAMBURU PASTORAL LANDS, KENYA
KIVAI, STANISLAUS, Nicholas Ouge, Paul Muoria, Afework Bekele

The endangered Grevy's zebra is semi-endemic to northern Kenya and south-east Ethiopia. It has undergone 88% decline in population for the past 27 years in Kenya and highest populations occur in community pastoral lands in southern Samburu. To assist in making informed conservation decisions here, we undertook a study on diet, food preference and intake, and feeding behavior using focal sampling and vegetation clipping techniques. Grevy's zebras foraged on 31 plant species. *Indigofera spinosa* was the most important food resource in availability (14%) and dietary composition (33%). However, *Sericocomopsis hildebrandtii* and *Cyperus rotundus* were preferred during dry and wet seasons with respective indices of 6.8 and 4.0. Daily adult forage consumption varied from 8400 (± 800) to 11800 (± 1200) g between dry and wet seasons with browsing (70%) being recorded more frequently. Our study has shown that the Grevys zebra is adaptive to changes in food plants, being largely a browser in this highly degraded environment and a grazer in Lewa Downs, a protected area with better range condition. This may be attributed to limited grass availability due to high livestock biomass. There is need for a concerted and inclusive effort in formulating appropriate grazing system that will allow environmental recovery, reduce conflicts while enhancing in situ conservation of the species.

BIODIVERSITY AND BIOGEOGRAPHY OF REEFS IN KWAZULU NATAL - STEPS TOWARDS
EFFECTIVE CONSERVATION
LAWRENCE, CLOVERLEY, Jean Harris, George Branch

Reef habitats in KwaZulu-Natal (KZN), on the east coast of South Africa, are poorly studied and lack basic information i.e. location and extent. Information on the distribution and abundance of benthic organisms associated with these ecosystems are also deficient. Drastic decline in most harvested line-fish stocks is a warning that the health and integrity of local reef systems is under threat. This lack of knowledge inhibits effective conservation of reef biodiversity which supports important commercial and recreational activities. A survey of reef systems has been undertaken to determine the nature and location of subtidal reefs, to understand their associated biodiversity and to make recommendations for adequate conservation of reef biodiversity in KZN. Four depth categories were sampled between 10 and 30 m at nine localities using line-intercept and quadrat transects to quantify benthos. Multi-variate analyses revealed no significant differences between depth categories but a pronounced biogeographic differentiation emerged. Reefs in the north

were dominated by fauna and clearer waters while algae dominated nutrient-rich, turbid waters in the south. The northern biogeographic zone is completely protected within a marine protected area while reefs are scarcely protected within the southern biogeographic zone. A substantial MPA in the southern biogeographic zone is therefore recommended.

STUDYING THE EVALUATION OF MANAGEMENT EFFECTIVENESS OF PROTECTED AREA- A CASE STUDY OF WU-WEI-KANG WILDLIFE REFUGE IN TAIWAN LU, DAU-JYE, Mu-Ning Wang

Based on the WWF RAPPAM methodology, together with literature review, qualitative interview, participant observation, and focus group, we had conducted three participatory workshops and a series of activities to evaluate the management effectiveness of the Wu-Wei-Kang Wildlife Refuge in Taiwan from the middle of 2004 to the end of 2006. The evaluating results showed that the advantages for the management of this refuge were clear management objectives, good communications and information, and proper policy-making processes. Its weaknesses, however, were those involved planning, staffs, finances, and management processes. Compared to cases of Bhutan and China, our case showed particular low scores for the management plan and finances. This may suggest that, in Taiwan, people paid more attention to biological and ecological dimensions, but not the logics, of the management of protected areas. This study showed that the WWF RAPPAM methodology needed more amendment to consider the characteristics of Taiwanese refuge. We also found that the participatory workshop not only helped to resolve conflicts, identify common grounds, and create visions among stakeholders, but also can be used as an alternative policy-making mechanism for refuge management.

GLOBALIZATION, NEOLIBERALISM AND CONSERVATION: CROSS COUNTRY COMPARISON FROM LATIN AMERICA MILLINGTON, ANDREW

We present a cross-country analysis (from Argentina, Bolivia and Peru) of the impacts of globalization and neoliberal political change on conservation initiatives in the montane forests along the eastern slopes of the Andes. We analyse social, economic and political factors at local, provincial, national and international (South America, and global) scale in terms of their positive and negative impacts on conservation (both within, and external to, protected areas). The analyses show the following groups of factors are most influential across all three countries: (1) international trade (both legal and illegal) which mainly has negative influences, (2) international conservation policies (both positive and negative influences), (3) national government national policies in the areas of transportation, education provision, national trade, demography and colonization schemes (mainly negative), and (4) political change (political dislocation and policy shifts caused by regime change). The impact of regional policies (i.e. policies related to the Andean Pact nations, and the southern cone common market - MERCOSUR) have little impact on conservation. Local scale factors are generally subsumed within or overridden by national or international factors with the exception of the influence of illegal coca cultivation (for the global cocaine trade) in parts of Bolivia and Peru.

CROCODILE CONSERVATION IN WEST AFRICA: PLANNING FOR THE FUTURE SHIRLEY, MATTHEW H., William Oduro

West African crocodiles are among the least known and most exploited crocodilian species. The goal of this project was to establish a foundation for the conservation of *Mecistops cataphractus* and *Crocodylus niloticus* in West Africa by assessing their conservation status in Ghana and Cote d'Ivoire, building capacity in local practitioners, and examining the specific status of *C. niloticus*. Conservation status for both species was determined through systematic surveys of population, distribution, bushmeat threat, and cultural implications. Capacity building was achieved via 3 short courses and hosting 8 students for extended periods. The systematic analysis will utilize a total evidence, phylogenetic approach employing 8 molecular markers and 12 morphological characters (in progress). *C. niloticus* was present in extremely low abundance (avg. < 0.5

ind./km) while only 12 *M. cataphractus* were encountered in 4 different locales. Strong cultural affinities preclude commercial pressure for bushmeat, despite low-level exploitation for traditional practices and home consumption. Preliminary evidence from phylogenetic analysis suggests that West African *C. niloticus* may represent a unique species. This study established a baseline for further research on the status, distribution, and threats facing these crocodiles. It also empowered locals to carry out future conservation initiatives and raised interest and awareness in a region where crocodiles have been largely disregarded.

SECURING THE INTEGRITY OF THE WESTERN SERENGETI THROUGH PRIVATE PUBLIC PARTNERSHIP

Goodman, Peter, Brian Harris, CLAIRE LEWIS, Ed Schachenmann

The Grumeti Reserves complex, comprising the Grumeti and Ikorongo Game Reserves, the Sasakwa concession area and the Issenye, Nyakitono and Ikoma Open Areas, is situated along the western boundary of the Serengeti National Park. Since the migratory herds of wildebeest and zebra spend up to three months of the year in this area, its integrity is important from an ecosystem perspective, but also critical for the future sustainable development of the region. In 2003, the Grumeti Fund in partnership with the Tanzanian Wildlife Division embarked on an ambitious project to secure the integrity of the area and one of its goals was to rehabilitate the resident wildlife populations which had been severely impacted by both legal and illegal use. Over the last four years a significant investment has been made into wildlife protection and the development of ecotourism infrastructure in the concession, as well as socioeconomic development in the neighbouring community. The effectiveness of these inputs is being monitored for the most logical desired outcome namely an increase in the status of the resident herbivores. Large herbivore populations were surveyed at intervals using aerial Distance sampling. All locally resident species have shown increases in their population sizes since the first survey in September 2003. Warthog have demonstrated the greatest increase (10 fold) while the small (est. 229) population of Grant's gazelle has shown a small but statistically insignificant increase over this period. Other species' populations which are important from an ecological and ecotourism perspective e.g. buffalo, eland, elephant and giraffe have demonstrated increases of the order of 2 to 4 fold.

REDUCING THE THREAT OF ILLEGAL WILDLIFE HARVESTING USING COMMUNITY POLICING AND PROMOTING ECONOMIC ACTIVITIES AT HOUSEHOLD LEVEL SICHILONGO, MWAPE

Mumbwa District in Zambia is adjacent to the 22,480 km² Kafue National Park. One of the threats to the park is illegal and unsustainable harvesting of wildlife. In Mumbwa Prison, 90% of the inmates are incarcerated for wildlife related offences. A high percentage of them are repeat offenders. Law enforcement and community based natural resource management (CBNRM) are expected to assist reduce the problem through community participation and sharing of income from trophy hunting outside the park as an incentive. Data on law enforcement, CBNRM activities, and wildlife counts for a three year period (2002-2005) was collected. Wildlife officials, CBNRM practitioners, community leaders and convicted poachers were interviewed. The data was analysed for trends and decision models. Resource depletion is still continuing. Individuals in the community are still making the decision to poach mainly due to economic circumstances at household level. We recommend that law enforcement should engage more in preventive work through outreach using community agents. Community monitoring of law enforcement and resources will improve local capacity. Economic activities at household level will counter the main reasons for poaching. This strategy should also address inmates.

A NETWORK APPROACH TO INTEGRATING TOOLS FOR COASTAL-MARINE ECOSYSTEM BASED MANAGEMENT

CARR, SARAH, Patrick Crist

Coastal-marine ecosystem-based management (EBM) is a highly complex activity that involves integration across terrestrial, freshwater, and marine ecosystems. Conducting EBM requires a wide variety of sophisticated software tools and techniques that address different discipline-specific analyses such as: • predicting ecosystem response to natural disturbances in watersheds and the marine environment • selecting optimal areas for conservation or restoration • visualizing the impacts of development and resource-use scenarios on an ecosystem • collecting local knowledge about a resource • facilitating stakeholder understanding of and input on management alternatives. These tools have been developed independently, creating significant difficulties in their integration to serve EBM. In response, the Packard Foundation has funded the EBM Tools Network. The Network is comprised of a large number of national and global institutions that develop and/or apply software tools to coastal-marine EBM. Forming this network has stimulated a variety of activities to increase interoperability of current tools and develop guidelines to promote interoperability of new tools. We will present the Network activities, a summary of the key criteria for EBM tool interoperability, and case studies of current interoperability activities among 3 tools, MARXAN, NatureServe Vista, and N-SPECT.

USING LOCAL KNOWLEDGE TO REDUCE HUMAN-CARNIVORE CONFLICT IN TANZANIA, AFRICA AND MONTANA, U.S.A.

WILSON, SETH, Laly Lichtenfeld

Conservation of grizzly bears (*Ursus arctos*) or lions (*Panthera leo*) largely depends on reducing human-caused mortality, particularly when these carnivore populations overlap with livestock. We describe efforts to reduce human-carnivore conflict in Tanzania, Africa and Montana, U.S.A. that rely on traditional ecological knowledge (TEK). Our methods rely on a practice-based and collaborative framework. In the Tarangire case, spoor counts conducted with Hadzabe trackers were used to monitor seasonal lion distribution and abundance. Independent tests of the Hadzabe's abilities to correctly detect lion spoor resulted in 100% success in 16 cases. The Hadzabe correctly determined age group and sex in 94% (47 lions) and 97% (29 lions) of cases. These data were supplemented with reported livestock depredations and verified by Maasai informants. Preliminary results of 81 livestock depredations by carnivores indicated that 53% of attacks occurred when animals were lost at pasture. Lion movement and livestock attack data will be used to develop conflict avoidance projects with villagers. In Montana, GIS was used with ranchers to document seasonal grizzly bear activity and traditional agricultural practices. These data were integrated with grizzly bear conflict data from wildlife authorities to guide mitigation efforts including livestock carcass removal, fencing, and communication networks. Preliminary results suggest that verified grizzly bear conflicts have fallen by 91% from 2003 - 2006 with no confirmed livestock depredations since 2004 and zero grizzlies trapped since 2005. In both cases, TEK was used in a problem-oriented manner that engaged people through the research process to garner support for inclusive decision-making for conflict mitigation efforts.

INTEGRATING CONSERVATION ACROSS TERRESTRIAL, FRESHWATER, AND MARINE ECOSYSTEMS USING DECISION SUPPORT TOOLS

CRIST, PATRICK, Pat Comer, Daniel Dorfman

Traditionally, conservation planning has been conducted separately among ecosystem types owing to different scientific disciplines and responsible agencies and institutions. Recently, conservation organizations have begun developing more integrative approaches recognizing that effects of conservation, as well as threats, cause effects across ecosystem boundaries. Taking an integrative approach can potentially lead to more efficient conservation solutions by achieving multiple ecosystem objectives through strategically placed actions. Because of the complexity of analyzing and linking multiple ecosystems, decision support tools can be of great utility in integrative conservation planning. We will present summaries of case studies from Puerto Rico,

U.S.A. and Jamaica that illustrate the integration of three tools: MARXAN, NatureServe Vista, and N-SPECT. These tools supported the expression of land use scenarios, predicted the land use effects on terrestrial, freshwater, and marine ecosystems, optimized conservation site selection across ecosystems, and facilitated development of compatible land use scenarios to achieve stated conservation objectives. The results of these analyses are currently informing development of national land use and protected area plans and conservation acquisition priorities. Multi-institutional partnerships have also been formed as a result of the ability of the tools to inform cross-ecosystem planning.

POPULATION GENETICS OF BLACK RATS (*RATTUS RATTUS*) IN THE GALAPAGOS ISLANDS, ECUADOR: INTRODUCTION, IMPACT, AND ERADICATION

Jarcho, Michael, CODY W. EDWARDS, Robert C. Dowler, R. Brand Phillips, Howard L. Snell

The black rat (*Rattus rattus*) was a known inhabitant of the Galapagos Islands by the time of Charles Darwin's visit in 1835. At present, this species is found on the four inhabited islands, Isla Santiago, and thirty-one small (< 3,000 ha) islands. The detrimental impact of these rats on native species has led for a call for eradication. However, little is known regarding the timing/mode of historical introduction(s) nor present intra- and inter- island exchange. This information is critical for implementation of a comprehensive eradication plan. We assessed the nature and extent of genetic variation in island populations in an attempt to answer the following questions: 1) Is the observed genetic structure indicative of a single colonization event or multiple unique colonization events? 2) Can the chronologies of invasions be determined? 3) What factors influenced the maintenance of genetic diversity? We examined 581 individuals from 15 islands/islets using 5 polymorphic microsatellite loci. Significant departure from Hardy-Weinberg equilibrium was detected in all populations (due to excess of homozygotes). F_{ST} and R_{ST} values were moderate (ranges for both values: 0.11 - 0.14) indicating on-going gene flow among populations. Patterns of inter-island exchange, impacts on native flora/fauna, and conservation plans will be discussed.

CONSERVATION OF THE ENDEMIC INVERTEBRATE FAUNA OF THE CAPE PENINSULA PRYKE, JAMES, Michael Samways

The Cape Peninsula is an area of outstanding biological diversity and endemism. Very little is known of the invertebrates of this region. Table Mountain has been shown to have the highest diversity of invertebrate fauna on the Cape Peninsula. The aims of this project are to assess the status of irreplaceable endemic taxa, ascertain current invertebrate diversity levels and determine the factors influencing diversity. Several sampling techniques are being used to assess differences in invertebrate diversity across different the land mosaic of the mountain. Variables measured are vegetation type, elevation, aspect, disturbance from pine forests and fire ecology. Phenological changes are being monitored. Preliminary results show that young forests and cultivated gardens (Kirstenbosch) show the highest epigaeic invertebrate diversity, while flying insects are most diverse in cultivated gardens. Both ground invertebrate and flying insect diversity was higher at low elevation sites. Fynbos sites on the north and west sides of the mountain (the drier hotter sides), had higher diversity than the two other sides. Furthermore, several rare and threatened species have been found on the mountain. Disturbance, such as pine removal and fire, also are shown to have dramatic effects on the invertebrate community.

DOCUMENTING AND MONITORING COMMUNITY USE ZONES IN CROCKER RANGE PARK (SABAH, MALAYSIA): THE BUAYAN-KIONOP RESOURCE CATCHMENT ASSESSMENT MARTIN, GARY J., Agnes L Agama, James Wong, Miki Yassin, Adam Murphy, Raj Puri, Adrian Lasimbang, Jamili Nais

Are subsistence farming, fishing, gathering and hunting practices compatible with biodiversity conservation and protected area management? Since 2003, this issue of global relevance has been the focus of our applied research in proposed community use zones (CUZs) of Crocker Range Park, the largest terrestrial protected area in Sabah, Malaysia. With support from the UK Darwin Initiative, we have been carrying out a Resource Catchment Assessment (RCA) with

Dusun people living in the remote Buayan-Kionop area of the Park. The RCA uses a diverse range of anthropological, ecological and ethnobiological methods – including household surveys, livelihood analyses, diversity indices, ethnobotanical inventories, estimations of hunting offtake, homegarden studies and soil analyses – in a participatory assessment of subsistence activities. The results, collated in a GIS-integrated database, have led Sabah Parks (the state protected area authority) to embrace a new approach to delimiting CUZ boundaries and to recognising local resource rights. In addition, the RCA has contributed to new policy tools, including a Buayan-Kionop CUZ Agreement and an amendment to the Sabah Parks Enactment that strengthens the legal recognition of CUZs. We are currently designing a community resource monitoring process that will help local people and Sabah Parks staff to adaptively manage the CUZs. Our approach will be documented in a handbook on “Best Practices for Assessing CUZs in Protected Areas”.

THE QUEST FOR THE GLOBAL COMMONS: PUBLIC-PRIVATE PARTNERSHIPS AND COMMUNITY LAND RIGHTS IN THE GREAT LIMPOPO TRANSFRONTIER CONSERVATION AREA

SPIERENBURG, MARJA, Conrad Steenkamp, Harry Wels

The Great Limpopo is one of the largest TransFrontier Conservation Areas (TFCAs) in the world, encompassing vast areas in South Africa, Zimbabwe, and Mozambique. By arguing that residents living in or close to the TFCA will participate in its management and benefit economically, TFCA proponents claim social legitimacy for the project. The establishment of the Great Limpopo required negotiations between the three nation states, but also between different government departments within these states, and various donors contributing funds. This paper explores how these negotiations and interactions affected the institutional choices made with regards to the management of the Great Limpopo and how these impacted on the control and benefits of local residents. It is crucial to look at the differences between the different actors in terms of power and capacities, yet, in the promotion of TFCAs these are often glossed over. By comparing the experiences of local residents in the South African part of the TFCA with those in Mozambique we will furthermore show how international negotiations interact with national policies of decentralisation to influence local government institutions.

ARE AREAS OF ECOLOGICAL TRANSITION IMPORTANT FOR BIODIVERSITY CONSERVATION?

VAN RENSBURG, BERNDT, Salit Kark, Noam Levin

One of the main conservation efforts that have been taking place in recent years is the identification of endemic hotspot areas, i.e. areas characterized by high numbers of small ranged species. Research often focuses on pre-defined ecosystems, ecoregions or other distinct landscape units when identifying such areas. Consequently, areas of transition where these units integrate are often excluded from such conservation programmes. Here we examine whether areas of transition between ecological systems are being characterized by higher numbers of range-restricted species than expected by chance after taking environmental energy availability and spatial autocorrelation into account. Using data on birds and frogs in South Africa, at a spatial resolution at which practical conservation planning takes place, we examined the relationship between species richness and range size rarity at the quarter-degree grid cell resolution and the distance to boundaries between adjacent plant-based ecoregions. Analyses suggest that the number of range restricted species, for birds and frogs, decreases with an increase in distance to boundary regions between ecoregions along a negative decelerating curve rather than exhibiting a unimodal relationship. Consequently, in addition to transitional areas being species-rich, these areas also harbour many rare species and should be considered important areas for biodiversity conservation.

ASSESSMENT OF THE BUSHMEAT TRADE IN SOUTHEASTERN KENYA

Smith, Bradley, Natalie Jones, Bridget Sutton, MICHAEL STOKES, Charles Kimwele, Doug McElroy

Western Kentucky University and the University of Nairobi have partnered to develop a wildlife conservation management research and teaching program as well as a new field research station in southeastern Kenya. An important part of our program is defining the extent of the bushmeat trade in the region. Based on a study sponsored by the Born Free foundation and reports in Kenyan newspapers, bushmeat is frequently passed to unsuspecting buyers as domestic meat (typically goat or beef) in both commercial butcheries and in restaurants, especially in the Tsavo National Park area. To evaluate the reliability of these rumors, we collected nearly 300 samples from butcheries and restaurants by purchasing chopped meat or stews. We sequenced the samples using the cytochrome B region of mitochondrial DNA. We then identified the sequences to species using a BLAST search on the NCBI database. With about one-third of the samples run to date, we've found no bushmeat, though there is some mislabeling of domestic meat products. The large number of snares we find in the bush leaves no doubt that poaching is common, but based on our results and associated social surveys, we suspect that the market for bushmeat is primarily localized and informal.

LAST ENDEMIC PRIONS FACE EXTINCTION FROM FALCON PEREGRINATION

JIGUET, FREDERIC, Alexandre Robert

Understanding how anthropically induced interacting factors may compromise the viability of a particular species or population necessitates expressing them in terms of quantitative effects on population dynamics. The use of mechanistic models to assess these effects is especially helpful to management plans when the causes of species decline are multi-factorial and potentially interacting. Here we took opportunity of observed predation by a vagrant falcon on a rare and endemic seabird to develop a population dynamics model encompassing multiple deterministic and stochastic threats. The Macgillivray's prion *Pachyptila macgillivrayi*, with a world breeding population confined to one rat-free islet off Saint-Paul island (Southern Indian Ocean), faces high extinction risk from vagrant falcon predation. Recent rat eradication on Saint-Paul mainland helps the prion to face this threat as it released the carrying capacity of the colony, but earlier population size might never be recovered if falcons carry on frequently preying on prions. This rare burrowing petrel provides a remarkable case study of an endemic insular species threatened with predation by alien mammals, that reduced dramatically historical population size, and by genuine vagrants as catastrophic events that reduce population growth and increase its temporal variance, and might cause the ultimate extinction.

ECOLOGICAL CONDITION OF BIOLOGICAL COMMUNITIES IN THE U.S. GREAT LAKES COASTAL REGION

NIEMI, GERALD, Valerie Brady, John Brazner, Jan Ciborowski, Nicholas Danz, Robert Howe, Lucinda Johnson

Coastal regions are among the world's most threatened ecosystems. These ecosystems house the majority of human populations and are repositories of substantial nutrient and chemical waste. In 2006 we completed a five-year effort to develop multi-scaled indicators of ecological condition at coastal margins of the entire U.S. Great Lakes basin. We used over 200 GIS variables to quantify anthropogenic stress and to distribute sampling effort across the basin. Biota were sampled at over 200 coastal wetland systems. The ecological indicators included population, community, and landscape variables, thereby representing biodiversity over a range of spatial and temporal scales. Analyses of linkages between stressors and amphibian, bird, fish, and macroinvertebrate assemblages indicated that agriculture and urban-residential land uses exerted the primary effects on ecological condition. Point source pollution effects were largely confined to industrial, human-dominated landscapes. Because most of the land in the U.S. Great Lakes region is affected by agriculture and low- to medium-density residential development, these stressors have the greatest overall influence throughout the basin. Invasive species and

fluctuations in water levels are also prominent influences. Upcoming substantial changes in biological diversity of the Great Lakes coastal region are expected as residential development, invasive species, and climate change effects accelerate in the region.

LANDSCAPE STRUCTURE AND DISEASE ECOLOGY IN TANZANIAN GRASSLANDS COLLINGE, SHARON, R. Jory Brinkerhoff, Peter Coppolillo

Many diseases are shared by wildlife and humans, and so it is critical to understand the ecological factors that influence the abundance and distribution of disease-carrying animals. We examined how land use affects small mammal species composition by live-trapping in four types of study sites: 1) areas grazed only by wildlife, 2) areas grazed only by wildlife but recently burned, 3) areas grazed by wildlife and domestic livestock, and 4) fallow fields adjacent to villages. We established grids of small mammal live-traps in 12 study areas (3 in each of the 4 treatments described above) and trapped each site for four nights. We identified each individual to genus or species and anesthetized the animal for collection of blood and ectoparasite (flea and tick) samples. We captured 100 unique animals from 7 genera, but most captures (56%) were *Mastomys natalensis*, which was very abundant in village sites, absent from all other types of sites, and is known to carry the plague bacterium, *Yersinia pestis*. None of the blood samples were positive for antibodies to *Y. pestis*, suggesting that these animals were not recently exposed to plague. We collected a total of 107 fleas from five mammal species and 493 ticks from three mammal species. We conclude that land use strongly influences abundance and community composition of small mammals in central Tanzania, and in particular, sites near villages supported the highest abundance of a species known to carry plague.

MEASURING AND APPLYING ECONOMIC VALUES AND ECONOMIC IMPACTS OF A MARINE MANAGED AREA IN BELIZE HARGREAVES-ALLEN, VENETIA

Marine managed areas (MMAs) are being heavily invested in, to help conserve coral reef ecosystems and the myriad of benefits they provide in tropical areas. MMAs provide goods and services that can be translated into dollar values and compared to the costs of management. This case study uses a mixture of economic methodologies to quantify fisheries, tourism and other benefits provided by an actively managed MMA in Belize, net of management costs incurred. Management and policy applications of this information are illustrated. In addition, the economic impacts of the MMA for local, national and international stakeholders are quantified. Many of these impacts, such as awards of large grants which help provide local employment and expertise, involve a transfer of payment between stakeholders, as they are simultaneously local benefits and international costs of the protected area. They are therefore not captured in traditional economic valuation estimates. However they are likely to have a key role in MMA success, through their effects on stakeholders, whose support and compliance is essential for MMA effectiveness. The results of both valuation and impact analyses are presented and compared. A discussion follows as to the value of each technique in assessing or monitoring MMA effectiveness.

DELINEATION OF ESU IN A TROPICAL TREE: *SANTALUM AUSTROCALEDONICUM* IN NEW CALEDONIA BOTTIN, LORRAINE, Jacques Tassin, Jean-Marc Bouvet

Various approaches have been developed to define conservation units for plant and animal species. One of them is that of Crandall (2000), which uses ecological and genetic exchangeability to define evolutionary significant units (ESU). However, it has been barely used in plant species, and our study is one of the first applications on a forest tree species. *Santalum austrocaledonicum* is a tree endemic to New Caledonia, that has been overexploited for its scented wood, and whose populations are now strongly reduced. To define ESU in this species, we combined the studies of variation of nuclear and chloroplast microsatellites, leaf and seed morphological traits, and climatic variables. Genetic results showed that differentiation was strong

between islands ($F_{stnuc}=0.22$) but also within the main island Grande Terre, highlighting a limited gene flow; and a cluster analysis discriminated two main groups consisting of i) the populations of Grande Terre and Ile des Pins and ii) those of Iles Loyauté. In parallel, a PCA revealed a clear difference of leaf and seed traits between the same two geographical entities. A high correlation between rainfall and morphological traits suggested an impact of climate on the phenotypic variation. The combination of genetic and ecological results allowed to identify these two units as ESUs, and to determine sub-units, like some populations of Grande Terre, threatened by their small size, that need to be restored.

STAKEHOLDER PARTICIPATION IN MARINE RESERVE PLANNING AND MANAGEMENT DALTON, TRACEY, Richard Pollnac, Graham Forrester

Local residents, resource users, and other stakeholders play an important role in the governance of marine reserves. We examined stakeholder participation in reserve planning and management and how this participation relates to reserve performance. We conducted over 500 structured interviews with individuals in Belize and Honduras who live in communities associated with marine reserves. We found no difference in perceptions of overall reserve success between those who participated and those who did not, but there were differences in perceptions of more specific measures of success. For example, those who participated were more likely to think that the reserve brings financial benefits to the local community. Analyses of responses from only those individuals who had participated in reserve planning and management indicated that specific features of the process were related to different perceptions of performance. For example, participants who thought that it was clear how decisions were made during reserve planning and management were more likely to think that conflict in the community had declined since the reserve was established. Our results highlight the complex nature of stakeholder participation in reserve management. It is important to better understand this complexity as reserves continue to grow in popularity as a conservation tool.

THE EFFECTS OF HOUSING DENSITY ON FOREST BIRDS IN THE UNITED STATES PIDGEON, ANNA, Volker Radeloff, Curtis Flather, Christopher Lepczyk, Susan Stewart

In the United States, housing density has substantially increased in and adjacent to forests. Our goal in this study was to identify the effects of human populations, as measured by housing density, on forest bird diversity across the conterminous forested United States. We conducted a nation-wide analysis using data from the North American Breeding Bird Survey, the U.S. Census, and the National Land Cover Database, and focused on forest bird communities, grouped by migratory and nesting habits, and synanthropic species. Housing affected forest bird species richness in all forested areas, but there were important regional differences that appear to be due to variation in landscape context and the degree of housing development. The strongest guild response to housing occurred in the heavily forested Adirondack-New England ecoregion, where 29 of variation in richness of the permanent resident guild was related to housing density. In this case, richness was positively related to total housing density and negatively related to seasonal housing density. Regional stratification improved models most for cavity nesters and short-distance migrants, suggesting that these guilds may be especially sensitive to regionally specific patterns of residential development. Overall, we found that housing density and residential land cover are significant predictors of forest bird species richness, and their effects are likely to increase as development continues.

ASSESSING SOCIO-ECONOMIC DRIVERS AND ANTHROPOGENIC PRESSURES OF BIODIVERSITY CHANGE OHL, CORNELIA, Kinga Krauze, Peter Bezák

There are always problems with allocation of funds and efforts when risk to biodiversity and ecosystem services is to be analysed, and steps for problem solving are to be made. Thus one goal of the ALTER-Net, NoE (A Long-Term Biodiversity, Ecosystem and Awareness Research Network, Network of Excellence) – a partnership of 24 organisations from 17 European countries,

funded by the EU's 6th Framework Programme – is to identify the most important socio-economic drivers and anthropogenic pressures of biodiversity change. To fulfil this task we present criteria (first and second order criteria), related measures and scales developed within the work package R1 of the ALTER-Net, NoE. With the help of these criteria we identify key features and components of drivers and pressures constituting the risk related to each of them. This provides a basis for understanding the problem, recognition of gaps in knowledge and required expertise. A first application of the assessment tool will be demonstrated to show how the tool delivers driver and pressure specific risk profiles at different spatial scales (local/site to national, regional/EU level) and how the tool can be adapted to the needs of a participatory process of decision making.

THE VOICES OF THE YELLOWSTONE RIVER: CONSERVATION IMPLICATIONS FROM LARGE NS QUALITATIVE RESEARCH HALL, DAMON, Susan Gilbertz, Cristi Horton

The Yellowstone River is the longest undamed river in the United States at 1080 km (670 mi). The river irrigates the most productive agricultural lands in Montana. It is also an icon for fly-fishing and a growing recreational destination for hunting and rafting which have led to rapid riverfront development. This influx has brought new cultural values into the valley. These user groups coexist until periodic flooding rearranges the places owned, farmed, and loved by river residents. In 1996 and 1997, the Yellowstone River experienced two one-hundred-year floods that destabilized the physical, ideational, and discursive landscapes of the river. This flooding revealed conflicts over the preservation of the river's ecological, recreational, and agricultural meanings and practices. Funded by Conservation Districts and the Army Corps of Engineers we conducted hour-long open-ended interviews with 313 people in their riverfront places distributed between five geographical segments across five user groups (Agriculture N=86, Residential N=68, Civic Management N=76, Recreation N=76, and Native American N=7). From our findings and experience, we argue that conservation of natural river places is inherently intertwined with the conservation of livelihood and meaning. Furthermore, the nuances of conserving meaningful places exist in the linguistic and communicated constructions of place and use.

CAN MARINE PROTECTED AREAS BE DESIGNED TO MITIGATE THERMAL STRESS? SELIG, ELIZABETH, John Bruno, Kenneth Casey

A major challenge for scientists and resource managers is to determine whether protected areas can be used as an effective management strategy for mitigating the effects of global climate change. One body of theory suggests that by reducing other stressors, protected areas can increase overall ecosystem resiliency or the ability of the ecosystem to return to a pre-disturbance state. We address several key questions relating to coral reef ecosystem resiliency including how temperature anomalies vary spatially and temporally and if current MPAs have higher levels of coral cover than non-MPA areas with similar levels of thermal stress. First, we created a 21-year dataset of sea surface temperature anomalies using 4 km ocean temperature data from NOAA's satellite-based Pathfinder program. We then used data on thermal stress event size and spatial autocorrelation to develop specific management guidelines for the size and spacing of MPAs in networks. In addition, we used spatial databases on MPAs, coral cover, and bleaching to determine whether protection affected bleaching severity or percent coral cover—a measure of ecosystem health—after thermal disturbance events. Our results have important implications for the design of MPAs in the context of global climate change and provide a starting point for evaluating the resiliency strategy.

THE VALUE OF OIL PALM PLANTATIONS FOR BIRD DIVERSITY AND FOOD PRODUCTION IN THE FOREST ZONE OF GHANA PHALAN, BEN, Rhys Green, Andrew Balmford

Can biodiversity losses to agriculture be minimised by wildlife-friendly farming, or by increasing crop productivity to enable land to be spared for nature? Answering this question is crucial for the

effective conservation of tropical forests under pressure from growing demand for agricultural land. Evaluating the trade-offs between “wildlife-friendly” and “land-sparing” approaches requires assessments of the value of different land-uses for biodiversity and food production. Those species which are most intolerant of any disturbance to their habitat (which likely includes many species of conservation concern) will be favoured by a land-sparing approach. The densities of a range of bird species was assessed using point counts in four study regions in southern Ghana, each including forests, oil palm plantations and a mosaic of farmed and fallow land. Interviews were conducted to evaluate food production in the same areas. Oil palm plantations had high inputs, high fruit yields and low bird species diversity. Forest reserves, although they have been degraded by logging and hunting, supported a higher diversity of species, including some not found even in the more “wildlife-friendly” farmbush mosaic. Oil palm plantations are of limited value for bird diversity, but their high productivity could help reduce demand for further land-clearance. Conservation efforts in southern Ghana may be best focused on improving forest protection, rather than on wildlife-friendly farming.

CONSERVATION STATUS AND THE FUTURE FOR PROTECTED AREAS IN SOUTH-EAST PERU

WILLIAMS, ROBERT, Carolina Tovar Ingar, José Antonio Saito Diaz, Pedro Vasquez Ruesta

The Madre de Dios watershed of south-eastern Peru is one of the most biodiverse areas in the world, extending from Andean highlands into the Amazonian lowlands, and contains six protected areas encompassing 6 million hectares. The region faces increasing pressure from human activities resulting in rapid forest loss and fragmentation. We used satellite monitoring (images from 1990, 2000 and 2005) to examine human caused habitat change within and around protected areas. All the protected areas examined were suffering from habitat change, a 20.7% increase in habitat loss being detected between 2000-2005, and the rate of change was found to be accelerating, a four-fold increase in the annual mean rate of habitat change in 2000-2005 compared to 1990-2000. The principal causes of habitat change are: agricultural expansion, population increase, settlement and change in lifestyle of indigenous peoples living within protected areas, and gold-mining. We also discuss the potential impact of paving the Inter-oceanic highway through the region and illegal timber extraction. If the high diversity of the region and protected areas are to be adequately protected in the long-term increased resources for protection and rapid changes in popular and political attitudes to the protected areas and the environment are necessary.

LAND-USE OPTION BIODIVERSITY CONSERVATION - TOWARDS AN INTEGRATED ASSESSMENT OF AGRICULTURE, FORESTRY AND CONSERVATION IN LAND USE MODELLING

JANTKE, KERSTIN, Uwe Schneider, Christine Schleupner

Mitigation of climate change calls for alternative energy sources. Bioenergy is a currently discussed strategy to reduce dependency from fossil fuels. Increased cultivation of bioenergy crops will decrease the available land for nature reserves and for traditional agriculture and forestry. To implement promotion of bioenergy without ignoring possible threats to biodiversity associated with it, an integrated assessment of economic and ecological aspects of land use is essential. We present a novel approach to assess biodiversity conservation within an economic modelling framework. Methods from systematic conservation planning are applied to estimate habitat requirement functions for endangered species and habitat types of European conservation concern. Those functions are integrated into a dynamic economic optimization model, which simulates the economic and ecological impacts of land use activities. The model estimates costs of habitat protection, covering simultaneously endangered species and habitat types, as well as complementarities and tradeoffs between different environmental qualities related to land use (e.g. biodiversity effects vs. bioenergy supply, carbon sinks, soil erosion, and water quality).

PARTIAL CAPTIVE BREEDING: A NEW TECHNIQUE FOR REDUCING POACHING IN NEOTROPICAL PARROTS

Briceño-Linares, José Manuel, JON PAUL RODRÍGUEZ, Kathryn M. Rodríguez-Clark, Pablo Antonio Millán, Roberth Fernández, Douglas Vázquez, Deicys González, Pedro Vázquez, María Alejandra Faría-Romero

The main threat to the psittacids of Margarita Island, Venezuela, is poaching for the illegal pet trade. The yellow-shouldered parrot (*Amazona barbadensis*) and the blue-headed conure (*Aratinga acuticaudata neoxena*), are listed nationally as endangered and critically endangered, respectively. The Venezuelan NGO, Provita, has implemented nest protection and environmental education since 1989 to reduce poaching. Though this has been relatively successful with the parrot (increasing the population from 700 in 1989 to 1,700 in 2006), the conure has continued to decline (from ~200 to 20-50), and poaching pressure on both is still high. Between 2004 and 2006, we implemented a set of new field interventions. We found that while 24-h field surveillance and foster nests were relatively successful, "partial captive breeding" was the most effective strategy: every night, after parent birds left nests, nestlings were removed to a secure site. Every morning, they were returned. Parent-nestling interactions displayed no evidence of being disturbed. In 2006, 100% and 80% of partially captive-bred parrots and conures fledged, respectively. This contrasted sharply with past figures, where 50-100% of nestlings were poached. The relatively low costs and simple technology of partial captive breeding make it a promising technique for minimizing poaching in Neotropical psittacids.

MATRIX MODEL FOR ARRAU TURTLE (*PODOCNEMIS EXPANSA*) IN THE MIDDLE ORINOCO RIVER

MOGOLLONES, SOL, Guillermo R Barreto, Diego Rodríguez, Omar Hernández

Podocnemis expansa is an endangered freshwater turtle distributed along the Orinoco and Amazonas rivers. In Venezuela, a management program has been implemented in the Arrau Turtle Wildlife Refuge (RFSTA), middle Orinoco River, since 1989. This program involves protection of nesting beaches and headstarting of hatchlings. The purpose of our study was to evaluate the population dynamics of the species in the zone. We first calculated vital rates (fecundity and survivorship), based on a 15 years data base available in the Venezuelan Ministry of Environment. Then, we constructed a stage-dependent matrix model allowing us to determine population status and to simulate the effectiveness of several management options. Additionally, we performed a body growth curve to estimate sexual maturity age in females. Our estimations indicate that sexual maturity is reached at 15-28 years. Recruitment of nesting females are expected in ten years from now. According to our simulations, manipulating the survivorship of juveniles and small adults is the conservation action that could reverse a population decline. In contrast, manipulating other vital rates, will not, alone, reverse population decline. We conclude that additional efforts focused on juveniles and small adults Arrau turtle protection, such as reinforcement of illegal hunting controls, must be implemented in order to ensure the success of this program.

WHERE HAVE ALL THE ALLELES GONE: A GENETIC BOTTNECK ANALYSIS OF REINTRODUCED MARTEN POPULATIONS IN MICHIGAN

Bicker, Sara, Brad Swanson, CLAY BUCHANAN

The American marten, *Martes americana*, was extirpated from the Lower Peninsula of Michigan by 1911, largely due to human exploitation and a decrease in suitable habitat. More conservative resource management practices increased suitable marten habitat, allowing the Michigan Department of Natural Resources to reintroduce a total of 85 marten in to the Pigeon River and Manistee areas of the northern Lower Peninsula in 1985-86. It is likely that these populations experienced a bottleneck during their reintroduction, creating both short and long-term concerns. We analyzed tissue sample from 40 live-trapped marten at 8 microsatellite loci and found significant genetic differentiation ($R_{ST}=0.07$) between the two populations. Each population ($A=5$; $A=4.6$) has significantly fewer alleles than the source ($A=7$) population from Chapleau, Ontario.

We failed to find a significant difference in the heterozygosity values between the reintroduced populations ($H=0.61$; $H=0.63$) and the source population ($H=0.63$). The M-ratio failed to detect a bottleneck in either of the reintroduced populations. Program BOTTLENECK indicated that the Pigeon River population experienced a bottleneck but detected no such signature in Manistee population. Our data indicate that the Lower Peninsula Michigan marten are showing the initial stages of a bottleneck and with proper management the decline in genetic diversity can be halted.

IMPACT OF AQUACULTURE ON THE MANGROVE ECOSYSTEM OF INDIAN SUNDARBANS, A WORLD HERITAGE SITE : EVALUATION AND RECOMMENDATIONS GUHA, INDRILA, Rajarshi Banerji

The study explains the importance of aquaculture industry as a major forex earner and employment sector for West Bengal, India with huge potential for growth; identifies linkages between growth of aquaculture in districts adjoining Sundarbans, a World Heritage Site, in recent years and resultant degradation of forest cover; details adverse impacts of aquaculture industry and Prawn Seed collection on the biodiversity of fragile mangrove ecosystem. The study is based on district and block-wise secondary data from the Departments of Land Reforms and Fisheries, Govt. of West Bengal and from Govt. of India followed by focus group discussions with the affected stakeholders to have an effective overview of the adverse impact of aquaculture on the mangroves and the efficacy of the mitigation measures. Shrimp Exports from West Bengal rose from 8009 MT in 1991-92 to 17,692 MT in 2001-02. This increase saw a corresponding rise in the area under aquaculture in the blocks adjoining Sundarbans from 14532.63 ha in 1991-92 to 33102.43 ha in 2001-02. Deforestation in Sundarbans caused directly due to growth in aquaculture was 18569.89 ha between 1991-92 and 2001-02 in 11 blocks in the districts adjoining Sundarbans. The study rounds off with detail concrete recommendations for specific mitigation measures for the reduction of ill effects of aquaculture industry on Sundarbans that are actually synchronous with a sustainable growth of the industry itself.

USE OF SPIDER SIZE AS A BIO-INDICATOR OF LAND USE: AN EXPERIMENTAL STUDY OF SPIDERS FROM A SAVANNA ECOSYSTEM IN KENYA WARUI, CHARLES M., Truman P. Young, Martin H. Villet

Diversity measures have been used in conservation studies as indicators of habitat quality for a range of invertebrates. However, studies on the use of body parts of individual species for bio-indication are very few and more so for spiders worldwide. The current study reports on a case study where spider size (cephalothorax length and width) was used as an indicator of the habitat quality in relation to the presence and absence of keystone herbivores. The study was conducted in a savanna ecosystem in Kenya on a long-term multi-species vertebrate exclusion experiment (KLEE). Two dominant species *Runcinia flavida* Simon (Thomisidae) and *Cyclosa insulana* Costa (Araneidae) were measured for size in the differentially grazed plots. Although previous research had shown that these two species differed in abundance among the herbivore treatments, it appears that these treatments did not significantly affect the mean sizes of individual spiders. This suggests that the herbivore treatments were affecting the population sizes of spiders through means other than food limitation, perhaps through changing habitat structure in ways that affecting their predators. It also suggests that as a bio-indicator, the (easier to measure) metric of spider size may not be as informative as the (harder to measure) metric of population size.

THE IMPACT OF DENSITY AND CLIMATE FACTORS ON THE SURVIVAL OF DALMATIAN PELICANS

DOXA, AGGELIKI, Alexandre Robert, Kostas Theodorou, Dionyssia Hatzilacou, Giorgos Catsadorakis, Theodoros Naziridis, Harris Nikolaou, Alain Crivelli

Although climate change is one of the major factors likely to affect the dynamics of species and populations, long-term datasets are needed to examine its effects and its interactions with population density. In this study, we use extensive data from marked Dalmatian pelicans (*Pelecanus crispus*), collected between 1984 and 2005 from two colonies in South-western and

Northern Greece. The Dalmatian pelican is considered as a vulnerable species in Europe. Using multi-state capture-recapture models, we examine the impact of winter temperature and density on age specific survival rates. We use the average of daily temperatures per month to model the impact of winter temperatures and the number of breeding couples as a measurement of density effect. The most parsimonious survival models are obtained when both density and temperature effects are considered for all age classes. We uncover an increasing trend in survival estimates in both populations over the study period, which is consistent with the increasing density of breeding couples obtained through independent census. Overall, results suggest that despite a strongly increasing trend observed over the last 20 years, Greek Dalmatian pelicans are highly vulnerable to climatic changes affecting individual survivorship.

PRIORITIZING CONNECTIVITY CONSERVATION THROUGH THE IDENTIFICATION OF MOVEMENT PERMEABILITY AND PINCHPOINTS, ALTERNATIVE CORRIDORS AND CORRIDOR BOUNDARIES

HEINEMEYER, KIMBERLEY, Richard Tingey

Explicit consideration of connectivity is needed to support wide-ranging species whose spatial requirements include the use of multiple Conservation Areas at seasonal, annual or generational time spans. We used two different applications of least-cost path (LCP) modeling to predict movement potential across 16 million hectares in northern British Columbia, Canada. Movement decisions are modeled based upon costs that are assumed to be a weighted combination of relative energetic, risk and behavioural variables, including measures of total distance, topographic considerations, generalized habitat values, and the avoidance of human development features. A LCP approach was used to develop a regional permeability analysis that identifies landscape pinchpoints, as well as areas of dispersed movement potential. Permeability analysis allows the prioritization of landscapes based on potential movement importance, and therefore may be used to guide management of landscapes for connectivity at multiple spatial scales. We also used the LCP cost surfaces to identify specific primary and alternative corridor routes connecting identified Conservation Areas and also to define the potential corridors boundaries, based upon the highest cost "accepted" along the LCP. For every identified Core Conservation Area, we identified potential corridors to a minimum of 3 surrounding Core Areas, selected based upon the lowest-cost distance not the straight-line distance.

STATUS AND TRENDS IN DEMOGRAPHY OF NORTHERN SPOTTED OWLS, 1985-2003

ANTHONY, ROBERT, Eric Forsman

We analyzed demographic data from northern spotted owls from 14 study areas over 18 years. Estimates of survival rates and annual rate of population change were based on 11,432 individual owls, which were re-sighted 32,054 times. The number of young fledged per female (NYF) varied among years with a biennial cycle of high and low reproduction. NYF was highest for adults (>2 yrs. old), lower for 2-year olds, and very low for 1-year olds. Fecundity was stable over time for 7 study areas, declining for 5 areas, and slightly increasing for 2 areas. Survival rates varied by age and study area with adults generally having higher survival than 1- and 2-year olds. Survival rates were declining on 5 study areas, particularly those in Washington state, but stable on the remaining areas. Estimates of the annual rate of population change indicated that populations were declining on 8 of the 14 study areas and declines were particularly prominent in Washington. The mean estimate of annual rate of population change was 0.963 suggesting that populations over all the areas were declining about 3.7% per year during the study. Owl populations on federal lands had higher demographic rates than elsewhere, suggesting that the Northwest Forest Plan was having a positive effect on demography of the species. The possible causes of population declines included but were not limited to habitat loss from timber harvest and fires, competition from barred owls, and severe weather patterns.

REPRODUCTIVE AND SURVIVAL PATTERNS AS INDICATORS OF INVASION POTENTIAL OF ALIEN MAURITIUS THORN *CAESALPINIA DECAPETALA* (ALSTON ROTH) IN BWINDI IMPENETRABLE

Edward, Andama, ALASTAIR MCNEILAGE

Human-wildlife conflict negatively influences attitude of the front-line communities towards conservation initiatives. Around Bwindi Impenetrable National Park communities lose substantial portion of their crops to wild animals. Although there are not yet concrete solutions to the problem, several interventions tried indicated promising results. One of which is *Caesalpinia decapetala* hedge, which is an exotic shrub, originating from South Eastern Asia. This study investigated the potential of *Caesalpinia* to become invasive in BINP through examination of its reproductive ecology, survival patterns, impact on soil nutrients, natural regeneration. *Caesalpinia* pollinators were sunbirds (Nectarini) and insect species. *Caesalpinia* was partially autogamous and reproduced by vegetative means. Flower abortion was high due to infections by the fungus, and predation by insects and birds. Humid and cool conditions reduced seed dispersal by explosion. Growth of *Caesalpinia* was limited by nutrient poor soils. Germination and survival of the *Caesalpinia* seedlings was limited by a combined effects of canopy cover, ground vegetation cover and root competition ($R^2=0.852$, $p=0.005$). *Caesalpinia* had no significant effect on the soil nutrient status and natural regeneration. The population structure of *Caesalpinia* was retrogressive. The study suggests that *Caesalpinia* may not invade natural habitats in BINP and other similar habitats.

DRAFTING A JOINT RESEARCH POLICY FOR THE GREAT-LIMPOPO TRANS-FRONTIER PARK

PIENAAR, DANIE, Bartolomeu Soto, Piet Theron

The Great Limpopo Transfrontier Park (GLTP) was established in 2002, and it incorporates the Limpopo National Park of Mozambique, the Kruger National Park of South Africa and Gonarezhou National Park of Zimbabwe. The goal of establishing the GLTP is biodiversity conservation and sustainable socio-economic development across international boundaries, yet knowledge on the current status and trends in achieving these goals in the respective parks is limited. It was identified that a joint research policy was necessary to guide research & monitoring, compare information, share data and measure performance between the partner parks. We will describe the process followed to generate this policy, the joint research objectives and priorities generated for the GLTP as well as the joint approaches regarding specific issues such as control of bio-prospecting, baseline mapping and inventORIZATION and building capacity. Specific issues that each partner has to address to create a facilitating and enabling environment were also identified as well as how the individual project registration procedures could be simplified to stimulate external research. We trust that this product will solicit input and stimulate interest in research collaboration from the scientific community as well as be helpful to other trans-frontier conservation areas who are dealing with cross-border research issues.

WETLANDS PROTECTION AND SUSTAINABLE MANAGEMENT: THE CHILEAN EXPERIENCE

PALACIOS, PILAR, Manuel Contreras, Natacha Oyola, Malcolm Hunter, Aram Calhoun

Wetlands have diverse functions such as nutrient cycling, sediment retention, flood control, and providing wildlife habitat. Anthropogenic activities that threaten these functions include, water use for mining activities, spillage of pollutants, and draining for agriculture. In Chile, there is a need to approach wetland conservation in a concerted, adequate and efficient way. We were asked by the Chilean government to classify Chilean wetlands, to prioritize them, and to create management plans for their conservation. For this, we used a geographical information system to classify wetlands into different ecotypes based on physical features such as temperature, precipitation, soil permeability, and slope. To determine watershed-based conservation priorities for wetlands, each ecotype was associated to functions and threats. This information was combined with information on threats such as proximity to populated areas and, water extraction,

to identify a hierarchy of sites to conserve based on landscape-scale characteristics of the wetland. With the information about the features of each ecotype, we created management plans for each one of them. This project will lead to a national strategy of wetland conservation in which economic development and biodiversity protection will be balanced.

PREDICTING SPECIES DISTRIBUTIONS UNDER CLIMATE CHANGE: COMBINING
STATISTICAL MODELS WITH EXPERIMENTS
LATIMER, John Silander, Anthony Rebelo

Current distributions of species and vegetation types will change as climate and land use patterns change. An important problem for both conservation and restoration is identifying the tolerances of species and thus what combination of environmental factors will support them in the future. We show how hierarchical statistical models can be used to characterize key environmental factors correlated with current distributions of species of Proteaceae in the Cape Floristic Region, and at the same time identify areas that are suitable but currently unoccupied. Unlike widely used climate envelope approaches, these models quantify the relative suitability of different areas, and also can show likely dispersal barriers and thus areas at risk for fragmentation due to climate change. We also show how our transplant experiments, designed to test the tolerances of a group of *Protea* species across a gradient of temperature and precipitation, can supplement these models and enable conclusions about the mechanisms driving current and likely future distribution limits. This can inform conservation through assessment of connectivity of current and potential distributions, and by assessing potential success of native and exotic species at new locations.

ECOLOGICAL EFFECTS OF FIRE AND SAVANNA TREES ON WOODY PLANTS IN MESIC
SAVANNAS
KHAVHAGALI, VHALINAVHO PATTERSON

I studied the effects of fire and savanna trees on woody plants in mesic savannas of Kruger National Park, as part of understanding factors that influence pattern and process at which forest trees colonize mesic savannas. Species richness was greatest under the canopies of *Sclerocarya birrea* and *Terminalia sericea* than open habitats with no canopy effect. Large savanna trees act as nucleation sites and they facilitate the germination and growth of woody/forest species. Fire sensitive or intolerant species were highest under tree canopies on unburnt and triennial fire plots than open habitats. However, frequent burn plots, annual and biennial plots had more fire tolerant and typical savanna species than triennial and no burn plot. In unburnt plot and triennial fire treatment, species richness was significantly increased relative to annual and biennial treatments. Frequent burning reduced woody plants biomass by killing seedlings, saplings and adult trees whereas fire exclusion led to high recruitment of seedlings and sapling with a complete canopy cover. I conclude that fire and savanna trees influence forest colonization and woody plant recruitment, and both factors are important for conservation management of these savannas, and perhaps other vegetation types.

THE MISMATCH BETWEEN BIODIVERSITY AND PROTECTED AREAS IN MESOAMERICA
JENKINS, CLINTON, Chandra Giri

The conservation community often views protected areas as the cornerstone of biodiversity protection. That view is despite the fact that many protected areas were not created with biodiversity in mind. Mesoamerica has an exceptionally rich biodiversity, likely due to its varied topography and climate. The extent to which protected areas include this diversity is a concern. Using topography and land cover, we refined the range maps for 250 mammals endemic to Mesoamerica. Our refined maps show a more realistic view of current diversity patterns than would simple geographic ranges. In comparing the distributions of endemic mammals to protected areas, we found that the smallest ranged species are largely outside of protected areas. Small-ranged species tend to be more vulnerable to extinction than larger ranged species and so are of particular concern. The mismatch between protected areas and small-ranged

species suggests that the current system of protected areas would not prevent the extinction of many mammals. However, opportunities to increase protection exist across Mesoamerica, as small-ranged species concentrate in a few sites. Protection of these sites could greatly enhance the protected area system while not requiring a large expansion of the total area protected.

DOCUMENTING THE GLOBAL THREAT OF INVASIVE SPECIES TO MARINE BIODIVERSITY MOLNAR, JENNIFER, Rebecca Gamboa, Carmen Revenga, Mark Spalding

Invasive species are widely recognized as a threat to marine biodiversity and the geographic expansion and intensification of this threat through globalization make it imperative to have a global perspective on trends, patterns and risks associated with the movement and distribution of species. To date there have only been limited examinations of the impact and distribution of biological invasions at the global scale. Here we describe a new dataset that for the first time enables worldwide assessments of overall numbers of invasive species, as well as their impact and degree of risk to biodiversity. We have developed a geographically-referenced database of non-native species in marine ecoregions. We have documented information about species' pathways, and have scored the threat of each species to native biodiversity in the following categories: Ecological Impact, Geographic Scope, Invasive Potential, and Management Difficulty. Our intent is to use the variation in threat between taxa and regions to inform strategies and funding allocations to defend vulnerable habitats from the most harmful invasive species and to better manage the most threatening pathways and transport mechanisms. We will demonstrate how information from our database can be useful to guide policy and conservation decision-making.

GLOBAL PRIORITIES THAT INTEGRATE PLACES, STRATEGIES AND OUTCOMES: A CASE STUDY FROM THE NATURE CONSERVANCY HARDESTY, JEFFREY L., Jonathan Hoekstra

Global conservation priorities are usually presented as maps of important places. But maps don't tell you which strategies need to be implemented or what outcomes will be achieved. Map-based priorities are also static -- expressing perspectives that change slowly even as the world changes quickly. The Nature Conservancy recently completed its first global priority-setting exercise with a goal of working with others to conserve 10% of every biome by 2015. The outcome focus of this goal motivated our organization to specify achievable conservation objectives and prioritize strategies as well as places. The effort was scientifically and organizationally challenging -- requiring integration of top-down and bottom-up assessments of biodiversity, threats and enabling conditions; specification of outcomes at multiple biological scales and organizational levels; mechanisms for adaptively updating; and concomitant alignment of staff, accountability, and funding. Initial lists of >400 terrestrial, freshwater and marine ecoregions, and >200 strategic actions were distilled to six priority strategies, each aimed at achieving outcomes in specific geographic areas. Science played a vital role in priority-setting, but management judgments about feasibility, organizational capacity and other business considerations were equally important. The dynamic suite of priority strategies, places and objectives that emerged will guide The Nature Conservancy's action over the next decade.

THE EFFECTS OF PERSONAL EXPERIENCE AND WILDLIFE DENSITY ON PUBLIC ATTITUDES TOWARDS BLACK BEAR IN NEW JERSEY PAULIN, JOSEPH, David Drake, David Ehrenfeld, Patrick Carr, Kelcey Burgess

Human-black bear (*Ursus americanus*) interactions are on the rise in New Jersey, the most densely peopled state in the United States. Black bear numbers have grown from 100 in 1970 to over 1,600 in 2006 within 1,500 square kilometers the state. Bears are frequenting suburban areas increasing their chances of coming into contact with people. Although decisions regarding wildlife conservation should be science-based, current policy regarding bears is being driven by public sentiment. Is the majority opinion being heard and more importantly are people who live in bear-country being heard? To address these questions we implemented a mail survey based on

Dillman (2000 and 1978). Survey respondents identified several factors influencing their attitudes towards black bears and their management including the likelihood of interacting with a bear, location of the interaction, specific type of interaction, perception of the interaction itself, and potential for danger, especially to children. Respondents who live in areas with high densities of bears were more likely to favor lethal management whereas residents of areas with low bear densities were less likely to support lethal options, but at the same time did not want to see more bears in their area. Additionally, public misconceptions about management options that are currently in the research phase, for example reproductive controls, versus those that are currently available for implementation, are playing a role.

CONSERVATION PLANNING ON A BUDGET: A RESOURCE LIGHT METHOD FOR MAPPING PRIORITIES AT A LANDSCAPE SCALE

DIDIER, KARL, David Wilkie, Shivani Bhalla, Iain Douglas-Hamilton, Laurence Frank, Nicholas Georgiadis, Anthony King, Max Graham, Festus Ihwagi, Belinda Low, Alayne Cotterill, Dan Rubenstein, Stuart Williams, Rosie Woodroffe

Many conservation projects may be reluctant to try geographic priority setting because existing methods are burdensome in terms of time, money, and data. We developed a "resource light" method for geographic priority setting and applied it to the Ewaso-Nyiro Landscape of central Kenya. Using expert assessments, we incorporated current abundance, vulnerability, and potential for recovery/recolonization of targets, and conservation costs. Over the course of a 6-month preparation period and 1-week participatory workshop, we created maps of the distribution of four representative targets, conservation cost, and target-specific and cross-target conservation priorities. Total time investment across was approximately 30 person-weeks, and the workshop budget was approximately \$US 30,000, excluding investments previously made by researchers. To stay within these constraints, we sacrificed consideration of quantitative goals for targets (e.g., how many animals do you want to save?) and the spatial extent of areas needed to meet these targets (e.g., how much land do you need?). We also did not negotiate trade-offs between conservation and human land uses, or identify the "optimal network" of conservation areas. However, these steps were not critical for conservationists to try geographic priority setting, introduce landscape-scale conservation concepts to stakeholders, and begin implementing landscape conservation strategies.

COMMUNICATION AND TRANSFORMATION: USING AUTHENTIC ARENAS TO BUILD CONSERVATION PARTNERSHIPS

NAGLE, FIONA

Information exchange among scientists, managers, and resource users can transform 'intractable' conflicts into productive partnerships. An example was Hawaii's Kona/Kohala Natural Resources Roundtable, which occurred in response to a dispute between a government agency and private landowners over watershed protection. The roundtable began as hostile and highly polarized, with little hope for dispute resolution. However, after several transformative steps including an unprecedented series of educational and scientific dialogues, the negotiation produced significant social and informational benefits. I used the Authentic Arena Theoretical Framework, a new interdisciplinary tool for building and diagnosing arenas for decision-making, to analyze how the roundtable members converted their original intractability into a constructive partnership for conflict management. I found the roundtable had acute disadvantages in political and legal support. However, it had sufficient Social Authenticity and Communicative Authenticity (two of the six conditions for an authentic arena) to empower the members and allow them to create a relationship with positive repercussions and permanent benefits. I suggest specific principles of negotiation enabled effective communication, the sharing of scientific and traditional knowledge, and the recognition of common values and priorities among the roundtable members.

IDENTIFYING A LARGE FOREST HERBIVORE'S HABITAT: A MULTI-SCALE APPROACH
COMBINING FIELD DATA AND IMAGERY FROM THREE SENSORS
ESTES, LYNDON, Gregory Okin, Adam Mwangi, Herman Shugart

The poorly-understood, endangered mountain bongo antelope probably selects habitat at different spatial scales. The bongo's environment (montane forest) and rarity restrict field data collection, which impairs predictive habitat modelling. Remote sensing (RS) provides complete coverage of bongo range, but the ability of RS data to detect habitat features limits predictive model power. We analyzed field ($n = 150$) and RS data (derived from SPOT, ASTER, and MODIS) ranging in scale from 25-859,329 m² to determine: 1) how well RS data detect vegetation structure; 2) which data/scales best predict bongo habitat. Variables derived from spectral mixture analysis (SMA) of ASTER and MODIS data and texture analysis of SPOT data (5 measures calculated in 5 window sizes) were strongly correlated with forest canopy structure ($r = |0.46-0.57|$), but weakly linked to understorey structure ($r = |0.01-0.21|$). Logistic regressions showed that field data (primarily understorey variables) best predict bongo habitat (entropy adjusted- r^2 (e- r^2) = 0.21), while ASTER variables aggregated to 463 m were second-best (e- r^2 = 0.12). Combinations of field data and the 5 best RS variables (463 m ASTER and SPOT 9X9 texture) predicted bongo habitat better than field data alone (e- r^2 = 0.26-0.28), indicating that both micro- and macro-features are selected. These results demonstrate that both intensive (field) and extensive (RS) data are needed to understand a large forest herbivore's habitat needs.

THE ECONOMIC, ENVIRONMENTAL AND SOCIAL IMPACTS OF INVESTMENT AND TRADE
OF SOYBEANS ON THE BRAZILIAN CERRADO
Espinoza, Raimundo, MARIA-ELENA GUTIERREZ, Matthias Schultz, Sajal Sthapit

Soybeans (*Glycine max*) are an important globally traded agricultural commodity. Soy meal is the cheapest source of protein for making animal feeds while soy oil is the most consumed edible oil in the world. Rising affluence and the subsequent increase in protein consumption worldwide is increasing the demand for animal products and fueling the expansion of soybean production. Brazil is the second largest producer of soybeans in the world, and sixty percent of Brazil's production is located in the Cerrado, the world's most biodiverse tropical savanna with a high degree of plant endemism. More than half of the Cerrado has already been converted into agricultural use, resulting in reduced biodiversity and altered ecosystem services. We assess the environmental, social and economic impacts of the soybean expansion in the Cerrado by tracking trade and investment flows. We found that current investments in research and infrastructure are likely to encourage expansion of soybean production in Brazil. Also, as Brazil starts to produce biodiesel from soybean oil, the demand for soybeans will increase even further. Finally, we analyzed future scenarios and projections, and proposed a set of recommendations to address the negative impacts of the soybean boom in the Cerrado, including conservation and restoration, sustainable land use, responsible investment, as well as efforts aimed at changing perceptions and encouraging environmental education.

UTILIZING REMOTE SENSING INFORMATION TO IDENTIFY BONOBO (*PAN PANISCUS*)
HABITAT IN SALONGA NATIONAL PARK, DEMOCRATIC REPUBLIC OF CONGO
STABACH, JARED, Gay Reinartz, Nadine Laporte, Wayne Walker

Endemic to the dense tropical forests of the Democratic Republic of Congo, bonobos (*Pan paniscus*) face ongoing human threats and are one of the world's most endangered great ape species. Salonga National Park, Africa's largest tropical forest park and one of the only federally protected areas within the species home range, is a priority survey site. However, due to the park's remoteness, the population abundance of the species is poorly understood. The primary objective of this study was to provide detailed vegetation information about the habitat throughout the park, aiding researchers with information to better assess the conservation status of the species. We combined field data collected during bonobo surveys, such as forest composition and structure, with high resolution satellite imagery to develop a detailed habitat map. We will discuss how the map produced could be improved by collecting specific land cover type

information during animal surveys; allowing to better model bonobo distribution from local to regional scales, reduce the need for expensive field surveys, facilitate the future conservation of the species, and support the goals of the Great Apes Survival Project initiative (<http://www.whrc.org/africa/prioritypops.index.htm>).

CONSERVATION IMPLICATIONS OF COMPETING ECOLOGICAL EXPLANATIONS FOR SEXUAL SEGREGATION IN UNGULATES MAIN, MARTIN

Hypotheses proposed to explain sexual segregation in ungulates include social and ecological explanations, but only the latter can adequately describe why sexes often use entirely different areas and habitats. Leading ecological explanations include the reproductive strategy-predation risk hypothesis (RSH) and gastrocentric or forage selection hypothesis (FSH). Although both the RSH and FSH have received support in the literature, neither the basis for support nor areas of overlap between these hypotheses has been adequately evaluated. Understanding the impetus for sexual segregation is important because conservation implications for ungulates and their habitats differ between the RSH and FSH. I reviewed the literature and analyzed peer-reviewed studies of north temperate ruminants that provide seasonal sex comparisons of habitat forage quantity, forage quality, and diet quality to test predictions of the RSH and FSH. Analyses of empirical data supported predictions of the RSH, but did not support two of three key predictions of the FSH. However, FSH predictions that larger body size enables males to consume poorer quality diets appears to be important when high quality forage is scarce, which is consistent both with RSH arguments that males forage optimally and FSH arguments that males consume poorer quality diets. Conservation plans should acknowledge habitat use by females is dictated by needs of offspring and males respond to foraging opportunities.

HABITAT CHARACTER AND CONSERVATION STRATEGY OF THE CONIFER-DOMINATED FORESTS OF THE TAO RIVER BASIN, SOUTHERN GANSU, CENTRAL CHINA WANG, JIE, Yue-hua Sun

Conifer-dominated forests in the Tao River basin holds water conservation functions for the Yellow River and hence key for inhabitants of the arid area and hydropower stations downstream. They represent the alpine conifer forests along the Qinghai-Tibetan Plateau, which are highly rich in endemic fauna and flora. As an example, over 10 vulnerable and poorly known bird species or subspecies recorded in this forest, including *Strix davidi*, *Garrulax sukatschewi*, *Perisoreus internigrans* and *Paradoxomys przewalskii*. Unfortunately, due to forest logging and other human activities, virgin forest had decreased 15-20% and highly fragmented now, e.g. 77.3% of forest patches were smaller than 10 ha, with a satellite analysis for an area of 600 km². These changes has threatened the endemic birds survival, according to our study of their population density. Meanwhile, their water conservation functions are impaired: annual runoff of the Tao River reduced 32.8%, silt content increased 73% and soil erosion area enlarged by 44.5% compared to 1960s. 94% local people are farmers with poorer incomes and some still do unecological activities, such as illegal hunting, medical plants collecting, severe overgrazing, and shifting cultivating. Local nature reserves are incapable of biodiversity conservation and poorly cooperated. Therefore we suppose a strategy for restoration and unite management of the forest ecosystem, methods including community education, capacity building, alternative livelihood

BIOLOGICAL EFFECTS WITHIN NO-TAKE MARINE RESERVES: FROM TROPICAL TO TEMPERATE SYSTEMS LESTER, SARAH, Benjamin Halpern , Jane Lubchenco, Kirsten Grorud-Colvert, Satie Airamé, Benjamin Ruttenberg, Robert Warner, Steven Gaines

Marine protected areas, particularly no-take reserves, are increasingly espoused as an important management tool for conserving marine ecosystems, counteracting over-fishing, buffering against unpredictable environmental conditions, and providing a baseline against which to evaluate impacts of activities outside the reserve. Marine reserves have been shown to support more

intact communities, with a greater abundance and biomass of key species compared to areas outside. Nonetheless, questions remain about their benefits and management utility. For example, many have asserted that reserves are not as effective in temperate as in tropical systems. Scientific studies of marine reserves are accumulating rapidly, providing data on the biological impacts of reserve protection for a wide variety of geographic locations and organisms. By conducting a comprehensive survey of peer-reviewed scientific literature, we compiled a global database of studies documenting biological effects (density, biomass, individual size, or species diversity) from fully protected marine reserves. We show that reserves can have parallel, if not greater, positive impacts in temperate versus tropical ecosystems. We also demonstrate that the effect of reserve protection varies for different taxonomic groups, and likely depends on characteristics of the species being considered. Lastly, for the rather limited range of reserve sizes represented by published studies, reserve effects do not depend on reserve size.

THE BEST OF BOTH WORLDS: COMBINING LARGE-SCALE HABITAT RESTORATION WITH RESEARCH IN CALIFORNIA NATIVE PERENNIAL GRASSLANDS RUSSELL, VANCE, Rodd Kelsey, Jamie June, Chris Rose

A trade-off exists between large-scale habitat restoration and conducting quantitative research. Large restoration projects are limited in their ability to replicate and control for different treatments. Audubon California's Landowner Stewardship Program is attempting to address this issue by combining monitoring of large-scale restoration with smaller, more quantitative research projects. In 1999 we began restoring 437 hectares of native California perennial grassland on private land using combinations of burning, herbicides, and native seeding. Simultaneously, four research projects were conducted by university and agency researchers. Monitoring documented an initial decline in non-native grass cover (75% to 45%) across sites with a rebound of invasive non-native grasses to over 65% four years following initial treatments, indicating the need for ongoing management. The research projects confirmed these results and documented an increase in bird abundance in restored grasslands, positive response of native grasses to herbicide treatments, significantly greater water retention and soil fertility in perennial grasslands, and the value of remote sensing for evaluating forage production in restored rangeland systems. Combining general monitoring of the overall restoration with data gained from quantitative research projects, allows us to benefit both from immediate feedback that helps us adjust our restoration programs and the longer-term insight gained from research.

THE LEGAL TRADE IN LIVE ANIMALS TO THE UNITED STATES: HIGHLIGHTS, CONSERVATION IMPACTS AND POLICY IMPLICATIONS RUFFLER, HEIDI

According to Interpol, trade in wildlife and wild products is worth \$10 billion and represents a growing industry. This trade can have important conservation implications in importing countries, particularly through the introduction of novel diseases and invasive species. Defenders of Wildlife, in collaboration with the Consortium for Conservation Medicine, commissioned an investigation into the volume, scope and implications of intentional imports of live animals into the United States. This presentation will discuss the author's contribution to this report: data analysis, consideration of impacts and policy implications. Highlights of all imports recorded by the U.S. Fish and Wildlife Service between 2000 and 2004 are based on 1.1 billion individual and an additional 5.2 million kg of live imports. At least 2,240 non-native species of live animals were imported, of which a major proportion are included on at least one U.S. or international list of harmful or invasive species. Impacts include risks to human and wildlife health, and ecosystem and economic ramifications due to the spread of invasive species. Recommendations in the report include increased international communication about perceived threats, and the termination of high-risk imports until scientifically based risk analyses rule out undue risks to the environment, economy, or health.

CONSERVATION GENETICS OF NAMIBIAN BLACK RHINO

VAN COEVEDEN DE GROOT, PETER, Peter Erb, Candace Scott, Michael Kim, Colleen O'Ryan, Don Melnick, Peter Boag

Major conservation efforts have increased *Diceros bicornis bicornis* from ~ 100 (1960s) to > 600 alive in Namibia. With 9 microsatellites from 145 adult *D. b. bicornis* collected 1989-2000, we asked are: a) the founders of introduced *D. b. bicornis* in Waterberg N. P. representative of Etosha N. P. genetic diversity, b) there genetic groups within *D. b. bicornis*, c) there spatially distinct genetic groups within Etosha N.P. rhino and d) there differences in dispersal scale among male and female rhinos. Waterberg founders had similar levels of expected heterozygosity to Etosha rhinos: $H_e = 0.526 \pm 0.014$ (\pm SE) vs. 0.522 ± 0.004 , but a lower number of alleles: 3.8 ± 0.3 vs. 5.2 ± 0.2 . Bayesian analyses (STRUCTURE) showed no genetic structure in the 145 rhino under conditions of admixture/no admixture of source populations and correlated/uncorrelated allele frequencies for sexes combined and apart. Spatial analyses (BARRIER) of inter-individual genetic distance among all Etosha residents ($n=110$), suggested no subdivision. However males in the northwest appear segregated from other Etosha males. Inter-individual spatial genetic autocorrelation suggest Etosha rhinos are not randomly dispersed, with females showing greater autocorrelation at lower distance classes than males at 10, 25 and 40 km scales. Although spatial-genetic signals are stronger when limited to 1998-2000 samples, it is likely to few generations have passed for putative social groups to be genetically differentiated.

ANTHROPOGENIC PRODUCTIVITY HOTSPOTS INCREASE LONG-TERM ECOSYSTEM BIODIVERSITY IN AN EAST AFRICAN RANGELAND SAVANNA

VEBLEN, KARI

The regular creation and abandonment of traditional cattle corrals creates localized hotspots of productivity throughout much of eastern and southern Africa, often in areas managed for both wildlife conservation and livestock production. In the semi-arid Laikipia district of Kenya, these hotspots create a mosaic of nutrient-rich treeless patches ("glades") in the wooded savanna landscape that persist for at least several decades. I collected soil, vegetation and dung data on a chronosequence of glades. The data indicate that these patches are significantly elevated in some nutrients, but depressed in others. Glades support distinct plant communities that undergo a successional change from *Cynodon plectostachyus* dominance to dominance by *Pennisetum stramineum*, and elevated wildlife use is associated with both of these plant communities. Experimental data collected in the Kenya Long-term Exclosure Experiment (KLEE) indicate that wildlife and cattle have very different effects on the trajectory of this succession via their influences on plant competition and facilitation. This research highlights the synergistic effects of cattle and wildlife on glades, from their inception until their eventual reversion to wooded savanna. The conservation of biodiversity in such mixed-use lands should consider these potentially positive aspects of livestock management, as well as the more well-documented negative aspects.

BETWEEN DISCOURSE AND PRACTICE: INVESTIGATING THE ROLE OF TROPHY HUNTING IN CONSERVATION AND POVERTY REDUCTION, CASE STUDIES FROM TANZANIA AND CAR

HAUSSER, YVES, Pierre-Armand Roulet

Trophy hunting is frequently quoted by both practitioners and scientists as a new important tool for conservation and poverty reduction through the use of participatory approaches. The growing debate regarding the role of the trophy hunting in should be enlightened by recent findings from the field. The aim of this paper is to provide a trans-regional comparison of the introduction of community based conservation models and their results in two important biodiversity countries in Africa, Central African Republic and Tanzania. The paper builds on years of experience of field work by the authors in the development of these schemes, through research, operational projects and consultancies. Results are contrasted and could partly be explained by local factors, but as well by the choices that have been made at political and institutional levels. Determinant factors

identified were the role and influence of donors, the will of the industry to engage into such co-management schemes, the planned resistance of the State agencies to transfer rights and management responsibilities, the role given to communities and the benefit sharing agreements negotiated. When ecological assessment is globally quite positive – the hunting help to maintain vast tracts of natural ecosystem and resources, the development assessment is more contrasted, particularly when looking to absolute and relative values. The financial part kept at local level remains very little when compared to the global turnover of the industry. Moreover, threshold effects appear rapidly and do not permit to occur an increasing of financial benefits. Finally, valid critics support that these approaches are just another mean for conservation organisations to extend their influence and control outside protected areas, on village land.

THE WORLD'S MOST REPRESENTATIVE AND UNIQUE ECOREGIONS FOR VERTEBRATE BIODIVERSITY

HOEKSTRA, JONATHAN, Michael Jennings, Taylor Ricketts

Biodiversity conservation seeks to protect places that best represent the diversity of life, as well as preserve the unique components of biodiversity that are truly irreplaceable. At global scales, conservationists traditionally stratify their efforts across ecological gradients, such as biomes and biogeographic realms, to achieve the former. Threatened or endemic species are targeted to achieve the latter. But how do we distinguish the most representative community within a biome? How can we rank the uniqueness of a community in addition to the occurrence of threatened or endemic species? How do we account for the identities rather than just the number of species when comparing the biodiversity of one community to another? Here we present a straightforward similarity index that quantitatively compares community composition among any number of regions. We use this index to rank the representativeness and distinctiveness of vertebrate diversity in the world's terrestrial ecoregions. Biogeographic patterns of representativeness and distinctiveness differ from patterns of richness and endemism, revealing fresh perspectives of global biodiversity distribution and providing new information for decisions on conservation investments. We suggest how quantitative comparisons of community composition can be applied to conservation planning at any scale.

DECREASING UNCERTAINTY IN CLIMATE CHANGE PROJECTIONS: AN EXAMPLE OF THE FATE OF THE MEDITERRANEAN BIOME

KLAUSMEYER, KIRK, M. Rebecca Shaw, Emma Underwood

Climate change is projected to affect the distribution, structure, and diversity of habitats across the globe. However, the large uncertainties, coarse spatial resolution, and lack of agreement among general circulation models (GCMs) make planning for climate change difficult. Using the mediterranean biome as an example, we evaluate agreement among all 138 state of the art GCM realizations currently available, downscaled to approximately 4 km. With Aschmann's mediterranean climate definition, we identify areas where at least 80% of the GCM realizations agree change will occur. We find 58-70% of current mediterranean climate is projected to persist by 2085 and 3-7% is projected to be lost - becoming too warm and/or too dry. The fate of the remaining 27-35% is uncertain due to the lack of agreement between GCM realizations. The scale of impact varies across biogeographic realms. In South Africa, 80% of the GCM realizations agree that only 24-56% of the mediterranean climate will remain and 4-28% will be lost. In other regions, mediterranean-type climates are projected to expand into new areas, for example, an expansion between 1-13% in the Western U.S.A. and 5-14% in South America. Our approach, which can be applied to any terrestrial biome, has the advantage of synthesizing all available GCM realizations to determine agreement on the location, magnitude, and nature of projected climate change.

THREE PHILOSOPHIES OF ED RICKETTS AND THE CHALLENGES OF ECOSYSTEM BASED MANAGEMENT SAGARIN, RAPHAEL, Sheril Kirshenbaum

Ecologist Ed Ricketts' philosophy of "non-teleological thinking" which stresses the importance of "is" rather than "should" statements is appealing to conservation biologists who root their work in natural history. Yet when it comes to applying our science to the policy arena, by contrast, we tend to suggest a priori rules and definitions and expect positive policy outcomes to follow. This is especially true in the case of the current struggle to implement "ecosystem based management" (EBM) in marine systems. Through a review of current literature and conservation programs based on EBM concepts, we show how even broad guidelines for implementation often fail to account for the full scope of impacts in a given situation. Here, Ricketts holistic philosophy, which builds individual observations of humans and nature into a complete ecosystem picture, can play a guiding role. Finally, Ricketts' philosophy of "breaking through", which stresses that true progress often follows a period of extreme crisis, is applicable to the current crisis in marine conservation biology. We argue that EBM may be the way to break through this crisis, but only if it is applied in the holistic framework that Ricketts espoused.

HISTORICAL DEVELOPMENT OF THE PROTECTED AREA NETWORK IN TURKEY: COVERAGE, REPRESENTATIVENESS AND SOCIOPOLITICAL CONTEXT Bilgin, Can, UGUR ZEYDANLI, Ayse Turak

Turkey is a temperate country that shows a high degree of climatic and topographic diversity, leading to diverse communities and high levels of endemism. Yet protecting land for nature conservation was not a major issue until 1958, when the first national park was declared. We describe and analyze the development and management of the national protected area network through four stages that closely reflect perception of nature, role of central planning in administration, and sociopolitical situation at the time. The first stage (1958-1974) is shaped largely by the U.S.A. experience, and although several national parks were founded within this period, there was little place for the human element. The period 1975-1986 was a time of turmoil with severe political, social and economic problems and this is reflected in a complete hiatus. The third stage (1987-2000) witnessed a revival, with adoption of new administrative and legal tools, an increase in the influence of civil society through NGOs and the press, and a gradual adaptation of modern wetland planning and management approaches. The last six years (2001-2006) have seen the recognition of the human element as a crucial and integral part in conservation, the adoption of participatory approaches in planning and management, addressing bias in geographical coverage and representativeness, and the use of systematic conservation planning for site selection.

ENGAGED CONSERVATION PLANNING AND THE LANDSCAPE KNOWLEDGE NETWORK: RECONNECTING SOCIETY AND NATURE WHILE CONSERVING BIODIVERSITY GALLO, JOHN

Conservation scientists are creating increasingly sophisticated tools and algorithms for determining the spatially explicit needs of biodiversity. But once determined, these needs are not actually being met by the institutions responsible for implementation. As a result, there is a growing call to utilize a transdisciplinary approach to address the complex social, political, and economic dimensions of human-environment relations. This paper synthesizes several literatures—conservation psychology, public participation GIS, information and communications technology, socio-ecological resilience, and planning—to provide an ambitious vision termed engaged conservation planning and management (ECPM). This approach not only identifies the spatially explicit and management needs of biodiversity, but also integrates scientific understanding into community life while fostering care and respect for the living world. The landscape knowledge network is a central component to ECPM, and effectively engages the community in a living decision-support system and multiple-scale adaptive co-management. People are engaged in two ways: the gathering of biophysical information through a certification

approach to citizen science and/or participating in a web-enabled collaboration and learning environment for incorporating stakeholder values and visions into the scientific analyses and implementation strategies. The theoretical and applied strategies for avoiding expected pitfalls are also provided.

DEVELOPING A SUSTAINABLE APPROACH TO ENVIRONMENTAL EDUCATION – EMPOWERING TEACHERS TO TEACH ENVIRONMENTAL EDUCATION WITHIN THE EXISTING NATIONAL CURRICULUM MWENI, TSOFA, Ronwyn Jackson

Environmental Education (EE) and awareness creation are critical components in all conservation work. Rarely will conservation efforts succeed if communities do not understand and appreciate the local and international value of their natural resources. In Kenya, EE is not an examinable subject in either primary or secondary schools and as a result it receives little attention. Traditional methods of EE involve working directly with groups of children. These tend to have a relatively localised impact and are unsustainable. A Rocha Kenya's environmental education programme operates in a biodiversity hot spot on the north Kenya coast and is trialling a new approach that can reach many more children with greater sustainability. The method enables local teachers to integrate EE with ease into their routine teaching of all major subjects without adding to the already existing workload or compromising the National Curriculum. A series of simple yet exciting and beautifully illustrated supplementary handbooks and materials are being developed together with focus groups of teachers. These highlight local species and habitats and cover key environmental themes and topics as well as meet the National Curriculum's objectives. Teachers are supported to expand the method to neighbouring schools through simple workshops with fellow teachers. In this way, through strategically empowering and resourcing a few teachers, large numbers of children can be taught to appreciate the environment.

STATUS AND TRENDS IN MEDITERRANEAN-TYPE ECOSYSTEMS UNDERWOOD, EMMA C., M. Rebecca Shaw, Kirk R. Klausmeyer, Robin L. Cox, Scott A. Morrison, Matt S. Merrifield

Mediterranean-type ecosystems are renowned for their high endemic biodiversity and high vulnerability and as such, have been designated as priorities by a number of global assessments. These assessments, however, tend to focus on current condition and neglect trends in habitat protection and conversion over time. We conduct a global Gap analysis and determine that less than 5% of the mediterranean biome is protected (IUCN categories I-IV) and 30% is converted. To understand trends in the status and threats to mediterranean biodiversity we compare five indicators in 1990 and 2000. We find that the area protected in mediterranean regions increased by 32.6% with 652 new protected areas created. The amount of urban area increased by 13.3% from 1990-2000, while conversion of natural habitat to agriculture was surprisingly low, increasing by 0.3%. Population density increased by 12.9% from 72 people/ km² in 1990 to 81 people/ km² in 2000. Finally, fragmentation analysis from one region indicates a decrease in core natural/semi-natural area of 3.6% and average patch size by 2.5% from 1990 to 2000. Integrating trends in threats with information on gaps in the current protected area network can assist in identifying priorities for future conservation of mediterranean-type ecosystems.

TARGETING CONSERVATION ACTION TO PREVENT SPECIES EXTINCTIONS FROM SEVERE HABITAT FRAGMENTATION BOYD, CHARLOTTE, Thomas Brooks, Stuart Butchart, Michael Hoffmann, Simon Stuart, Will Turner

Habitat loss is the major threat facing global biodiversity. Small populations isolated by habitat fragmentation face increased risk of extirpation, reduced probability of rescue by recolonization, and a gradual decline in genetic diversity. There are therefore strong calls for conservation action in the matrix to reconnect habitat patches. But, while numerous metrics exist for fragmentation per se, targeting conservation action requires measures of the degree to which fragmentation

threatens biodiversity – which do not exist at present. We use data on all 2,925 threatened terrestrial birds and amphibians from the IUCN Red List of Threatened Species to identify regions for which fragmentation is a driving force of species threat. Many more amphibians than birds are listed because of severe fragmentation (45% compared with 19%), but additional data available for birds indicate that the total percentage of species facing severe fragmentation may be higher for both taxa (at least 28% for birds). Fragmentation is a major threat in regions such as the Western Ghats and Sri Lanka, the Philippines, the coastal forests of Eastern Africa, and the Atlantic Forest. Once remaining sites have been conserved, these regions must become top priorities for restoration of degraded matrix habitat. Results like these, based on threats to globally threatened species, are a more effective guide to prioritization than the simpler biodiversity metrics typically applied in global-scale analyses.

SUCCESS AND DIFFICULTIES IN IMPLEMENTING AN ECOLOGICAL MONITORING PROGRAMME FOR KATAVI NATIONAL PARK AND RUKWA-LUKWATI GAME RESERVES, WESTERN TANZANIA

MEYER, BRITTA, Johannes Balozi, Mussa Shanyangi

Status quo and changes of the ecosystem comprising Katavi National Park, Rukwa-Lukwati Game Reserves and the bufferzones are widely unknown because of its remoteness. It is therefore important to establish a long-term ecological monitoring programme (EMP). The objectives of the EMP are capacity building in field work and computer operation, enhancement of knowledge about the ecosystem and enabling the management to continue the EMP when the external support is over. As a base for plotting ecological data a GIS is built up. The ecological monitoring parameters are derived from the threats facing the ecosystem. Field and analysis methods for each parameter are chosen. Existing procedures and formats are integrated. A major component of the EMP is the ranger based monitoring. Climate, hydrology, flora, fires, fauna and illegal activities are monitored. Personnel are trained in the operation of GPS and GIS. Considering particularly the scaling up of the GIS based EMP to a national level using the same methods as in the experiment of Katavi Rukwa so as to generate comparative data from other protected areas, the constraints and limits of this tool are financing, running costs, capacity building and time allocations for permanent staff. The conditions for the efficiency of the EMP and therefore its sustainability highly depend on the institutional support to implement new standardized tools and on acceptance of the importance of information technology on protected area level.

DOES SIZE MATTER? INVESTIGATING ALLELIC DIVERSITY IN ISLAND AND MAINLAND POPULATIONS OF THE RED-BACKED SALAMANDER, *PLETHODON CINEREUS* VEVERICA, PAULA, Bradley Swanson

In recent years, amphibian populations have demonstrated significant global declines. Theories in conservation genetics predict that as effective population size decreases, genetic drift increases, leading to reduced genetic diversity. Smaller populations should therefore have fewer alleles than larger populations. In particular, island population should exhibit both reduced allelic diversity as well as increased genetic differentiation. We used the red-backed salamander, *Plethodon cinereus*, to test these predictions in a temperate-region amphibian. Tissue samples were collected from five populations across Michigan; three from islands in the Beaver Archipelago and two mainland populations from the Lower Peninsula. DNA was extracted and amplified at 8 species-specific microsatellite loci. Island populations exhibited lower allelic diversity ($A=2.0$) than mainland populations ($A=4.0$), with the fewest number of alleles found on the smallest islands. Pairwise comparison of populations across all loci revealed higher F_{ST} values between mainland and island populations (avg. $F_{ST}=0.15$) than among either the island (avg. $F_{ST}=0.1$) or mainland ($F_{ST}=0.02$) populations. Island populations of red-backed salamanders have lower genetic diversity than larger mainland populations due to inhibited gene flow and restricted size, a trend which may be applicable to other amphibian populations.

COSTS AND BENEFITS OF LONG-TERM MONITORING: LESSONS LEARNED IN TWENTY-FOUR YEARS OF GOLDEN LION TAMARIN CONSERVATION IN BRAZIL

DIETZ, JAMES, Lou Ann Dietz

The achievement of biodiversity conservation results requires a broad, long-term strategy with continuous monitoring and the capacity for adaptation as more knowledge is gained. Yet support for most research and conservation projects is only for short term efforts. How can the cost of long-term monitoring be justified? The golden lion tamarin conservation program began in Brazil in 1983 with the broad goal of conserving this critically endangered species in situ. Golden lion tamarins exist only in lowland Atlantic Forest of Rio de Janeiro State, Brazil, where capture for the pet trade and habitat destruction reduced the population to an estimated 200 individuals. Almost nothing was known about the species. Scientific research on the biology of the tamarins, funded as short-term theoretical research projects, coordinated as a continuing integral component of the conservation program monitoring the tamarin population, their habitat, and threats, provided information that allowed the program to set specific measurable objectives, develop targeted actions, evaluate their effectiveness, and adjust goals and strategies as our knowledge increased. In 2003, the golden lion tamarin was reclassified from critically endangered to endangered status. This success is a result of applying the best available science to guide the actions of a broad partnership of local Brazilian landowners, government agencies, and communities, as well as other institutions worldwide.

DESIGN AND IMPLEMENTATION OF A NETWORK OF WETLANDS OF IMPORTANCE FOR FLAMINGO CONSERVATION

ARENCO, FELICITY, Patricia Marconi, Omar Rocha, Marcelo Romano, Ana Laura Sureda, Eduardo Rodriguez, Arturo Cornejo

Three flamingo species are found in southern South America. The Chilean Flamingo (*Phoenicopterus chilensis*) is broadly distributed throughout the southern cone. The James' (*P.jamesi*) and Andean (*P.andinus*) Flamingos are less numerous and mostly restricted to the shallow salt lakes of the Andes Mountains, although they use lowland wetlands in central Argentina, especially in winter. The Andes wetlands and their associated flora and fauna are threatened by mining, road and pipeline construction, unregulated tourism, overgrazing and egg collection. Lowland wetlands are threatened by agricultural activities, unregulated hunting and tourism, and habitat alteration from road and dam construction. Using flamingo population data and natural history information we developed a tiered list of wetlands of importance for flamingo conservation. We evaluated conservation status of these wetlands and available resources and defined research and conservation activities focused on 14 priority sites in the four rarer flamingo range countries: Argentina, Bolivia, Chile and Peru. We have implemented flamingo and waterbird monitoring schemes and breeding site protection measures at key sites. We have designed activities that will promote cross-border coordination among sites and integration of conservation and management of wetlands at a regional scale. Flamingos are ideal flagship species for wetland conservation because of the landscape-level scale at which they use resources.

UNDERSTANDING THE FORCES DRIVING BUSHMEAT HUNTING IN WESTERN SERENGETI ECOSYSTEM: PROTEIN CONSUMPTION AND SOCIO-ECONOMIC FACTORS

RENTSCH, DENNIS

Illegal hunting of wildlife by communities around Serengeti National Park (SNP) severely impacts wildlife throughout the ecosystem. Through a longitudinal study of villages throughout the ecosystem, I seek to better understand the relationship between village level socio-economic factors, household level demographics and bushmeat consumption. Over 2,000 people were interviewed from 18 villages bordering SNP to determine the level of consumption of various sources of protein, including bushmeat. More than 27% of participants surveyed admitted to consuming bushmeat in the last 7 days. Villages were surprisingly heterogeneous with regard to consumption, ranging from 0.05 to 2.13 bushmeat meals per family per week. Preliminary

findings in addition to past studies suggest that heterogeneity in bushmeat consumption among villages is attributed primarily to poverty and lack of alternative sources of protein. Therefore, strategically targeted small-scale livestock development programs might help reduce bushmeat hunting in this area. This study explores one such initiative – a program to improve the health and production of local chickens by vaccinating against a highly pathogenic avian virus. The hypotheses are: 1) villages with higher poultry production have better access to protein and increased income; 2) villages with improved poultry production consume less bushmeat. Initial analyses suggest that this is a viable strategy to address the driving forces behind bushmeat consumption.

HOW THREATENED IS SOUTH AFRICA'S DIVERSE AND UNIQUE FLORA

RAIMONDO, DOMITILLA, Wendy Foden, Janine Victor, Lize Agenbag, Ismail Ebrahim

The South African (R.S.A.) botanical community are currently completing the largest Red Listing project ever undertaken: the assessment of R.S.A.'s 20 000 plant taxa. The results from the imminent plant Red List, based on assessments conducted using IUCN 3.1 criteria, indicate a significant increase in the numbers of plant species reported to be threatened with extinction over the past decade: 663 taxa (3% of the total flora) listed in 1996 to 2292 taxa (12% in 2007). The reasons for this increase include new threats particularly from the agriculture sector where expanding international markets for South African wines and teas are leading to continuous conversion of unique areas with high levels of plant endemism. Further causes include updated population trend information and threat data obtained from recent field data collected during civil society atlasing projects; recent taxonomic revisions; and the fact that previous Red Data Lists significantly underestimated threat statuses being conducted only for those groups with experts active in the field and not using the IUCN criteria. We conclude by highlighting the challenges of red listing taxa in a highly biodiverse country where many taxa lack recent taxonomic revisions and scientific capacity is limited and recommend approaches for other third world biodiverse countries.

CAVIAR DREAMING? EVALUATING THE SUCCESS OF STURGEON CONSERVATION EFFORTS AND THE BOLD STEPS NEEDED TO AVERT EXTINCTION

DOUKAKIS, PHAEDRA, Ellen Pikitch, Daniel Erickson

Unrelenting fishing pressure for black caviar and habitat degradation have made sturgeons (Order Acipenseriformes) one of the most endangered groups of fishes alive today. Years of conservation attention have ensued. To consider whether such efforts have resulted in positive change, we reviewed the status of sturgeon species and fisheries globally and considered changes in trade policy (e.g. Convention on International Trade in Endangered Species (CITES)), legislative action, fisheries management, market mechanisms/consumer outreach, and caviar aquaculture. Legal commercial fishing continues to pressure more than half of the extant species while illegal fishing threatens all species. Local extinctions have occurred in 70% of species. A boom and bust cycle of historic fisheries is apparent, with over one third of recorded fisheries crashing within 20 years of inception. All major sturgeon fisheries have surpassed peak productivity, with present catches below 10% of historic peak landings in the most important fishery (Caspian Sea). While some positive change is apparent, our review suggests that the most powerful tools available for affecting change are not being adequately implemented, with populations plummeting as a result. We provide recommendations for averting extinction including a stronger stance on fisheries management and trade policy regulation.

IDENTIFYING (FINE SCALE) SITES OF GLOBAL CONSERVATION IMPORTANCE IN THE ATLANTIC FOREST OF BRAZIL

Paese, Adriana, Pedro Develey, Matthew N. Foster, Rob P. Clay, Lucio C. Bede, RAFAEL DE CARVALHO SPOSITO, Adriano Pereira Paglia

In the last five hundred years the Atlantic Forest of Brazil has been subjected to extensive habitat loss. Today, its associated fauna and flora are restricted to habitat patches that are, in their

majority, not greater than 100 ha In this context, an appropriate conservation priority setting strategy is to identify precise locations where the most threatened components of biodiversity remain, so that decision makers can take conservation actions immediately. In this work we explore the key biodiversity areas methodology for identifying fine scale sites of global conservation importance. A number of practical questions arise from the application of KBA identification/delineation issues such as: I) How to integrate KBA and Important Bird Areas (IBA) boundaries; II) How to make the best use of biological information; III) how to delineate KBAs/IBAs when a constellation of small habitat fragments should comprise a single KBA/IBA; IV) How to best integrate land tenure information into the definition of boundaries. A total of 524 KBA, including 122 IBAs for 144 globally threatened species were identified. Our results show that there is considerable overlap between KBA/IBA boundaries. 122 IBA also contain non-bird taxa as KBA trigger species. These encompass 131 or 91.6% of all species analyzed.

THIRTY YEARS OF LANDSCAPE CHANGE ON MOUNT GORONGOSA, MOZAMBIQUE: REMOTE SENSING AS A TOOL FOR CONSERVATION PLANNING AND DECISION MAKING WALKER, WAYNE, Nadine Laporte, Frank Merry

Mount Gorongosa, located adjacent to Gorongosa National Park at the southern limit of the Albertine Rift Valley in central Mozambique, is the perennial water source for sustaining life in the Greater Gorongosa Ecosystem. Although the 1,800 m mountain is a national symbol, revered by local communities as a sacred place, its diverse humid tropical forests are rapidly being destroyed by unsustainable agriculture and forestry practices. With support from the Carr Foundation and NSF, research has been conducted to determine the rate and pattern of deforestation on Mount Gorongosa using a four-date (1972, 1992, 2000, and 2005) Landsat image time series spanning 30+ years. A segmentation-based change detection algorithm was used to compute the amount of tropical forest lost between each of three time-series intervals and the annual loss rate was estimated for each time period. Additionally, the Fragstats package was used to quantify the spatio-temporal pattern of forest fragmentation. Our results confirm that the rate of deforestation has increased significantly since the 1970s/80s (0.1%/yr), with the highest loss rate observed during the 2000-2005 time period (0.9%/yr). A concomitant increase in landscape fragmentation was also observed. The results of this research are being used by the authorities in Mozambique to support ongoing conservation efforts focused on the restoration of the Greater Gorongosa Ecosystem and the proposed gazettement of the mountain.

SPATIAL DYNAMICS OF SYMPATRIC CANIDS: MODELING THE IMPACT OF COYOTES ON RED WOLF RECOVERY ROTH, JAMES, Dennis Murray, Todd Steury

Interspecific competition can substantially impact sympatric carnivore populations and may threaten reintroduction attempts of threatened species. Coyotes (*Canis latrans*) are the primary threat to the recovery of red wolves (*C. rufus*) in the wild, either through hybridization or through competitive interactions that reduce space available for wolves. Using data collected from a recovering red wolf population in North Carolina and from the literature, we modeled spatial dynamics of sympatric red wolves and coyotes to elucidate the potential role of expanding coyote populations on wolf recovery and reintroduction success. Survival of juvenile and adult wolves had the greatest impact on wolf population size and extinction likelihood. Introducing coyotes substantially decreased wolf numbers, but the model was highly sensitive to estimates of the competitive impact of coyotes on red wolves, which affected wolf productivity. We simulated coyote management through either removal (lower survival) or surgical sterilization (lower reproductive rates); both management strategies increased the viability of red wolf populations, especially during colonization. Additional information on resource use and dietary overlap between coyotes and wolves in the red wolf recovery area will elucidate the current and potential competitive impact of coyotes on red wolf populations.

ERADICATION AND IMPACTS OF INVASIVE VERTEBRATES ON ISLANDS

KEITT, BRADFORD, Yiwei Wang, Alan Saunders, Mick Clout, Jacob Sheppard, Karl Campbell, Josh Donlan, Bernie Tershy

Islands are important for the conservation of biodiversity because they house ~15-20% of terrestrial plant and vertebrate species, have suffered 64% of IUCN-listed extinctions and have 45% of IUCN-listed critically endangered species. Yet islands make up only ~3% of terrestrial surface area. The main cause of extinction and endangerment on islands is invasive vertebrates. Fortunately, many extinctions can be prevented by eradicating invasive vertebrates from islands. To assess the current state of this conservation tool, we compiled a database of vertebrate eradications from islands. There have been >725 island eradications of 25 species in 12 families. Most eradications have been of rodents (332) and bovid ungulates (160). These have been facilitated by significant technical advances in detecting, hunting, trapping and poisoning these taxa. Moderate numbers of eradications have been of suid ungulates (41), rabbits (40) and cats (56) and techniques for these species are still being refined. Island area and the presence of non-target species continue to be the most significant variables limiting implementation of eradications for these species. We found few eradications of invasive reptiles (1), mongoose (1), and macaques (0) despite their wide distribution and documented impact on island ecosystems. Improved techniques and a willingness to initiate eradications of these taxa could prevent future extinctions.

ECOLOGY OF THE FLORIDA BLACK BEAR (*URSUS AMERICANUS FLORIDANUS*) AT THE URBAN-WILDLAND INTERFACE OF THE OCALA NATIONAL FOREST

NEILS, ALETRIS, Walter McCown, Melvin Sunquist

Black bears have disappeared from most of their former range as a result of habitat conversion and direct persecution by humans. Human-bear interactions are a critical issue for bear managers in rapidly growing Florida. Understanding how bears utilize areas at the urban-wildland interface (UWI) is crucial to their management and conservation. In Florida, urbanization adjacent to the Ocala National Forest, which contains the state's largest black bear population, has resulted in bears living in close proximity to human communities. We are investigating home range size, habitat use, movement rates, and activity patterns within UWIs and comparing them to similar characteristics for forest dwelling bears. Between 2005 and 2006 a total of 32 adult and sub-adult bears (17M, 15F) and 7 cubs (1M, 6F) were captured and equipped with radio collars. A higher proportion of bears at these interfaces appear to be sub-adults or yearlings (41%; n= 24) compared with bears captured in the forest (25%; n = 8). Preliminary results indicate that bears at the UWI have larger home ranges, utilize similar habitats, and are more likely to make large movements at night. This research indicates that some bears seasonally move into the UWI from the core forest areas, and this has conservation implications for maintaining corridors. In addition, these results contribute to understanding whether or not UWI's serve as biological sinks for wildlife.

THE PROTECTIVE CAPACITY OF MANGROVES DURING TROPICAL STORMS: A CASE STUDY FROM WILMA AND GAMMA IN BELIZE

Granek, Elise, BENJAMIN RUTTENBERG

Globally threatened mangrove forest habitat is often considered to be an important buffer zone protecting coastlines from wave and storm impacts and coastal erosion, but there is a little empirical evidence quantifying the protective effects of mangroves during storm events, primarily due to the difficulty of predicting where and when a storm will impact the coast to facilitate pre- and post- storm event data collection. Opportunistic results from an ongoing study quantifying differences between intact and cleared mangrove areas on Turneffe Atoll, Belize, provide such pre- and post-storm data from tropical storms Wilma and Gamma in 2005. We compare differences in retention of 3 types of experimental devices installed in intact mangroves and adjacent cleared mangroves. Retention of 3 types of equipment was greater in intact mangroves, demonstrating empirically the protective capacity of mangroves during moderate magnitude storm

events. The results of this fortuitous experiment support the assumption that removal of mangroves diminishes coastal protection not only during catastrophic storm events (e.g. hurricanes or tsunamis), but also during smaller, more frequent events such as tropical storms. This conclusion highlights the importance of improved coastal zone management as storm events may increase in frequency with changing climate while coastal mangrove forest habitats continue to decline.

A WORKING CLASS APPROACH TO ADAPTIVE MANAGEMENT IN CONSERVATION SALZER, DANIEL, Jeff Baumgartner, Tim Tear, Nick Salafsky

Numerous authors have drawn attention to three barriers that inhibit effective conservation practice: (1) inadequate frameworks to guide conservation planning and action; (2) poor monitoring and evaluation practices; and (3) inconsistent and unreliable learning from past practice. Adaptive management is often cited as a solution for overcoming these barriers but government agencies, conservation non-government organizations, and land stewards have a poor track record in this field and examples of applied adaptive management practices are rare. We report on the efforts of The Nature Conservancy to implement an adaptive management process specifically designed to overcome these barriers and better integrate conservation science with conservation practice. The Conservation Action Planning (CAP) process provides an objective, consistent and transparent accounting of conservation actions and the intended and actual outcomes of conservation projects. The CAP process is supported by guidance materials, hands-on training workshops, and software tools that facilitate application of the process and the sharing of conservation practices and lessons learned via a web database. Results from over 450 CAP projects in North and South America and the Asia Pacific region demonstrate widespread adoption of CAP. Time, resource, and technical skill limitations, especially for monitoring and evaluation, remain obstacles to full implementation of this applied adaptive management process.

THE IMPACT OF CAPE GROUND SQUIRRELS ON DESERT COMMUNITIES IN NAMIBIA? WATERMAN, JANE, James Roth, Corris Kaapehi

The Cape ground squirrel (*Xerus inauris*) is a semi-fossorial rodent that inhabits the arid regions of southern Africa. Many different species make their homes in the burrow systems of Cape ground squirrels, suggesting that this species plays a significant role in the assembly of the desert community. However the importance of this species for local biodiversity has never been tested, and they are currently eradicated by farmers in the region. We examined the effects of Cape ground squirrels on small vertebrates and invertebrates in the Kalahari region of Namibia. We compared the species number and abundance of small vertebrates and invertebrates in burrow clusters and in random areas in the veldt without burrow clusters during the winter of 2005. Eight pairs of sites were sampled for four days using transects and pitfall traps. Overall, species that prefer open habitats were attracted to burrow areas where squirrels had removed vegetation. Three of 7 mammals and 66% reptiles were predominantly found at the burrow area. Overall species richness and abundance were higher in burrow areas for reptiles and most arthropods. We conclude that Cape ground squirrels could be considered ecosystem engineers in this region because of their impact on biodiversity.

INNOVATIVE APPROACHES TO TACKLING FISHERIES BYCATCH CROWDER, LARRY, Rebecca Lewison, Michelle Sims, Daniel Dunn, Ramunas Zydelis, Jeffrey Moore, Bryan Wallace

Bycatch, or incidental take, of vulnerable vertebrate species in fishing gear is a global conservation problem. Because of the highly variable nature of bycatch and severe data limitations, generating accurate bycatch estimates, placing bycatch in an oceanographic context, and understanding population-level impacts of bycatch requires new analytical approaches. Here we describe several new approaches being developed and tested by Project GloBAL, a collaborative and international research initiative. This includes using Bayesian models to re-calibrate bycatch rates to reflect unequal fishing and observer effort, generating models that can

create a more realistic spatial designation for longline fishing effort, establishing protocols to integrate telemetry data into bycatch assessments, and developing novel population and life history models that use existing population information to gain insights as to how vulnerable populations are affected by current levels of bycatch. This range of methodological development illustrates the importance of new techniques to tackle the not-so-new issue of bycatch. This quantitative work, in addition to collaborative efforts to strengthen communication and cooperation among bycatch researchers worldwide, is critical to help reduce bycatch of vulnerable species and promote sustainable fisheries.

A LEGAL CHALLENGE TO FORESTRY IN TASMANIA: THE USE OF A POPULATION MODEL FOR THE WEDGE-TAILED EAGLE BEKESSY, SARAH, Brendan Wintle

A recent ruling in the Federal Court of Australia has major ramifications for management of the country's forests under regional forest agreements. The court found that Forestry Tasmania was in breach of the Environmental Protection and Biodiversity Conservation Act (1999) because its logging operations failed to protect several listed species, including the Tasmanian wedge-tailed eagle (*Aquila audax fleayi*). The ruling has created a political storm, raising fears that the judgement will affect other land uses where development could impact on an endangered species, or its habitat. Changes to the law have been proposed to 'remove uncertainty', with some politicians stating that the judgment created a definition of 'protect' that went far beyond that envisaged by the Government. This paper describes the population model for the wedge-tailed eagle used as evidence in the court case and outlines several challenges to using model results in a legal context.

INVENTORY AND MONITORING DATA DETERMINES THE ANTI-POACHING STRATEGY FOR FOREST ELEPHANT PROTECTION IN ODZALA NATIONAL PARK, CONGO BOURGES, DJONI, Stephen Blake

Despite much rhetoric to the contrary, there are few genuine examples of quantitative ecological data driving management activities in central Africa's forested national parks. We report on management interventions that were developed as a direct result of data collected from the first systematic forest elephant and great ape survey of the 13,500 km² Odzala National Park, Congo. We found clear patterns in the distribution and abundance of these species that was significantly correlated with a previously unknown pattern of human induced threats. A comprehensive infrastructure of permanent guard posts with associated anti-poaching patrols was designed, much of which was implemented in a climate of intense financial difficulty. Quantitative monitoring of management effectiveness is possible, but is, unfortunately, prohibitively expensive under the current budgetary reality in the region.

RESOURCE PARTITIONING BY NORTHERN FUR SEALS (*CALLORHINUS URSINUS*) FROM THE PRIBILOF ISLANDS, ALASKA: INTEGRATING DIET AND TELEMETRY DATA FOR CONSERVATION ZEPPELIN, TONYA, Kathryn Call, Rolf Ream

The Pribilof Island population of Northern fur seals (NFS), which represents the largest concentration of breeding NFS worldwide, has experienced a severe and continued population decline since the late 1990s. The cause of the decline is likely a combination of factors including diet or foraging restrictions resulting from environmental changes and/or increased commercial fishing around the Pribilof Islands. We used both food habits and satellite telemetry data to describe the relationship between breeding sites and foraging habitats of adult female NFS from the Pribilof Islands, Alaska. Fecal samples (n = 4171) were collected between 1987 and 2000 and satellite transmitters (n = 39) were deployed on seals during the 2004 breeding season at breeding rookeries on St. Paul and St. George Islands. Hierarchical cluster analysis indicated differences in diet (frequency of occurrence of prey) and foraging behavior (trip direction,

distance, and duration) of individual seals among islands and rookery sites. We found spatial and dietary partitioning as females from five geographic areas were associated with specific hydrographic domains related to the Bering Sea shelf. The habitat partitioning and important prey resources defined in this study are useful for future management measures needed for effective conservation of this declining species and its marine environment.

RELATIONSHIPS BETWEEN AMPHIBIANS, WATER QUALITY, AND LANDSCAPE CONTEXT OF WETLANDS IN AN AGRICULTURAL REGION OF IOWA, U.S.A.

LODA, JENNIFER, David Otis

Contaminants and habitat degradation are two of the suspected culprits in worldwide amphibian declines. Although these factors may be major issues in the Midwestern U.S., little field research has been done to rigorously examine the potential relationships between contaminants, land use context, and amphibian communities. In 2006 we conducted amphibian surveys at wetlands in north-central Iowa, a region dominated by intensive row crop agriculture. The Iowa DNR collected water quality, contaminant, and surrounding land use data from these same wetlands. We utilized three survey techniques to obtain relative indices of amphibians for each site. We used the information-theoretic approach to choose models that best estimated relationships between relative abundances of amphibian species at a site, and parameters such as pesticide levels, nutrients, specific conductivity, turbidity, surrounding land use, and fish. The best models varied for each species. For example, the pesticide model and land use model had the best fit for the *Bufo americanus* data while the fish model had the best fit for the *Ambystoma tigrinum* data. The most commonly encountered relationships were negative correlations between amphibian indices and levels of the herbicide alachlor, although there were also negative correlations with atrazine, conductivity, and the presence of fish. These results suggest priorities for continued assessment of effects of agricultural practices on amphibians.

BIODIVERSITY CONSERVATION GAPS AND PRIORITIES ACROSS AFRICA: REGIONAL AND NATIONAL PERSPECTIVES

HAWKINS, FRANK, David Knox, Ando Rambeloson, Daniel Rogatschnig

The biogeography of Africa is both well understood and documented. Various priority setting approaches have highlighted key regions for conserving Africa's unique biodiversity. Here we critically evaluate these and assess the degree to which, and where, they overlap. While these global and continental prioritization efforts highlight regional areas of conservation significance, conservation action is primarily implemented within individual countries. Thus, we complemented these analyses with an evaluation of the number of threatened, endemic species in each country. This analysis reveals that the Cape Floristic Region, the Indian Ocean Islands, the coast of Eastern Africa, the Afrotropical systems, the Congo forests, the Gulf of Guinea and Upper Guinea consistently rank as high priority regions. Moreover, countries such as Cameroon, D.R. Congo, Ethiopia, Kenya, Liberia, Madagascar, South Africa and Tanzania are among the highest priority countries on the continent. We conclude that the next step must be to locate specific, site level conservation targets in these countries; initiatives such as the identification of 'important bird areas' and 'alliance for zero extinction' sites provide an excellent starting point for this. Expanding these sites taxonomically to identify key biodiversity areas, sites important for all biodiversity, will be essential to ensuring conservation action is well targeted in high priority countries.

EXCHANGE AT THE LAND-SEA INTERFACE IN MONTEREY BAY: THE DISCHARGE PLUME FROM THE ELKHORN SLOUGH

FISCHER, ANDREW, John Ryan, Erich Reinecker, Laurence Breaker, Nicholas Welschmeyer

Monterey Bay lies in the heart of the largest marine sanctuary in the United States. The Elkhorn Slough, a tidally-forced estuary, serves as a significant year-round link between the bay and surrounding coastal watersheds. The plume that exits the slough can directly influence coastal ocean biogeochemistry, sediment budgets and pollution. There is, however, limited knowledge of this land-sea exchange, due to its ephemeral and dynamic nature. In this study, we characterize

the physical dynamics, biological and chemical content of the slough discharge plume. The plume was sampled in three dimensions, at various tidal stages, for sediment, temperature, nitrates, and surface flow patterns using several, innovative in situ, remote and autonomous instruments. Water samples were analyzed for pigments and fatty acids. Results reveal a ten-meter deep, jet-like, sediment laden plume extending one kilometer offshore at low tide. Nitrates and water temperatures, in the plume were 25 times greater and 2.3C warmer than surrounding bay waters, respectively. Plume samples show distinct populations of phytoplankton with high concentrations of terrestrial and bacterial fatty acids. The ability to characterize such dynamic and ephemeral features provides managers the ability to incorporate dynamics at the land-sea interface into the management of marine resources.

ESTIMATING ENVIRONMENTAL QUALITY FOR SEED EATING BIRDS IN A SAVANNAH MOLOKWU, MARY, Ola Olsson

We present and discuss a general method for estimating environmental quality for granivores. This can be a valuable tool in conservation work. We used the method of giving-up densities (GUDs, amount of food left behind by foragers in depletable food patches) in a savannah area at the Jos plateau, Nigeria. The area is a mixture between open savannah and fringing forests. Food patches were placed at six sites in the area in the open and close to cover, and GUDs were measured during three years, 2004-2006. At two sites water was naturally available during extended parts of the years, whereas the other sites were mostly dry. In the two latter years water was experimentally made available during every second week. The results showed that 1) food availability to the seed eating birds varied dramatically over the seasons, with a decline during the dry season and a strong increase during the wet season, 2) habitat quality to the seedeaters differed strongly between the habitat types, 3) access to water made the experimentally provided food relatively more valuable in the poor habitat, but less valuable in the rich habitat. We conclude that the GUD technique is a very valuable tool to assess aspects of environmental quality, and particularly suitable to seed eating birds, and also to assess the impact that these birds have as predators on seeds in a savannah ecosystem.

PLANNING FOR CONSERVING A PAPER PARK: BUILDING PARTNERSHIPS TO SECURE THE BALE MOUNTAINS NATIONAL PARK NELSON, ALASTAIR, Mohammed Nur Jemal, Addisu Abeba, Berhanu Jilcha, Abdurhaiman Wario, Zelealem Tefera, Deborah Randall

The Bale Mountains National Park in Ethiopia is suffering a management impasse: whilst nominally a National Park, it is not officially gazetted, Ethiopian law precludes people from residing in it and using its resources, yet approximately 8,000 permanent and 30,000 temporary residents use BMNP resources illegally and unsustainably. As a result the Afroalpine and montane forest biodiversity and ecosystem processes are threatened, as is the water security to c.10 million downstream users. Effective conservation is challenged by lack of management capacity, inertia to gazette the park and the lack of an effective conservation strategy. BMNP is, therefore, a "paper park". In response, a multi-stakeholder team, building partnerships between government, NGOs and local communities, has drawn on participatory forest management approaches to create a management strategy and action plan, encapsulated within a General Management Plan, that uses zonation and negotiated natural resource use agreements to bring current unsustainable resource use under management control, alongside tourism and park development. Partnerships between government, local and regional communities, international bodies, the private-sector and civil society are required for successful implementation. Although challenging to implement, and requiring additional political will and financial and human resources, we believe this approach presents a realistic approach to secure the ecosystem by using socio-economic approaches to achieve effective conservation. However, without a rapid evolution of national legislation and interpretation of international prescriptions, the framework to support this more inclusive partnership approach will be lacking.

RECENT DECIMATION OF THE LION POPULATION OF SOUTHERN KENYA Frank, Laurence, SEAMUS MACLENNAN

Lion populations are in decline throughout most of Africa, largely due to conflict with humans over livestock. The problem is acutely urgent in Kenyan Masailand, where local residents are spearing and poisoning lions at a rate which will ensure local extinction within a very few years. Kajiado and Narok Districts contain two of Kenya's most important tourist destinations, Amboseli National Park and the Masai Mara National Reserve, where lions are the primary attraction for overseas visitors. Limited data from the Tsavo-Amboseli Ecosystem (lying between Amboseli and Tsavo West National Parks) indicate that a minimum of 120 lions, and probably many more, have been killed in the region since 2001. In spite of a generous compensation program which pays people for livestock lost to predators, lion numbers on Mbirikani Group Ranch have declined steadily, and evidence suggests that the situation is as bad or worse elsewhere in the region. Young warriors who engage in traditional lion killing do not face significant consequences because of lax law enforcement and judicial corruption. Without drastic changes in conservation practice and law enforcement in the immediate future, Kenya will soon lose its most important tourist attraction.

HIGH PRIORITY CONSERVATION COUNTRIES, THE GEF AND INTERNATIONAL NGOS: DO THE NUMBERS ADD UP?

Hawkins, Frank, DAVID KNOX, Ando Rambeloson, Daniel Rogatschnig

Nearly 90% of the \$6 billion of annual conservation funding originates in and is spent within economically rich countries. However, this still leaves globally flexible funding of hundreds of millions of dollars annually from multilateral agencies such as the Global Environment Facility, and other bilateral aid. Given that biodiversity and threats are unevenly distributed within Africa, if the GEF is to play a key role in the 2010 target of significantly reducing the rate of biodiversity loss, then it will be imperative that these funds target the highest priority countries for biodiversity conservation. Here, we identify the highest priority countries in Africa across multiple taxonomic groups. We then evaluate the degree to which GEF resources have been used across these countries. Additionally, we examine the degree to which international NGOs are complementing this work with additional funding and conservation action across high priority countries. While the GEF, and other organizations are increasingly putting these key resources where it is required most, there is still much work to be done in several high priority countries. Most notably, São Tomé e Príncipe, the Comoros, Ethiopia, and Somalia, receive far less conservation attention than their endemic biodiversity demands.

JUVENILE AGE CLASSES CONTRIBUTE MEASURABLY TO POPULATION GROWTH AND SURVIVAL OF LONG-LIVED SPECIES: CASE STUDY OF CHICK MORTALITY ON ALBATROSS POPULATION

FINKELSTEIN, MYRA, Melinda Nakagawa, Paul Sievert, Daniel Doak

Adult mortality is considered a major threat to population survival for long-lived species with low annual fecundity and high adult survivorship. However, for albatrosses, long-lived seabirds that raise at most one chick per year, mortality of juvenile age classes can measurably impact population growth and stability and therefore warrants the attention of conservation programs. Lead-based paint is a known cause of mortality for Laysan albatross (*Phoebastria immutabilis*) chicks on their primary breeding ground, Midway Atoll, part of the Hawaiian archipelago. We used population viability analysis (PVA) to explore the relationship between lead poisoning of albatross chicks and population growth. As many as 10,000 albatross chicks per year are lead poisoned equaling a 0.23% drop in Laysan albatross annual growth rate (λ) using a demographic population-based model. The reproductive value of approximately five chicks is equal to one adult, demonstrating how juvenile mortalities, traditionally considered to have a negligible effect on population growth for long-lived species, may be important for long-lived species with low annual fecundity. Our results point to the benefits of reducing and/or eliminating logistically straightforward threats to juvenile age classes while efforts are underway to prevent adult

mortalities through more complicated processes such as a reduction in international bycatch rates.

SETTING THE STANDARD FOR MARINE CONSERVATION PLANNING: AN INNOVATIVE APPROACH IN THE MEDITERRANEAN SEA

LOMBANA, ALFONSO, Marco Costantini, Alessandra Pome, Helen Fox

The Mediterranean Sea faces severe pressures of urbanization, pollution, and overfishing from the area's nearly half-billion residents and tourists. Conservation efforts often stall due to political barriers stemming from the numerous countries and interest groups with a stake in the region. To address this challenge, WWF launched an ambitious strategic initiative comprising the entire Mediterranean Sea that convened scientists representing Croatia, France, Greece, Italy, Libya, Morocco, Spain, Tunisia, and Turkey. We followed the newly-implemented WWF Standards of Conservation, a holistic planning cycle designed to achieve results more efficiently than with conventional methods by combining technical, scientific analysis with program management guidelines. The approach is independent of spatial and temporal scales, allowing us to develop projects at site or basin-wide levels to be implemented soon or in the distant future. Despite numerous competing topical and geographic priorities, we reached a consensus and the resulting conservation plan highlighted fisheries and MPAs as key elements to pursue. We identified poor management of MPAs as an issue requiring attention and located priority areas that are good candidate sites for establishing new MPAs. The plan has the potential to influence government and European Union fisheries policies and strengthens the case for continued international collaboration of this kind in the Mediterranean and in other parts of the world.

BIODIVERSITY CONSERVATION IN AFGHANISTAN

DEHGAN, ALEX

Conservation of Afghanistan's eroding natural resource base may be, in part, the key to its security. With over 80% of Afghans dependent on the country's natural resource base, long-term stability will be directly dependent on sustainable management of natural resources. The Wildlife Conservation Society is leading the effort to conserve biodiversity, and build conservation policy and capacity that has been destroyed over three decades of conflict. This talk will focus on the work being done in three biologically important regions of Afghanistan: the 6000 m and higher peaks of Wakhan and Afghan Pamir, the arid Central Hazarajat Plateau and the Eastern Forests, the last remaining forested region in the country. Each region represents a uniquely rich diversity of culture, history, language, ecology and environment. WCS field teams have collected the first baseline data in nearly 30 years on large and small mammals, birds, rangelands, forest cover, and landscape epidemiology. Data has shown dramatic declines in Ibex populations in former protected areas, the continued presence of Snow Leopards (*Uncia uncia*) and Marco Polo Sheep (*Ovis ammon polii*) in the Wakhan and Markhor in the Eastern Forest region on the Pakistani border. In addition, WCS discovered more than 22 species of birds not previously known to the Wakhan region. The conservation of wildlife in Afghanistan represent an effort to work on conservation in conflict, in Afghanistan, and other parts of the world.

MODELING HUMAN POPULATION GROWTH IMPACTS ON BIOLOGICAL RESOURCES IN CALIFORNIA'S SAN JOAQUIN VALLEY

BEARDSLEY, KAREN

In the next 40 years, the eight counties of California's San Joaquin Valley are projected to more than double in population from 3.3 million to 7 million. The region faces many challenges regarding its capacity to accommodate this increase in population while preserving its diminishing biological resources. The Information Center for the Environment (ICE) at the University of California, Davis developed seven San Joaquin Valley urban growth scenarios for the year 2050 using UPlan, a GIS urban growth model. These scenarios were developed based on different goals and assumptions: 1: Assumes growth will continue according to current trends and patterns. 2: Assumes improvements in the East/West highway infrastructure that will attract

growth. 3: Assumes growth will only occur within the existing spheres of influence. 4: Assumes no growth will occur in farmland defined as prime or statewide importance. 5: Assumes no growth will be allocated between the two major highways. 6: Assumes new cities will be established along existing transportation routes avoiding high-value agricultural land. 7: Assumes large metropolitan areas will grow to accommodate a majority of the projected population increase. UPlan was used to assess the potential impacts of each growth scenario on the region's biological resources. Scenario 3 had the least overall impact on biological resources. The methods developed may be applied to other parts of the state and, potentially, the world.

MOVING FROM THEORY TO PRACTICE: THE CHALLENGES OF MARINE ECOSYSTEM BASED MANAGEMENT

KIRSHENBAUM, SHERIL, Raphael Sagarin

Effective management of marine ecosystems is difficult due to the dynamic nature of the environment, complex species interactions, and the intricate social, economic, and ecological relationships between humans and systems. Over the past decade, there has been growing interest in the theory of Ecosystem Based Management (EBM) practices. In 2005, a scientific consensus statement on Marine EBM was released, though it has been difficult to translate into optimal governance structure in the real world. Further complicating the theory, policymakers, scientists, stakeholders, and the public often communicate in different languages. Even under optimal circumstances, stochastic events unrelated to meticulous ecological and social planning may easily and unexpectedly undermine seemingly comprehensive initiatives. Here we examine six distinct regional EBM case studies that incorporated the principles of EBM in the development process. We look for benchmarks measuring success and consider local events influencing the status of these regions. We suggest that although EBM is a valuable model to consider in environmental planning, it may fall short as the best solution to sustaining systems unless fully understood and implemented.

HABITAT MODELING UTILIZING REMOTE SENSING TOOLS FOR CHIMPANZEE CONSERVATION IN WESTERN UGANDA

LAPORTE, NADINE, Jared Stabach, Wayne Walker, Matt McLennan, Lilian Pintea, Andy Plumptre

Over the past century, chimpanzee populations throughout equatorial Africa have been reduced to a small fraction of their historic range. While recent surveys in Uganda suggest a population of roughly 5000 individuals of the eastern subspecies (*Pan troglodytes schweinfurthii*), most are located in small, isolated patches of forest with varying degrees of protection. Our research was focused on two large forest reserves (Budongo and Bugoma) in western Uganda that have relatively large populations (600 each) of *P.t. schweinfurthii* and are separated by a complex matrix of farmland interspersed with small forest patches of varying levels of degradation. The objective of our research was to build a spatially explicit habitat model to identify habitat corridors that could maintain the long-term viability of these isolated populations and their associated ecological diversity. Our result demonstrates how remote sensing information can be integrated with field surveys to model chimpanzee habitat and provides a recommendation to National Authorities and conservation NGOs towards re-connecting these two reserves to ensure the future conservation of the species. This project is funded by NASA to support the application of remote sensing tools for conservation policy in the Albertine rift region and bridge the gap between the remote sensing science and conservation communities.

USING MICROSATELLITES TO DETECT INTER-PENINSULA MISREPORTS OF HARVEST LOCATIONS FOR BOBCATS IN MICHIGAN

SCHUMACHER, KATELYN, Bradley Swanson

Sound management of a harvested resource requires accurate information regarding the harvesting levels. Misreporting of the location from which an animal was harvested can result in localized depletion or even extirpation of the animal. We examined the influence that harvest

regulations have on the frequency of misreported harvest locations of bobcats in Michigan. Bobcats (*Lynx rufus*), commonly harvested furbearers, are distributed throughout Michigan's Upper Peninsula (UP) and the northern half of the Lower Peninsula (LP). Bobcats from the two peninsulas are separated by the Straits of Mackinac and exist as genetically distinct populations. Different harvest regulations between the two peninsulas creates the need for a reliable technique of detecting poaching. Prior to 2005, Michigan's harvest regulation included a season bag limit of three bobcats, using any combination of hunting and trapping, with only one of the three being harvested in the LP. Under these regulations 7.7% - 13.7% of bobcats were misreported as to their peninsula of harvest. Current harvest regulations detail that a total of two bobcats may be taken per season, with no more than one being harvested from the LP. We analyzed 65 bobcats returned by trappers at 4 microsatellite loci and found misreporting rates of 4.8% - 8.8%. Our results show that the change in harvest regulations succeeded in reducing the misreporting of bobcats, thus allowing for more accurate management strategies.

COMPARISON OF DISPERSAL RATE, INBREEDING, AND POPULATION STRUCTURE IN *SISTRURUS CATENATUS CATENATUS* IN NORTHERN AND SOUTHERN MICHIGAN KROPIEWNICKI, RACHAEL, Bradley Swanson

Throughout its range in the United States and Canada, populations of *Sistrurus catenatus catenatus* (eastern massasauga rattlesnake) are declining due to habitat destruction and fragmentation, vegetative succession, and persecution. Michigan is considered the last stronghold for this species with an estimated 77% of its populations remaining, yet no research has addressed the reasons for this trend. Previously, the DNA from two populations of snakes was amplified at eight microsatellite loci to determine dispersal rate, degree of inbreeding, and population structure. From this data, we concluded that interpopulation dispersal is contributing to the persistence of Michigan populations. New samples were collected from northern and southern Michigan, including an island population, and were analyzed at the same loci as the previous snakes. The F_{ST} between regions was 0.21 while the mean F_{ST} within each region was 0.069. This indicates that northern populations are more similar to each other than they are to southern populations. This could be caused by the higher level of development in southern counties compared to northern counties. Therefore, biologists should manage Michigan snakes as two populations rather than one. Also, the island population contains greater allelic diversity and lower inbreeding than mainland populations. This indicates that the island supports a more diverse group of snakes and could be used as a source of new alleles for mainland populations.

DETERMINING THE IMPACT OF LIVESTOCK REMOVAL ON AVIAN GUILDS: HOW LIFE HISTORY TRAITS IMPACT RESPONSE GRAY, ELIZABETH, Kara Shaber-Nelson, Jim Evans

Livestock grazing threatens riparian areas worldwide, leading to a decrease in critical habitat for many avian populations. Currently, no consensus exists as to whether cattle must be removed from riparian areas year-round or whether seasonal removal is equally as effective to improve avian habitat. To address this, we experimentally compared the effects on bird populations of total exclusion vs. seasonal usage on riparian areas in the San Joaquin Valley, California, U.S.A. Avian species richness and density were measured over five years. In general, avian guilds with common ecological characteristics, including foraging and nesting behavior, had similar responses to grazing disturbance. Native species richness and density increased between 2001 and 2004, with more pronounced effects in total exclusion zones. Cattle exclusion benefited cavity nesters and aerial foragers but negatively impacted ground nesting species. A direct comparison with Breeding Bird Survey (BBS) data revealed that observed trends were the effect of experimental treatment rather than a reflection of regional trends. A long-term monitoring program at these sites will provide ongoing data on the recovery of avian populations over time.

THREATENED SMALL MAMMAL SPECIES OF THE ATLANTIC FOREST – DO THEY INDICATE ECOSYSTEM INTEGRITY?

Bueno, Adriana, Fabiana Umetsu, RENATA PARDINI

Threatened species lists are important to guide environmental assessments and evaluate impacts. The commonest criteria for classifying threatened species are based on population size and/or distribution, unavailable for most tropical species. Therefore, these lists may include predominantly naturally rare and/or narrowly distributed species, but not necessarily those affected by humans. Using a standardized database obtained in 68 sites in 3 landscapes in the Atlantic forest in the State of São Paulo over 5 years, we analyzed if small mammals listed as threatened by the Brazilian legislation and/or by the IUCN are affected by habitat quality/fragmentation. We captured 3408 individuals of 41 small rodents and marsupials, including 4 (*Abrawayaomys ruschii*, *Rhagomys rufescens*, *Monodelphis sorex*, *M. scalops*) of the 10 Atlantic forest threatened species. Although they were clearly rare, representing <2% of the individuals, they were not restricted to larger fragments, continuous or undisturbed mature forests. On the other hand, the 2 species (*Oryzomys russatus*, *Thaptomys nigrita*) most affected by forest fragmentation/disturbance were the dominant species in continuous mature forests and are widely-distributed in the Atlantic forest. Rare species do not necessarily indicate ecosystem integrity and ecological data, such as habitat specificity/response to human disturbances, should be included as additional criteria for classifying tropical species into categories of threat.

BASIN-WIDE EXTENT AND INTENSITY OF SUBSISTENCE HUNTING IN AMAZONIAN PROTECTED AND UNPROTECTED AREAS

PERES, CARLOS, Romulo Batista, Iain Lake

Hunting is one of the most widespread patterns of nontimber forest resource exploitation, yet few studies have quantified its extent and impact in large regions of tropical forest. We mapped the total area affected by hunting throughout the Brazilian Amazon, and estimated the proportion of strictly protected, extractive and indigenous reserves that are hunted to varying degrees. The extent of hunted areas and intensity of hunting pressure were primarily related to the density and spatial distribution of the local human communities, rather than the land-use status, reserve category and local geographic features describing protected and unprotected areas. The basin-wide extent of hunting pressure exceeds all other forms of disturbance in Amazonian forests. We conclude that many lowland tropical forest reserves created on paper will become increasingly defaunated of harvest-sensitive game species unless considerable investments are allocated to implement reserve regulations and manage wildlife stocks.

PRIORITIZING RESEARCH FOR SPECIES AT RISK RECOVERY PLANNING: AN ANALYSIS OF INFLUENTIAL PARAMETERS IN SPATIAL PVA MODELS

NAUJOKAITIS-LEWIS, IILONA, Janelle Curtis, Peter Arcese, Rosenfeld Jordan

Population viability analysis (PVA) is recommended as a defensible framework for species at risk and habitat recovery planning. Data requirements of spatial PVAs, however, are intensive and parameter estimates and model structure are often uncertain. Sensitivity analyses of spatial and non-spatial input parameters can inform data needs and research priorities to help reduce uncertainty. We analyzed results of sensitivity analyses used in 95 spatial PVA models of plants and animals to identify influential parameters to prioritize costly research for species and habitat recovery planning. We focused on stochastic demographic PVAs of metapopulations using generic software published from 2000 to 2006. Out of 34 variables, the 9 most influential parameters on model predictions included the number of populations (88% of studies), metapopulation configuration (86%), carrying capacity (80%), initial abundance (75%), dispersal survival (75%), vital rates (74%), catastrophes (71%), dispersal function parameters (56%), and dispersal rate (51%). Although spatial parameters were the most influential, on average, only 13% of all studies varied these inputs. Relative to non-spatial parameters, spatial parameters were ranked highest in terms of data uncertainty and we recommend investing in research to increase their accuracy. Few spatial PVAs carried out comprehensive sensitivity analyses

indicating a need for tools to measure spatial and non-spatial parameter influence on model predictions.

WHO OWNS THE OCEANS, AND DOES IT MATTER FOR CONSERVATION?

HARRISON, AUTUMN-LYNN, Scott Shaffer, Yann Tremblay, Henri Weimerskirch, Darren Scott, Michelle Kappes, Bill Henry, Daniel Costa

In 1982 the United Nations Convention on the Law of the Sea reached a global consensus on ocean space as government property, defining 226 Exclusive Economic Zones (EEZs) within 200 nautical miles of the shoreline for coastal nations. About 40% of the Pacific Ocean falls under the political jurisdiction of at least 42 countries, each with unique policies on resource management and biodiversity conservation. Ocean waters falling outside national jurisdiction represent a global commons with weakly enforced conservation laws. The question of who owns the oceans is particularly relevant to the conservation of highly migratory species, including marine birds, turtles, and cetaceans. These animals can be affected by the fishing activities and management policies of multiple nations during their vast trans-Pacific migrations. Evaluating threats to these species depends on integrating detailed knowledge of their at-sea distribution with marine conservation policies and management regimes. We deployed over 100 miniature satellite tags on three far-ranging seabird species, including the animal with the longest known migration, over a two-year period. Our results provide novel insights into the amount of time each species spent in over 30 EEZs, revealing considerable spatial and temporal overlap with commercial fisheries management zones. We discuss the ecological factors affecting migration patterns and implications of our findings within the context of conservation policy.

EVALUATING PATTERNS OF VITAL RATE VULNERABILITY TO PERTURBATION

HARTWAY, CYNTHIA, Scott Mills, Matthew Kauffman

Elasticity analysis has proven to be a powerful tool in the conservation and recovery of rare and endangered species, and many matrix-based studies have advocated management actions that target vital rates with high elasticity. Past research has shown that patterns of vital rate elasticity are conserved across life history types, leading some to suggest that general management actions can be based on these patterns if more precise demographic data is unavailable. However, uncertainty remains as to whether vital rates of high elasticity are amenable to improvement through management. Looking across a range of anthropogenic perturbations to populations, we asked which vital rate was most altered in populations moving from an “unimpacted” to an “impacted” (in some cases, imperiled) state. Using data on over 100 species, including plants, birds, and mammals, we quantified the proportional change in each vital rate caused by different types of perturbations (including both anthropogenic stressors and management actions). Our findings indicate that only in some cases are the vital rates with the highest elasticities the ones most altered by anthropogenic perturbation. We evaluate the extent to which recorded patterns of vital rate vulnerability (i.e., response to perturbation) are explained by a species life history type and the type of perturbation experienced. These results have broad applicability to the use of matrix models in conservation biology.

INDIGENOUS PERCEPTIONS OF WILDLIFE AND CONSERVATION IN GUINEA-BISSAU

CASANOVA, CATARINA, Claudia Sousa

Conservation strategies that do not consider socio-economic variables and local participation are doomed to fail. Variables such as wealth, ethnicity, gender or religion must be incorporated in conservation projects. Many of these variables are identity factors of human communities and strongly influence perceptions of nature, biodiversity, landscapes and ecosystems. This work will present and discuss data collected in Guinea Bissau (one of the 9th poorest countries of the world). Data was collected via questionnaires applied in tabancas (small rural villages) in isolated geographical areas (Tombali & Quinara). Wildlife meat consumption was not common among all religious groups but hunting was performed by individuals having different religious backgrounds (Muslims, Christians, and Animists). While gender is another factor that affects the perceptions of

other animals (e.g. intelligence and proximity ranking, aesthetic values, among others), age is a factor that influences bushmeat consumption. Species were categorized by the interviewed as “good”, “eatable”, etc. The existence of sacred forests (to which specific taboos are associated) can be seen as traditional strategies that may contribute to biodiversity conservation. Although our results pinpoint that cultural variables are essential for conservation programmes to succeed, when more difficult contexts arise (e.g. draughts, diseases) economic variables are the ones who influence most human behaviour towards wildlife.

EFFECTS OF PERSISTENT DEMOGRAPHIC HETEROGENEITY ON THE EXTINCTION RISK OF SMALL POPULATIONS

Nogeire, Theresa, BRUCE E. KENDALL, Elizabeth A. Cunningham

Within a population, individuals may differ in their demographic traits their propensity to survive or their expected reproductive success. When linked to age or size, these differences can be incorporated into age- or size-structured models to project the population dynamics. However, differences may still remain after accounting for age and size a phenomenon we call “demographic heterogeneity.” Prior work has demonstrated that demographic heterogeneity may influence the variance in population growth rate due to demographic stochasticity, and hence influences the extinction risk of small populations. In that work an individual’s traits were uncorrelated across years. We now extend these models to consider situations where an individual’s demographic traits e.g., greater than average or lesser than average survival probability are acquired at birth, and retained throughout the individual’s life. Using branching process models to calculate extinction risk, we show that in a non-age-structured population, heterogeneity in individual survival probabilities decreases extinction risk, whereas heterogeneity in fecundity slightly increases risk. In addition to influencing the demographic variance, heterogeneity may also influence the mean and variance of the distribution of trait values. Thus, demographic heterogeneity can influence population dynamics in surprising ways, and may often need to be included in population viability models.

THE DELINEATION OF BIOLOGICAL SPECIES IN TAXONOMY AND PHYLOGENETIC SYSTEMATICS: AN INTERESTING PARADOX AFFECTING CONSERVATION ACTIONS

Mayden, Richard, ANNA GEORGE

The discipline of systematic biology is a broad area of science charged with many responsibilities for the discovery of biodiversity. The discipline is most familiar as one charged with describing diversity, with extensive debate over what species are and how to recognize them. The other main goal of systematic biology is the reconstruction of evolutionary relationships between taxa, a fundamental step in understanding all other biological processes for those species. Both of these domains rely on characters that could be grossly classified into general classes of data, such as morphological, functional, behavioral, ecological, molecular, biochemical, or physiological. However, our survey of the vertebrate systematic biology literature from 1998-2005 demonstrates that these two domains of this discipline do not generally use the same classes of character data equitably. Rather, each is inherently biased towards certain classes of data to answer what are effectively the same questions – the existence of species, ancestral or descendant, and the delineation of biodiversity. This paradox in data generation and appreciation is not justifiable in most instances and serves as an impediment in the progress of the discipline of systematic biology, the discovery of biodiversity, and the conservation and protection of this justifiable diversity.

CONSERVATION PHYSIOLOGY: HOW PHYSIOLOGY CAN CONTRIBUTE TO EXTINCTION

COSTA, DANIEL, John Arnould

Placing population declines within a physiological context can arm conservation biologists with unique perspectives on conservation. Physiology can limit the ability of species to respond to changes in the marine environment, and may contribute to extinction in the face of anthropogenic change. For example, populations of California sea lions and most fur seals are growing rapidly.

These species feed near the surface. A few fur seal species and the remaining four sea lions have small, stable, or declining populations. These species feed at or near the bottom. An important physiological component of foraging is the aerobic dive limit (ADL). Animals operating at or near maximum diving performance are less likely to be able to increase foraging effort in response to reductions in food availability whether due to climatic changes (El Nino, global warming), fishery related activities (bottom trawling), or both. We compared the ADL of benthic (i.e. sea floor) diving sea lions and fur seals to those foraging near the surface. The tendency of each species to exceed its calculated ADL was compared to its diving behavior. We found that benthically foraging seals tend to approach or exceed their ADL compared to seals foraging near the surface and would have less ability to increase foraging effort in response to declines in prey. We suggest that the physiological constraints on this group make them more susceptible to anthropogenic changes in the marine environment.

USE OF SMALL FOREST FRAGMENTS AND ANTHROPOGENIC LANDSCAPE MATRICES BY DUNG BEETLES: IMPLICATIONS FOR CONSERVATION RENJIFO, LUIS MIGUEL, Gustavo Kattan, Claudia Medina, Alberto Galindo

Extensive transformation of natural landscapes into rural landscapes makes it essential to understand the role of different landscape elements to conserve native species, particularly in highly transformed ecoregions. Small forest fragments as well as matrices created by productive systems may have a potential to play that role. Nevertheless, their actual roll remains largely untested for most tropical systems and taxa. We sampled dung beetles in 5 forest plots within continuous forest, 5 forest fragments surrounded by pastures for cattle, 5 forest fragments surrounded by exotic-tree plantations, 5 pastures, and 5 exotic-tree plantations (*Eucalyptus*, pine and cypress), using pit fall-traps, on the west slope of the Central Andes in Colombia. We captured 3083 individuals of 19 species. Pastures were very impoverished in terms of both number of species and individuals. In contrast small forest fragments surrounded by either landscape matrix, and exotic-tree plantations were very similar or inseparable from continuous forest in terms of species composition and abundance of dung beetles. Although landscape transformation in the study region started over one century ago, our results suggest that the community of dung beetles is well conserved at forest fragments and, more surprisingly, within exotic-tree plantations. These results emphasize the potential of rural landscapes for the conservation of some taxa.

SURVIVAL IN TROPICAL BIRDS: EFFECT OF SEX AND PATCH SIZE ON THE SURVIVAL OF THE WHITE-RUFFED MANAKIN (*CORAPIPO ALTERA*) IN COSTA RICA RUIZ-GUTIERREZ, VIVIANA, Thomas Gavin

Habitat loss and fragmentation are the primary causes for worldwide population declines and species extinctions. In order to make stronger inferences, fragmentation research has shifted to factors directly linked to fitness of populations. These studies have mainly focused on reproductive success in temperate regions. But, reproductive success might not be the main driver of population change in tropical regions, where certain taxa like birds tend to be longer lived. To address these questions, we analyzed the effects of sex and patch size on survival for the white-ruffed manakin *Corapipo altera* in southwestern Costa Rica. All individuals were marked and recaptured in six forest fragments from 1994 until 2006. Capture data was analyzed using transient models in MARK software. We expected apparent survival to be higher in males than females given that this is a lekking species. We also expected apparent survival to increase with patch size. We found no significant effect of sex on survival, suggesting that in disturbed landscapes, males experience increased sources of mortality. We also found no significant effect of patch size on apparent survival (Pearson's $\chi^2 = 0.80$), suggesting that other factors like matrix effects might play a larger role in influencing survival.

LANDSCAPE AND POPULATION GENETIC STRUCTURE IN SPOTTED OWLS THROUGHOUT THEIR RANGE

HAIG, SUSAN, W. Chris Funk, Eric Forsman, Thomas Mullins

Traditional population genetic analyses render critical data and insight into the status and structure of small populations. However, it has become increasingly apparent that linking patterns of population fragmentation with natural and anthropogenic fragmentation of the landscape will result in more specific diagnoses of factors threatening specific populations and regions. To that end, we used 11 variable microsatellite loci to examine these relationships in more than 400 threatened Spotted Owls (*Strix occidentalis*) sampled across the species range and including all three subspecies. Results suggest significant population fragmentation related to habitat fragmentation, particularly throughout much of the range of Northern Spotted Owls. Landscape patterns discerned natural barriers to dispersal as well as newer areas of lost or degraded owl habitat. This landscape approach to understanding population processes will be helpful in understanding the recent invasion and success of Barred Owls (*S. varia*) in Spotted Owl habitat. This is particularly critical in the Canadian Province of British Columbia where less than 20 Spotted Owls remain.

CONSERVATION SCIENCE, TRAINING, AND AWARENESS. TRYING TO REACH THE CRITICAL MASS WHERE CONSERVATION TAKES OFF. BAT COUNT PHILIPPINES AS A CASE STUDY

MILDENSTEIN, TAMMY, Apolinario Cariño

With so many species teetering on the edge of extinction, biologists are in a race against time to get much needed ecological information for conservation. However, such scientific baseline information often becomes available long before there are capable managers and concerned communities interested in using it. This is especially true in biodiversity hotspots, where research is a funding priority but capacity building, education and awareness often come as secondary goals, if addressed at all. We have been developing baseline ecological information through our research of endangered flying foxes in the Philippines. In the ten years since our project started, we have learned that developing an educated conservation community along with research activities not only strengthens the implications of our research but often produces more immediate conservation outputs. During this time, our outreach activities have led to on-going community-based conservation efforts such as educational programs, citizen-based conservation groups, bat monitoring by local management teams, and community-organized sanctuaries around roosts. We have also witnessed a critical mass phenomenon, at which biologists, managers, and communities began to synergistically motivate each other. A recent example was on the resort island, Boracay, where a development project was halted by a local bat conservation club that tapped the expertise of bat researchers and environmental non-profits.

THE EFFECTIVENESS OF MPA'S TO PROTECT TWO SPECIES OF SEA TURTLE (LEATHERBACKS AND LOGGERHEADS)

NEL, RONEL

Two species of sea turtles nest of the shores of northern KwaZulu-Natal and southern Mozambique. The numbers of nesting females of both of these species were severely suppressed and required active intervention by the conservation authority (the Natal Parks Board) at the time. A monitoring programme was started in 1963 which allowed for data collection as well as foot patrols and physical protection of sea turtles and their nests/eggs. In the mid '70s this protection was scaled up to not only focus on the individuals but on the nesting and interesting habitats and the Maputaland Marine Reserve was created with a 3 nm offshore extent. In 1999 the conservation status was scaled up to a world heritage site and in 2003 the highest protection status was reached which banned most forms of beach driving in South Africa. With this conservation attention the numbers of loggerhead turtles have increased significantly (tracks = $1071.8 + 18.1\text{year}$; $N=40$, $P<0.001$ $R^2=0.28$) with the largest number of nests (3811) in the

2005/6 season. Leatherback sea turtles on the other hand, having received identical attention have showed no significant recovery in numbers, despite the younger first breeding age, shorter life span, faster growth rate and higher fecundity per individual. Both species are migratory and spend most of their time outside of SA EEZ. It may be important to elucidate where the majority of time is spend to design an effective protection programme for leatherback turtles.

USING MODIFIED THREAT REDUCTION ASSESSMENTS TO ESTIMATE SUCCESS OF
CONSERVATION MEASURES WITHIN AND ADJACENT TO KRUGER NATIONAL PARK,
SOUTH AFRICA
ANTHONY, BRANDON

The importance of biodiversity as natural capital for economic development and sustaining human welfare is well documented. However, resource degradation rates and persistent deterioration of human welfare in developing countries is increasingly worrisome. Measuring biodiversity loss continues to pose unique challenges, particularly where there is a paucity of historical data. Evaluation of the effectiveness of Kruger National Park (KNP) and Limpopo Province (LP) in mitigating threats to biodiversity since 1994 was conducted through modified threat reduction assessments in four geographical areas. Results indicate that mitigation efforts in the northern areas have been less successful compared with southern counterparts, with 11 of 21 threats showing no improvement in mitigation. Secondly, illegal resource use occurs for subsistence needs but also entails increasing commercial activities. Thirdly, although threats can affect relatively small areas, they can be locally intense and thus require higher priority. Finally, both the poor state of the KNP fence and increasing elephant populations are facilitating faunal movement, increasing the probability of disease transfer between wild animals and livestock. Study results suggest that policies and enforcement within the study area since 1994 have largely been ineffective in threat mitigation and enforcement and/or developing new strategies are necessary to curb this trend.

PERCEPTIONS AND ATTITUDES OF A MAASAI COMMUNITY REGARDING WILDLIFE-
DAMAGE COMPENSATION, CONSERVATION AND THE PREDATORS THAT PREY ON
THEIR LIVESTOCK
RODRIGUEZ, SHARI

World-wide, carnivore numbers are declining, largely, due to conflict with humans. Wildlife-damage compensation is one potential way to increase tolerance for carnivores while minimizing the financial loss people incur when carnivores prey on livestock. The Predator Compensation Fund (PCF) is one such scheme. Operating on Mbirikani Group Ranch (MGR), a Maasai area in southern Kenya, the PCF compensates owners for livestock attacked/killed by carnivores, in hopes of conserving their remaining local populations. This study examines the PCF and the attitudes and perceptions of the MGR community regarding the PCF, conservation and carnivores. Selected using stratified random selection, 101 subjects were interviewed in mid-2005, using a semi-structured format. Results show that although the PCF increased tolerance for carnivores, subjects felt the project was unfair and inequitable. Many also lacked an adequate understanding of the project, which led to misperceptions and further negative attitudes. Successful resolution of these issues depends on frequent and extensive education efforts about the PCF and timely information dissemination for the community. Also, adjustments to some rules/procedures are recommended to increase perceptions of fairness and to shift responsibility back to the community for properly protecting against carnivore attacks. Implementing such changes should have significant positive effects for the PCF, the MGR community and, ultimately, carnivores.

A PROGRAMME FOR THE CONSERVATION OF CACTI IN CUBA
Gonzalez-Torres, Luis, ALEJANDRO PALMAROLA

Cuba supports the highest diversity of cacti of the Caribbean hotspot with 51 species, 33 of them are endemic. The majority of these species are critically endangered as consequence of human

activities. In 2004, a prior project allowed identifying the main problems for cactus conservation in Cuba setting a framework for the design of the Cuban Cacti Conservation Programme (3C Programme). The 3C Programme is aimed to enable the conservation and management of Cuban cacti and their habitats by building capacity; undertaking ecological, conservationist and socioeconomical researches; conserving population genetic diversity; providing education advice and information and avoiding the damage of wild populations. The 3C Programme is not fully implemented yet but at this time we have discovered and censused a new population of both almost extinct endemic species (*Leptocereus scopulophilus* and *L. wrightii*). We continue monitoring *Melocactus actinacanthus* population and maintaining the ex situ collections of this species. The 3C Programme is promoting taxonomical studies of Cuban *Melocactus* and working toward the establishment of ex situ collections of all critically endangered Cuban cactus. It continue developing environmental education activities in rural communities adjacent to cactus native populations.

THE QUEST FOR SUSTAINABLE HARVESTING OF MEDICINAL BARK VERMEULEN, WESSEL, Coert Geldenhuys

Bark harvested from selected forest and woodland tree species is commonly used in traditional medicine in South Africa. An experimental bark harvesting research project was initiated in the southern Cape forest to develop yield regulation systems and best practices for bark harvesting. Six forest tree species were selected for the study. The treatment entailed the removal of vertical strips of bark, 1 m in length and of different widths, and applied during different seasons. Recovery rates through phellogen edge and sheet regrowth were recorded, as well as the extent of insect damage and fungal growth. The results showed a differential response of tree species to bark stripping, both in terms of wound closure through bark regrowth, and susceptibility to insect and fungal attack. A decision tree was developed to aid with the formulation of harvest prescriptions for different species. Two main groups were distinguished, namely species that show no wound closure after bark stripping, and species where wound closure occur through phellogen sheet and/or edge development. The latter was further subdivided, based on the rate of wound closure and the extent of insect and fungal damage. Harvest prescriptions were formulated for the different species groupings, incorporating aspects such as strip width and length, and harvest rotation. For species that show no wound closure after bark stripping, a full tree harvest system needs to be developed.

SURVEY OF HUMAN-ELEPHANT CONFLICT ISSUES IN THE DIGYA NATIONAL PARK, GHANA KUMORDZI, BRIGHT BOYE, William Oduro, Abena Owusu-Sekyere

The Digya national park is the larger of the two conservation areas established in the transitional vegetation zone of Ghana. The park is important in that it is believed to host probably a quarter of Ghana's elephant population. The park is located in one of Ghana's most important food production areas and reports of elephant crop raiding are common. The situation has resulted in several incidences of farmer agitations. In view of the national commitment to elephant conservation and poverty reduction especially among the rural poor, we conducted the first ever systematic survey of elephant issues in the range. We employed the dung-based transect survey, participatory rural appraisal and GIS techniques to determine elephant distribution and understand the problem of human elephant conflict in the area. We estimated 357 +/- 54 elephants in the area. Location and distance of farm from park boundary influenced their raiding. Raiding was all year round but had a peak in April-June. Although all crops were affected, yam was the most preferred. Local mitigation methods applied in isolation were temporary effective. We recommended the combination of local methods and a special cropping system and provided vital information on strategic control by the wildlife division staff.

THE CURRENT AND FUTURE THREATS TO THE SOUTH AFRICAN IMPORTANT BIRD AREAS NETWORK

COETZEE, BERNARD, Mark Robertson, Berndt J. van Rensburg, Barend Erasmus

There are nine institutional global conservation prioritization frameworks, one of which is the Important Bird Areas (IBAs) initiative of Birdlife International. It differs from most prioritization frameworks in that it does not assess algorithmic irreplaceability or relative vulnerability of sites. The literature is replete with calls to move broad scale conservation prioritization analysis to the finer, regional scales where conservation implementation takes place. In this study we assess the South African IBAs network using various measures of vulnerability to anthropogenic landscape scale threats and assess the biological importance of sites from an avian diversity perspective. Avian assemblages between sites are compared using nine biological importance indicators, like species richness, irreplaceability scores, endemic species richness, range size rarity scores and threatened status of species assemblages. We assess current threats such as human population densities and landscape transformation patterns and also future threats such as potential suitability for afforestation and susceptibility to alien plant invasions. By combining vulnerability with irreplaceability we can identify sites of highest immediate and future conservation importance. Preliminary results indicate the Wilderness-Sedgefield Lakes Complex as overall biologically very valuable and under high vulnerability to land transformation.

JAGUAR AND OCELOT DENSITY, PREY AVAILABILITY AND HUNTING PRESSURE IN THE COLOMBIAN AMAZON

PAYAN, ESTEBAN, Jenny Gallo

Jaguars (*Panthera onca*) and ocelots (*Leopardus pardalis*), as ideal focal species, are threatened by habitat degradation, hunting, and prey competition with humans. The Colombian Amazon represents the stronghold for their conservation. Twenty camera trap stations in a 3,000 km² National Park were used to infer density and abundance of cats and prey, and measure indigenous hunting. From 2,356 camera trap nights 5 jaguars/100 km² were estimated, with a Relative Abundance Index (RAI) of 0.38/100, higher than previous estimates for Amazonia. Ocelot number is twofold. Photos evidence a rich carnivore guild (n=7) and abundance of prey species (n=16), especially tapir (*Tapirus terrestris*; RAI 0.64) suggest a well conserved park. Tikuna legal hunting in the park takes 27 individuals/month of 9 species on average, by 22 hunters (3.2% population). Although indigenous subsistence hunting for millennia has been sustainable, it should be continually monitored due to increase in gun usage, demographics and demand from markets. This park acts as a haven for spotted cat populations, which are still recuperating from the hunting of the fur trade decades, nevertheless the park's size is insufficient for long term conservation of jaguar. Carnivore and prey presence suggests good forest cover, but not necessarily an intact plant composition.

USING ECOLOGICAL RIVER TYPES IN CONSERVATION PLANNING

TURAK, EREN

Defining appropriate conservation targets is a critical step in regional conservation planning. I developed an ecological typology of rivers for the Australian state of New South Wales (801,428 km²) to provide a scientifically rigorous tool for prioritising conservation initiatives for freshwater ecosystems. I analysed data from 372 river reference reaches across the state. Four separate typologies were developed for fish species (1), macroinvertebrate families from river edge (2) and riffle (3) habitats, and a large number of abiotic attributes (4). The typologies contain six, eight, five and ten river types respectively. Classification trees and identification keys allow river reaches to be allocated a river type for each of the four typologies. Using these keys, I mapped the river types within one region of NSW (Hunter region, 37,000 km²) and used the extent of each river type and its representation in protected areas as a basis for ranking river types for regional conservation priority. I assigned conservation priority to each of 42 large subcatchments (500-1000 km²) within this region by combining river type-priority with information on current

condition, threats and special ecological features. All typologies gave similar results. The use of ecological river types in this way complements prioritisations based on terrestrial biodiversity and assists in developing holistic conservation priorities.

ACTIONS AND PRIORITIES FOR CONSERVING THE WORLD'S AMPHIBIANS

HOFFMANN, MICHAEL, Ariadne Angulo, Janice Chanson, Don Church, James P. Collins, Neil Cox, Claude Gascon, Joe Mendelson, Robin Moore, Simon N. Stuart, Bruce Young, Kevin Zippel

Roughly one-third of the world's amphibians are considered threatened with extinction, compared with one-quarter of all mammals and one-eighth of the world's birds. This is almost certainly an underestimate, since there are insufficient data to make reliable assessments of extinction risk for 23% of amphibians. Results of the IUCN Global Amphibian Assessment reveal that while the major threats to most species are habitat loss and pollution, other threats, such as disease and climate change, are especially important at driving species rapidly to extinction. A recent proposal, endorsed by representatives of the world's herpetological community, estimates the cost of addressing these poorly understood declines at US\$400 million. Within the framework of this action plan, and using the most comprehensive dataset available to date, we revisit the conservation needs for globally threatened amphibians. We show that site-based action in the form of habitat protection remains the most significant conservation action required for the majority of threatened species. However, a combination of species-targeted actions, such as the establishment of ex-situ assurance colonies, complemented by landscape-level actions and policy initiatives, are also necessary to combat the effects of emerging threats. We also identify several important research priorities. In light of the need for such an integrated approach, we outline explicit conservation actions for immediate implementation.

ALIGNING CONSERVATION PRIORITIES ACROSS TAXA IN MADAGASCAR, A BIODIVERSITY HOTSPOT

CAMERON, ALISON, Atte Moilanen, Steven Phillips, Robert Hijmans, Chris D. Thomas, Henk Beentje, John Dransfeld, Brian L. Fisher, David C. Lees, Edward E. Louis, Christopher J. Raxworthy, George Schatz, Miguel Vences, David R. Vieites, Patricia C. Wright, Michelle Zjhra, Claire Kremen

Conservation biologists aim to create efficient protected area networks that conserve the most species in the least space. This ideal is difficult to achieve because species richness, endemism and turnover patterns rarely align well; although minimum complementary sets often can represent a relatively high proportion of other studied taxa. A more serious, but less-studied, trade-off, is that accounting for persistence of selected species may reduce representation of other species in the network. In an unprecedented collaborative effort for a global biodiversity hotspot we collated data for 2345 species, representing all endemic species from six taxa. We produced significant species distribution models for 837 species and used these in combination with point locality data for a further 1508 rarer species. Using a new conservation planning tool called Zonation we first assessed conservation priorities for each individual taxon. Then in a combined analysis of all six taxa we found that all 2345 species can be represented in a reserve network with relatively minor losses of both representation and persistence probability, despite complex and largely non-concordant patterns of micro-endemism. Use of similar methods for selecting and evaluating reserve design solutions could accelerate development of systematic conservation plans for other hotspots, while allowing explicit examination of tradeoffs between taxa and representation versus persistence goals.

MEASURING THE SOCIAL IMPACT OF PROTECTED AREAS: A GLOBAL REVIEW AND PROPOSED ASSESSMENT FRAMEWORK

Khurshid, Atif, MICHAEL B MASCIA

Protected areas have rapidly grown in number in the past few decades. In recent years, the social impacts of protected areas have become a significant concern for conservation practitioners, academicians and social scientists. This paper reviews peer-reviewed journal articles and online

published reports to document the varied types of protected area social impacts and the indicators used to measure these impacts. Researchers have generally examine the social impacts of protected areas in six social domains – governance, well-being, health, education, social capital, and culture – but there is lack of consistency in the indicators that researchers use to measure these social impact. Based on this literature review, we propose a set of SMART, sensitive, outcome-oriented, and robust indicators to guide future assessments of the social impacts of protected areas. This assessment framework provides the basis for the continuous monitoring and periodic evaluation that is essential to inform effective conservation policy.

COMBINING CONSERVATION AND DEVELOPMENT ON PRIVATE LANDS: AN ASSESSMENT OF ECOTOURISM-BASED PRIVATE GAME RESERVES IN SOUTH AFRICA'S EASTERN CAPE

LANGHOLZ, JEFF, Graham Kerley

Privately owned protected areas continue to expand throughout much of the world. Recognizing potential risks and benefits of this trend, delegates to the 2003 World Parks Congress in Durban, South Africa produced a Private Protected Area Action Plan that included a call for increased research to fill critical information gaps. We surveyed ten ecotourism-based private game reserves (PGRs) in order to assess their contribution to conservation and development in the Eastern Cape region. Sample findings include: 1) the ten PGRs protect 116,608 hectares (median 6,993), representing six of South Africa's eight biomes and an immense diversity of plants and animals; 2) in changing from farming to wildlife-based ecotourism, the total number of employees increased 450% and the average annual salary per full-time employee rose 480%; 3) gross revenues, and revenues per hectare, have shown steady increases over the past four years and are projected to continue rising; and 4) the PGRs were engaged in a wide variety of social development projects in and around their reserves. We conclude that PGRs provide an attractive alternative to traditional land-uses in this area, and we make several recommendations for improving their overall contribution to conservation and development.

SECURING URBAN BIODIVERSITY PRIORITY SITES IN GAUTENG: A PARTNERSHIP WITH NATIONAL, PROVINCIAL AND LOCAL AUTHORITIES

PILLAY, DESHNI, Lala Steyn, Tamara Smith, Anthea Stephens

The Grassland biome covers 30% of South Africa's landscape and extends into 6 provinces. Currently approximately 40% is irreversibly transformed and only 3% formally conserved. The National Spatial Biodiversity Assessment conducted in 2003 identified the grassland biome as a conservation priority for South Africa. As a result the South African National Biodiversity Institute, initiated the GEF funded National Grasslands Programme in May 2005. The goal is to ensure ecosystem services are sustained and contribute to economic development by focusing on the urban, agricultural and forestry production sectors. The main partners and implementing agencies include the National Grasslands Biodiversity Programme (NGBP), Gauteng Department of Agriculture Conservation and Environment (GDACE) for the urban component, Department of Agriculture/AgriSA for the agricultural component and Forestry South Africa for the forestry sector. This paper will discuss mainstreaming grassland biodiversity into urban development and process followed in ensuring the urban component of the NGBP is successfully implemented by securing the biodiversity priority sites in Gauteng from transforming land-uses.

ECONOMIC INCENTIVES FOR SIBERIAN TIGER CONSERVATION: THE TIGER FRIENDLY CERTIFICATION PROGRAM

MIQUELLE, DALE, Nikolai Kazakov

Whether poverty alleviation programs have the capacity to reduce environmental degradation has been severely questioned over the past decade. New approaches that provide clear and specific linkages between conservation objectives and economic development are essential. The unsustainable extraction of natural resources poses a threat to a unique assemblage of plant and wildlife species in the Russian Far East including the endangered Siberian tiger. Unemployment

levels in rural communities reaches 90%, forcing the local unemployed to further increase pressures through poaching and illegal harvest. Our goal is to foster sustainable development in local communities with economic incentives linked to biodiversity conservation in the Russian Far East. Tiger Friendly Certification (TFC) uses tigers as an indicator of ecosystems integrity, and as a charismatic marketing tool to evoke “green” consumer behavior. By purchasing products sustainably harvested from TFC lands consumers can actively participate in conservation of tigers by providing economic incentives for local people to conserve tigers and their habitat. The rich flora of the Russian taiga includes medicinal herbs and berries desired by Western markets. TFC links access to those markets for communities that meet certification criteria, which include presence of tigers, adequate prey densities, effective anti-poaching activities, sustainable harvest practices, community involvement and fair distribution of profit.

FUNCTIONAL SANDY BEACHES UNDER THREAT

SCHOEMAN, DAVID. S, Thomas A. Schlacher, Mariano Lastra, Alan Jones, Jenifer Dugan, Felicita Scapini, Omar Defeo, Anton McLachlan

Sandy beaches dominate the world’s open coastlines and are iconic assets to society. But escalating threats to these systems pose formidable conservation challenges. Although beaches are best known as prime destinations for human recreation, they also harbor unique biological assemblages and provide a range of ecosystem services. Unfortunately, however, human population growth is driving a phenomenon known as ‘coastal squeeze’, with beaches becoming trapped between burgeoning coastal urbanization and various marine stressors caused by climate change. Globally, most beaches are eroding because of anthropogenic modification of sediment supply and transport processes, sea-level rise, and increased storminess. When eroding beaches are unconstrained they migrate inland, but this is increasingly prevented by the presence of coastal infrastructure. Resulting management responses involve either “soft” engineering (beach nourishment) or “hard” shoreline armoring. Neither is without detriment to the functioning of sandy beaches; nor are the plethora of other human activities that involve beaches. Conservationists can, however, not provide adequate advice in this situation, because many fundamental ecological properties of beaches remain poorly understood by mainstream ecologists. Here, we aim to bring the essence of the emerging field of sandy beach ecology to conservationists and to highlight the need for sandy beaches to be viewed as functional ecosystems rather than piles of sand.

DOES DWELLING ON THE EDGE OF A TIGER RESERVE WORTH IT: A CASE STUDY FROM SOUTHERN INDIA

DEVY, M.SOUBADRA, R. Ganesan , T. Ganesh

Conservation displacement due to establishment of parks has often led to troubled relationships between conservationists and rural community. This has a large impact of either the forced removal of people from their homes or what you call economic displacement which is a denial of access to natural resources, a source of livelihood. Tiger which been symbol of conservation efforts in India and about 19 reserves have set aside for tigers in India. Most of these reserves have hundreds of villages and most of these depend on the forests for basic needs such as fuelwood and fodder. Last decade has seen a reconciliation effort by federal government which has implemented a suite of alternate livelihood options supported from external sources around the Tiger Reserves. We present the results of the evaluation of the implementation in 3 villages targeted by the government around Kalakad-Mundanthurai Tiger Reserve in South India. Livelihood alternatives offered has not been sustainable and often these were linked with micro-credit system. In fact the government imposed the ‘fine and fence’ system more emphatically as the people have now accepted micro-credits offered by them. What was initiated as reconciliation effort has led to biomass crisis and lot of resentment among the rural community.

DO FOREST FROGS DISPERSE OVER A DESERT BARRIER? INSIGHTS FROM
POPULATION GENETICS OF *SCHOUREDENELLA XENODACTYLOIDES* IN THE TAITA
HILLS, KENYA
MEASEY, JOHN

Amphibians are in decline worldwide, and high altitude tropical areas appear to be the worst affected. This is in stark contrast with current information we have on gene flow in amphibian populations which focus on temperate pond breeding species. Using AFLP markers, we show that a small, direct-developing, leaf litter frog from the Taita Hills in south-west Kenya (*Schourenella xenodactyloides*) has extended populations covering large areas (>3.5 km) of fragmented, forest habitat, uncharacteristic of typical amphibian models. Further, we demonstrate high levels of gene flow (FST *S. xenodactyloides*), which features passive downhill and active uphill movements over large areas, contrasting with limited cross slope movements. Our study highlights the importance of the diverse reproductive strategies of the Amphibia when considering dispersal and gene flow, and hence conservation management.

C.A.P.E. FINE-SCALE BIODIVERSITY PLANNING PROJECT: CREATING TOOLS TO DRIVE
PROACTIVE PROTECTED AREAS NETWORK DESIGN AND REACTIVE LAND USE
DECISION MAKING
Pence, Genevieve, KERRY TE ROLLER, Tracy Timmins

The Fine-Scale Biodiversity Planning Project (FSP) is funded by the Global Environment Facility and forms a vital component of the Cape Action for People and the Environment (C.A.P.E.) Programme. C.A.P.E. is a partnership programme that seeks to conserve and restore the biodiversity of the Cape Floristic Region (CFR) and adjacent marine environment, while delivering significant benefits to the people of the region. Systematic fine-scale biodiversity planning will occur for 9 of the local municipalities falling within 5 identified biodiversity priority areas within the CFR. The project aims to integrate both terrestrial and aquatic surrogate data to produce the best possible representation of biodiversity for the areas. In order to achieve this, the project requires data in a valuable format for the planning exercise and will thus be commissioning the undertaking of various specialist assessments and mapping exercises, such as transformation, vegetation, rivers, estuaries, wetlands, groundwater, etc. The final biodiversity planning products will be used firstly to guide the reactive land use decision making process undertaken by state officials of all spheres of government and secondly to inform the identification process of land to be proactively targeted by conservation officials for stewardship agreements and ultimately contribute to the protected areas network.

ESTABLISHING A NOVEL METHODOLOGY AND BASELINE FOR MONITORING THE
ILLEGAL KILLING OF ELEPHANTS (MIKE)
KAHINDI, ONESMAS

Within the framework of Monitoring the Illegal Killing of Elephants (MIKE), our project, in collaboration with the Kenya Wildlife Service, established a mortality baseline for a population of 5,400 elephants in the Laikipia / Samburu MIKE site, a mainly unprotected area of 25,000km² in northern Kenya. Elephant deaths were recorded by local people, ground patrols, aerial patrols, aerial surveys and law enforcement intelligence. Each carcass was later physically verified. In our site over 60% of the 600 plus carcasses that died in the period were first found by herdsman, compared with less than 40% detected by all other methods combined. The average annual recovery rate of elephant carcasses was 2.4% of the living population, the highest for any of the 55 MIKE sites in Africa, due to high rates of detection. Almost 30% of mortality in our MIKE site was due to illegal killing, with 15% due to problem animal control, and the remainder to natural or unknown causes. The elephant population was nevertheless still increasing. Mortality causes showed distinct spatial properties with marked differences between “illegally killed”, “problem animal control” and “natural” mortality. We attribute our success in monitoring elephant mortality as greatly enhanced by the participatory method.

HURRICANES AND SEA TURTLE DECLINES AT THE DRY TORTUGAS NATIONAL PARK (USA)

Van Houtan, Kyle S., ORON L. BASS

Sea turtles populations are 99% depleted from pre-Columbian estimates, despite recent reported increases across the Atlantic. These historic declines are largely due to unabated overexploitation of adults and nests before 1900, though many threats remain today. Adult turtles migrate long ocean distances encountering hunting, long-line fisheries, and shrimp fisheries. Nesting suffers from beach habitat loss and from poaching nesting females and their eggs. We analyze nesting surveys at the Dry Tortugas National Park (Florida, USA) from 1982–2004. Though five turtle species are observed locally, only loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*) regularly nest here. All species are protected by state, federal, and international regulations. Nesting trends generally agree with the recent increases documented across the Caribbean since 1980. However, the Dry Tortugas populations declined since 2000. More problematic, nest excavations reveal that while clutch sizes remain constant, hatching success decreased 50% since 1995. These decreases are largely from strong tropical storms that can wash away entire islands and their nests. Invasive plants and nest predators are also factors. We also report the early onset of nesting with rising ocean temperature. As many ecologists consider nesting beach protection critical for turtle conservation, these trends urge attention.

SUCCESS AND FAILURE OF UNGULATE RELOCATIONS IN SOUTH AFRICAN GAME PARKS, 1950–2000

VAN HOUTAN, KYLE S., Stuart L. Pimm, Rudi J. van Aarde

Why do some introductions succeed where others fail? We collected and analyzed data for nearly 20 species of large mammals, spanning more than 20 private South African nature preserves, comprising the most extensive empirical tests of these questions that we know. We compare different models to account for population change and consider both density-independent and density-dependent scenarios. As population relocations are notoriously difficult, we were surprised that most relocated populations fared rather well and grew quickly, independent of the size of the initial cohort. We observed Allee effects only occasionally for some species, and noted a weak 'genetic rescue' effect across all species. The strongest factor predicting translocation success was whether the preserve's location was inside a species' known historical distribution. Reserve size was not a significant factor, though we considered few reserves to be small. Many relocated populations succeeded from few individuals, challenging conservation approaches that strictly consider genetic effects.

WHAT INFLUENCE DOES CLIMATE CHANGE HAVE ON CARBON SEQUESTRATION PROJECTS?

KNOWLES, TONY, Albert S. van Jaarsveld, Robert J. Scholes

As highlighted in both popular and scientific literature, climate change may be one of the greatest challenges facing humanity in the 21st century. Consequently, importance has been placed in understanding the mechanisms by which climate change occurs and developing appropriate mitigation responses. A question that has not been addressed is how climate change itself affects mitigation efforts, particular carbon sequestration through the restoration and conservation of degraded ecosystems. We present a methodology for assessing the influence of climate change on carbon sequestration projects using the Century Ecosystem Model, and assess the effect of climate change on a suite of potential carbon sequestration projects across sub-Saharan Africa. Our results show that forecasted climate change leads to a positive increment in the amount of carbon sequestered for all vegetation functional types across sub-Saharan Africa. However, the magnitude of the effect is not constant across vegetation functional types, ranging from 5% to 37%. Although a diverse array of global climate change scenarios and models were used to simulate the likely effects of climate change, the effect on carbon sequestration is similar in magnitude for a particular vegetation functional type. The results of this study highlight that policy

makers need to be cognisant of the effect of climate change when developing methods to assess carbon sequestration ventures and ecosystem services in general.

ARE PROTECTED AREAS REALLY PROTECTING LEMURS? A LOOK AT THE GENETIC DIVERSITY IN AND AROUND RANOMAFANA NATIONAL PARK, MADAGASCAR
MORELLI, TONI LYN, Richard A. Brenneman, Edward E. Louis

A principal strategy in conserving endangered species has been to maintain isolated areas of habitat that are protected from human development. This approach has been highly successful in some areas; for example, in Madagascar, most of the remaining forests are contained in national parks and special reserves. However, little research has investigated how barriers such as reserve boundaries and roads impact the cohesion of mammal populations. Since the newest management techniques focus on corridors and connectivity between protected areas, as well as the dynamics of metapopulations, research on the impact of natural and artificial barriers on gene flow is particularly important. We analyzed heterozygosity levels and tested for Hardy Weinberg equilibria within and between populations of 4 rainforest lemur species found both within Ranomafana National Park and outside its protected boundaries in southeastern Madagascar, including *Propithecus edwardsi* (n=94), *Eulemur rubriventer* (n=30), *Eulemur fulvus rufus* (n=32), and *Hapalemur griseus griseus* (n=33), using 17-20 species-specific polymorphic nuclear microsatellite loci, and analyzed the results using population genetics software including FSTAT, Genepop, structure, and Bottleneck. Results indicate that barriers such as roads and rivers impact the movement of genes between adjacent populations, with variation in population differentiation potentially reflecting differences in species-specific behavior and locomotion. This study will provide baseline data for the genetic health of Malagasy prosimians as well as aid future management strategies to maximize heterozygosity in endangered lemurs.

PUMA-LIVESTOCK CONFLICT IN ANDEAN PRIVATE LANDS OF COLOMBIA
Esteban, Payan, MARIA PAULA QUICENO

Pumas (*Puma concolor*) share much of their range with livestock ranchers, creating a conflict due to attacks from pumas to farm animals and retaliatory hunting from ranchers. Thus, addressing this problem is key for the survival of the Andean puma. Puma-livestock conflict was studied in the surrounding buffer zone to the Nevados National Park (583 km²) in 56 km² of private lands. Extensive dairy livestock breeding with little management is done in these areas. Details of the attack site, the attacker's ecology and behaviour, the victim's characteristics and some management practices were registered. In three years over 120 attacks occurred, by at least 2 pumas. Pumas attacked livestock ranging from 5 to 400 kgs, with preference 100 kg mass victims. Puma attack sites were associated to water 74% (n=23) of the time, all attacks occurred in paddocks at distances = 500 m from forest border, 94% (n=17) of attacks occurred at distances larger than 150 m from the homestead. Pumas attacked all prey by biting at the neck and nape, dragged victims to specific consumption points and ate primarily muscle tissue. The smaller and economically poorer farms were most affected by predation and consequently showed the least tolerance to it. Opportunity and necessity appear to be critical factors in depredation, thus "cheap and easy" antipredator strategies are proposed for different size farms in order to limit losses, but always coupled with natural prey and habitat conservation.

POPULATION GENETIC ANALYSIS OF TRUE AND PSEUDO FRAGMENTED TREE SPECIES IN THE SACRED GROVES OF KODAGU, WESTERN GHATS, INDIA
CHAITHRA, G.N, B. Tambat

Sacred groves are relics of pristine forests that are conserved in the name of god. However, in recent years due to change in land use pattern, they appear as islands in the matrix of agricultural landscapes. Certain coffee plantations adjoining these groves retain native vegetation for shading purpose, which is expected to play important role in connecting fragmented groves. We assessed the genetic diversity of *Litsea floribunda*; occurs only in groves (true fragmented) and compared with *Mangifera indica*; found both in groves and adjoining coffee plantations (pseudo fragmented).

Nine groves of size 0.3 to 18 ha were selected and samples of both the species were collected from Kodagu district, Western Ghats. Using 10 RAPD (Randomly Amplified Polymorphic DNA) primers PCR was performed. Based on amplification profile Sorenson's dissimilarity index was computed. Results indicated within population genetic dissimilarity index increases with increase in grove size in *Litsea* but in *Mangifera* it remains same. Further, in *Litsea* frequency distribution of dissimilarity was also different for different size class of the grove. Our study suggests that presence of native trees in adjacent coffee plantations facilitate gene flow that connects the fragmented groves and plays important role in conservation of forest genetic resources.

THE IMPLICATIONS OF LARVAL FISH DYNAMICS FOR MPA PLANNING STRYDOM, NADINE A.

Stock declines of wild-caught fishes in many parts of the world, including South Africa, have put pressure on fisheries managers. MPA's are considered a vital management tool for protecting fishes, necessitating the establishment of more MPA's, as existing protected areas are unable to counter the effects of fishing. The success of any fish population is intricately linked to the success of the larval phase. The biology and ecology of larval fishes are starting to provide information about fishes that can be used by planners and managers of MPA's. This paper reviews the aspects of the early life history of fishes such as influence of the size of the mother on larval size and subsequent survival, larval habitat requirements, effects of ocean conditions on dispersal, self-recruitment back to natal reefs and swimming abilities that can facilitate effective conservation strategies for fishes. The passive drift hypothesis underpinning the effectiveness of MPA's, in terms of reseeding potential for fishes to neighbouring unprotected areas, will be discussed with respect to swimming abilities of larvae. Preliminary results from swimming trials on postflexion stages of *Diplodus capensis* and *Sarpa salpa* (Family Sparidae), tested in a swimming chamber for the first time in South Africa, are presented.

THE PERFORMANCE OF ELECTRIC FENCES AS ELEPHANT BARRIERS IN AMBOSELI, KENYA

Kioko, John Musila, Philip Muruthi, PATRICK OMONDI, Patrick I. Chiyo

Electric fencing is increasingly used as a tool for elephant conservation in human-dominated landscapes and is considered effective in deterring elephants from raiding crops. However, factors determining the effectiveness of fences are not fully understood. We assessed the performance of Namelok and Kimana electric fences in reducing human-elephant conflict by comparing elephant crop-raiding and perceptions of farmers on the effect of fences in reducing conflicts within fenced and adjacent unfenced farmlands. We also examined the effect of intact fence wires, presence of current and amount of voltage on elephant entry inside fences. Electric fencing reduced elephant crop-raiding and other forms of conflict. Namelok fence was not broken by elephants whereas Kimana was broken several times probably because it borders Kimana Sanctuary which provided a safe area where elephants could retreat after crop-raiding. Fence breaking by elephants was not related to presence of current or to fence voltage prior to fence breaking due to poor maintenance. Elephants entered fenced areas more when the fence wires were broken than when wires were intact. Our results suggest that, fence maintenance and proximity of fences to areas of high elephant concentration are significant determinants of long-term performance of electric fences in mitigating elephant crop-raiding.

THE CONSERVATION OF GOLDEN MOLES IN SOUTH AFRICA WITH EMPHASIS ON THE CRITICALLY ENDANGERED *NEAMBLYSOMUS JULIANAE* (AFROSORICIDA; CHRYSOCHLORIDAE)

MAREE, SARITA, Paulette Bloomer, Gary. N. Bronner , Nigel C. Bennett

Environmental changes occur amid human-induced stress on biodiversity and causes habitat change that often first affects specialist species. Yet, smaller species such as the *Chrysochloridae* are often overlooked even when facing extinction. These insectivorous, range-restricted, burrowing mammals are endemic to sub-Saharan Africa. Thirteen of 21 species

delineated on morphological and cytogenetic grounds are considered threatened due to habitat degradation (IUCN 2006). Even so, instability typifies their taxonomy and little is known about their life history and genealogy. Here we present results of current molecular research based on a suite of mitochondrial and nuclear gene sequences aimed at 1) constructing an extensive molecular phylogeny to assess whether cryptic species are possibly contained within 21 putative species that would merit protection as distinct evolutionary lineages; 2) determining intraspecific relationships and overall gene flow levels in selected non-threatened taxa (*Amblysomus hottentotus*) to be used as models for threatened taxa e.g. the critically endangered *Neamblysomus julianae*. The three remaining geographically isolated populations of this species suggest that the Pretoriuskop population represent a lineage genetically distinct from the eastern Pretoria-Nylsvley populations. Since a sound taxonomy forms the basis of accurate conservation planning these results contribute significantly to the conservation and subsequent survival of chr

GOVERNANCE, LIVELIHOOD AND CONSERVATION IN THE ZAMBIAN SECTION OF THE KAVANGO- ZAMBEZI TRANSBOUNDARY CONSERVATION AREA METCALFE, SIMON, Samu Nesbert

The mobility of Africa's terrestrial wildlife requires management collaboration throughout its range, and the resolution of conflicting ecological and economic management goals between state and communal landholders. Communal landholders have insufficient incentive to accommodate significant costs of wildlife. The African Wildlife Foundation (AWF) is implementing a communal land reform project in the Zambian section of the Kavango-Zambezi Transboundary Conservation Area to promote conservation connectivity and wildlife corridors in the communal areas. While an ecologically connected landscape sounds fine in principle, when it comes to "living off biodiversity" the question is: "whose land, whose resources, and where?" This paper analyses communal land tenure in the context of proposed wildlife corridors that require sound communal-state governance and efficient communal-private sector investment partnerships. AWF has established community development trusts that address governance and livelihood issues and provide a basis for resolving social-ecological scale mis-match. The community trusts are potentially able to resolve the contradictions inherent between customary and participatory authority, engage private sector investment efficiently and equitably, and achieve this within a scaled-up landscape conservation approach. Naturally challenges remain related governance, livelihood and conservation but the new framework provides a basis that enables ecological connectivity betw

REGENERATION STATUS THREATENED TREE SPECIES IN SACRED FORESTS OF KODAGU, WESTERN GHATS RAGHAVENDRA, S., C.G. Kushalappa, Syam Viswanath , Shonil Bhagwat

Sacred forests are unique landscapes of vegetation and preserved with community based conservation concept. These have relevance in conservation of biodiversity but, their current situation and their survival are big questions for future generation. Hence, we made an attempt to assess the regeneration of tree species which are listed in threatened category and *Garcinia gummi-gutta*, *Artocarpus hirsutus*, *Hydnocarpus pentandra* and *Cinnamomum macrocarpum* which are endemic to the Western Ghats. The study was conducted in sacred forests of semi-evergreen and moist deciduous vegetation Kodagu district which is considered as "Hot spot of sacred grove tradition" in the world. The regeneration status was assessed for endemic species viz. Our results indicate that regenerating individuals of threatened category have low population status and not significantly different in both the vegetation types. When regeneration pattern of endemic tree species is considered specifically, there was no significant difference regeneration between large and small sacred forests. Due to over exploitation and other disturbances, poor regeneration was recorded. The conservation strategies are formulated by considering population status of specific species.

Adaptive management and monitoring

1. Withdrawn

2. VOLUNTEERS IN MARINE ENVIRONMENTAL MONITORING. 2002-2005 DIVING FOR THE ENVIRONMENT: MEDITERRANEAN SEA BIODIVERSITY PROJECT **GOFFREDO, STEFANO, Patrizia Neri, Antonio Orlandi, Maria Scola Gagliardi, Angela Velardi, Francesco Pensa, Corrado Piccinetti, Francesco Zaccanti**

Biodiversity is an indicator of environmental health. Monitoring is the first step towards natural resource management. "Diving for the Environment" wanted to obtain data on the state of the marine biodiversity along the Italian coasts, by the collaboration of recreational scuba divers. On a specially formulated questionnaire, volunteers reported the presence of 61 marine taxa encountered during recreational dives. This research was patronaged by the Italian Ministry of the Environment and supported by ASTOI (Association of Italian Tour Operators), A.DI.SUB (Association of Italian Scuba Diving Agency – IDEA, PADI, PSS, SNSI, SSI) and the popular scientific magazine Quark. During the 4-year study, 3,825 divers have completed 18,757 questionnaires, corresponding to 13,539 diving hours. In the Ligurian and Northern Tyrrhenian seas, data showed a north-south gradient, where the best situations were in the southernmost areas. This trend was confirmed by data collected by the Italian Ministry of the Environment, which were based on chemical and physical analysis of water samples. This condition could be related to the high anthropogenic stress in urban and industrial zones of northern areas. Divers were willing to take part in monitoring and contributed in scientific terms by collecting considerable amounts of data over short time periods, and in economic terms by decreasing costs. The greatest limitation was the difficulty in obtaining a uniformly distributed sample across space.

3. AUTOMATING MONITORING DATA IN ORDER TO EVALUATE WHETHER THRESHOLDS OF POTENTIAL CONCERN HAVE BEEN EXCEEDED **KRUGER, JUDITH, Matthew Jones, Mark Schildhauer**

Thresholds of Potential Concern (TPC's) form an explicit part of the Kruger National Park's (KNP) Adaptive management framework. These thresholds are determined for certain biodiversity themes with levels of exceedance or limits of undesirable change. Once these TPC's have been exceeded or predicted to be exceeded certain management actions need to be taken. To determine the current status of the biodiversity themes monitoring programs have been devised to collect data on these themes. Once this data has been collected algorithms and in certain cases complex data manipulation need to take place to establish whether the TPC has been exceeded. In order to be certain that these manipulations are repeatable a system needs to document both the data and the scripts used in these analyses. The KNP is developing an automated system whereby metadata and outputs and results of these analyses can be stored and queried through a web interface. A metadata catalogue is used to store the data and the analytic workflow software Kepler draws data directly from this catalogue and runs the r scripts. One of the biodiversity themes will be used as an illustrative example.

4. CONCEPTUAL MODEL: HARVESTING STRATEGIES OF FUELWOOD AND KRAALWOOD USERS AT MACHIBI, AND THE FACTORS THAT INFLUENCE THEM **SCHEEPERS, KELLY**

Natural resources such as fuelwood, brushwood and kraal posts play an important role in rural livelihoods. However, many woodlands and forests in South Africa have been used and managed unsustainably (where demand exceeds supply). There is a need for a better understanding of how local people determine forest and woodland ecosystems to be of use to them, particularly in terms of the natural resources they provide, and what 'usefulness' means to different groups of resources users. This is important as the ways in which people interact with their environment, and the natural resource use decisions they make, ultimately affects the well-being of current and future generations. Consequently, this paper aims to identify which factors influence people's landscape and species preferences and patterns of natural resource use at Machibi, Eastern Cape, with the aid of a conceptual harvesting model. This model integrates social and ecological systems, builds on the principles and paradigms of cost benefit analysis and optimal foraging theory, and draws on local and scientific knowledge to ensure that it is sensitive to the local context, and that any management recommendations are credible and legitimate to the local people.

5. THE SEARCH FOR ELEPHANT IMPACT MONITORING TOOLS: RESPONSES OF MISTLETOES TO ELEPHANT BROWSING IN THE ADDO ELEPHANT NATIONAL PARK, SOUTH AFRICA

MAGOBIYANE, BUNTU, Marietjie Landman, Graham Kerley

The development of appropriate indices to detect shifts in ecosystems caused by elephants is a priority for the management of this species and their impacts. In subtropical thicket elephants are associated with a range of impacts on biodiversity from soils to herbivores. We predicted that mistletoes would respond to elephant herbivory through declines in individual plant size, decreased abundance and a decline in richness. We tested these ideas by measuring mistletoe community structure in nine sites of increasing elephant occupancy (ranging from 0-52 years) in the Addo Elephant National Park, South Africa. Mistletoes were not significantly ($p=0.143$) smaller in elephant occupied areas (33 cm vs. 26 cm), but showed an exponential decline in abundance and richness, with *Viscum crassulae* disappearing in the presence of elephants. *Viscum rotundifolium* persists at very low densities in elephant habitat. These responses were rapid (a 60% decline in abundance within 6 years), and after a decade of elephant occupancy, mistletoes were too infrequent to be used as measures of elephant impact. These models show that mistletoes can be used as sensitive tools to detect short term changes brought about by elephants.

6. ESTIMATION OF BREEDING POPULATION SIZE IN ASYNCHRONOUS COLONIALY BREEDING WADING BIRDS

WILLIAMS, KATHRYN, Peter Frederick

The breeding population size of birds is often used as a biological indicator for ecosystem management. However, visibility bias and asynchrony in nesting are large potential sources of error that must be estimated in order to model the true size of avian populations. We examined visibility bias in large populations of ciconiiform birds through the comparison of aerial and ground counts of marked plots, and found that vegetative occlusion causes average estimation error in aerial surveys of -9.2% (12.2%) for White Ibises (*Eudocimus albus*), and -5.3% (43.7%) for Great Egrets (*Ardea alba*). We also used aerial survey techniques to follow individually identifiable nests through time and develop estimates of nest turnover. We used a superpopulation approach (a variation of the Jolly-Seber model) to model the proportion of breeding activity that occurs between surveys and thus is not typically included in estimates of breeding population size. Superpopulation estimates of Great Egret breeding colonies were 45%-316% greater than estimates from traditional methods. Inclusion of errors associated with both visual bias and asynchrony resulted in 1.5-3.3 times greater estimates of breeding population size than traditional methods. This new methodology has implications for many aerial monitoring projects, as accurate estimates of avian breeding population sizes are essential for making informed management decisions on both a population and ecosystem scale.

7. PRECISION OF HELICOPTER BASED COUNTS IN THICKET ENVIRONMENTS IN THE EASTERN CAPE

PEINKE, DEAN, Jan Venter

Reliable information on the size and distribution of wildlife populations is important for the sound management of protected areas, as well as for the conservation of specific species. It may be predicted that count precision will reflect habitat structure as well as the behaviour of wildlife species, and we tested this using repeat helicopter counts of wildlife in habitats ranging from closed thicket to open grassland. As expected, better levels of precision can be attained for those species which frequent more open habitats (e.g. red hartebeest) compared to those using closed habitats (e.g. bushbuck). Thus confidence in counts will vary among habitats and species. The implications are that population changes are more likely to be detected in species occupying open habitats than in species occupying closed habitats. Thus, greater effort should be focused on monitoring closed habitat species in order to detect population trends that are statistically robust.

8. DOES THE INCREASED ELEPHANT POPULATION HAVE AN ADVERSE AFFECT ON BIODIVERSITY IN THE KRUGER NATIONAL PARK?

GRANT, RINA, Laurence Kruger, Judith Kruger, Harry Biggs

The mission of the South African National Parks is to maintain biodiversity in all its natural facets and fluxes. Significant value changes involving animal rights and the value of ecosystem services led to a moratorium on elephant culling in areas where they have been successfully protected. Since this happened the elephant density has increased from an average density of 0.41 elephant /km² in 1994 to 0.66 elephant /km² in 2006. This increase in elephant density has led to concern that biodiversity may be affected as previous studies elsewhere have shown that a conversion of woodland to shrubland took place at elephant density above 0.5 elephant /km². To be able to fulfill SANParks's mission, the effect of elephant on biodiversity in its full complexity of process, function and structure, needs to be understood. A framework to evaluate these aspects traces the effects on vegetation structure and composition as a function of plant traits and elephant preferences, and the resultant knock-on effects on other species. Preliminary monitoring and research results are used to examine these hypotheses. Large trees have decreased over time, although it is difficult to relate this to elephant impacts alone. Changes in tree structure effect bird and bat diversity especially if this is associated with a loss of layers at different heights. Very little effect on rodents, amphibians and reptiles can be shown at this early stage

Alien and invasive species

9. CHEMICAL CONTROL OF SPANISH BROOM (*SPARTIUM JUNCEUM*) INVADING NATIVE GRASSLANDS: EFFECTIVENESS AND IMPACT ON NATURAL VEGETATION

SANHUEZA, CRISTINA, Sergio Zalba

Argentinean grasslands are rare ecosystems severely threatened by the advance of invasive plants. Control of alien plants often requires the use of herbicides, a management technique resisted in protected areas. This work evaluates the efficiency of chemical control of Spanish broom in a grassland nature reserve and its potential impact on non target vegetation. Experimental control was performed on three dense stands where all the brooms were cut and other not managed three. Three month before almost all the plants had re-sprouted growing as small cushions ca. 50cm tall. One-hundred re-sprouts from each cut stand were sprayed with herbicide (tryclopir+picloram) while another 100 from each uncut area remained as controls. Total vegetation cover was estimated at the moment of cutting, immediately before spraying and at two month intervals until ten months after the clearance in circular plots centered in treated and untreated plants. Ninety-nine % of the sprayed plants did not re-sprout. Total vegetation cover showed a similar behaviour in sprayed and non-sprayed areas, it was higher, however, in sprayed treatments, especially in the period immediately following cutting, and at the end of the study. These results highlight the efficiency of chemical control and its reduced impact if carefully applied.

10. MINK (*MUSTELA VISON*) ARE EATING BIRDS IN INLAND WETLANDS IN ONE OF THE LAST PRISTINE ISLAND ECOSYSTEMS IN CAPE HORN BIOSPHERE RESERVE, SOUTHERN CHILE

IBARRA, TOMÁS, Cristián Bonacic, Ricardo Rozzi, Ximena Arango

This study reports the presence and negative effects of an invasive alien species (IAS) in one of the last 37 pristine ecoregions of the World located in Navarino island (54-55° S), Cape Horn Biosphere Reserve, Southern Chile. Birds evolved in this region nesting in the ground since they lacked predators. The first report of mink presence in the island is very recent (2001) and the effect of their presence is barely known. Ground surveys in shore wetlands and inland wetlands in 4 different seasons demonstrated that mink were present in 37/47 ponds surveyed and more abundant in inland ponds. A total of 56 bird species were identified most of them migratory species arriving in September-October (Southern hemisphere spring). Birds are present in 48% of mink scats. *Chloephaga picta*, *C. poliocephala*, *C. hybrida* and other passerines are most in danger of mink predation. This project included an educational component to create social awareness of the effect of an alien species in the ecosystem and future ecotourism opportunities based on bird watching to avoid that mink becomes a charismatic species although invasive as beavers are.

11. *SCHINUS MOLLE* (PERUVIAN PEPPER TREE): REPRODUCTIVE POTENTIAL AND SEEDLING ESTABLISHMENT IN RELATION TO INVASION IN SOUTH AFRICA ECOSYSTEMS

IPONGA, DONALD M., Suzanne. J. Milton, David. M. Richardson

Some woody plants introduced to South Africa a century ago appear to have naturalised without becoming invasive, despite good climatic matching. One such species is *Schinus molle* (Peruvian Pepper Tree). This species is currently invasive in semi-arid savannas, however its potential for further invasion is not known. This study investigates seed production, dispersal and seed predation as well as seedling survival across a rainfall seasonality gradient. *S. molle* is dioecious; and the seed production average is $25\,889 \pm 1851$ / square metre for female trees. We found that there was less seed predation in the winter-rainfall region than in the summer rainfall region; however seedling densities were lower in winter than summer rainfall areas. A range of biotic and abiotic factors, including seed predation by insects and seed dispersal by birds, may interact to define the potential of *S. molle* spread in the arid savanna of South Africa. There was no evidence that disturbance helps invasion of arid savanna by *S. molle*.

12. MANAGEMENT OF INVASIVE SPECIES FROM MULTIDISCIPLINARY PERSPECTIVES

LIU, TZU-MING

Invasive species have been quickly spread around the world intentionally or accidentally by human activities. Research projects in different discipline areas have been developed to control bio-invasion yet the number of invasive species is still expected to increase in the future. This gap may be the result of control plans lacking interdisciplinary considerations. I conducted a review of literature from ecology, economics and other disciplines in order to synthesize recommendations on invasive species control plans. Three major findings were uncovered through this research. Firstly, tariff and other trade barriers act as limits for small economies and developing countries to control invasive species. Next, live release, often associated with religious activity of releasing animals into the wild, is an important cause of invasive species introduction. Lastly, ecological factors, such as Allee effects, are rarely included in analyses of control policies. Based on these findings, I recommend that developing countries should form regional trade agreements and implement inspection and surveillance to improve the effectiveness of invasive species control. Religious and ethnic groups' roles in preventing bio-invasion should be addressed. To incorporate results of ecological research into control plans can increase benefits and mitigate negative externalities of control. Restoration of disturbed ecosystems invasive species is also crucial for success of invasive species management.

13. DISAPPEARING FORESTS: IMPACTS OF HYPERABUNDANT NON-NATIVE HERBIVORES ON BOREAL FOREST REGENERATION

HERMANUTZ, LUISE, Brian McLaren, John Gosse

Hyperabundant herbivores have caused serious negative impacts on forests, often resulting in alternate regeneration trajectories. On the island of Newfoundland (Canada) moose (*Alces alces*) was introduced 100yrs ago and in the absence of the main predator (wolves *Canis lupus*) have reached densities 10X that of its mainland range. In addition to moose, a suite of other non-native animals (e.g., red squirrel (*Tamiasciurus hudsonicus*, a seed predator) were also introduced. In existing balsam fir (*Abies balsamea*) dominated forest, 95% of understory fir trees are stunted by moose herbivory to 30 cm, a problem compounded by competing vegetation. Seedling recruitment has not been detected in 10 years of monitoring. Increased competition with regenerating hardwoods shielded from moose browsing by experimental fencing causes prolonged stunting of balsam fir even in areas where it occurs in sufficient density to become dominant. In no areas has fir 30 cm been measured at 1,000 stems per ha, confirming that the regeneration trajectory has been changed to an alternate state dominated by dense deciduous hardwood species. Measurements of up to 5% per year mortality in overstory fir trees together with the lack of seedling recruitment and insufficient seed production suggest that within two decades this species will be eliminated. Restoration using tools such as planting and moose reduction will be necessary for forest recovery.

14. CAN INVASION BY THE NON-NATIVE PLANT *CIRSIIUM ARVENSE* (CANADA THISTLE) SUPPRESS NATURAL REGENERATION IN BOREAL FORESTS?

HUMBER, JESSICA, Luise Hermanutz

Canada thistle (*Cirsium arvense*) is an aggressive, invasive non-native weed commonly found in agricultural fields, roadsides and rangelands throughout North America. However, it has recently invaded the balsam fir (*Abies balsamea*) -dominated boreal forests in Gros Morne National Park, Newfoundland (Canada), where it has been documented to occur in near-monocultures in 40-55% of disturbed forest plots. These forests are heavily browsed by hyperabundant moose (*Alces alces*) which suppress sapling recruitment, allowing these shade-intolerant weeds to persist. To evaluate the effects of Canada thistle on balsam fir regeneration, twenty sites disturbed by domestic cutting (n=10) and natural processes (n=10) were selected for a fir seed-addition experiment; half of the sites contained thistle. Fir seeds planted into forest edges (control) and disturbed seedbeds lacking thistle had higher rates of emergence ($38.8\% \pm 48.8\%$ (SD) and $34.7\% \pm 47.7\%$, respectively) than seeds planted into thistle monocultures ($10.6\% \pm 30.9\%$) and areas where thistle was removed by cutting or digging as potential restoration methods ($11.3\% \pm 31.7\%$ and $14.4\% \pm 35.2\%$, respectively); however, emergence was variable among sites and may reflect allelopathic effects. Seedling survival was higher in naturally-disturbed sites than in domestic cuts. Not only must excessive moose browsing be reduced, but Canada thistle must also be eradicated to restore forests within this National Park.

15. *LANTANA CAMARA* AN INVASIVE WEED; INDIGENOUS TRIBES OF SOUTH INDIA ARE JUDICIOUSLY CONVERTING THIS WEED INTO VALUABLE PRODUCTS RAMESH, KANNAN, Gladwin Joseph, Uma Shaanker.R

Lantana camara is an invasive shrub originally from Latin America. It was introduced into India as an ornamental plant in 1807. Since then, this perennial flowering shrub has invaded virtually all possible habitats in India, and has become a menace to forest managers, forest dwellers and farmers. Soligas an indigenous tribe of MM hills in South India were traditionally bamboo basket weavers, and more than 60 percent of their income was derived by basket weaving. Once bamboo resources were depleted by indiscriminate industrial extraction, they became marginalized. Need for an alternative raw material forced them to find locally available resources and the appropriate technology to use it. The Soligas showed a resilient spirit, and when they found *Lantana camara* could be an alternative they started fabricating furniture out of *Lantana*. Stems of *Lantana* ranging from 1cm to about 9cm girth are used for making a variety of articles ranging from waste paper baskets to pen stands to furniture. The stems most suitable for furniture making are those which are long, with little branching and longer internodes. There are 80 families involved in this *Lantana* furniture making at present. Their income level has increased from \$14 per month to \$67 per month. The livelihood improvement is also reflected in the number of working days, which have increased two fold by *Lantana* furniture enterprises. There are reliable markets for the *Lantana* products in rural as well as in urban areas.

16. Withdrawn

17. COMMUNITY BASED MANAGEMENT OF *PROSOPIS JULIFLORA* AS INVASIVE SPECIES IN GABEL ELBA PROTECTORATE, EGYPT MOHAMMED, USAMA

A study on invasion process of *Prosopis juliflora*, a leguminous species introduced to Gable Elba protected area (GEPA) in Egypt, Was carried out in GEPA as Egypt's most important protected area. During the last 20 years this area has been faced the risk of invasion by *Prosopis juliflor*. The goal of my research to identify the areas of invasion, reasons and impact of *Prosopis* invasion and to explore with local community the applicable solutions. With participation of local community, we conducted ethno-botanical study, using PRA to identify historical stages and invasion paths. An ecological study was conducted, the population of *Prosopis* we analyzed in forty plots, in each plot we estimated density, total coverage, total basal area, and estimated a nutrient and organic content for *Prosopis* and soil. We found that mesquite was introduced by community for agro forestry in Halaib area after 1985, has been spread by camels grazing and along a trade track between Egypt and Sudan, and has serious impacts on structure of plant communities within GEPA, depending on their biological characteristics. Base on results we recommended a trans-boundary management plan for *Prosopis* and community-based follow-up monitoring program for detection and controlling the invasion.

18. ASSESSING LOCAL SCALE IMPACTS OF *OPUNTIA STRICTA* (CACTACEAE) INVASION ON ARTHROPOD ASSEMBLAGES IN THE KRUGER NATIONAL PARK, SOUTH AFRICA

HARRIS, KYLE, Berndt Janse van Rensburg, Mark Robertson, Julie Coetzee

In the Kruger National Park (KNP), South Africa, introduced prickly pear (*Opuntia stricta*) has invaded some 30 000 ha of conserved land and its effects on biodiversity are a major cause for concern. We investigated the effects of different levels of infestation of *O. stricta* on Coleoptera species assemblages in the Skukuza region of the KNP using unbaited pitfall traps over a 12-month period. Species characteristic of each infestation level (indicator species) and species able to predict the change in intensity of infestation levels (detector species) were identified using the indicator method (IndVal). A total of 2160 Coleoptera individuals were collected representing 72 species in eleven families. Species richness was found to be significantly higher in high infestation sites compared with medium infestation sites and control sites. There was no significant difference in species density across the treatments. No species fulfilled the criteria for the indicator and detector species concept. We found that Coleoptera species richness is affected by *O. stricta* infestations. This finding is in direct contrast with the primary objectives of the KNP, which is to minimize the effect of invasive alien plants and maintain the integrity of indigenous biodiversity.

19. CONTRASTING FUNCTIONAL TRAITS BETWEEN NATIVE AND EXOTIC CALIFORNIA PLANTS

Broitman, Bernardo R, Elsa E Cleland, SEAN M WATTS

Exotic species that both disperse and establish well in novel communities appear to violate long-standing theories of trade-offs between colonization and competition. We divided a random subset of 957 species from the California flora into four life forms: annual, herbaceous perennial, sub-shrub, shrub/tree. Small seed size was a proxy for high dispersal and plant height for competitive ability. Positive correlations between seed size and plant height (both native and exotic) suggest that all species are subject to basic colonization-competition trade-offs. We further evaluated traits among the four most speciose families. In general, exotic species had greater plant heights- particularly in the Fabaceae (legumes). With the exception of the Poaceae, seed sizes did not differ between natives and exotics. For the Fabaceae, this implies that exotics achieve greater biomass across life forms, while maintaining dispersal ability. For exotic Poaceae, the production of smaller and presumably more easily dispersed seeds, while maintaining competitive adult sizes suggests another advantageous breakdown in tradeoffs. These simple yet fundamental axes of plant lifetime performance integrate ecological and phylogenetic constraints and may thus be a useful model to forecast consequences for native floras of shifts in ecological conditions, such as those imposed by exotic species introductions.

20. INVASIVE WEEDS THREAT TO THE BIODIVERSITY - A CASE STUDY FROM DISTRICT BANNU NORTHWEST PAKISTAN

KHAN, IKRAMULLAH, Khan Bahadar Marwat

Due to a diverse climate, Pakistan is rich in both agricultural and wild biodiversity including a wide variety of crops and medicinal plants. These indigenous plants are used by local people for different ethnobotanical purposes including medicine, nutrition, and shelter. Besides the effects of factors such as insects, pathogens and nematodes, flooding, and water scarcity on native biodiversity, invasive species are playing a devastating role. Between March 2002 and September 2003, we surveyed 200 farmers from 30 villages in the Bannu District of North West Frontier Province (NWFP), asking about Invasive weeds. Ten species of weed were reported as invasive. These were *Avena fatua*, *Carthamus oxyacantha*, *Prosopis juliflora*, *Eucalyptis camaldulensis*, *Phragmites australis*, *Xanthium strumarium*, *Galium aparine*, *Asphodelus tenuifolius*, *Imperata cylindrica* and *Trianthema portulacastrum*. Of these *Prosopis juliflora* and *Eucalyptis camaldulensis* were purposely introduced. The remaining species were either introduced accidentally or were present in the local flora, but became invasive due to changes in the ecosystem. Due to the aggressive behaviour of these species our local biodiversity including endemic species are at risk of extinction. To conserve the native biodiversity we should control the existing species and prevent the introduction of invasive species in the future.

21. POPULATION GENETICS OF TWO INVASIVE RODENTS (*RATTUS NORVEGICUS* AND *MUS MUSCULUS*) IN THE GALAPAGOS ISLANDS, ECUADOR
HENRY, TAMMY, Michael Jarcho, Cody W. Edwards, Robert C. Dowler, R. Brand Phillips, Howard L. Snell

The large number of unique species on the Galapagos Islands have led to its designated as a UNESCO World Heritage Site and Biosphere Reserve as well as a part of the Tumbes-Chocó-Magdalena biodiversity hotspot (CI). Although most of the land is protected within the Galapagos National Park, the ever-growing human population is impacting the biodiversity of the Islands, especially with modern technology making these islands readily accessible despite being located 1000 km west of the Ecuadorian coast. Ecotourism and human activity have led to the introduction of several invasive rodent species. These species have been linked to the rapid decline and even extinction (three species) of endemic rodents on the islands. Although *Rattus rattus* is distributed across much of the archipelago, the distributions of *Rattus norvegicus* and *Mus musculus* are still limited. The impact of these species can be minimized/reduced if their dispersal patterns within the archipelago can be determined. This study investigates the genetic diversity and dispersal patterns of *R. norvegicus* and *M. musculus* using six microsatellite loci. Our study included a total of 43 samples of *R. norvegicus* (from three islands) and 93 samples of *M. musculus* (from seven islands). Discussion will include genetic structure of invasive rodents in the Galapagos Islands and information for management, containment, and possible eradication of these invasive organisms.

22. CORRIDOR INTERCHANGE AND FOUNTAIN GRASS (*PENNISETUM SETACEUM*) SUCCESS IN SOUTH AFRICA
RAHLAO, SEBATAOLO, Karen Esler, Suzanne Milton, Phoebe Barnard

Roads and rivers are corridor systems that transport fountain grass (*Pennisetum setaceum*) seeds, an alien invasive perennial grass from the Mediterranean North Africa and the Middle East. When these systems interact at disturbed road-river crossings, they exchange the grass seeds that fly and float. Spot recordings of fountain grass along major roads in the semi-arid rangelands of South Africa using drive-by surveys were undertaken. The corridor interchanges form about 10 percent of the total distance travelled but host larger plants with more flower heads than the non-interchanges. Road-river crossings are relatively inaccessible and hence protected from the routine roadside management; they maintain a continuous supply and exchange of fountain grass seeds. The soil used (landfill) for building these bridges is a potential source of propagules and is suitable for recruitment, and there is little competition if fountain grass is among first colonizers. Also, there is extra moisture and nutrients from debris deposited by rivers beside bridges. All these factors may maintain successful fountain grass populations on these interchanges. We conclude that the more frequent the interchanges, which provide optimal recruitment opportunities, the greater the invasion risk for this grass.

Amphibian and reptile conservation

23. PROPOSED MINING IN A BIODIVERSITY HOTSPOT: EFFECTS ON AMPHIBIANS
Kouamé, N'goran Germain, CALEB BOATENG OFORI, Mark-Oliver Rodel

The Atewa range forest reserve, one of the few remaining pristine montane habitats in Africa is currently in the focus of planned mining activities. We assessed the amphibian diversity of the Atewa Range Forest Reserve in Ghana, West Africa, using both visual and acoustic opportunistic survey techniques. We recorded a total of 32 species, but predict that overall species richness of the area can be expected to reach 40-50 species. The amphibian community is exceptional by a) an extremely high proportion of threatened species (1/3) b) being the habitat for the possible largest remaining population of the Critically Endangered species (*Conraua derooi*) c) having a species mixture that is so far only known from either East or West of this site, and d) a very high percentage of species that are endemic to the Upper Guinea forests. The Atewa range represents an outstanding site for the maintenance of West African amphibian diversity in particular and outstanding biodiversity in general. We recommend an upgrading of its protection status to a national park and conclude that any mining activity in this area would have catastrophic effect to this ecosystem of national and regional importance.

24. CONSERVATION OF ENDEMIC CHAMELEONS IN KARST FOREST OF WESTERN MADAGASCAR

RANDRIANANTOANDRO, CHRISTIAN, Roma Randrianavelona, Raphali Andriantsimanarilafy, Richard Jenkins

Madagascar had three endemic genera of chameleons, *Furcifer*, *Calumma* and *Brookesia* and many taxa are threatened by deforestation and illicit collection for the pet trade. We studied the habitat preference and distribution of chameleons in Tsingy de Bemaraha National Park, western Madagascar, using nocturnal transects during 2006. The two endemic species to the park, *Brookesia perarmata* and *Brookesia exarmata*, were most abundant in relatively intact forest whilst *Brookesia brygooi*, a relatively widespread species in western Madagascar, was most abundant in degraded forest. *B. perarmata* (VU, CITES Appendix I) was only found in the north of the park and was only abundant in the east of its range. *Furcifer nicosiai* was found in low abundance in the forest. Longitudinal differences in *B. perarmata* abundance appear to be related to habitat structure and collection pressure whilst its absence from the south of the park can probably be explained by physical dispersal barriers. Conservation of wild populations of *B. perarmata* requires the maintenance of remaining intact forest within the reserve and a coordinated plan with local government, transport agencies and conservation groups to reduce the collection pressure from the remote western flank of the national park.

25. SUBMERGENCE DYNAMICS OF *ALLIGATOR MISSISSIPPIENSIS*

BUGBEE, CHRISTOPHER, Kenneth Rice, Frank Mazzotti

Biannual alligator surveys are currently carried out in the Greater Everglades Ecosystem to monitor population changes resulting from restoration efforts. Methods are being developed to estimate rates of detectability of alligators during these night-light surveys. The objective of this study was to obtain information on alligator submergence behavior and to relate such behavior to a variety of environmental variables such as season, time of day, water level, air and water temperature, wind, solar radiation, moon phase, atmospheric pressure, and rainfall. To meet this objective, we examined twenty-eight alligators for a total of eight months in the interior wetlands of Arthur R. Marshall Loxahatchee National Wildlife Refuge in western Palm Beach County, Florida, U.S.A. Radio transmitters were designed to emit different signals depending on whether or not they were submerged, and a fixed receiver continually recorded the status of all transmitters. Submergence data was correlated with weather data and analyzed using a repeated measures logistic regression in the statistical program SAS. The results indicate that the study animals spend approximately two-thirds of their time underwater, and that water level, air and water temperature, time of day, and moon phase are all statistically significant predictors of whether or not an alligator is submerged. These results will be quantitatively applied to current alligator survey methods to improve their accuracy and reliability.

26. EXTENDING CHELONIAN RESEARCH, EDUCATION AND CONSERVATION IN SOUTHWEST CAMBODIA

SUN, YOEUNG David Emmett, Sitha Som, Chamnan Kim, Sokhorn Kheng, Kagna Chea

The distributions of many species are uncertain owing to a lack of records and because almost no records exist for wild tortoises or turtles. Previous research found 10 species in Cambodia. Chelonian species are extremely threatened (local consumption, trading for market demand). The goals of the 2005-06 follow-up project was to further find out the distribution, abundance, threats, habitat occurrence and to raise awareness to local people and the publics. The project's components: 1.) education university and local students, village committee, authorities, and government rangers, 2.) research on the endangered *Indotestudo elongata*, *Pelochelys cantorii*, *Hieremys annandalii*, *Platysternon megacephalum*, and *Manouria impressa* and 3.) creating national working group to collect all turtle and tortoise information through meeting between government, NGOs, and rangers. Till now we found 222 shells and 56 live individuals of nine species, of which all of them are globally threatened, and two that have never been recorded in Cambodia (*Manouria impressa* and *Platysternon megacephalum*) adding to the 10 species. The species include: *Hieremys annandalii*, *Indotestudo elongata*, *Manouria impressa*, *Heosemys grandis*, *Siebenrockiella crassicolis*, *Cuora amboinensis*, *Amyda cartilaginea*, *Platysternon megacephalum*, and *Cyclemys atripons*. Also, we did two training courses on turtle identification to rangers, a course to university students, and three training courses for local students.

27. NEW DATA'S OF CONSERVATION AND DISTRIBUTION OF THE CRITICALLY ENDANGERED DAREVSKY'S VIPER (*VIPERA DAREVSKII*) IN ARMENIA

LEVON, AGHASYAN, Boris Tuniev , Natalia Ananjeva, Aram Aghasyan

With the aid of research which included range clarification, studies of distribution, GIS mapping, with further extrapolation of habitat was clarified the area of this species with new record sites which was main aim of this project. The area covered the south-eastern part of the Javakheti Ridge in extreme north-west of Armenia near the border with Georgia. As a species with limited range, Darevsky's viper is listed in 2006 IUCN Red List of Threatened Species as a category CR C2b. The key factor of existence is availability of flat stone plates on the screes which create appropriate microclimate for vipers in harsh highland conditions. Land use for agriculture (pastures, hay grounds etc.) and high selectivity of this snake for habitat quality (subalpine meadows at elevations 2600-3000 m) make this species more vulnerable. There was considered possible ways of genesis of three species (*V. kaznakowi*, *V. dinniki*, *V. darevskii*) of the complex *Vipera kaznakowi*, and there was given analysis of phylogenetic relationships of these vipers. We provide new information about morphology, activity, reproduction and snake ecology, the principal threats and consider the possible mitigation and ways. The home ranges are suggested for the spatially focused conservation measures. The results and recommendations on conservation are particularly valuable in light of the governmental plan to establish the transboundary Arpi Lich National Park in 2007 under financial support of KfW.

Bird conservation

28. AN ARTIFICIAL BREEDING ISLAND FOR FLAMINGOS AT KAMFERS DAM, KIMBERLEY, SOUTH AFRICA

ANDERSON, MARK

Kamfers Dam is home to the largest permanent population of flamingos in southern Africa, supporting c. 20,000 Lesser Flamingos. Lesser and Greater Flamingos have attempted to breed at the dam, but these attempts have been unsuccessful due to a receding water level and disturbance by people and dogs. The Lesser Flamingo is globally near-threatened, mainly due to anthropogenic changes to its three African breeding sites (Sua Pan, Etosha Pan and Lake Natron). In order to promote the species' conservation, a 25x250 m breeding island was constructed at Kamfers Dam, the first such island in Africa and the third in the world. The island is S-shaped with the long-axis facing into the prevailing wind, thus limiting erosion by wind and wave action. Two sheltered bays with gentle slopes allow the flamingos easy access onto the island. It was constructed with 26,500 tons of material, mainly calcrete, but also a 200 mm topping of clay/sand. Four large ponds are fed from a submerged water pump, thus providing mud for nest construction. 1000 artificial nest turrets were also constructed; hopefully the stimulus that will encourage early breeding, thus contributing to the conservation of Lesser Flamingos in Africa. Kamfers Dam also has potential tourism and economic benefits for Kimberley.

29. WHAT FACTORS ARE LIMITING BREEDING SUCCESS OF THE GLOBALLY THREATENED IMPERIAL EAGLE IN HUNGARY?

HORVATH, MARTON, Andras Kovacs, Ivan Demeter, Tamas Szitta, Gabor Firmanszky, Imre Fater, Bela Solti

Recently an intensive shift was observed among the main breeding habitat types of the globally threatened Imperial Eagle *Aquila heliaca* in Hungary. Till 1988 only forested mountain habitats were used, but recently population switched mainly to lowland agricultural areas (76% of the 81 breeding pairs in 2006). We have evaluated 346 breeding attempts of 65 pairs. The proportion of successful breeding attempts was lower among lowland pairs (64% vs 78%), but if they succeed, they could raise significantly more fledglings than did the mountain pairs (1.75 vs 1.43). During a field study executed in 2003-2004 we have found that human presence was the main cause of failures and it was significantly higher around lowland nest sites during incubation period (24.2% vs 1.6%). On the other hand lowland pairs spent significantly less time with hunting, but brought more prey to the nest. The proportion of the most optimal prey species (brown hare) in the diet was correlating with breeding success and it was significantly higher in lowlands (31.8% vs 8.4%). These data suggests that the main limiting factors are different in the two habitat types, while available prey sources are limiting the number of fledglings in mountains and human disturbance is limiting lowland hatching success. We suggest that supplementary feeding in mountains and restriction of human activities

around lowland nest sites can significantly increase the overall breeding success of imperial eagles in Hungary.

30. CONSERVATION STATUS OF ABERDARE CISTICOLA *CISTICOLA ABERDARES* IN MAU NAROK / MOLO GRASSLANDS ADHIAMBO, PHILLISTA, Mercy Ojoyi

The Aberdare Cisticola is listed as globally endangered in the IUCN red list. It inhabits moist highland grassland on both sides of the Rift Valley, at Molo, Mau Narok and the Aberdare mountains, in Central Kenya. The species is threatened by rapid habitat loss and fragmentation due to expanding agriculture. We carried out surveys on the current population, habitat extent and threats facing the species. Total population was 195 birds with a density estimate of 3.8 individuals/km² in Molo and 2.6 individuals/km² in Mau Narok. Results showed that good numbers of the species exist in the remnant grasslands of the IBA. The species occurred in grassland patches surrounded by cultivated land, which were greatly isolated from other grasslands. They were concentrated in a few grassland remnants into which they are pushed by unfavorable land uses that now occupy larger proportions of the IBA. The importance of the IBA for other grassland bird species was established by the abundance and diversity of grassland species recorded during this survey. This was exhibited by the common occurrence of the Near-threatened Jackson's Widowbird, Sharpe's Longclaw and other grassland specialties. Other non grassland species recorded were the great Crested Grebe also regionally threatened (Critically) and Maccoa Duck were encountered. There is great need for advocating for the conservation of these IBA. There is need to increase more efforts in monitoring, raising awareness and making crucial contacts for formation of a Site Support Groups as crucial steps towards this direction. This survey recognized the urgent need for more thorough ecological studies.

31. DOES BUSH ENCROACHMENT IMPACT ON FORAGING SUCCESS OF THE CRITICALLY ENDANGERED NAMIBIAN POPULATION OF CAPE VULTURES? SCHULTZ, PHILIPPA, Rob Simmons, Peter Ryan

The Namibian population of the Cape Vulture *Gyps coprotheres* has declined from around 500 birds in the 1940s to a current low of 12 birds. Secondary poisoning is most likely the primary factor responsible for this decrease, but bush encroachment also has been suggested to contribute to the collapse of this population. We tested the impact of increased bush density on the foraging success of the Cape vulture by two methods: 1) measuring the time taken for birds to locate carcasses put out in differing levels of bush density and 2) using PTT satellite data to find carcasses scavenged by Cape vultures and measuring bush density at these sites. There was a strong correlation between bush density and time taken to find food ($R^2 = 0.663$, $n=16$), with vultures failing to locate most prey in areas of dense bush cover. The maximum bush density that vultures located food in was 2210 trees.ha⁻¹. A total of 24 carcasses were located using the satellite data derived from three adult male Cape vultures. Kudu were the most common prey item ($n=13$), followed by cattle (4), eland (2), oryx (2) and horse (1). Most (16) carcasses were found in open habitats (2000 trees.ha⁻¹). Both results suggest that bush density is a key factor for vulture foraging success, and support the hypothesis that bush encroachment has adversely affected this population.

32. RELATIONSHIP BETWEEN POPULATIONS OF SOME TRANS-SAHARAN MIGRATORY BIRDS BREEDING IN NORTHERN ITALY AND NDVI IN THEIR WINTER GROUNDS BANI, LUCIANO, Dario Massimino, Valerio Orioli, Luca Moiana, Renato Massa

Recent studies showed that population of trans-saharan migratory birds that breed in Palearctic may be strongly influenced, amongst other causes, by meteorological conditions in wintering grounds which, in turn, can affect mortality and reproductive success. As weather conditions influence primary production, we analysed the relationships between the Normalized Difference Vegetation Index (NDVI) and the populations of twelve bird species breeding in Lombardy (Northern Italy) and wintering in sub-saharan Africa. Trends of breeding populations were also evaluated for the period 1992-2005. Two species showed a significant correlation between their population and the NDVI of the immediately preceding wintering season, which may be explained by an influence of weather on mortality rate in wintering grounds. For another seven species population level was found to be significantly correlated with the NDVI of the previous year's wintering season, suggesting that weather in wintering grounds may affect birds physiological conditions and, therefore, individual performance and productivity whose effects on population are measurable in the following year. Five out of nine species showed a positive correlation with the NDVI, while the other four

were negatively correlated. Although NDVI did not have a significant trend in the period considered, most species breeding in open and ecotonal areas showed a population decline.

33. PRELIMINARY OBSERVATIONS ON NESTING ACTIVITIES OF THE AFRICAN GREY PARROT IN THE FOREST RESERVES OF BUDONGO AND THE SSESE ISLANDS, UGANDA

AMUNO, JOHN-BOSCO, Renato Massa

The breeding biology of the African Grey Parrot is poorly known in the wild. A few nests of the African Grey Parrot have been reported but no detailed observations were reported. Most of the information on reproduction in the African Grey Parrot is known from captivity, and whereas such information may be useful in understanding the general biology and behaviour of the species, they are unlikely to provide information that is needed for the design and implementation of conservation programmes for populations in the wild. The objective of our study was to assess the requirements and process of the nesting behaviour of the African Grey Parrot in the wild. We visited the forest reserve in Budongo and the Ssesse Islands between September 2005 and February 2006 to make observations on the nesting behaviour of the species. Tree species most used by the African Grey Parrots was *Celtis melbeadi* (52.9%) followed by *Alstonia boni* (11.8%) and least used were *Piptadeniastrum sp* and *Albizia sp* (both 5.9%). All cavity trees branched above half their heights indicating that they all grew in a closed canopy primary forest. The average nest height was 23.9m (n=11), the tallest nest being 29.0m. And the average tree circumference was 419.5cm (n=11) (Largest 605.0cm and smallest 200cm). In all cases, 90.9% of the nest cavities were located above tree mid-height while 90.1% of nest cavities were located below the first branch. We observed that nest preparation before laying of eggs often took place with adults throwing out debris & soil from a nest cavity. Exaction of a tree trunk by the Greys was also observed. Moving out of a nest followed a predictable pattern, with time between 11.00am and 4.00pm being spent in the nest. As chicks grew and the demand for food and protection increased, breeding pairs returned to the nest more regularly. Chicks that fledged were between 2 and 4 per nest (average 2.6, n=3). From this study, the nesting requirements of the African Grey Parrots are seen to be more specific, with trees being those of old forests. Management of forest stands would play a major role in enhancing the breeding populations of African Grey Parrots in the wild.

34. UNDERSTANDING THE MOVEMENTS OF WATERBIRDS IN SOUTHERN AFRICA: CAN OUR MOST COMPREHENSIVE DATASETS REVEAL THE PATTERN? THOMAS, HANNAH, Philip AR Hockey, Graeme S Cumming

In southern Africa, many waterbirds are nomadic or highly dispersive. Understanding their movement patterns is important for population and habitat management, as well as for predicting and managing the spread of pathogens such as avian influenza. Co-ordinated monitoring programmes and databases, such as the Atlas of Southern African Birds (SABAP), South African Bird Ringing Unit (SAFRING), and Co-ordinated Waterbird Counts in South Africa (CWAC) have aimed to provide information about avifaunal densities, distributions, and movements. We used Red-billed Teal (*Anas erythrorhynchos*) as a focal species for interrogating these datasets to determine whether they supported conclusions drawn from published studies. Monthly counts from sites across the sub-region suggest that high spatial and temporal variation in teal abundance may be related to an east-west seasonal rainfall gradient. SABAP data revealed no evidence for seasonal redistributions, since purely presence/absence records masked the amplitude of abundance. SAFRING data provided clear movement vectors but biases in ringing and recovery sites, combined with low recovery rates, made it impossible to draw significant conclusions about seasonal movements. Bi-annual CWAC counts were uninformative because the count timings did not coincide with the peaks of teal abundance across climatic zones. These results demonstrate some of the weaknesses of large-scale monitoring efforts that lack finer-detail research objectives. Future monitoring protocols could be improved by incorporating abundance and sampling effort estimates into SABAP, broadening the geographical coverage of SAFRING, and improving the temporal resolution of CWAC through quarterly counts.

35. STATUS AND BREEDING NOTES OF THE ENDEMIC SICHUAN WOOD OWL (*STRIX DAVIDI*) AT LIANHUASHAN, GANSU, CHINA FANG, YUN, Wolfgang Scherzinger, Yue-Hua Sun

Supported by a conservation programme sponsored by British Petrol (BP), 40 nest boxes were mounted in suitable habitat at Lianhuashan Natural Reserve, Gansu in 2002-2003, which enabled close observation of breeding success of this rare species in 2005 for the very first time. The first pair bred laid 2 eggs in a nest

box and both young were fledged. In 2006, we documented the breeding habit and the territorial song of the owls by photo and tape recordings. We obtained recordings of 3 territorial males, 2 females and 2 freshly hatched young ones. In late May, one male was detected at the rocky mountain ridge to the south, where a female also approached. The calling and begging of both sexes, as well as the records of droppings and pellets clearly hint that an active breeding site is in this area. Two young owls were detected in the crown of a tall spruce tree, situated directly at the base of a vertical precipice, on which was thought to be their nest site. Due to the small remaining patches of mountain forests, the habitat of this owl is extremely threatened by fragmentation. The 4700 ha of natural woodland in the reserve forms a distributional relict of great importance with the help of the nest boxes, which will hopefully allow the survival of this nearly unknown owl.

36. EFFECTS OF GREAT WHITE PELICAN PREDATION ON THREATENED SEABIRD SPECIES

MWEMA, MARTIN MUSANGU, Peter Ryan, Marta de Ponte Machado

Great White Pelicans, *Pelecanus onocrotalus*, feed mainly on fish and other aquatic organisms, but in southern Africa, birds breeding at offshore islands also feed on chicks of seabirds. This behaviour apparently has increased in recent years, leading to concerns that pelicans may be negatively impacting threatened seabird populations. This study assesses the effect of pelican predation on five seabird species at Dassen Island. We recorded the number of chicks eaten and monitored breeding success among Kelp Gulls, and four species of cormorants. We observed predation of chicks of Kelp Gulls as well as Cape and Crowned Cormorants. Pelicans may also have caused some mortality of Bank and White-breasted Cormorant chicks. Breeding success of all species was low, with at most 5.3% of Kelp Gull chicks fledging successfully. Only Eight chicks from 250 Crowned Cormorant nests and 11 chicks from 24 White-breasted Cormorant nests fledged successfully. All Cape Cormorant and five of eight Bank Cormorant nests were abandoned due to rough seas and pelican predation. Pelicans greatly reduced the breeding success of Kelp Gulls, and Cape, Crowned and possibly Bank Cormorants breeding at Dassen Island in 2006. The three cormorant species are endemic to the Benguela Upwelling Region, and all are globally threatened or near-threatened. Pelican predation increases pressure on these species hence management action should be considered to halt the increase in pelican numbers.

37. CONSERVATION PLAN OF THE ARARIPE MANAKIN *ANTILOPHIA BOKERMANNI* A CRITICALLY ENDANGERED BIRD FROM NE BRAZIL

Campos, Alberto, Weber Girão, THERES PINTO, Ciro Albano

The Araripe Manakin is a Critically Endangered bird endemic to the moist forests in the slopes of the Araripe plateau, Ceará State, NE Brazil. Five years of systematic field research have led to a reevaluation of its conservation status, including population estimates, increased range, genetic variability, habitat evaluation, ecology, reproductive biology and major threats to the species and its habitat. Research results were summarized and presented to stakeholders and environmental authorities, and were thoroughly discussed in order to produce a strategic planning presented as a Conservation Plan. The Plan lists 21 priority actions aimed at, in the short term, to avoid the extinction of the species, and in the medium to long term, to increase environmental quality and to promote the recovery of its limited remaining habitat. Top priority actions include: the creation of a fully protected area (including the remaining habitat of the Araripe Manakin, surrounding areas with potential for recovery, and a buffer zone, which were mapped in detail); the integrated management of this fully protected area with the existing 'sustainable use' protected areas; conduct a recovery program for the water resources in the slopes of the Araripe plateau, including the protection of springs, the recovery of gallery forests and original water dynamics; improve the existing tools to increase the participation of local stakeholders in the conservation process.

38. EFFECTS OF HABITAT STRUCTURE AND ALTITUDINAL GRADIENTS ON AVIAN SPECIES DIVERSITY AT KURRA FALLS FOREST, NIGERIA

LONGTONG GARBA, TURSHAK, Shiwua Manu

How does habitat structure and altitudinal gradients affect species diversity in savannah woodland of north central Nigerian forest interspersed with gallery forest, patches of grassland, and rocky outcrop? Line transect technique was used to register avian composition of the study site and habitat variables were measured. A total of 175 bird species were recorded, two of which are among the four endemic birds to Nigeria, Rock Firefinch (*Lagonosticta sanguinodorsalis*) and the Jos Plateau Indigobird (*Vidua marye*). Tree height, density of trees, and percentage canopy cover interacted together had a significant effect on bird

species diversity and this led to the conclusion that these habitat variables are perhaps crucial to the continued survival of bird species diversity in the study area. Altitude had no significant effect on bird species diversity although there was a slight decline of bird species diversity with higher summit. This perhaps indicates that altitudinal gradients in the study area are not sufficiently heterogeneous to cause any significant variations in species diversity across spans of altitudes.

39. SPATIAL DISTRIBUTION AND ACTIVITY PATTERN OF THE GREY-CRESTED HELMET-SHRIKE *PRIONOPS POLIOLOPHUS* AND IMPLICATION FOR THEIR CONSERVATION IN NAIVASHA, KENYA

ADHIAMBO, PHILISTA, Muchai Muchane, M Balakrishnan

The Grey Crested Helmet Shrike is an East African endemic bird species which is globally threatened and vulnerable due to its small range and declining population. The current study examined its spatial distribution and activity pattern in the woodlands around Lake Naivasha, Kenya. Spatial distribution was assessed by identifying the different vegetation types and use by the species monitored. The proportion of each vegetation type in the study site was estimated and habitat selectivity calculated. Observations were made by focal scan samples for all the groups that were observed and their activities monitored for diurnal patterns. Results showed species preference for *Acacia xanthophloea* woodlands and *Tarconanthus camphoratus* shrublands, forming extensive corridors with a high canopy cover and herbaceous undergrowth. The shrikes preferred to forage in dense areas within the *Acacia xanthophloea* woodland and *T. camphoratus* bush habitats with herbaceous cover. Feeding was the principal day time activity. They showed responses to all kinds of predatory threats by eliciting alarm and flight calls and were cooperative in all their activities. The study recommends specific management and conservation plans while providing baseline information on which sound conservation and monitoring strategies of the species and the habitat can be developed.

40. EDGE EFFECTS AND UNDERSTORY BIRDS: HOW IT HAPPENS IN PATCHES OF SECONDARY VEGETATION IN THE ATLANTIC FOREST

Banks, Cristina, JEAN PAUL METZGER

The Atlantic Forest is a Biodiversity Hotspot. It was reduced to nearly 8% of its original area and it is now mainly constituted by fragments of secondary forest, where patch borders do not differ significantly in vegetation from forest interiors. In this context, it is important to evaluate the existence of edge effects at patches, aiming at how it influences the bird community. To address this question, we studied 8 patches in a highly forested region in the São Paulo State, Southeastern Brazil. In each patch we simultaneously sampled understory birds in two sites, one 5 m close to the edge, following its contour, and another around 50 m away from any patch border. At each site we used ten 12 m mist-nets to accomplish 510 net/hours. Wilcoxon tests were used to evaluate differences in bird richness and abundance between edge and forest interior. Species sensitive to fragmentation, insectivorous birds and overall bird abundance was reduced at edges of 7 patches. Hummingbird richness and abundance increased at the border of 6 patches, while frugivorous birds did not respond. These results are very similar to those of studies conducted in continuous forests, and suggest that although many species were extinct in fragmented areas part of remaining ones still avoid the patch border. This indicates that the border area should be extracted from the patch size to calculate the area of suitable habitat available for species and this should be factored in management plans.

41. SUBLETHAL EFFECTS OF METHYLMERCURY ON JUVENILE WHITE IBIS DEVELOPMENT: THE CONSERVATION IMPLICATIONS OF NON-LINEAR EXPOSURE RELATIONSHIPS

ADAMS, EVAN, Peter Frederick

Relatively few controlled studies of the effects of mercury on birds include environmentally relevant exposure levels or sublethal endpoints despite the toxicant's prevalence in many aquatic and terrestrial ecosystems. We raised pre-fledgling White Ibises (*Eudocimus albus*) in a free-flight, open-air aviary in Gainesville, FL, USA on diets that approximated the range of methylmercury exposure in the South Florida wetlands (0, 0.05, 0.1 and 0.3 ppm wet weight). To measure whether methylmercury exposure affects group foraging efficiency, we allowed ibises to forage on live fishes in artificial ponds, and created several levels of foraging difficulty by varying levels of structural complexity. We also collected fecal samples and quantified the levels of testosterone and estradiol for individual birds at multiple times over their non-breeding season.

These largely independent tests of effects showed that treatment groups differed over time but not in a linear way. Foraging efficiency improved over time and decreased with increased habitat complexity, but we found the middle treatment groups to be more efficient than both the control and high-dose groups. And while testosterone showed few treatment effects, we found large differences in estradiol levels over time between the middle groups and the others. These data suggest that the dose-response relationship for mercury is not linear at low, environmentally relevant levels.

42. DISTRIBUTION, HABITAT, BREEDING NOTES AND CONSERVATION OF THE ENDEMIC SICHUAN TREECREEPER IN CHINA

JIANG, YIN-XIN, Yue-Hua Sun, Zhong-Lin Bi

The Sichuan treecreeper, *Certhia tianquanensis* Li, 1995, was recognized as an independent species in 2002. It was first thought to be an endemic relict species occupying an extremely small range in western Sichuan, China. In 2005, we found new distribution spots of the bird at Taibai Mountain, Yang County in Qinling Mountains in Shannxi province, and at Jiuzhaigou, the northwest most in Sichuan Province. During April to July 2003, supported by the BP Conservation Programme, we studied basic breeding biology of the birds according to five nests found on Wawu Shan in Sichuan province, southwest China. According to 22 random vegetation samples, the habitat showed the characters of old firs with dense bamboo bush. The average fir density was 0.68 trees/ha with the average diameter at breast of 51.7 cm. All nests were situated in cracks and fissures of dead fir stems, with the clutch size of 4 eggs. Nest materials were mainly mosses. The eggs were white with dense red spots. During incubation, the female started daily recesses at 6:23 and finished at 19:48 (n=8), resulting in an active period of 795 min. The female took 22.1 ± 3.2 (n=7) recesses per day, with the recess length of 8.2 ± 3.2 min (n=173), and predominantly (97%) between 4-16 min. From their breeding habits, we suggest the conservation of virgin forest is significant for this species, and removing the dead trees out of the forest, which was one of the main actions most forestry managers did, should be strictly stopped.

43. COMMUNITY-BASED MONITORING ON THE THREATENED AVIFAUNA OF MTTL AREA, ORIENTAL NEGROS, PHILIPPINES

CARIÑO, A.B, A.C Cadeliña, R.V Vendiola, H.A Abancio, S Enid, J Baldado, M Teves, C Fabre

On Negros Island and elsewhere in the Philippines, where over 90% of its original forest has been removed and implementation of existing wildlife laws remain weak, populations of many wildlife species including birds, are rapidly declining and may become extinct. Though these species were studied by experts and/or scientists once or twice a year the monitoring process of the threatened species becomes limited to these periods. It is fortunate however, that most of the threatened birds of Negros still thrive in the fragmented forests of Mt. Talinis and Twin Lakes, the only remaining forests of southeastern Negros. This community-based monitoring project started with a capacity-building program to empower local communities surrounding the area by providing skills on survey techniques necessary to monitor the threatened birds found in their forests. The results of the monitoring were presented to the Protected Area Management Board of the Twin Lakes for its urgent management plan and the possibility of integrating the data generated to enhance the bird watching activity as part of the ecotourism plan in the area. Data presented were also used by the Provincial Wildlife Conservation Committee in increasing environmental awareness on birds throughout the Province of Oriental Negros.

44. CYCLONE IMPACTS ON THE AVIFAUNA OF FRAGMENTED LOWLAND RAINFORESTS IN NORTH-EASTERN AUSTRALIA

MOLONEY, JAMES

We have much to learn about interactions between natural and anthropogenic disturbance on biological communities. In March 2006, Cyclone Larry crossed the North-eastern Australian coast, causing widespread damage to already fragmented lowland rainforests. A prior study examining the avifauna of patches provided an opportunity to a) examine the impacts of a severe cyclone on a tropical bird community, and b) compare the impacts and recovery between continuous and fragmented habitats. Three unfragmented sites, 3 large fragments (>25 ha) and 3 small fragments (<25 ha) were surveyed prior to the cyclone, and 6-8 weeks, 5 months, and 9 months post-cyclone (to date). Birds were sampled by strip transect, and hemispherical photographs were used with visual estimates to quantify vegetation structure. Vegetation was largely defoliated and canopy cover was reduced to below 10%. Overall bird diversity and abundance decreased,

with frugivores virtually disappearing from all sites after the cyclone. Insectivores were less impacted, although the diversity of rainforest specialist insectivores dropped significantly, and remaining insectivores tended towards mixed flocking, possibly due either to predator avoidance or to limited food resources. Although all sites lost bird species after the cyclone, fragments did not lose proportionately more species than unfragmented sites. In other words, there is no evidence at this stage of an interaction between the human and natural disturbances.

45. IMPACTS OF A SOUTH AFRICAN COASTAL GOLF ESTATE ON SHRUBLAND BIRD COMMUNITIES

FOX, SARAH-JANE CAROLINE, Philip Hockey

Golf courses and estates are one form of development threatening coastal vegetation in South Africa's Cape Floristic Region. They occupy substantial tracts of land, fragmenting indigenous vegetation. This study investigates the effects on bird community structure and function of replacing Strandveld vegetation with a 170 ha golf estate in which 46 ha of natural vegetation was retained. Bird assemblages of the fragments in the golf estate were compared to those in the adjacent Strandveld conservation area. The golf estate was more species rich overall, but many species were uncommon, several were present only as a consequence of the creation of new habitats, and species were not evenly distributed across the fragments. Bird diversity and abundance were significantly higher in the adjacent conservation area. It is estimated that more than 8500 individual birds were displaced by construction of the golf estate and four Strandveld species were not represented at all within the estate. Within the estate, species richness increased with increasing fragment size and the minimum area of continuous pristine vegetation required to maintain the natural species assemblage was estimated at 51 ha. The golf estate was characterised by a high proportion of generalist and granivorous species, but at the cost of reduced numbers of frugivores and nectarivores. Golf courses and golf estates will not substitute the natural habitats they have replaced but careful design may mitigate the effects.

Climate change

46. THE GLOBAL CLIMATE CHANGE ISSUE: AN ISSUE OF LEGITIMACY IN THE MEDIA

FELDPUSCH, ANDREA, Tarla Peterson

From the 1980's to the present, climate change has been a topic of much global debate. Though the issue has waxed and waned, Hurricane Katrina became an event-based driver for further deliberation on environmental concerns in the United States. Since news media have been the primary source of information on Katrina and global warming, it has contributed to the issue of scientific and social legitimacy. This study therefore sought to determine how climate change is being viewed by the communications industry. Using Luhmann's theory of modern function systems, I analyzed 107 articles from four leading U.S. newspapers over a two year time period surrounding Katrina's devastation to New Orleans, Louisiana (August 29, 2005). Each sample period lasted two weeks. I found that articles changed emphasis from predominately science, to one of politics and economics over the two years. Though science, with the addition of policy, still received attention, it was no longer the focus of the climate change issue or how society viewed the situation. The articles also showed a lack of consensus on the reliability of scientific findings as well as whether or not climate change is the driving force behind increasing natural disasters such as hurricanes and tsunamis.

47. CORRIDOR FANDRIANA – VONDROZO (MADAGASCAR): AN EXAMPLE OF ZONAGE IN A PROTECTED AREA

RAKOTOMANJAKA, ANDRY JEAN MARC

The definition of legal and spatial limits for 4 million hectares of new conservation areas under Madagascar's "Durban Vision", whose goal is to protect approximately 10% of Madagascar's natural areas, is in his final step. Most of these areas are already delimited. However, the challenge is to make a "zonage" or an area management for each temporarily protected area. The first step in regional planning is to select conservation targets. We used available biodiversity data like some threatened predicted distribution species and associated layers of geographic features, socio-economic information such as the population's density and the existence of infrastructures. Marxan is used to define where the "core" and the buffer zone are. Then, we

also consider the map based on the local population proposition. Finally, the result is a proposition map for the zonage. This is not efficient but we tried to consider biodiversity data and to use GIS and modelling for a zoning management.

48. THE FIRE-WEATHER RELATIONSHIP IN THE SOUTH AFRICAN FYNBOS: IMPLICATIONS UNDER CLIMATE CHANGE

WILSON, ADAM, Andrew Latimer, John Silander

Fire is a defining component of the fynbos ecosystem in the Cape Floristic Region (CFR) of South Africa. Many ecologically important species require fire for reproduction and the frequency of fire is a primary determinant of species composition. It has been hypothesized that climate change will increase fire frequency by raising temperature and reducing the reliability of rainfall. However, little work has been done to quantify the relationship between fire occurrence and climate factors. In this study, we present spatio-temporal statistical models to explain the monthly variability of fire frequency in mountain fynbos regions from 1980-2000. Meteorological data are from the Climate Systems Analysis group in Cape Town and the fire data were provided by CapeNature. We found a clear relationship between temperature, precipitation, and fire events, with more and larger fires occurring in hotter, drier months and years. Other important factors include total precipitation over the previous 12 months and the El Nino Southern Oscillation. These findings have important ramifications for conservation and management of fynbos. If climate change leads to higher temperatures or lower rainfall, our models imply that fire frequency will increase. Increased fire frequency will favor re-sprouters and other species that reproduce quickly over plants with slower reproduction cycles. Thus, if the fire regime changes, the community composition of the fynbos could change.

49. SAEON NDLOVU NODE: AN OBSERVATION NETWORK FOR LONG-TERM ECOLOGICAL RESEARCH IN THE SAVANNA BIOME

STEVENS, NICOLA, Tony Swemmer

The value of long-term ecological research for the current and future management of conserved areas has become clear from long-term projects established in many countries. While South Africa has a long history of ecological research, much of this is disjointed and little is known of long-term patterns and processes. SAEON (the South African Environmental Observation Network) is a research facility which aims to improve the detection, prediction and reaction to environmental change by providing a platform for long-term ecological research. The Ndlovu Node, based in the savanna biome, is currently establishing a collaborative network of academic institutions, private and government conservation organisations to make existing environmental data available to the research and conservation community. Furthermore, a network of monitoring sites is being established to measure key environmental processes and relevant aspects of environmental changes both inside and outside of conserved areas. SAEON encourages research collaborations to broaden the range of long-term research conducted at these sites. All data collected will be made publicly available, and facilities such as laboratories and logistic support are available to prospective students wanting to study the causes or consequences of long-term environmental change.

50. HABITAT TRANSFORMATION INFLUENCES THE PHYSIOLOGY OF ANGORA GOATS AND MAY HAVE CONSERVATION IMPLICATIONS FOR WILD UNGULATES

HETEM, ROBYN, Brenda de Witt, Linda Fick, Graham Kerley, Shane Maloney, Leith Meyer, Duncan Mitchell, Andrea Fuller

Globally, pastoral practices have led to the transformation of habitat, which often leads to desertification. These effects are rarely assessed at the level of herbivores affected, despite the potential conservation implications. We investigated the effects of habitat transformation on the physiology of Angora goats inhabiting transformed and untransformed sites in the Eastern Cape, South Africa. When goats were subjected to a thermal stress imposed by shearing, goats inhabiting the transformed site reached a higher daily maximum body temperature (40.0 vs 39.8°C, $P=0.04$) earlier in the day ($F_{1,18}=5.8$, $P=0.03$), had a faster rate of rise in body temperature in the morning ($F_{1,18}=11.6$, $P=0.003$) and displayed an increased 24-hour body temperature amplitude (1.8 vs 1.6°C, $P=0.0002$) compared to goats inhabiting the untransformed site. Post-shearing, goats inhabiting the transformed site had higher water turnover rates ($F_{1,17}=37.1$, $P<0.0001$), even though they obtained less water from their diet ($F_{1,20}=6.2$, $P=0.02$), than goats inhabiting the untransformed site. Goats that inhabited the transformed site were more water dependent and appeared more susceptible to thermal stresses in their environment than were those that inhabited the untransformed

site. We predict that indigenous herbivores will be similarly affected in desertified landscapes and, with climate change predicted to exacerbate desertification, the conservation of many species may be compromised at a physiological level.

Communications, outreach and education

51. COMMUNITY LEVEL FOREST CONFLICTS AND THEIR MANAGEMENT STRATEGIES

Kombat, Cosmas, LAMBINI SAKAB

Natural resource conflict is gaining high currency in Ghanaian forest management. Forest conflict in Ghana is characterised by land use decision making, benefit sharing, access to timber and non-timber forest products, crop damage compensation payment, boundary disputes among others. Skewed power shares among various stakeholders are embedded in forest conflicts. Forest conflict mismanagement could adversely affect sustainable livelihood and could lead to forest policy derailment. Collective management of forest resources would go a long way to attain the global conservation goals, hence the need for the shift of the 1948 forest policy to the current sustainable management approach. The research concentrated on the causes and coping strategies of actors in community level forest conflict over compensation so as to give recommendations for their management. The study adopted participatory rural appraisal tools for data collection and also made use of some secondary data in the pursuit of its objectives. These methodological approaches included the research unit of analysis and research style. Data obtained was analysed in a stepwise and systematic manner using case summaries. Crosschecking and validation were done using a validation workshop with all stakeholders. The study revealed that the major causes of compensation conflict included; failure of timber companies to contact farmers, high charges for compensation by farmers, imbalance of power between timber companies and farmers, and the mediation role of bush managers and tree hunters. These causes are interrelated and intertwined hence very difficult to draw a clear-cut demarcation. Farmers cope with such conflicts by reporting, resisting, keeping quiet, selling and killing of trees. On the other hand, timber companies cope with compensation conflicts by not contacting farmers, use of skidders, taking logs away when farmers are not around and getting affected farmers arrested by the police. The FSD however can play an active role in managing compensation conflict. All stakeholders in such conflicts should play a collective role in managing it. Moreover, forest fringe communities should actively participate in sustainable forest management. In this sense, the FSD has to enforce policies on crop damage compensation payment so as to halt compensation conflicts and their adverse effects on farmers, timber companies and sustainable forest management.

52. SEVEN HABITS OF HIGHLY EFFECTIVE CONSERVATION EDUCATORS

JACOBSON, SUSAN, Mallory McDuff, Martha Monroe

Conservation educators work for parks, natural resource agencies, nature centers, extension programs, zoos, and schools. Their goals are to help solve conservation problems and promote sustainability. How do they accomplish their Sisyphean task? We reviewed and synthesized several hundred conservation education programs from around the world to identify key capabilities of effective conservation educators employing appropriate strategies for their programs. Seven successful "habits" included: (1) Using program planning processes that involved stakeholders and identified goals and outcomes; (2) Applying relevant theories of teaching, learning, and behavior change to develop education and outreach programs; (3) Making use of the outdoors to increase concern for the environment through hands-on activities and field trips; (4) Engaging audiences in the multiple perspectives inherent in environmental issues through techniques such as storytelling, games, case studies, and role-playing; (5) Connecting conservation to communities and schools through community-based research and citizen science programs; (6) Considering the learning preferences and technological capabilities of their audiences and institutions to take advantage of mass media and technology; (7) Monitoring and evaluating their programs performance and recognizing if changes are needed. We provide analysis and specific international examples to demonstrate these characteristics.

53. SEEING THE FOREST AND THE TREES: LINKING RESEARCH WITH EDUCATION PROGRAMS TO IMPROVE CONSERVATION EFFORTS IN PROTECTED AREAS

GROSS-CAMP, NICOLE, Nsengiyunva Barakabuye, Francois Bizimungu, Beth A. Kaplin, Michel Masozera

We explored a simple approach to link ecological research in a protected area with local school programs to improve conservation efforts. We organized a 1 ½ day workshop for educators and school administrators from sectors experiencing wildlife-human conflict surrounding the Nyungwe National Park (NNP), Rwanda. The workshop presented our research program on primate seed dispersal in the NNP. A pre- and post-workshop questionnaire was used to evaluate the workshop's impact on participants' knowledge and attitudes towards primates and understanding of ecological concepts, i.e. role of research in management. A majority of participants came to the workshop supportive of ecological research, and with a basic understanding of ecosystem services provided by the forest and the general role of primates as seed dispersers. Participants lacked, however, detailed knowledge on the primate species in the Park and specific ways in which ecological research may benefit their communities and management practices. Responses highlighted the support of these communities for the Park and willingness to cooperate with Park management. Integrating scientific research findings into local educational programs can strengthen conservation by helping to identify problem areas, and offers opportunities for further collaboration between scientists and local communities.

54. OUTREACH PROGRAMMES IN PARTICIPATORY FOREST MANAGEMENT PROGRAMMES IN INDIA

KAMESWARI, V.L.V.

Since British times, forest management in India had been firmly entrenched with the state through the forest department. Early 1990s saw a major shift in the forest management philosophy in the country. Propelled by changing development perspective at the global level and glaring field realities, the forest policy of the nation was altered to accommodate the local communities/ user groups. Under the new arrangement, forest management was partly transferred to an identifiable group of users in lieu of certain facilities. This apparent democratic way of managing the resource was, however, not matched by concomitant shift in the communication strategy. Based on a study conducted in a state in Central India, this paper examines the outreach strategy adopted by the forest department in participatory forest management programs. While some attempts were made to include group interactions to replace predominantly one way communication prevalent hitherto, a well thought out communication strategy to meet the challenges of the changed scenario was lacking. A scale developed to assess communication skills of the field staff has been presented and elaborated. The study points to a need to widen the scope of outreach activities by the department and involve new communication media/technologies in an innovative manner.

55. SUPPORTING CONSERVATION OF ENDANGERED WEST CAUCASIAN TUR

AVALIANI, NATALIA, Tamar Chunashvili, Ivane Skhirtladze, George Sulamanidze, Ia Gurchiani, Tamar Khardziani

West Caucasian tur is one of the most endangered and highly endemic species (EN-IUCN) the range of which stretches in a narrow stripe for 250 km along the western part of the Greater Caucasus, occurring in Russia and Georgia. There are several protected areas on the territory of tur habitat in Russia while Georgian part of its distribution remains unprotected. This part is mostly situated in the province Svaneti. Study area is recently proposed as candidate for National Park status although the lack of recent data renders impossible to carry out any conservation activities. We aimed to gather as much information as possible from locals and to build new communicative links with them. The questionnaire survey held in Svaneti revealed that despite the fact that Red List of Georgia forbids hunting on the turs the poaching is still the main problem for this animal. Hunting has been a tradition for centuries but since 1990s the poaching pressure has increased significantly. Turs are mainly hunted for their horns. According to questioning 15 local hunters 8 main gorges of intensive hunting pressure were identified and explored. We conclude that to initiate long-term conservation activities it's important to promote the interest of locals especially hunters toward the animal as one of the flagship species. After the held educational work they also realize that they may have financial interest in ecotourism development and national park creation for finding employment in the future.

56. BIOMIMICRY EDUCATION: DESIGNING CURRICULA TO TEACH YOUNG STUDENTS ABOUT BIOLOGICALLY-INSPIRED DESIGN

STIER, SAM

The emerging field of biomimicry is an exciting discipline which, among other things, offers young students an entirely new reason to become interested in biology and nature conservation. Biomimicry is a field of research which develops new products, services, and systems based on inspirations from nature. Antibiotics which do not require preservatives or refrigeration, based on the biochemistry of microorganisms (phylum *Tardigrada*); buildings which use engineering principles found in termite mounds to reduce heating and cooling costs; and wind turbine blades with lower drag based on humpback whale fins, are all existing examples of biomimicry. While biomimicry is an application of biological research with direct and significant relevance to humans, curricula for young students does not currently address biomimicry in the K-12 system, or in the numerous non-formal educational venues. As a first step to filling this gap in curricula, we are developing the key themes and assembling case studies that will be used to create the framework and content of a new generation of curriculum pieces which introduce young students to biomimicry.

Conservation capacity building

57. BUILDING BIODIVERSITY MANAGEMENT CAPACITY IN MADAGASCAR

RABARISON, HARISON

Conservation International/Madagascar places a high priority on capacity building of its conservation partners. A consortium composed of Conservation International, Wildlife Conservation Society, and Durrell Wildlife Conservation Trust works together through a Network of Conservation Educators and Practitioners to improve biodiversity management capacity of conservation professionals. We describe a process used for creating training modules and implementing in-service training for conservation practitioners. Training analysis was conducted by this consortium to identify partners and their needs in terms of biodiversity management training. Meetings and door-to-door negotiation with conservation stakeholders such as universities, national institutions such as the Ministry of Environment, Water and Forests, and national associations such as the National Association for Protected Areas Management were conducted. As a result, five professional training courses have been developed. These include practical methods for managing natural resources (land, wetland, forest) in a sustainable way. This training analysis process and these professional courses may be useful to improve biodiversity management capacity of conservation practitioners at international and regional scales.

58. NETWORKING ACROSS BORDERS FOR THE CONSERVATION OF THE ENDANGERED ANDEAN CAT

Merino, Maria Jose, MAURO LUCHERINI, Lilian Villalba, Claudio Sillero-Zubiri

The Andean Cat Alliance (AGA) is an international network of conservationists brought together to ensure the survival of the Andean cat (*Oreailurus jacobita*), one of most endangered felids in the world, found only in the High Andes of Argentina, Bolivia, Chile and Peru. Through research, education, community participation and information integration AGA seeks to support conservation-oriented management of natural resources. Recently, teams from Argentina, Bolivia, Chile and UK established a cross-border project to coordinate and integrate data collection and are training villagers and protected area staff to develop a network of local wildlife monitors. Through a series of regional workshops educators from all range countries have linked to develop a global conservation education strategy, and produced a training guide for High Andes environmental educators. We are presently training motivated local educators and integrating them into an international network. Our ultimate aim is to build capacity in local communities, raise awareness and eventually develop into a larger network of community education officers, which would in time link with the network of wildlife monitors. We hope that this cross-border networking strategy will provide long-term benefits for the conservation of the High Andes biodiversity.

59. OVERCOMING CHALLENGES IN DEVELOPING SUCCESSFUL COLLABORATIVE PARTNERSHIPS USING THE HUMAN-WILDLIFE CONFLICT COLLABORATION AS A CASE STUDY

HODGDON, CHRISTINE, Aleta Wiley

Collaborative partnerships are becoming increasingly common in the conservation field. While research exists on how to develop collaborations that are successful, information regarding application of this research is lacking. This presentation will describe the challenges collaborations face in the nascent stages of development, review tangible recommendations to more effectively deal with these challenges, and highlight the Human-Wildlife Conflict Collaboration (HWCC) as an example of an organization that applied the results of this research at its inception. Existing research suggests the overarching condition necessary for a successful collaboration is an environment that facilitates trust among its members. A team of graduate students from the University of Maryland formulated recommendations to achieve such conditions by synthesizing information gleaned from interviews with professionals experienced in developing partnerships, discussions among human-wildlife conflict practitioners present at the HWCC launch meeting, and grey literature on existing collaborations. The HWCC incorporated these recommendations at the early stages of its development and had many positive results including the establishment of an open, transparent, and trusting environment. These recommendations can be applied to any collaborative partnership to be more prepared in dealing with the challenges identified, which in turn improves the efficiency of the collaboration in achieving its goals.

60. PARTICIPATORY MAPPING AS A TOOL FOR NATURAL RESOURCE MANAGEMENT IN AMAZONIAN COMMUNITIES: A CASE STUDY FROM NORTHEASTERN PERU

SUMMERS, PERCY, Richard Chase Smith

The conservation and management of natural resources in tropical developing countries depends on the participation of local people in whose territories most of these resources currently exist. Participatory mapping techniques have been used to empower local communities in managing and protecting these resources. On the other hand Geographic Information Systems (GIS) and Geographic Positioning Systems (GPS) have permitted local communities to compile the information on their lands with the precision demanded by governmental agencies. We summarize the experience of a local NGO, Instituto del Bien Comun, and a community in Northeastern Peru, El Chino, in a collaborative process to build natural resource use maps. Household level maps were jointly done in the field using satellite images and locally available materials. Household members mapped out the different natural resources used in their territory over scaled satellite images. A GIS allowed overlapping household level maps and zoning their territory based on the distribution of their natural resources and intensity of use. We found that the process was as important as the final products, allowing community members to interact and reflect on their territory and encouraging them to take decisions about managing their resources more effectively than top-down approaches would.

61. STRENGTHENING TECHNICAL CAPACITY GLOBALLY FOR THE USE OF IUCN RED LIST CATEGORIES AND CRITERIA AT THE NATIONAL LEVEL

Rodriguez, Jon Paul, Caroline Pollock, Natasha Roberts, Simon N. Stuart, Craig Hilton-Taylor, William Darwall, JEAN-CHRISTOPHE VIÉ, Jonathan Baillie

Although the IUCN (the World Conservation Union) Red List Categories and Criteria (RLC&C) were designed for application to the global range of species, the largest use of them is probably at the national level. Many countries have embraced the system developed by IUCN, and integrated the RLC&C into their threatened species legislation or conservation priority setting. As most conservation action probably takes place at the level of countries, provinces, states, etc., the RLC&C are likely to become increasingly influential in defining how conservation funds are invested. There exists a clear need, however, for strengthening technical capacity worldwide on the correct and appropriate use of the RLC&C. National assessors are often unaware of all the steps involved in applying the RLC&C, or feel intimidated by the incorrect perception that large datasets are required. Thus, the RLC&C are often used inappropriately or are modified to suit the national assessors needs, weakening their major strengths of objectivity, repeatability, comparability, and direct reflection of extinction risk. We present an initiative from 13 partner organizations

around the world to 1) provide readily accessible, comprehensive training in biodiversity assessment and red-listing at the national level, 2) build linkages to enable two-way data flow between national Red Lists and the global IUCN Red List; and 3) facilitate more effective communication between people compiling national and global Red Lists.

62. AWAKENING THE SLEEPING GIANT – MOBILISING THE CHURCH IN KENYA TO ENVIRONMENTAL ACTION

JACKSON, RONWYN, Colin Jackson, Tsofa Mweni, Craig Sorley

Despite efforts by conservationists to slow down environmental destruction through a wide range of conservation initiatives, Kenya continues to suffer serious environmental degradation. Forest cover, originally at 10%, today covers <1.7% of land area; loss of top soil continues unabated resulting in heavy sediment loads in flash-flooding rivers, animal and bird populations continue to diminish and pollution is rife in the waterways. As a direct result, the poor are getting poorer. Caring for the environment is a key biblical principal that has largely been ignored by the church in Kenya, if not worldwide. A Rocha Kenya, a Christian conservation organisation, has joined other church bodies to 'awaken the sleeping giant' of the extensive Kenyan church network through challenging church leaders on their biblical mandate to care for the environment. Workshops, conferences and practical training with 15 local churches and several hundred national church leaders on this theme have led to the start of a positive change of attitude and behaviour towards the environment. Practical action resulting from this has included re-afforestation, use of appropriate technologies, reduction of pollution and more sustainable living. These initial results have highlighted the vast potential for the Church to be a critical agent of change in reversing the environmental degradation in Kenya.

Conservation genetics

63. GENETICS, TAXONOMY AND CONSERVATION OF VERVET MONKEYS IN SOUTH AFRICA

TURNER, TRUDY, Joseph Lorenz, Patricia Whitten, Magali Jacquier, Kerry McAuliffe, David Beller, J. Paul Grobler

Confusion over the taxonomic designation of vervet monkeys *Chlorocebus aethiops* has hampered efforts to effectively conserve these animals. Even though vervets are widespread in sub-Saharan Africa, they are listed, as are all primates, on Cites Appendix 2. Vervets have a problematic relationship with humans. They are considered by some to be pest animals that raid human food and are sometimes killed. On the other hand, several rehabilitation centers exist where orphaned animals are housed. We report on the case in South Africa where the status of vervets is currently undergoing revision. The results of this revision can affect the possibility of release of animals from rehabilitation centers. We have collected and analyzed STR and mitochondrial CO I data on more than 120 vervets from 8 locations that represent the geographic range of vervets in South Africa. An analysis of Molecular Variation (AMOVA) using microsatellite data shows that 96.7% of total genetic variation in the populations sampled is found within populations and only 3.2% between populations. Within-population variation remained high when vervets from East Africa were included as a reference group. Our results indicate that South African vervet monkeys are members of a single evolutionary significant unit (ESU). This information can be used to help shape policy regarding release of rehabilitation center animals back into the wild.

64. HIDDEN DIVERSITY: HOW DNA REVEALS THE SECRET LIVES OF PETRELS

BROWN, RUTH

For conservation strategies to be efficient, they must preserve the maximum amount of diversity for the minimum effort. Current taxonomic classifications can give a misleading picture of diversity both above and below the species level. However, there is now a growing body of molecular data which may help to uncover variation that would not otherwise be obvious. The gadfly petrels are a group of ~40 species of pelagic seabirds that breed on remote oceanic islands. Difficulty in accessing colonies coupled with low levels of phenotypic diversity have led to enormous confusion over the taxonomy of these birds. In addition, their slow life cycle and island habitats make them extremely vulnerable to disturbance, particularly by introduced predators. Many petrel species are now threatened with extinction. My work focuses on the phylogenetics of petrels from Round Island in the Indian Ocean and from the Madeiran archipelago in the North Atlantic.

Mitochondrial DNA sequence data reveals startlingly different patterns of genetic diversity in these two groups, which could not have been predicted from studying phenotype, behaviour or life history. Such patterns have profound implications for the management of these species. Whilst molecular work is expensive and time-consuming, internet databases make the results freely available to everyone. Thus data from many individual projects can be pooled together to provide a powerful tool for assessing and implementing conservation projects.

65. SPECIES SPECIFIC DIAGNOSTIC PCR-RFLP FOR IDENTIFICATION OF INDIAN FRESHWATER CHELONIAN SPECIES ROHILLA, MANOJ SINGH, P.K. Tiwari

The problem of species-identification important in conservation and management of endangered species population. Genetic analyses have been successfully used to accurately identify the species using different biological sources such as skin, muscles, whole or part of preserved animals or dry blood spots or even dead animals. DNA based identification of species has extensively been carried out with the help of polymerase chain reaction (PCR). Most of the designed species-specific identification methods are based on mitochondrial Cytochrome b (Cyt b) gene, due to the availability of well-documented universal primers for the gene. Most of the studies on cytochrome b have shown variations between the species to be greater than within species. In this report a rapid and simple PCR-RFLP (ARFLP) method was optimized to identify three Indian freshwater turtle species viz., *Kachuga dhongoka* a hard shell turtle (Emydidae) and two species of soft shell turtle, *Asperidetes gangeticus* and *Lissemys punctata* (Trionychidae). Universal primers were used for the PCR amplification of a 900-bp fragment encoding mitochondrial cytochrome b gene. PCR product from the three species were digest with Alu I, Msp I, Taq I, Fok I, Kpn I, Hpa I, Sal I, Nco I, Xho I and Hind III restriction enzymes. The resulted RFLP patterns visualized by silver staining and discriminated on the basis of fragment length. Six of these enzymes Alu I, Msp I, Taq I, Fok I, Hae III and BamH I generated diagnostic restriction patterns specific to each species. The molecular method was found simple, rapid and reliable and hence, can be routinely applied for identification of species in forensic case at the molecular level. We have also standardized methods of DNA to extract from turtle fresh and ethanol preserved blood, salt dried vertebrate muscles, buccal swab or other tissues as well as formaldehyde preserved museum specimen. It may be suitable for DNA sample available from any source and can provide valuable information to wildlife authorities dealing with illegal trade of endangered chelonian species, particularly in South East Asia.

66. GENETIC STRUCTURE AND DISPERSAL IN THE HARVESTER ANT *POGONOMYRMEX BARBATUS* SUNI, SEVAN, Deborah Gordon

We used a landscape genetics approach to investigate fine-scale genetic structure and patterns of dispersal in the harvester ant *Pogonomyrmex barbatus*. Some populations of *P. barbatus* operate under a newly discovered system of genetic caste determination, in which there are two interbreeding but genetically distinct lineages. Between-lineage matings result in the production of workers, and within-lineage matings result in the production of reproductives. Males are haploid and are produced by parthenogenesis. The dependent-lineage system imposes constraints on colony establishment and reproduction because females must mate with males of both lineages to found colonies with both workers and female reproductives. The lineage ratio among males at the nuptial flight influences the probability that a queen will successfully find a colony. We found highly asymmetrical lineage ratios, strong genetic structure, and limited dispersal between seven sites within a 100 km² area in the southwestern United States. The persistence of populations of *P. barbatus* may thus be the result of frequency dependent selection within sites.

67. GENETIC ANALYSIS OF THE DESERT ELEPHANTS OF NAMIBIA LEGGETT, KEITH, Betsy Fox, Al Roca, Peter Van Coeverden de Groot, Don Melnick, Nicholas Georgiadis, Stephen O'Brien,

Desert elephants inhabit the northwest Namibian deserts near the Hoanib and other river catchments, such as the Hoarusib. Historically numbering about 3,000 individuals, the population reached a low of 257 in 1983 before rebounding to more than 600 individuals. To examine the genetic distinctiveness of desert elephants from other African savanna elephants (*Loxodonta africana*), we have amplified and sequenced mitochondrial DNA from desert elephants and from other Namibian populations, including a region of the mitochondrial ND5 gene in DNA from dung samples, and a 2.5 kb region of mitochondrial ND5 and ND6 in DNA from

tissue samples. Additionally, 13 short tandem repeat or microsatellite nuclear loci were amplified using DNA from the tissue samples. Our results suggest that desert elephants are related to other African savanna elephants, but exhibit a low level of genetic diversity suggesting limited gene flow between them and other populations.

68. AN INVESTIGATION OF THE ORIGIN OF CHEETAH TRANSLOCATED INTO SOUTH AFRICA KOTZE, ANTOINETTE, Paul Grobler, Karen Ehlers

Conservation authorities are constantly aware of illegal trade in cheetah over the Namibian and Botswana borders with South Africa. The aim of this analysis was to determine the possible origin of six cheetahs confiscated in South Africa. Hair samples were taken and animals were genotyped at 16 nuclear DNA microsatellite loci. These were compared with genotypes of wild and captive bred cheetah of known origin, contained in a National Genetic Database. An assignment test using a Bayesian approach indicated that five out of the six unknown cheetah were assigned to Namibia, with probabilities of 14.4-85.5%. The remaining unknown individual was assigned with Botswana as the most likely source population (probability = 98.3%). These assignments were supported by a genetic distance based assignment test when using Nei et al.'s algorithm whereas output based on Goldstein et al.'s distance was inconclusive. The latter result demonstrates that all cheetah screened are relatively closely related, reflecting a low overall level of geographic differentiation in the species which may restrict the power of resolution of assignment tests. Nevertheless, the results suggest that all or five of the unknown cheetah originated from Namibia. The application of DNA technology for forensic purposes is well accepted in courts in South Africa and can be used as a valuable tool to solve illegal trade.

69. Withdrawn

70. HYBRIDIZATION BETWEEN BLACK- AND BLUE WILDEBEEST (*CONNOCHAETES GNOU* AND *C. TAURINUS*): APPROACHES TO THE GENETIC MANAGEMENT OF SYMPATRIC CONGENERICS GROBLER, PAUL, Antoinette Kotze, Karen Ehlers, Paulette Bloomer, Ian Rushworth, James Brink, Savvas Vrahimis

Black- and blue wildebeest have been kept side by side at numerous localities in southern Africa over the last few decades. Recent evolutionary divergence coupled with disrupted social structure associated with artificial management may result in hybridization. The hybrids are fertile and while F1 hybrids are morphologically identifiable, the identification of backcrosses is problematic which cast doubt on the level of purity of numerous black wildebeest populations. The problem has been acknowledged since the 1980's but remains unresolved. Limitations include insufficient molecular markers, limits to the power of resolution of markers, sample size, funding, consensus on criteria for pureness, and consensus on the fate of herds with introgressed genetic material. South African researchers and conservation managers have started a concerted effort to pool resources and expertise to find markers and criteria for the identification of hybrid herds. In this paper, we present the results of microsatellite analysis of more than 300 animals using 13 loci originally developed in cattle, goat and sheep. These loci allowed the approximate identification of pure and hybrid herds but are not powerful enough to identify all hybrid individuals. We review the strengths and weaknesses of the research completed to date and discuss future avenues for improvement, notably species-specific microsatellite loci, Y-chromosome markers and supplementation of genetic data with osteological techniques.

71. INBREEDING AND DISEASE SUSCEPTIBILITY IN THE GLÁPAGOS MOCKINGBIRDS HOECK, PAQUITA, Lukas Keller

Despite the significant role of both inbreeding and disease resistance on the dynamics and persistence of small populations, little is known about their interaction and their effects on extinction risk in natural populations. Our study tests the hypothesis that reduced genetic variability due to inbreeding lowers the ability of small and inbred populations to respond to infectious diseases. To this end, we studied the genetic variability and immunocompetence of four allopatric species of Galápagos mockingbirds. Due to extinction on the main island of Floreana, one of the four species, the Floreana mockingbird (*Nesomimus trifasciatus*),

occurs on only 2 little islets with approx. 30 and 80 individuals and hence is very prone to inbreeding. Preliminary population genetic analyses revealed large differences in the genetic variability and differentiation between mockingbird species and populations. One of the two *N. trifasciatus* populations seems to be highly inbred and a within-species comparison revealed a genetic differentiation as high as between-species comparisons found for other islands/populations. Furthermore, populations with the lowest genetic variability showed the lowest estimates of the innate component of the immune system. These results contribute to a better understanding of the relationship between inbreeding and disease susceptibility and provide crucial information for the recovery plan for *N. trifasciatus* currently in preparation.

72. THE GHOST OF BOTTLENECKS PAST: POPULATION STRUCTURE OF SMALLMOUTH BASS (*MICROPTERUS DOLOMIEU*) IN THE BEAVER ISLAND ARCHIPELAGO

GIBBONS, KELSEY, Bradley Swanson

In the early 1980's, the Beaver Island Archipelago supported a healthy fishery of smallmouth bass, *Micropterus dolomieu*. This fishery has since declined and the consequent genetic effects and population structure are not known. To determine the number of populations, dispersal between them, and identify a bottleneck, scales were collected from five sites on three of the islands in the archipelago. DNA was extracted from 180 samples, amplified, and analyzed at eight microsatellite loci. Doh found high rates of dispersal between the sites, consistent with the N_m value found by GenePop of 3.8 migrants/ population/ generation. This high level of migration and dispersal suggests that all five sites are part of one population. Our mean F_{is} value was high ($F_{is} = 0.25$) and mean heterozygosity ($H = 0.174$) and allelic diversity ($A = 6.125$) were low suggesting that the smallmouth are inbred. BOTTLENECK found no deviations from mutation-drift equilibrium, but this test can only detect recent bottlenecks. Our results indicate that the smallmouth population in the Beaver Island Archipelago experienced a major bottleneck in the past such that the population has returned to drift-mutation equilibrium. This bottleneck has resulted in a significant reduction in heterozygosity and allelic diversity with a concomitant increase in inbreeding putting this population at risk for local extinction.

73. INVESTIGATING POPULATION STRUCTURE AND PHILOPATRY IN RINGED SEALS DURING THE BREEDING SEASON USING MICROSATELLITE DNA

SELL, STEPHANIE, Brendan Kelly, Mervi Kunasranta, Bradley Swanson

The ice-associated ringed seal (*Phoca hispida*) provide important resources for the indigenous peoples of Alaska. The population structure of this species is poorly understood, however subsistence harvests are managed based on a single panmictic population. Increasing evidence of site fidelity during the breeding season suggests philopatry, and genetically differentiated populations. Inaccurate management during the harvest may cause localized depletions or extirpations. Eighty samples were collected from ringed seals or the ice in the Beaufort, Chukchi, and Baltic Seas. The Baltic Sea population exhibited high levels of unique variation compared to the Chukchi, Eastern and Western Beaufort Seas (F_{st} 0.073; 0.055; 0.094 respectively). STRUCTURE found the most likely number of populations to be three. Assignment tests further supported the conclusion of isolated stocks with low frequencies of misassigned individuals (Chukchi- 11.8%, W. Beaufort- 14.3%, E. Beaufort- 3.8%, and Baltic- 7.7%). Further research needs to be conducted on ringed seal population dynamics to ensure estimates for subsistence harvest are not affecting the genetic diversity of the species.

74. SUNDALAND CLOUDED LEOPARDS: PHYLOGEOGRAPHY OF A RECLASSIFIED SPECIES AND THEIR STATUS IN SABAH, MALAYSIA

Wilting, Andreas, Heike Feldhaar, Valerie Buckley-Beason, FRAUKE FISCHER

Recently the reclassification of Bornean clouded leopards (*Neofelis nebulosa diardi*) to species level (*N. diardi*) was suggested. Our data support this reclassification by wider sampling. We show that Sumatran animals cluster with specimens from Borneo in comparison to mainland individuals. Genetic analysis based on 18 microsatellite markers suggests that Sumatran individuals also belong to *N. diardi*. A significant population subdivision was apparent among *N. diardi* between Sumatran and Bornean individuals and we suggest the recognition of two subspecies *N. diardi borneensis* and *N. diardi sumatrensis*. During fieldwork conducted in Tabin Wildlife Reserve (Sabah, Malaysia) we applied a track classification method to obtain population estimates of 9 individuals/100km² for *N. diardi borneensis* in the study area. Our landscape analysis in Sabah confirmed the presence of clouded leopards in 25% of Sabah's surface. However only

four isolated areas covering just 5% of Sabah are classified as totally protected reserves and in the remaining areas selective logging and licensed hunting are permitted. Our assessment shows that *N. diardi* is under heavy pressure of extinction and a higher priority should be placed to protect this species. For conservation purposes the significant population subdivision between Sumatra and Borneo makes separate conservation strategies necessary.

Conservation in hotspots

75. Withdrawn

76. ARE BLACK HARRIERS INDICATORS OF RENOSTERVELD FRAGMENT QUALITY? CONSERVATION IMPLICATIONS FOR A THREATENED SPECIES IN A FRAGMENTED HABITAT

JENKINS, JULIA, Robert Simmons, Andrew Jenkins, Marion Atyeo

The Black Harrier (*Circus maurus*) is near-endemic as a breeding species to the fynbos biome with a world population of 1000-2000 birds. They are a globally vulnerable species that nest on the ground and rely on indigenous vegetation for nesting and foraging. Renosterveld is a highly endangered vegetation type occurring within the Fynbos biodiversity hotspot of South Africa that has lost 85% of its original extent. Remnants occur as isolated fragments on privately owned land. Black harriers breed in such fragments and this study assessed whether Black Harriers chose Renosterveld fragments that were more diverse in terms of small mammals, birds and rare and endemic plants than in fragments that were not used as nesting sites. Small mammal trapping, bird transects and plant transects were carried out on 20 Renosterveld fragments in the Overberg, South Africa, 9 with and 11 without breeding harriers. Fragments in each group were similar in size, isolation and surrounding land-use. There was no significant difference in bird or small mammal diversity, richness or abundance for patches containing breeding harriers versus those that did not. There were more rare and endemic plants on patches that contained breeding harriers. This suggests that harriers are linked to more diverse vegetation and could be used as an indicator species for the plant diversity of Renosterveld.

77. "CONNECTING PEOPLE AND FOREST": STRATEGIES FOR IMPLEMENTING ECOLOGICAL CORRIDORS IN THE ATLANTIC FORESTS OF ESPIRITO SANTO STATE, SOUTHEAST BRAZIL

RIBEIRO, SANDRA, Gerusa Bueno Rocha, Jayme Henrique Pacheco Henriques, Felipe Martins Cordeiro de Mello, Erica Rodrigues Munaro Turbay, Evie Costa Negro

The Brazilian State of Espirito Santo contains just 8% of its original Atlantic Forest cover. Because most of the remnants are privately-owned land, the success of implementing corridors will depend to a large extent on community involvement and local and regional partnerships. Using biological information and satellite images, 10 priority linkage areas was selected, which would connect 15 protected areas to representative fragments. Beginning in 2003, regional groups comprised of local NGOs, state and local governments, universities, and local community leaders were created to develop and co-manage conservation action plans for each of the selected areas. Local workshops were convened to identify potential sustainable economic alternatives and identify land owners interested in integrating their land into the corridors project. Planned and actual mitigation efforts include reforestation, development of native agro-forestry systems, development of agro-ecological practices, and programs to enhance ecotourism capacity among traditional communities. Multi-institutional collaboration has stimulated the creation of novel private and public protected areas that support connectivity efforts, and in 2006 a partnership with the private sector was established to finance most of the plantations. Connectivity efforts are currently priority for local governmental agencies, and it is hoped that such policies will ensure the long term conservation and sustainability of the Atlantic Forest.

78. CHANGES IN MAMMAL, BIRD AND LIZARD COMMUNITIES FOLLOWING FOREST CLEARANCE IN ARID SPINY FOREST, MADAGASCAR

MAHOOD, SIMON, BARRY FERGUSON

Forest clearance is one of the greatest threats to biodiversity. We investigated the impacts of anthropogenic forest clearance on the lizard, bird and small mammal communities in an area of arid spiny forest near Parcel 2 of Andohahela NP in Madagascar, a global biodiversity hotspot. Community composition, species richness and species abundance were assessed in six areas of forest and six cleared areas using standardized trapping and timed species counts. Forest clearance had a negative effect on species richness and community structure of all taxonomic groups. The response and sensitivity to clearance varied between groups and species: lizards (50%) and small mammals (40%) showed the greatest decline in species richness compared to birds (26%), although birds showed the greatest shift in community structure. Across all taxonomic groups range-restricted species of high conservation priority suffered the most from forest clearance; these species were lost and the community shifted to contain more widespread generalist and introduced species. The Mandrare Valley Forests where the research was conducted have been identified as a potential site for one of the country's largest multiple use protected areas under the Durban Vision. Our results will therefore be an invaluable tool for the design and management of this proposed park, and contribute to the growing wealth of knowledge on the response of species and communities to habitat degradation worldwide.

79. THE ARABUKO-SOKOKE SCHOOLS & ECO-TOURISM SCHEME (ASSETS) – AN INNOVATIVE COMMUNITY CONSERVATION INITIATIVE ON THE NORTH KENYAN COAST. IS IT WORKING?

BAYA, STANLEY

Arabuko-Sokoke Forest and Mida Creek on the north Kenya coast are internationally important sites for biodiversity conservation and form part of a UNESCO Biosphere Reserve. Arabuko-Sokoke Forest is considered among the most important forests for bird conservation on mainland Africa. However, as for many such sites, they suffer from illegal logging, poaching of animals, use of illegal fishing nets and trapping of sea turtles. Poverty levels for the area are among the lowest in Kenya and people are forced to survive off their local environment – the forest and creek, often cutting timber and trapping animals to sell to obtain money particularly for school fees. Through sustainable eco-tourism, ASSETS provides 'Eco-bursaries' to children of families living adjacent to the forest and creek for secondary school education. To date 174 students have received bursaries and a further 80 taken on in 2007. Surveys in 2006 indicate the attitude of ASSETS beneficiary families towards the conservation of the forest and creek are considerably more positive than others. ASSETS families have planted trees on their farms, constructed tree nurseries, formed a Parents Association to be proactive in the conservation of the forest and creek and are using alternative technologies to reduce their ecological footprint. This paper presents these advances and the impacts that ASSETS has had on the conservation of Arabuko-Sokoke Forest and Mida Creek.

80. DIVERSITY AND BIOGEOGRAPHY OF BLISTER BEETLES (*COLEOPTERA: MELOIDAE*) OF NAMIBIA FROM A CONSERVATION PERSPECTIVE

MONTALTO, FRANCESCA, Monica Pitzalis, Marco Alberto Bologna

Meloidae, a beetle group rich in species in Afrotropical savannas, was selected for a multi-method biogeographical analysis of the Namibian fauna. Georeferenced data was obtained from literature, collection specimens and 5 field samplings. A G.I.S. was used to obtain distribution maps of species and compare the species' distributions to infer general chorological models. A presence/absence matrix of species was constructed at the resolution of one degree grid squares. Species and quadrants were classified using cluster analysis (U.P.G.M.A. method) and comparing three indices of similarity: Jaccard, Sørensen, Baroni Urbani & Buser. The same study was performed analyzing the species distribution in the main ecosystems and relating it to some bioclimatic parameters. Some 147 species out of 24 different genus were found, but only 143 were used in the analyses: 58 species are new to Namibia, 4 genus and 19 species are still undescribed. The chorotype of each species was defined: the southern-african pattern of distribution is the most frequent, particularly the west-afromeridional one. SW Namibia has the most peculiar fauna and represents a relevant hotspot of biodiversity. Actually, this faunal district is strictly connected to the South African Namaqualand. Phylogenetic and biogeographical relationships (by both morphological and molecular approaches) among some endemic taxa were tested to define generalized patterns of distribution.

Conservation modeling

81. ECOSYSTEM MODELING USING WATER QUALITY PARAMETERS FOR CONSERVATION OF BHOJ WETLAND

VERMA, MADHU

Bhoj wetland (BWL), a 1000 years old wetland, now a Ramsar site located in the heart of Bhopal city of India with water spread area of 32 km² and catchment area of 370 km² provides water supply to 0.6 million population of the city besides being used for commercial fishing, recreation, water chestnut cultivation, washing of vehicles and clothes, idol immersion, direct flow of sewage from 17 municipal wards of the city. This led to considerable deterioration of its water quality and threatened its enriched biodiversity. The management authorities have taken various restoration measures recently but they do not show any perceptible change. Thus to suggest proper interventions and above all their prioritizations, an ecosystem model for the lake has been developed to understand the changes in the wetland ecology based on water quality parameters to show the impact of flow of sewage. A base scenario has been created using past 15 years data and various simulation runs have been performed for the pre and ongoing restoration activities for next 25 years so as to represent the health of the wetland's ecosystem. These scenarios suggest prioritization of future policy interventions for improving water quality and conservation of wetland biodiversity.

82. USING SIMULATION MODELING TO UNDERSTAND TRADE-OFFS AND SYNERGIES BETWEEN CONSERVATION AND DEVELOPMENT IN A TROPICAL FOREST LANDSCAPE

Sandker, Marieke , Bruce Campbell, Jeffrey Sayer, TERRY SUNDERLAND, Zachary Nzoo

This poster reports on the use of visioning and modeling tools to better understand the trade-offs and synergies between conservation and development in the Tri-National region of SE Cameroon. To understand exactly how conservation and development dynamics influence each other, basic modeling, in this instance, STELLA, a user-friendly modeling software package, can be used. When building a model of the landscape, all aspects which influence Natural Resource Management (NRM) are included and thus become explicit. Once we have created a model of the landscape, we can (i) test which entities are changed more easily than others, (ii) focus on those interventions with the highest impact, (iii) test which interventions have a positive impact on both conservation and development outcomes and, (iv) explore the effectiveness of different interventions under different future scenarios. We present the long-term impact of two different NRM strategies on the population of elephants and the average annual household income and explore their effectiveness under two different scenarios. In the first NRM strategy explored the total budget is spent on anti-poaching, for the second strategy, 30% of the budget is spent on "better governance". Our model shows that the elephant population increases under the first scenario but is reduced by a decrease in anti-poaching activities. However, under a better governance scenario where corruption is reduced, local livelihoods benefit from increased income from forestry and safari taxes. By building models that integrate livelihoods and conservation we believe the linkages between the two are more explicit and this could help develop better strategies for NRM.

83. ENFORCING RULES FOR THE CONSERVATION OF EXPLOITED SPECIES: THE DEVIL IS IN THE DETAIL

KEANE, AIDAN, E.J. Milner-Gulland

Conserving exploited species requires setting rules of behaviour. Without compliance, however, these rules are worthless. Management strategies commonly include systems to monitor and punish non-compliance, but the theory of enforcement is poorly developed. The models used to inform management decisions are often simplistic, ignoring the possible effects of stochasticity, individual heterogeneity and behavioural responses. We used an individual based model of poaching in a small, community-based wildlife management setting to explore the consequences of including these factors for the success and cost-effectiveness of enforcement of rules in exploited species conservation. Starting from a fully deterministic model, new aspects of complexity were introduced and their effects on the enforcement effort needed to secure full compliance and on optimal enforcement levels were explored. If the opportunity costs of monitoring vary between individuals, or if individuals are able to invest in avoiding detection, the optimal

level of enforcement increases. This study demonstrates that standard models of compliance may significantly mis-estimate the enforcement effort that communities need to expend for successful wildlife management. Given limited resources, enforcement must be carefully tailored to fit its context if it is to generate sufficient incentives for compliance while remaining affordable.

84. MANAGING FOR THREATENED SPECIES: INCORPORATING EXPERT KNOWLEDGE WITH FIELD DATA IN A BAYESIAN FRAMEWORK WITHIN A GIS INTERFACE

MURRAY, JUSTINE, Samantha Low Choy, Clive McAlpine, Hugh Possingham, Anne Goldizen

To manage threatened species we need to know their distribution and abundance. The cost of collecting data in the field, in terms of time, expense and necessary resources, can be very large and may substantially reduce the budget available for management. A source of cheap information is knowledge gained by experts over extended periods of time. We applied an expert elicitation tool within a web-based GIS interface to quantify expert knowledge of a threatened macropod species in eastern Australia, the brush-tailed rock-wallaby, *Petrogale penicillata*. Using a Bayesian regression model, this expert knowledge was combined with data sampled at 465 sites for brush-tailed rock-wallabies including habitat information at site and landscape scales. We compared the distribution predictions derived from field data alone with those derived by expert opinion alone, and both sources of information. We found the expert priors enhanced the predictions based solely on field data and focused experts to expressing opinions at scales consistent with those used by management agencies. Ideally continual extensive field monitoring is the best solution for managing threatened species, yet elicitation of expert knowledge in accessible software applications provides useful valuable information when resources are limited.

Conservation of wide-ranging taxa

85. INFLUENCE OF MASTING SYNCHRONY ON POPULATION PERSISTENCE OF A NOMADIC SEED SPECIALIST, THE RED CROSSBILL

KELSEY, RODD, Evan Girvetz

Many species in the northern forests of North America, Europe, and Asia are specialists on the seeds of conifers that are available intermittently as a result of mast seed production. The temporal variability in seed production varies among conifers and masting can be highly synchronous over large distances. The synchrony among trees that mast is thought to often be triggered by temperature cues, leading to the hypothesis that climate change could result in increased synchrony or an overall decreased variation in the temporal and spatial pattern of masting. This may have significant consequences for seed consumers since previous models have suggested that increased synchrony could reduce the population persistence of consumers specialized on the fruits of those trees. Based on published data describing existing synchrony of seed production and population fluctuations, we used spatially explicit population models to examine the influence of changes in synchrony of seed production on population persistence of a seed specialist, the red crossbill. Red crossbills are well known for their specialization on specific conifers and their nomadic movements in response to the temporal and spatial availability of seeds. Nomadic species that specialize on specific resources present significant challenges for conservation due to the spatial scales over which they move and the difficulty in gathering detailed life-history data.

86. THE DIVERSITY AND POPULATION STRUCTURE OF WOODY SPECIES BROWSED BY ELEPHANTS IN BABILE ELEPHANT SANCTUARY, ETHIOPIA: AN IMPLICATION FOR CONSERVATION

BELAYNEH, ANTENEH

Babile Elephant Sanctuary (BES), in the semi-arid region of eastern Ethiopia, has long been known for comprising one of the globally threatened, ecologically isolated and possibly distinctive subspecies of elephant population. Study on plant species diversity and population structure of woody species browsed by elephants in wet and dry seasons conducted. Total of 75 quadrats each 20 x 20m were analyzed and 24 plant species in 15 genera and 12 families identified. Out of these 11 (45.8%) trees and 13 (54.2%) were shrubs. Total density of the 24 woody species is 11559 individuals.ha⁻¹. The mean density is 481.6 ± 282.5 (S.E.). Total density of trees is 492 and shrubs 11066 individuals.ha⁻¹. Shrubs account 95.7% but trees only

4.3%. Total density of germinant, seedling and sapling was 3377 individuals.ha⁻¹ (where 5.5% for trees & 94.5% for shrubs). The population structure of shrubs exhibited inverted J-shaped whereas trees exhibited inverted J-shaped, broken inverted J-shaped, U-shaped and bell-shaped frequency distribution. These effects are highly associated with human-induced disturbances, due to population pressure.

87. HOW TO MEASURE EFFECTIVENESS OF WILDLIFE COMPENSATION PROGRAMS: SOME GLOBAL COMPARISONS HANEY, J. CHRISTOPHER

Wildlife compensation programs typically involve reimbursing private interests for the damages to crops and livestock caused by wild animals. Praise and criticism of this conservation practice, however, both tend to focus on single dimensions of effectiveness (e.g., economic, public opinion, etc.). Using data from compensation programs conducted in Europe, North America, Asia, and Africa, I show that program effectiveness is best perceived as graduated, multi-dimensional, and hierarchical. Realized unit costs per animal compensated are shown to be lower for some species than for others, as well as in some geographic locales of North America and Africa than elsewhere, thereby giving more conservation bang for the dollar spent at key sites. Especially in developed countries, effectiveness is multi-dimensional because no fewer than six broad elements for success are implicated as contributing to program outcomes: 1) biological compatibility, 2) economic feasibility, 3) transfer of social equity, 4) influence on public opinion, 5) legal and regulatory facilitation, and 6) administrative practicality. Certain dimensions of compensation success necessarily assume primacy when placed within a strict context of wildlife conservation. Thus, unless wildlife populations and habitat are ultimately enhanced, or unless threats to either are mitigated, compensation programs cannot be deemed truly successful.

88. AFRICAN WILD DOG CONSERVATION THROUGH UNDERSTANDING SCENT MARKING BEHAVIOR AND CHEMISTRY PARKER, MEGAN, John McNutt

From an historic distribution across sub-Saharan Africa, all but three African wild dog, *Lycaon pictus*, populations consist of fewer than 350 individuals, and most populations occur in protected areas smaller than several home ranges. Human development, human persecution, and disease carried by domestic animals represent the most serious threat to wild dog viability, where there has been a 20% population decline over the past three generations. In northern Botswana, wild dog movements, scent marking behavior and chemistry were studied to better understand the mechanisms of territoriality, ranging behavior and intra-species communication. GIS was used to analyze VHF and GPS telemetry and observational movements of wild dog packs which were highly territorial in this area. Scent marks contain information which may act to deter, repel or intimidate intruders by allowing the receiver to assess the status, physiological state or number of individuals in a social group. Scent marking behavior was observed and volatile chemistry was analyzed to determine differences between individuals and across areas. Scent marks were moved between packs to determine the effectiveness of manipulation of chemical communication systems in wild dogs in order to prevent, delay or reduce ranging into areas where wild dogs tend to face human conflict and high mortality rates.

89. POLAR BEAR MATING AND DISPERSAL – INFERENCES FROM MICROSATELLITES Saunders, Brenda, Peter Van Coeverden de Groot, Jackson Smith, Stephen Atkinson, PETER BOAG

Using over 600 capture-mark-recapture samples from a 1998-2000 census in McClintock Channel, Nunavut, we characterize components of the polar bear mating system and dispersal. Using nine microsatellite loci mother-cub relationships were verified and using categorical likelihood analyses to identified likely cub fathers. Our findings include: a) variance in reproductive success among male age classes - of the 52 cubs assigned a father with high confidence, older adult male bears (age 8-14) sired a disproportionate number of cubs compared to their cohort size within the population, b) multiple paternity in single litters and c) an adoption event. We calculated pairwise relatedness estimates (MER) for these samples and with age (from teeth) and GPS data, calculated and compared geographic distances among same/different sex first-order relatives in various age classes. Our findings support greater male-biased dispersal before the age of 6 and include: d) a difference between 3-5 yr (old) male-brother and 3-5 yr female-sister distances (male-brother,

316 ± 42km, female-sister 186 ± 30km; t-test, p 0.05) and g) female-sister distance was greater at 9+ yrs compared to 3-5 yrs (t-test, p < 0.05).

90. IMPORTANCE OF TRANSBORDER NGO NETWORKING FOR BOOSTING CONSERVATION OF WIDE RANGING SPECIES - THE "BALKAN NET" CASE IN SE EUROPE

GEORGIADIS, LAZAROS, Giorgos Giannatos, Dimitris Bousbouras

In Balkans most of rare wide ranging species of mammals and raptors occur in the highlands of Pindos - Dinaric and Rhodopi – Balkan ranges. These ranges are shared by several countries, so successful conservation means transborder cooperation. Since the beginning of its foundation in early 90's ARCTUROS - leading Greek NGO working on large carnivores - was interested in transborder cooperation to preserve biodiversity. This period coincided with the political changes in Balkans, when collapsing ex-communist Governmental institutions were unable to deal with the new conservation requirements. The populations of larger mammals were declining rapidly. However civil society movement intervened to reverse the situation. Since 1996 ARCTUROS cooperated with more than 20 conservation NGOs from Southern Balkans to complete seven large joint projects and continue with two running projects and two proposals. Additionally the decision for Prespa transfrontier park in the tri-national region of Albania, FYROM, and Greece, triggered the creation of 20 NGOs consortium from the three nations. These actions empowered local NGOs through capacity building and increased their influence on local governments. This resulted in proper adaptation of wildlife legislation, maintaining the existing transborder protected areas or creating new ones to include wildlife corridors for endangered and vulnerable species

91. USE OF HABITAT BY ASIAN ELEPHANTS (*ELEPHAS MAXIMUS*) IN THE BUXA TIGER RESERVE AND ADJOINING AREAS OF NORTHERN WEST BENGAL, NORTH EASTERN INDIA

ROY, MUKTI, Raman Sukumar, Natarajan Baskaran, Tanmay Bhattacharya

The elephant habitat in northern West Bengal, in the northeastern part of India belongs to the Eastern Himalayan range, latter being regarded as one of the biodiversity hotspots in India. The habitat is affected severely by high degree of habitat fragmentation and acute human-elephant conflict (Sukumar et al. 2003). The study was carried out in Buxa Tiger Reserve and Jaldapara Wildlife Sanctuary that together constitute a 1074 sq km area and harbour ~300 elephants (Sukumar et al. 2003). VHF tracking units fitted to nine elephants (five family herds and four bulls) in the Buxa Tiger Reserve and adjoining areas of northern West Bengal provided information on habitat use during 2001-2005. We used MCP (minimum convex polygon) to interpret vegetation usage by elephants. We used White & Garrot (1990) for our habitat utilization analysis. The areas of habitats were calculated from digitized polygon from arc view. The Mixed Vegetation, Mixed Plantation, Semi-Evergreen & Evergreen are preferred while Tea Garden, Cultivation & Settlement are avoided. In dry season they show preference to Mixed Plantation, Mixed Vegetation, and Semi Evergreen and Evergreen habitats where as in wet season no such strong preference was found to be associated with any of the habitats.

92. MONITORING OF CHANGES IN MIGRATION PATTERN AND HOME RANGES OF THE AFRICAN ELEPHANT IN THE WAZA NATIONAL PARK (CAMEROON)

FOGUEKEM, DÉSIRÉ, Martin Tchamba

Waza elephant began migrating after an ill-fated and partially remediate dam altered the hydrology and vegetation of the park in 1980. Consequently, human/elephant clashes have been taking places. Before 1994, home ranges were 3066 km² for the northern migrant and 2484 km² for the southern migrant cow, with distance-movements computed at 80km and 100km respectively. It was anticipated that, with improvement of the habitat of the park by artificial flooding in 1994-1997, elephant might reduce their movements spending more time in the park thus reducing their impact on local agriculture. The movements of these elephants were studied from 2000 to 2002 with GPS and Argos Satellite telemetry technique. Changes in elephant movement were observed. Home ranges varied from 5895.75km² for elephant migrating northward and 3678.51-5338.71km² for the herd undertaking southward migration, with distance movement calculated at 31.12km and 43.81-72.12km respectively. The shift in monthly distance-movements and home ranges of the studied population appears as consequences of marked monthly/seasonal environmental fluctuations, differences in the productivity of habitats used by elephants after the artificial flooding. Elephant migration

around Waza National Park emphasizes the conservation value of areas contiguous to protected areas, and underscores the value of migrations routes for elephant conservation.

93. CONSERVATION OF ASIAN ELEPHANTS (*ELEPHAS MAXIMUS*) IN SOUTHERN INDIA: A GIS ANALYSIS OF THE ANAMALAI ELEPHANT LANDSCAPE NAGARAJA, BASKARAN, Kannan Govindaraj, Sukumar Raman

The Anamalai Elephant Landscape (5700 km²) in the Western Ghats of southern India is one of the potential areas for the long-term conservation of the Asian elephant. This population is genetically more diverse and distinct from the much larger elephant population further north in the Ghats. This area is also known for its rich biodiversity along a rainfall and topographic gradient that supports natural vegetation ranging from tropical montane stunted forest and grassland to lower elevation evergreen, deciduous and thorn forest. Through extensive field surveys we assessed elephant habitats, mapped elephant distributions, land-use patterns and corridors, estimated elephant population size and documented elephant-human conflict. We identified several barriers to the movement of elephants arising mainly from developmental activities and topographic constraints. The mean density of elephants was estimated to be ~1 elephant/km² at a moderately skewed ratio of adult male to female (1:9). Elephant-human conflict was much higher along the eastern than the western part of the landscape, possibly due to different cropping patterns, greater fragmentation by non-forest activities and degradation of habitats. Based on our surveys and GIS analysis we make recommendations for the long-term conservation of this flagship species.

Conservation on private lands

94. "IF IT PAYS IT STAYS"-IMPLICATIONS FOR WIDE RANGING LEOPARDS SWANEPOEL, LOURENS, Wouter van Hoven

The principle, "if it pays it stays", is the basis for many successful community conservation projects. However, the implementation of such a strategy becomes complicated when being applied to wide ranging species, which impact on several different properties. This became evident in a study on leopards (*Panthera pardus*) on private farms in the Waterberg, Limpopo, where one male and three female leopards were collared to determine their home ranges. The combined range of the four leopards covered 500 km² over 35 different properties. A questionnaire survey indicated that 41.6% of property owners object to the presence of leopards while 45.9% maintain that leopards have no inherent economic value. Theoretically an increase in the value of leopards would stimulate conservation of the species. While hunting properties favour an increase in hunting quotas, ecotourism properties prefer habituation, research and green labelling as methods of increasing the value of leopards. However, conflicts will arise due to leopards traversing areas assigned to both ecotourism, and hunting. The large range sizes of leopards make successful habituation difficult and cannot justify increasing hunting quotas. Based on the data, it is suggested that landuse zones, and not property boundaries be used to utilise the leopard population in a sustainable way.

95. CHEETAHS OUTSIDE CONSERVATION AREAS IN THE THABAZIMBI DISTRICT OF SOUTH AFRICA: INVESTIGATING METHODS OF MONITORING POPULATION SIZE AND RANGE USE MARNEWICK, KELLY, Deon Cilliers

Cheetahs *Acinonyx jubatus* are notoriously difficult to survey this problem is further complicated on ranch lands where land is privately owned, access is restricted, the bush is often dense and cheetahs are frequently persecuted. However ranch lands are considered important to cheetah survival due to the absence of lions *Panthera leo* and spotted hyaenas *Crocuta crocuta*. Very little is known about these cheetahs. Cheetahs are individually identifiable by their unique spot patterns, making them ideal for capture-recapture surveys. In a pilot study, photographs of cheetahs were obtained using four camera traps placed in areas of known cheetah activity within a 300 km² area in the Thabazimbi District of South Africa. These data were analysed using the capture-recapture software package CAPTURE. The population was closed ($P = 0.056$) with a capture probability of 0.17 and an estimate of 6 - 14 cheetahs ($P = 0.95$) with a mean population size of seven cheetahs ($SD = 1.93$). To determine range use, cheetahs were trapped and fitted with radio or GSM/GPS collars. A coalition of two and three cheetahs were caught and monitoring is ongoing. A single male was caught but was shot by a landowner. The minimum convex polygon method produced a range size of 310 km² for the coalition of two and 190 km² for the coalition of three. Neither of

these ranges were asymptotic. This information is used in conflict resolution with landowners to prevent cheetahs being persecuted or trapped.

96. THE EFFECTS OF WILDLIFE ON CATTLE IN LAIKIPIA RANGELAND, KENYA ODADI, WILFRED, Truman Young

Concern over negative impacts of wildlife on livestock production has been rising among landholders in East African rangelands. Consequently, it is increasingly being recognized that the future of wildlife conservation outside protected areas will depend partly on better assessment of the impacts of wildlife on livestock and their associated costs to landholders. In Laikipia, Kenya, moderate densities of wildlife co-exist with livestock operations. Using a set of randomly stratified exclosures, we compared cattle diets and bite and step rates between plots exclusively accessible to cattle and those shared by cattle and large wild herbivores (> 15kg). Cattle consumed significantly fewer forbs, and had lower bite rate and higher step rate in plots they shared with wild herbivores ($P < 0.1$). Because forbs may be critical components of cattle diets, and changes in bite and step rates may affect cattle forage intake and energy expenditure, these results suggest potential seasonal costs of wild herbivores to cattle production in such rangelands, which are the subject of current research. Looking for ways to offset such costs may be valuable in sustaining wildlife conservation on private/communal land.

Desert conservation

97. ACACIA SENEGAL AND ITS GUM ARABIC: OPPORTUNITY FOR THE REHABILITATION AND SUSTAINABLE DEVELOPMENT OF THE DEGRADED RIFT VALLEY DRYLANDS OF ETHIOPIA BURRU, DAGNEW YEBEYEN, Mulugeta Lemenih, Sisay Feleke

Ethiopian Rift Valley is facing serious problems of degradation. Thus, there is a need for urgent measure to abate the destruction of this susceptible ecosystem. Managing the woodlands to offer economic incentive to the locals is probably a viable and lasting strategy. One of the options to provide economic incentive for the area is the production of gum arabic from *A. senegal*, which is one of the conspicuous element in the vegetation of the area. Despite the natural occurrence of *A. senegal* in this woodland, no studies have assessed the status of the population of the species nor the quality of gum it produces. Recently, we investigated both the population status and gum arabic quality of the *A. senegal* resources in this woodland. The result showed that density, abundance and importance value index for *A. senegal* was high in the various land use types assessed. The population structure of *A. senegal* also showed good regeneration. The physicochemical characteristics of gum arabic collected from *A. senegal* trees in the area fit very well with gum arabic qualities of commerce from known destinations such as the Sudan and also to international standards in all aspects, showing promising potential for commercialization. Therefore, if promoted gum based utilization of the Rift Valley dryland will rehabilitate the ecosystem and offer a sustainable development of the local and national economy while contributing to biodiversity conservation and combat desertification.

98. Withdrawn

99. CONSERVATION STATUS OF DESERT IRONWOOD: AN HISTORICAL PERSPECTIVE IN THE SONORAN DESERT ZUÑIGA, BERTHA, Humberto Suzán-Azpiri

Ironwood is among the most ecologically and economically important species in the Sonoran Desert. This legume tree is the main nurse for columnar cacti and plays an important role in the survival of many species. Ironwood has a long history of uses among indigenous groups. The most documented contemporary use is carvings. Originally, ironwood was carved by Comcaac Indigenous; but, currently, rural Mexican people dominate tourist stands and usurp the Comcaac creations. Many populations have been affected by the removal of branches and whole trees for charcoal and carvings. Also, clearing areas to induce grasslands exacerbates the effects of exploitation. We assess the current damage cut of four ironwood populations and compare results with a previous survey obtained in 1992. This historical review doesn't show an increase in damage cut. However, areas under exploitation are increasing and population densities have diminished. In these areas, we didn't observe seedlings. In contrast, populations without exploitation present juvenile

individuals. Ironwood is a species with special protection by Mexican legislation. Unfortunately, this designation might be insufficient to assure survival of these populations, as it is possible to conserve Sonoran Desert ecosystem and observed local extinctions of ironwood.

100. SPATIAL ECOLOGY AND WATER RELATIONS OF THE MISTLETOE *PLICOSEPALUS ACACIAE* ON ACACIAS IN THE NEGEV DESERT GRIFFITHS, MEGAN, David Ward

Acacia raddiana, *A. tortilis* and *A. gerrardii* populations infected by the hemiparasitic mistletoe *Plicosepalus acaciae* are suffering high levels of mortality in many parts of the Negev desert. Mistletoe numbers have increased on Acacia trees over the last 50 years as an indirect consequence of human activity. The primary dispersal vector of *P. acaciae* is the yellow-vented bulbul, *Pycnonotus xanthopygaea*, and populations of this bird have increased dramatically with the expansion of human settlements. We investigated the spatial distribution of the mistletoe *P. acaciae* on its Acacia hosts and found that the probability of infection declined with increasing distance from a human settlement. Furthermore, the movement of bulbuls within- but not between wadis (dry riverbeds) has contributed to the specialization of different *P. acaciae* genotypes on host populations within wadis. To determine if mistletoes are contributing to the decline of Acacias, we studied the water relations between the parasites and their hosts. We found that the degree of mistletoe infection did not affect Acacia water stress and there was no relationship between mistletoe infection and mortality in Acacias. This result is contrary to popular belief and it emphasizes the need to change management strategies for Acacia populations in the Negev desert.

Ecological restoration and reconstruction

101. ECOSYSTEM ENGINEERS IN THE WRONG PLACE: A BI-NATIONAL APPROACH TO RESTORATION OF AUSTRAL ECOSYSTEM BY BEAVER REMOVAL SAAVEDRA, BARBARA, Nicolas Soto, Fernanda Menvielle, Adrian Schiavini, Laura Malmierca, Daniel Ramadori

Canadian beavers were introduced to Tierra del Fuego in 1946. Since then the original 25 pairs has expanded to approximately 100,000 individuals in both Argentina and Chile. Now beavers occupy almost the entire Fuegian Archipelago, and individuals have reached the continent. As ecosystem engineers, beavers have seriously affected native biodiversity as they became a key factor in forest destruction, altering other ecosystems like rivers, jeopardizing local and global ecological, social and economic processes. Management strategies in Chile and Argentina were based primarily on the use of economic incentives to promote beaver capture. Interventions have failed to reduce beaver population and in preventing beavers to invade the continent. Faced with the impending ecological disaster that would follow the expansion of beavers onto continental South America, local governments from Chile and Argentina, convened two International workshops, after which a Bi-National Strategy for Beaver Eradication was agreed upon, and explicit commitment for working on restoration of Southern Patagonia through a large scale, bi-national level beaver eradication program was explicitly taken, and a shared vision, goals, and objectives were defined. The beaver eradication project will become a model for addressing a global threat to biodiversity, based on a transboundary bi-national effort, public-private initiative, developed from Tierra del Fuego to the world.

102. THE POTENTIAL OF AREA CLOSURE IN INCREASING WOODY BIOMASS AND REGENERATION IN TIGRAY, ETHIOPIA: STRATEGY FOR THE REHABILITATION DEGRADED DRY LANDS BIRHANE, EMIRU, Ermias Aynekulu, Nigussu Begashaw

The development of area closure is one of the commonly practiced strategies to restore the degraded dry land environment in most part of the Northern Ethiopia. However in areas with scarcity of resources, complete protection will lead to unwise utilization of the resource developed after rehabilitation. Therefore, it was necessary to study the impact of area closure on enhancing woody biomass accumulation, and regeneration pattern in order to determine the future development of the enclosures. 45 permanent plots with a radius of 5.6 m were laid down randomly to collect height, DSH, DBH, number, identity and life form and single tree-sampling method was used to estimate the biomass of each species. Biomass produced were 7.38 ton/ha, 9.2 tons/ha, 4 tons/ha & 3.8 ton/ha in enclosure 1, 2, 3 and 4 respectively. 745 individuals representing 30 species and 731 individuals representing 19 species were found in the two areas showed

an expanding type of regeneration. But some species like *Senna siengueaena*, *Maytenus senegalensis* and *Olea africana* formed distorted type of natural regeneration curve, an indicator of interference. Even though, the biomass produced is not enough for distribution among the society, it is necessary of considering participatory management of the rehabilitated area.

103. BIOTIC, SCIENTIFIC AND SOCIAL BENEFITS OF CLUSTERING STREAM RESTORATION PROJECTS IN A RURAL WATERSHED

WALTER, CYNTHIA, Jane I. Earle, Dean Nelson, Benjamin Wright

The 500 km² Loyalhanna Watershed typifies areas damaged from mining, air pollution and intensive agriculture that deplete aquatic biodiversity. To counteract such losses, we 1) constructed 8 ha of wetlands to intercept 700 kg. iron/day from abandoned coal mine drainage (AMD) to treat 5 km, 2) buffered acid deposition (AD) with 180 metric tons of limestone sand, restoring 10 km, and 3) protected over 30 pasture streams each with 2 km of fencing and riparian plantings. Six yrs. of monitoring after wetland construction indicates invertebrate diversity and abundance progressively increased in AMD impacted sites (Regression test $P < 0.001$). Two years of limestone treatments changed a downstream site to alkalinity, invertebrate and fish conditions that match healthy conditions upstream. Farm streams showed a significant depression in the proportion of invertebrate taxa sensitive to organic pollution before treatment, especially Plecoptera ;1-3 yrs later, these sites statistically matched upstream communities (two sample t tests $P < 0.01$). These restoration efforts are effective when a) healthy biotic communities are proximate, b) frequent monitoring by local academic, governmental and private experts collaborate on adaptive management, and c) citizens support maintains funding and site protection. These examples illustrate why clustering enhances restoration effectiveness biotically through natural invertebrate dispersal, scientifically through regionally appropriate methods, and socially through shared equipment and expertise.

104. THE EFFECTS OF GRAZING AND CONTINUOUS BROWSING AS A MEANS OF CONTROLLING BUSH ENCROACHMENT IN THE ARID SAVANNAS IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

DONDOFEMA, FARAI

Herbivory is a possible solution for controlling bush encroachment because it is recognised as a natural ecological process which is an economically viable solution for rangeland rehabilitation. An area densely encroached with bush was mechanically chopped to ground level and divided into a random experimental design of five 1.25 ha plots in 1975. Three plots were heavily grazed with cattle after the first frost in early winter, while two plots were grazed with cattle and continuously stocked with goats. Detailed annual botanical grass (point to tuft distance and disc pasture meter) and bush (species, height, and lowest browseable material) surveys were conducted during early summer in 600 m transects. These data were used to estimate changes in botanical composition, density, phytomass and browsing potential. ANOVA over 23 years indicates that the browsing/grazing treatments had significantly lower bush densities than treatments only grazed ($F = 144.7$; 21DF; $P < 0.05$) and showed that the browsing/grazing treatments significantly lower browsing units of bush than treatments only grazed ($F = 82.8$; 21DF; $P < 0.05$). Browsing/grazing treatments had significantly higher effects on the frequency of *Themeda triandra* than treatments only grazed ($F = 45.8$; 21DF; $P < 0.05$). This study increases the understanding of the effects of herbivory in bush encroachment control.

105. PLANTED HEDGES IMPROVE THE ROLE OF HIGHWAY VERGES AS REFUGES

LE VIOL, ISABELLE, Emmanuelle Porcher, Nathalie Machon

Highway verges could constitute refuges for native flora, possibly providing connectivity, particularly in agricultural landscape. The effectiveness of these functions depends on the ability of hedges to benefit significant proportion of local species pool and their functional attributes, i.e. on the efficient restoration and recolonization of these recently created habitats. Here, we investigate what factors affect plant diversity in highway verges and identify those that could be managed to favour biodiversity. We evaluated the contribution of several environmental conditions (including soil, slope, width, presence of neighbouring wood patches or planted hedges) to the composition of herbaceous communities in 31 highway verge stations (465 quadrats) of an agricultural landscape in France. We used capture-recapture methods, accounting for differences in probability detection, to estimate species richness. We observed 150 species only, but most (96%) of them were native. Species richness was primarily influenced by adjacent land-use, a factor that is

not easily manipulated. However, when verges were bordered by cultivated fields, the presence of planted hedges significantly increased species richness. We showed that this was due to herbaceous species with specific life history traits associated to hedgerows. We conclude that construction choices and management of highway verges are crucial to favour their role as refuges for common flora in agricultural landscapes

106. Withdrawn

107. JACKAL RESPONSES TO RE-INTRODUCED TOP PREDATORS: TROPHIC SHIFTS IN RESPONSE TO INCREASED OPPORTUNITIES AND COMPETITION
DE KLERK, CHRISTELLE, Graham Kerley, Matthew Hayward

The re-introduction of top predators has provided much evidence for the important role these animals play in the pattern and processes driving these ecosystems. The re-introduction of lions and spotted hyenas into the Addo Elephant National Park (AENP) allowed us to investigate the effect of large predator re-introductions on the diet of an existing medium-sized predator, the black-backed jackal (*Canis mesomelas*). We postulated that the re-introduced predators would lead to an increase in the incidence of carrion in the diet, due to increased carcass availability from kills. We also expected a decrease in the occurrence of small ungulates in the jackal diet, due to increased intraguild competition for this shared resource. Jackal diet was compared between two sections of the AENP, differing only in the presence or absence of lion and spotted hyena. Scat analysis was used to determine prey consumption. Results show some shifts in the diet, with a significant increase in the incidence of carrion and a decrease in the consumption of small ungulate species in the presence of lions and spotted hyenas. This demonstrates that top predator re-introductions not only affect prey populations, but also their co-existing mesopredators, through altering their trophic status. This should be taken into consideration when discussing management options.

Ecosystem / conservation area management: theory and practice

108. TOURISM, POACHING AND WILDLIFE CONSERVATION: WHAT CAN SUPPORT ZONE DEVELOPMENT PROGRAMME ACCOMPLISH?
ADELEKE, BOLA

Support Zone Development Programme (SZDP) has been recently established in many African countries to improve wildlife conservation and the welfare of local communities. However the effectiveness of this programme has been hampered by conflict and illegal harvesting of wildlife. This paper focuses on the management strategy of between a protected area and the local residents. Information was sought through structured questionnaires and interview schedule by purposive sampling of the Community Based Organisation (CBO) Leaders and the park administrators. Data collected were analysed through descriptive statistics. The park management benefit from wildlife conservation through tourism while the local residents benefit through enhanced poultry, trading, provision of agro-processing equipment and employment opportunities. SZDP relying mainly on decision made by park management did not promote wildlife conservation. In addition the welfare of the local people is still ambiguous. Bottom- top decision-making policy and partnership are therefore needed to foster wildlife conservation.

109. SMALL-SCALE HETEROGENEITY OF SPIDER (ARACHNIDA: ARANEAE) ASSEMBLAGES IN THE SOUTPANSBERG, SOUTH AFRICA: IMPLICATIONS FOR CONSERVATION
FOORD, STEFAN, Matodzi Mafadza, Ansie Dippenaar-Schoeman, Berndt Van Rensburg

Conservation area selection is often based on quarter-degree squares and neglects heterogeneity that is pervasive at smaller scales. Spiders are an abundant and easily sampled group that responds to the environment at smaller scales. Here we investigate the implications of small-scale variation in spider assemblages in the Soutpansberg for conservation. Five sampling methods were used: sweep nets, pitfall traps, beating, active search, and leaf litter sifting in five habitats selected based on structural differences. We collected 337 species in 49 families in an area of 450ha. Accumulation curves of observed species richness suggest that not all species were caught although the three species richness estimators, MMMeans, ICE, and ACE did level off for most of the habitats. Each habitat had a distinct spider

assemblage as well as species that had high fidelity and specificity for each of the habitats. Spatial structuring within each of the habitats was also observed based on the lack of any significant spatial autocorrelation for any of the habitats except one. Habitat diversity and structure explains differences between habitats but not within. Invertebrates should complement large-scale area selection based on vertebrates as indicated by their fine-scale response to environmental factors.

110. THE EVOLUTION OF ECOSYSTEM BASED MANAGEMENT: FROM THEORY TO PRACTICE **HIGGINS, MEGAN**

Both the Ocean Commission and Pew Commission Reports recommended the implementation of ecosystem based management to better manage the nation's marine resources. Ecosystem based management (EBM), an ecosystem approach to planning and management, is not new; elements have been used in the Chesapeake Bay, Great Lakes, and other regions and countries for decades. Now, advances in knowledge, technology, and governance and new partnerships make many of our coastal areas ripe for implementation of this comprehensive approach to marine resource management. A presentation will be made of the successes of EBM, the remaining challenges, and potential solutions.

111. HAY-MOWING AS A PROTECTIVE MANAGEMENT IN EUROPEAN STEPPE NATURE RESERVES AND ITS INFLUENCE ON SPIDER COMMUNITIES **POLCHANINOVA, NINA**

In Europe virgin steppes have remained only in small nature reserves. The lack of ungulates and natural fires lead to litter accumulation with further steppe degradation. Hay-mowing is widely used to prevent this process. However it affects different steppe inhabitants in different ways facilitating or suppressing their development. Therefore the elaboration of common strategy is a complicated matter. The goal of my research was to study the effect of hay-mowing on spider communities as part of the steppe biota. In 10 investigated nature reserves, species abundance was higher on the strictly preserved, or un-mowed, plots because of the presence of the forest-edge species. There was no species found restricted to un-mowed steppe. Spider complexes in herbage are renovated quickly: on the second year after moving they were similar to those on the un-mowed plots, while in litter which needs more time to be formed, spider assemblages were very poor. Only wandering litter dwellers preferred in some localities periodically mowed plots. To contribute to biodiversity in nature reserves, it is necessary to create a mosaic landscape by means of different management regime. Ecosystem / conservation area management: theory and practice

112. BUILDING COMMUNITY ROLES AND INCENTIVES IN ECOSYSTEM CONSERVATION AND MANAGEMENT: PILOTING THE ECOSYSTEM APPROACH IN AFRICA'S SERENGETI AND NORTH LUANGWA **SCHULTEN, CHRISTIANE, Godlisten Matilya, Moses Nyirenda**

This project is piloting the Biodiversity Convention's Ecosystem Approach in two of Africa's outstanding savannah ecosystems, the Serengeti (Tanzania) and North Luangwa (Zambia). Activities focus on the practical application of the Approach's five operational guidelines: a) establishing inter-sectoral ecosystem cooperation mechanisms; b) improving understanding of ecosystem processes and functions; c) decentralising management to local institutions; d) improving benefits and incentives for local stakeholders; and e) introducing adaptive management systems. The project is strengthening policy and practice that builds a central role for local communities in ecosystem management and, ultimately, will help ensure that key African ecosystems provide lasting conservation and livelihood benefits. The target groups are natural resource and development managers and policymakers, as well as local people who presently bear many of the costs while receiving few of the benefits of biodiversity conservation.

113. CONSERVATION PLANNING IN THE GREATER MAHALE ECOSYSTEM – CHALLENGES AND OPPORTUNITIES **DOODY, KATHRYN, Lilian Pintea, Zoe Balmforth, Nicholas Kinyau**

Mahale Mountains National Park lies at the core of the Mahale Ecosystem, a rich pocket of high biodiversity and endemism within the globally important 'Eastern Afromontane' biodiversity hotspot. Frankfurt Zoological

Society and Tanzania National Parks Authority (TANAPA) are jointly implementing a European Union funded project, the Mahale Ecosystem Management Project (MEMP). The Nature Conservancy's Conservation Action Planning (TNC CAP) methodology is being used by the project to guide conservation planning in the Mahale Ecosystem. Due to the large scale of the ecosystem, remote sensing is also being used as a conservation planning tool. This paper summarises the steps taken so far in the Mahale Ecosystem conservation planning process and details the challenges, opportunities and progress. Challenges include lack of detailed biological and socio-economic information on which to base planning initiatives and the lack of an obvious official institution (or institutions) to implement an ecosystem plan at the appropriate geographic scale. Opportunities include strong institutional support from conservation organisations and national government, and large areas of natural resources with very limited or no human impact as a result of low human population densities. However, with the highest rate of population increase in the country, the need for a comprehensive ecosystem plan and identification of clear institutional responsibilities is urgent.

114. IMPACTS OF BLACK RHINOCEROS ON POPULATIONS OF THREE EUPHORB SPECIES

Brown, Derek, Fred de Boer, Karen de Jong, Linda Heilmann, Bodina Luske, PETER LENT

The Great Fish River Reserve, South Africa, contains a sizable and growing population of black rhinoceros (*Diceros bicornis minor*) and several species of latex-producing euphorbs, including two tree species, *Euphorbia tetragona* and *E. triangulata*, and a shorter succulent species, *Euphorbia bothae*. Rhinos feed extensively on the tree species and on a localized population of *E. bothae*, which may provide 40% of the intake of some individuals. The sustainability of these plant-animal interactions was examined by comparing browsing incidence and intensity with areas without rhinos. Based on photography repeated over 2 months 36.6% of *E. bothae* plants accessible by rhinos were browsed, with average biomass loss of 13%; 1% were destroyed, and there was no significant compensatory growth. After 3 years, 70% of plants showed reduced biomass; 19% were killed and plant density had significantly declined. In another study plot 5-6% of the two tree species were killed by rhinos over a 2-month period. Clearly, black rhinos can overexploit euphorb populations as can elephants. Other species (kudu, baboons, porcupines) also use euphorbs heavily. Thus, special measures are needed for the conservation and sustainability of these euphorbs.

115. AN ANALYSIS OF LANDSCAPE LEVEL COVARIANCE IN ECOSYSTEM SERVICES IN FOUR REGIONS OF SOUTH AFRICA

SEYMOUR, COLLEEN, John Donaldson

Market based approaches to conservation, including payments for ecosystem services (ES), should provide incentives for good land management and sustainable agriculture. The conceptual framework has developed substantially recently, but scientific information supporting market instruments is lacking. Changes in benefits at different spatial scales, ecological requirements of various processes, the influence of land use on services, and covariance between services are mostly unresolved. Thus, particular service requirements, or tradeoffs between services can be indeterminate. We examined co-variance across ES at different spatial scales on farmlands in South Africa. We used data from four sites to establish if biodiversity and C sequestration co-vary under different land uses, and at two of these sites, co-variation in soil infiltration, plant diversity and soil nutrient status. There was no relationship between plant species richness and organic soil C at three of the four sites, but there was a significant positive relationship in Subtropical Thicket vegetation. Unique features of Thicket, and the link between C sequestration and a few key species, may explain this finding. Water infiltration rates and percentage soil N showed no relationship with richness of species or functional groups at two sites. These results suggest that ES vary independently across the landscape at a farm scale and we discuss implications for 'bundling' ES when developing markets for services.

116. DO BIOSPHERE RESERVES ACHIEVE CONSERVATION SUCCESS? A MULTI- SCALE INVESTIGATION AND A SUCCESS FRAMEWORK

BERTZKY, MONIKA, Susanne Stoll-Kleemann

UNESCO biosphere reserves (BRs) follow three objectives: biodiversity conservation, sustainable development, and logistic support. In practice, priorities for these objectives are set very differently from one site to the next. This has led to debates about whether or not BRs do in fact conserve biodiversity and thus

contribute to the achievement of the CBD's 2010 targets. This paper addresses this question by referring to the results from a multi-scale investigation: (1) an interview series with 70 protected area experts on their definition of conservation success, (2) a global telephone survey with 190 BR managers about their view on BR functions and conservation needs, and (3) case studies in Mexico, Thailand and Cuba to gain deep insights into activities and challenges on site. A success framework that interrelates conservation capacity, needs and activities while still taking into account the context aspects of importance, has furthermore been developed and applied in two Mexican BRs. The definitions for conservation success given by protected area experts show a common trend and largely overlap with the three BR objectives. A large fraction of BR managers regard a BR as a protected area. The success framework opens up new options for an assessment of conservation success without depending on ecological data, which are usually lacking due to capacity limitations. BRs do definitely contribute to meeting international targets, going even beyond the CBD's 2010 target.

117. THE EFFECTS OF WILDLIFE CONSERVATION ON LOCAL COMMUNITIES AND ANIMALS IN THE SIMIEN MOUNTAINS OF ETHIOPIA

GRANT, JULIE

The Simien Mountains in Ethiopia host a number of endangered wildlife species, many of which are endemic. As such, a number of conservation policies were implemented to protect the wildlife of the region, and in 1969 the Simien Mountain National Park (SMNP) was created. Through informal interviews with local people living in the Simien Mountains, this study aimed to document the effect of conservation policies on both local communities and wildlife. From these interviews it was concluded that the conservation policies of the SMNP can be both beneficial and detrimental to communities depending on their proximity to the park. Benefits manifest themselves in the form of income made from tourists visiting the region, and the establishment of firewood nurseries created by NGOs, to protect indigenous trees. Simultaneously, these conservation policies can also be detrimental as they limit land and resource use by some local communities. Unfortunately, however it seems that the conservation policies may not be benefiting the regions wildlife as intended. According to local people there are higher numbers of wildlife residing outside the park than within it.

Environmental politics and policy

118. BRIDGING THE GAP: KNOWLEDGE, COMMUNICATION AND ACTION FOR AN INTEGRATED SOCIETAL RESPONSE TO THE CHALLENGES OF NATURAL RESOURCE CONSERVATION IN INDIA

PATRA, JYOTIRAJ

India, of the megadiversity countries, is at the forefront of diverse conservation initiatives, policies, practices and cultures. These approaches and methodologies have undergone a significant change in their nature and characteristics, from 'coercive conservation' to 'participatory conservation'. Of late a gap, rather a gulf, has evolved in this entire matrix of production and application of knowledge pertaining to nature conservation in India, from species to ecosystems to integrated social-ecological systems (SESs). There has been a growing discontent among conservation scientists in India against the bureaucratic procedures and hurdles for carrying out research and studies in protected areas, which are under state control. Arbitrariness and unwillingness on the part of resource managers and absence of space to redress those, have been pointed out as one of the primary and underlying causes hindering the science of conservation in India. Non-relevance of the research outcomes without any policy ingredients and just mere academic exercises, are some of the counter arguments and replies. Diverse institutions operating with diverse mandates and interests across scales complicate, confuse and further widen the existing gap between knowledge and action. By triangulating the approaches of political ecology with that of Actor Network Theory (ANT), this paper identifies the gaps and locates the scopes for synergies to communicate and build trust among various actors associated with and responsible for the sustainable conservation of critical resources in India.

119. BEST PRACTICES & PRINCIPLES FOR ENGAGING LOCAL COMMUNITIES FOR CONSERVATION

MEZA, LAURA

This study collects and reviews the information from publicly available sources on Principles and Guidelines in how to engage local communities for conservation. The practices for engaging local communities were studied using a cross-section of international institutions and organizations during a 5-months period. The literature review included international conventions and the practices of the international conservation organizations, as well as the policies used by development organizations (such as the World Bank, regional development banks, and cooperation agencies) and recommendations provided by the different bodies of the United Nations system. Religious groups, think tanks, donor agencies, and private companies were also studied. This paper shows an evolution and progress on policies in favor of indigenous and local communities. The synthesis of the information-gathering shows a series of common principles declared by the organizations studied, that refer to participation and partnership, the rights of local people, transparency and accountability, benefit-sharing, and principles that mention values and knowledge systems. On the other hand, local groups express different demands ranging from proper representation, funding and support for capacity building, and ultimately a right-based approach of development and conservation projects.

120. RESOLVING CONFLICT IN BIODIVERSITY CONSERVATION: TOWARD A PARADIGM-BASED DIALOG

MALAN, LEON-C.

Conflict between two or more parties is the manifestation of differences at a deeper level -- differences between underlying assumptions, beliefs and interests. The debate and disagreement about best ways to conserve biodiversity through protected areas is no exception. Underlying the differences between proponents of strict parks without people and clear boundaries on the one hand, and those that favor extraction of natural resources by local communities on the other, are some fundamental belief systems and paradigmatic assumptions. Unless we gain insight into these paradigmatic differences, conflict resolution will remain elusive. This paper reports the results and conclusions of a discourse analysis and Q method study that explored the underlying assumptions about biodiversity conservation in protected areas. Three distinct paradigms emerged from the data. This paper will explain these paradigms and the implications for biodiversity conservation. The contribution of this study is gaining a deeper understanding of the sources of conflict about protected areas, suggesting ways to promote dialog, resolving conflict, and formulating successful policy.

121. TRANSBOUNDARY NETWORKS OF MARINE PROTECTED AREAS: HOW FAR HAVE THEY GONE?

GRILO, CATARINA , Raquel Ribeiro, José Guerreiro

Transboundary protected areas (TBPAs) have and are being created to conserve habitats and biodiversity, as their geographical distribution supersedes that of jurisdictional boundaries. They are also a way of facilitating good neighbourliness. Transboundary cooperation in marine conservation is a growing but recent trend. The present study aimed to understand how marine TBPAs are created by investigating groups of countries engaged in substantive cooperative management of marine biodiversity. The level of commitment between States was analysed, by identifying the institutional, financial and legal arrangements. The Wadden Sea and the TRANSMAP project area (Eastern Africa) are some of the examples surveyed. Some governance arrangements seem to facilitate the implementation and management of marine TBPAs: i) establishing joint coordinating bodies; ii) linking analogous State agencies; iii) pre-establishing a conservation status in each side of the border, iv) applying the same legal status for protected areas in the partner countries, as well as common regulations for fisheries; v) creating a common management plan developed by a joint management committee; and vi) revenue sharing (of particular relevance in developing countries). Evoking international conventions to engage States in further cooperation seems to be a quite common practice. This analysis provides insights into what may be a best practice procedure for the future establishment and management of marine TBPAs.

Fish conservation

122. ANTHROPOGENIC IMPACTS ON CONDITION OF INTRODUCED TILAPIAS IN UGANDAN CRATER LAKES

EFITRE, JACKSON, Lauren J. Chapman, Debra J. Murie

This study explored possible effects of fishing pressure and deforestation on the relative condition, defined as the weight of the fish relative to its length, of introduced tilapia species in 19 small volcanic crater lakes in Uganda and identified significant environmental predictors (biotic and abiotic) of fish condition. We selected two tilapia species (*Oreochromis leucostictus* and *Tilapia zillii*) that are widely introduced in these lakes and have divergent trophic niches as adults (planktivore and herbivore, respectively). We asked whether condition differs among lakes characterized by differences in fishing pressure and levels of deforestation, and developed predictive models of fish condition for the two species based on a suite of biotic and abiotic factors. We found that heavily fished populations of both *O. leucostictus* and *T. zillii* were in better condition compared to populations with low fishing pressure. In addition, condition of *O. leucostictus* populations was greater in severely deforested lakes than in moderately deforested lakes; however, condition of *T. zillii* did not differ between deforestation categories. Secchi depth (water transparency) and conductivity were significant predictors of *O. leucostictus* condition, whereas maximum depth, lake area, water temperature, water transparency, and conductivity were significant predictors of condition in *T. zillii*. These results should be integrated into development of innovative approaches for management of tilapiine populations in these lakes.

123. Withdrawn

124. LARVAL FISH DYNAMICS IN A PROPOSED NEW MPA, ALGOA BAY, SOUTH AFRICA

PATTRICK, PAULA, Nadine A. Strydom

The ubiquitous nature of larval fishes make them ideal life stages to target for fish inventories and monitoring work in Marine Protected Areas. Using a single gear type, namely a plankton net, larvae of fish species that are both common and cryptic can be assessed simultaneously, circumventing using an array of methods to sample the adults. Surveying adults is also genetically expensive. A new MPA is proposed in the eastern sector of the Algoa Bay nearshore, South Africa. A study was initiated to ascertain what species were present in the area as larvae and the level of use of the shallow nearshore by these larvae, prior to promulgation of the reserve, in order to provide a baseline for comparison once fish conservation begins in the area. The nearshore was selected as this habitat is poorly studied in South Africa yet is known from international literature, to be an important feeding ground for larvae and is in close proximity to alongshore currents that are known dispersers of plankton. To date, no information exists for larval fishes occurring in this part of the bay. This project aims to determine the composition, abundance, seasonality and distribution of larval fishes in the eastern sector of Algoa Bay. Larvae were sampled along two depth contours (5/6m and 15/16m) in the shallow nearshore region between Woody Cape and the Sundays Estuary mouth. Larvae were collected by means of boat-based bongo-net tows in all seasons between March 2005 and January 2007. Salinity

125. CONSERVATION AND MANAGEMENT OF FISH AND WILDLIFE POPULATION WITHIN SWEDISH JURISDICTION: THE NEED FOR INTEGRATING AN ECOSYSTEM-BASED APPROACH

CHRISTIERNSSON, ANNA

The diversity of species has decreased massively during the last century. Despite the array of legal instruments aiming at conserving natural resources applied since the middle of the 20th century the eradication of species has not been hindered. There may be several explanations for why the instruments have not been successful in hindering the decreasing diversity. One proposition for the failures is the lack of a holistic approach in regarding ecosystem characteristics such as inter-species and habitats relations. Another proposition is that the legal system should have an adaptive capacity to deal with complexity and uncertainty. The purpose of this paper is to assess the adequacy of the legal instruments for the protection of wildlife and fish species within the Swedish jurisdiction with reference to these two propositions. The results of the paper show that the legal instruments for the protection of species mainly are concerned with

the rational use or protection of a certain species rather than on the sustainability of ecosystems. There is also a lack of adaptive elements in the legislation, such as the lack of legal requirements on monitoring of the conservation status of species. The conclusion of the paper is thus that a legislative approach which is more holistic and more adaptive is necessary; otherwise there is a risk that the preservation of biodiversity will be further frustrated.

Forest conservation

126. THE EFFECTIVENESS OF THE PARTICIPATORY FOREST MANAGEMENT AND THE COMMUNITY BASED ORGANIZATIONS IN CONSERVATION OF THE INDIGENOUS FORESTS IN CENTRAL KENYA KURIA, DAVID KIMANI

In the recent past, the concept of community conservation has been gaining popularity in Africa. In Kenya for instant concept been embraced as Participatory Forest Management (PFM) within the forest sector and is allowing for co-management of natural resources with local communities. This approach just like many other conservation approaches has some strengths and limitations that could hasten or slow the attainment of conservation objectives of the resource at hand. This paper looks at how PFM is being implemented at Kereita Forest on the southern part of the much famed Aberdares forest. It specifically looks at the involvement and contribution of multi-stakeholders particularly the local communities, the achievements made so far and the challenges encountered. The paper further looks at the importance and contribution of the local community groups in the achievement of conservation objectives at this important biodiversity site. It concludes by highlighting the factors that are favoring PFM and tries to area for improvement.

127. IMPACTS OF DEFORESTATION AND SUBSEQUENT REFORESTATION ON THE BIRD COMMUNITY IN A UGANDAN PROTECTED FOREST MASSIMINO, DARIO, Simone Masin, Renato Massa, Christine Dranzoa

Tropical rainforests suffer from fragmentation and degradation, with consequences as the decline of interior or most selective species. For this reason, researches are undertaken that investigate the effects of these disturbance processes, possibly developing appropriate restoration plans. This research aimed to study the bird community composition of a reforested area 21 and 33 years after an intensive logging occurred in 1970. Surveys were conducted in 1991 and 2003-2004 by mist netting in Kanyawara area in Kibale National Park (Uganda). The earlier survey showed a ratio between generalist and interior forest species of 0.97, significantly different from that estimated in a contiguous primary forest (0.45). This alteration was mitigated in the second survey, which showed an intermediate ratio of 0.62. We therefore suggest that 35 years after intensive logging, our study area can partially recuperate a bird community typical of a mature forest, even though a significant alteration, probably due to the incomplete recover of all lost ecological niches, still remains.

128. IMPACTS OF PLANT EXPLOITATION ON THE RANGING PATTERNS OF GRAUERS GORILLA IN THE ITOMBWE FOREST, THE ALBERTINE RIFT, EASTERN D.R. CONGO KUSAMBA, CHIFUNDERA, Basilwango Lusolo

A one year survey has been conducted in the Itombwe Forest for assessing the impacts of plant exploitation on the ranging patterns of *Gorilla beringei graueri*. Using a 500 m long transect method, we found that encroachment, logging, mine extraction and tree cutting are the main threats to the forest and took place in 1996. In fact, before this year, the gorilla groups, 980 individuals in total, were ranging more widely than today and are located between Ulindi and Elila rivers, a small polygon of about 4,320.5 km², representing 31.6% of the original area of about 14,025 km². The fact that gorillas are ranging in a smaller area than before is an evidence of human pressure on the habitat and species, and this bad situation can lead to the disappearance of the species at local level if no conservation action is urgently undertaken. Under this banner the study strives to monitor the Lowland Gorilla populations and distribution, and to record all human activities that are destroying their natural habitat. The results will help to suggest appropriate conservation measures that could combine education, law enforcement and community development projects. International NGOs, such as WCS, WWF, BPCP and local CBOs, are working together in order to obtain

from the Congolese Government an official conservation status for recognising the Itombwe Forest as protected area.

129. EPIPHYTE ASSEMBLAGES ACROSS A GRADIENT OF HUMAN DISTURBANCE IN A TROPICAL MONTANE DRY FOREST LANDSCAPE

WERNER, FLORIAN A., S. Robbert Gradstein

We studied patterns and determinants of epiphyte species composition, richness and density across a gradient of human disturbance. Field work was done in the interandean Guayllabamba drainage of northern Ecuador (2300 m a.s.l., 530 mm rain/yr). Epiphytes on 100 trees of *Acacia macracantha* were sampled in five different habitat types including mature mixed and pure Acacia forest, mature forest edge, semi-closed secondary acacia woodland and isolated trees in pastures. Disturbed habitats hosted nested subsets of the mature forest assemblages. Species density of vascular epiphytes did not differ significantly between habitat types whereas bryophyte species density was greatly reduced on isolated trees. Secondary woodland was intermediate between isolated trees and mature forest types in terms of bryophyte species density, richness and floristic composition. Surprisingly, forest edge showed considerably lower species richness and density than secondary woodland and similar floristic affinity to isolated trees and mature forest. Species density was strongly correlated with crown closure. Distance to forest had no significant effect on species density of epiphytes on isolated trees. We conclude that microclimatic deteriorations act as key-driver for the observed impoverishment of epiphyte assemblages following disturbance, and that epiphytic cryptogams are excellent indicators of microclimate and human disturbance in montane dry forests.

130. CHILDREN AND CONSERVATION: MOVING BEYOND ADULTIST PERSPECTIVES ON THE ROLE OF CHILDREN IN ECOSYSTEM MANAGEMENT

McGarry, FLORIAN A., JULIA CLOETE

Conservation strategies are increasingly moving towards more participatory, sustainable management based ideologies; both locally and internationally, this shift has focused almost exclusively on adult resource users. The role of rural children as active harvesters of natural resources has been widely omitted from contemporary conservation research. Drawing on case studies from rural villages in the Eastern Cape Province of South Africa, this poster illustrates the significance of children as natural resource users, who have been ignored by both their parents and the environmental management community. As children's psychology and social status is vastly different to their adult counterparts, a new more interactive methodological design was created which draws on standard empirical/anthropological research methodologies, interactive visual aids and play in order to cross cultural, social and physical boundaries presented by standard academic methods. The combination of these methods allow children to contribute personally to the accumulation of knowledge. By providing evidence of a broad range of children's natural resource use activities, and illustrating the direct bearing these activities have on important conservation issues, such as community based natural resource management; and the use of wild foods in general food security and nutrition, this paper aims to offer new insight into the potential role for children in current conservation strategies.

Freshwater conservation

131. THE USE OF RELATIONSHIP BETWEEN CHLOROPHYLL AND CATCHMENT PRESSURE IN ASSESSING THE RISK OF FAILING ENVIRONMENTAL OBJECTIVE OF POLISH LAKES

GOLUB, MALGORZATA, Hanna Soszka, Agnieszka Kolada, Dorota Cydzik

Poland has about 1000 lakes larger than 50 ha which are considered as significant lake water resources according to Water Framework Directive. By 2015 they should achieve at least good status in terms of water quality. We argue that two methods can be used when assessing the risk of failing environmental objective: one based on water quality parameters (e.g. chlorophyll a, as widely used indicator of eutrophication effect) and the second one consisting in quantifying the significant pressures on catchment scale (so called Additive Pressure Index, APlIndex). In this study we examined the relationship between chlorophyll a and APlIndex using the linear regression. The analysis was performed for stratified and polymictic lakes separately. For these two groups of lakes boundary values of chlorophyll a were established to distinguish lakes being "at risk" and "not at risk" of failing good status. On the basis of regression equation the values of

APIIndex were assigned to risk classes established upon chlorophyll a concentration. Regression analyses did show the significant relationship between chlorophyll a concentration and APIIndex, however the determination coefficients were not too high. Stronger response of polymictic lakes may suggest that this lake type is more susceptible to pressures. Presented approach may be used while working out the water management plans, providing information not only on status of lakes (based on water quality parameter) but also a useful tool for identifying the potential reasons of lake degradation (based on catchment pressure).

132. CONSERVING FRESHWATER BIODIVERSITY IN THE CROCODILE (WEST) AND MARICO WATER MANAGEMENT AREA, SOUTH AFRICA

SMITH-ADAO, LINDIE, Jeanne Nel, Dirk Roux, Lucille Schonegevel, Devlyn Hardwick, Gillian Maree, Liesl Hill, Hermien Roux, Neels Kleynhans, Juanita Moolman, Christa Thirion, Colleen Todd

A planning exercise was conducted in the Crocodile (West) and Marico Water Management Area (WMA) to identify spatial conservation priorities for freshwater ecosystems. A systematic conservation planning approach was used, which included spatial analysis of inland water biodiversity pattern and associated ecosystem processes and ecological integrity, in conjunction with explicit biodiversity targets. River and wetland types which were used as coarse-scale biodiversity surrogates of freshwater biodiversity were complemented with 27 special biodiversity features, as well as data on six fish species and macro invertebrate families. Landscape-level river types, 46, (level 2 ecoregions and hydrological index classes); 115 stream-level river types (longitudinal river zones) and six wetland types (potential wetlands linked to a hydrogeological terrain map) represented freshwater biodiversity pattern. Main rivers, tributaries and wetlands with a present ecological integrity of "Natural" or "Good" were selected to represent small-scale biodiversity processes. A rehabilitation assessment was done for 49 stream-level river types that could not achieve their biodiversity targets. Overall, the proposed river selections and feasible rehabilitation would achieve the biodiversity targets for 89 (77%) river types in the study area. Different design options for achieving biodiversity representation as well as persistence were considered, taking into account aspects of implementation.

133. THE OCCURRENCE OF HEAVY METALS IN *LABEOBARBUS MAREQUENSIS*, WATER AND SEDIMENTS IN CROCODILE RIVER

Gyedu-Ababio, Thomas, RAMATSHEDISO MPHUTHI, Victor Wepener

Mining and agricultural activities are often associated with catchment pollution. In the Crocodile River catchment of Mpumalanga, South Africa, most mining activities take place in the Kaap River subcatchment. The majority of the mines are no longer active; however, there are still possibilities of metals leaching into groundwater. The Kaap River joins the Crocodile River just before it enters the Kruger National Park. In addition to mining, agricultural fields overlie the southern bank of Crocodile River for a distance of over 60 km. These fields are adjacent to the park and therefore pose a risk of pesticides, nutrient and metal pollution to the river. Water pollution affecting biota in the park is a threat to the conservation effort as well as tourism in Kruger National Park. On the basis of pollution from mining, it was therefore hypothesised that concentrations of heavy metals in *L. mariquensis* would form a gradient from the Kaap river confluence in the west, and then decline eastwards. Heavy metals were analyzed in fish, water and sediments, as well as the environmental parameters pH, dissolved oxygen, conductivity and temperature. The results of the environmental parameters did not follow any trend, except for the conductivity, which increased from west to east. From these preliminary results it can be concluded that agriculture contributes more than mining to the metal loading of Crocodile River. However, these results will be confirmed by further results.

134. PARTNERING FOR DESERT FISH RECOVERY: RESTORATION OF BIG WARM SPRING FOR THE RAILROAD VALLEY SPRINGFISH

SJOBERG, JON, Bridget Nielsen, Virginia Sanchez

The Railroad Valley springfish *Crenichthys nevadae* is a threatened species restricted globally to two locations in central Nevada, U.S.A. Big Warm Spring on Native American tribal lands is a large thermal spring complex which includes the greatest extent of historic springfish habitat within the native range of the species, but springfish were extirpated from this site because of habitat alteration and the introduction of nonnative aquatic species. Prior to 2002 Tribal concerns including the economic importance of a commercial aquaculture facility on the Big Warm Spring outflow precluded restoration of springfish habitat. Development

of a unique partnership including the Duckwater Shoshone Tribe, U.S. Fish and Wildlife Service, and Nevada Department of Wildlife has allowed removal of the aquaculture facility, renovation of irrigation infrastructure important to Tribal agriculture and water rights, restoration of 1.5 miles of aquatic, riparian and wetland habitat critical for springfish and other species of concern, and the restoration of important Tribal cultural and ceremonial areas associated with the Big Warm Spring source pool and outflow. Re-establishment of springfish into the restored habitats will substantially advance recovery of this imperiled species, and would not have been possible without successful development of an intergovernmental partnership which insured that Tribal cultural and economic concerns were incorporated into the conservation strategies.

135. INDICATOR VERSUS FLAGSHIP SPECIES IN IDENTIFICATION OF REGIONAL PRIORITY WATERSHEDS FOR CONSERVATION IN THE SOUTHEAST UNITED STATES AND SOUTH AFRICA

MUIR, RACHEL, Pierre de Villiers

The southeastern (SE) United States has relatively rich data resources regarding freshwater biodiversity and established public policies to implement conservation actions. South Africa has more limited freshwater biodiversity data (principally "flagship" fish species) and a recently established conservation policy for imperiled species and their habitats (National Biodiversity Act, 2004). In the southeast United States recent data (1985 to present) were compiled using standard methods to determine the distributions and trends for threatened freshwater fauna (fish, mollusks, crayfish and herptiles). These species were used as surrogates to identify priority watersheds or catchments for conservation actions. This threatened species distribution data and other data sets were used to develop coarse-scale priority watersheds as a tool for resource managers and researchers. For South Africa, information collected from the Orange-Vaal region of South Africa on flagship freshwater species (yellowfish, *Labeobarbus* spp.) and on key habitat areas (riparian) were used to identify priority sites for conservation actions. In addition, information is being developed on other potentially threatened (and indicator) species associated with yellowfish priority habitats. Results from the southeast United States assessment (data-rich, indicator species) and the South Africa (data poor, flagship species) approaches for determining priority watersheds are evaluated and compared. This comparison indicates that a flagship species approach in South Africa would benefit from the addition of indicator species information to more accurately identify priority catchments for conservation action.

136. THE ECOLOGICAL ROLE OF CAVE-DWELLING AMPHIPODS IN THE DOLOMITIC REGION OF SOUTH AFRICA

VAN TONDER, SIMONE, François Durand

Specialized stygobitic amphipods are found in ground water in dolomitic caves and aquifers in South Africa. Stygobitic amphipods form part of the food web within groundwater. Amphipods, water and soil samples were collected from water bodies within dolomitic caves in Gauteng and the Limpopo Province. General ecological observations were conducted at each of these sites. Bacteriological analyses were done on the gut contents of the amphipods and the silt and water at each collection site. Various microbiological tests were undertaken to establish the gut contents. Feeding experiments conducted on the amphipods in an environmental room show that amphipods are omnivorous, scavengers and predators. They feed on bacteria, fungi, plant and animal debris, bat faeces and prey upon one another. The conclusion is that amphipods feed on any organic material present within caves, including one another. Amphipods are the end consumers of an intricate food web situated both outside and inside the cave environment and above and below the water table. This study fills an important gap in our knowledge of stygobitic amphipod behaviour and the amphipod's relationship to t

Grassland conservation

137. GRASSLAND SPATIAL ASSESSMENT OF HIGH BIODIVERSITY IMPORTANT LAND OWNED BY FORESTRY SECTOR FOR CONSERVATION PLANNING

WISTEBAAR, PRECIOUS NOKUTHULA, Mathieu Rouget, James Jackelman

Despite the negative impact on biodiversity, production sectors (such as the forestry sector) can play an important role in conserving biodiversity. The forestry sector and the National Grasslands Biodiversity Programme have initiated a process of establishing contractual nature reserves on forestry-owned land.

Here we present an approach to select biodiversity-important forestry sites within South African Grasslands in order to establish contractual nature reserves. With 40% transformed and only 2.8% protected, the Grasslands are the most threatened biome in South Africa. However almost 500,000 ha of natural grassland are in forestry-owned land. Our approach combines a GIS desktop analysis at the biome level with site visits to finalise and ground truth the list of proposed sites. Several criteria were used such as size, spatial configuration, surrounding land use, biodiversity importance, site management and condition. The resulting 37 sites represent 36,000 ha of grassland in good condition. They cover 19 poorly protected vegetation types of which 4 are endangered and 9 are vulnerable. Implementation plans are presently being developed for each site to proclaim them as nature reserve or protected environments under the South African Protected Areas Act.

138. QUICKER-THAN-EXPECTED POSITIVE CHANGES AFTER GRASSLAND RESTORATION IN HORTOBÁGY, HUNGARY DÉRI, ESZTER, Szabolcs Lengyel, Balázs Deák, Béla Tóthmérész

The transformation of arable lands to grasslands is priority of agri-environmental schemes in Europe. We studied whether grassland restoration increases species richness in Hortobágy, one of the largest steppes and most unique areas in Europe with two Natura 2000 priority habitat types. Grassland restoration was started on 10 plots by sowing loess seed mixture on 44 ha and alkali seed mixture on 110 ha in fall 2005. A baseline survey found 42 carabid species, 46 vegetation-dwelling spiders and 34 bird species on the arable lands. In spring 2006, the dense vegetation cover held 56 weedy plant species. The weed cover was mown in June, which exposed grasses characteristic to the target steppes besides the ones seeded in the bottom grass layer. In all, 20 common species and 32 species typical of the target steppes were recorded. Pitfall traps detected 34 carabid beetle species, five of which were typical of loess grasslands. The number of vegetation-dwelling spiders increased to 65. The number of bird species observed to use the restored lands was 60 in 2006. These results show that grassland restoration on arable fields can progress quicker than expected and can be an efficient tool for maximizing landscape-level biological diversity. Further study is necessary to disentangle whether the initial increase in species richness is a temporary phenomenon followed by a relaxation, a relatively stable one-time increase or the first phase of a rapid increase in species diversity.

139. USEFUL THEROPHYTES OR ANNUAL PLANTS FOR WILDLIFE AND HUMAN CONSUMPTION PALE, FATIMATA A.

Therophytes or annual plants are the dominant vegetation of the Soudano-Sahelian zones of West Africa, particularly in Burkina Faso. They represent 40.7% of the savanna. Their seeds provide good tools for experimental studies. Most of the plants grown for food for humans and animals are annuals and are not well known or studied compared to spontaneous therophytes. Their adaptation to the soudano-sahelian climate make them potential genetic candidates for increase of food crop productivity. Selected therophytes for this presentation are from the families Poaceae(28 genera and 50 species), Leguminosae(8 genera and 16 species), Cyperaceae(8 genera, 16 species), Compositae(14 genera and 16 species), Amaranthaceae(4 genera and 8 species) and Labiatea(5 genera and 5 species).

140. GHOSTS OF ELEPHANTS PAST? REMNANT GRASSLAND ECOSYSTEMS AND PLEISTOCENE KEYSTONE HERBIVORES KNOWLES, TRAVIS, Peter Weigl

Norman Owen-Smith's "keystone herbivore" hypothesis proposes a dominant role for large grazing and browsing mammals as top-down effectors of vegetation structure and diversity through the Pleistocene. We hypothesize that certain temperate, montane, sub-timberline grassland ecosystems may represent a remnant legacy of disturbance by extinct megaherbivores and their successors—mesoherbivores and domestic livestock. We use the comparative method to propose candidate ecosystems as remnants of such interactions, citing evidence from paleontology, shade-intolerant plant diversity, and land use history. Examples include the southern Appalachian grassy balds of the USA, and the East Carpathian poloniny grasslands of Poland, Slovakia, and the Ukraine. For comparison we include a similar ecosystem hypothesized to be primarily fire-dependent: the grassy balds of the Bunya Mountains in Queensland, Australia. We call for renewed consideration and investigation of the role of grazing on grassland plant

conservation, especially in North America where the idea has often been overlooked or dismissed compared to climatic or edaphic factors.

Indigenous knowledge and conservation

141. NATURAL RESOURCES CONSERVATION IN ENCLAVE COMMUNITY OF BATANG GADIS NATIONAL PARK, NORTH SUMATRA, INDONESIA JANRA, M. NAZRI, Riswan S. Siregar, Ardinis Arbain

Remote livelihood in Batahan Village, enclave area of central part of a new borne Batang Gadis National Park has implied in level of dependency on natural resources. After the arrival of ancestral in 1800s, soon the villagers got habituation on definitely restricted area amongst jungle, then used surround materials as main supply for daily needs. In turn, nowadays it suppressed the utilization of external goods, created a self-complemented village environment for a considerably period. Local Users' Value Index (LUVI) Scoring through 'Pebble Distribution Method' (PBM) had revealed that Batahan villagers significantly depend more on plants resources than the animals' (80 : 20 in ratio). Benefit value of plant resources was mostly for the building purpose, and the highest valuation was given to bargot or sugar palm and bamboo. Whilst deer (*Muntiacus muntjak*), as animal resources for hunting purpose in most, was recorded as the frequently consumed species in supplying the needs on decoration, food, medicinal, religion-cultural-ritual, hunting and entertainment. Some traditional and cultural-historical values were concluded as the reason for sustainability of natural resources utilization in this place, included the faith on local myths and taboos.

142. HOME GARDENS: THEIR ROLE ON MEDICINAL PLANT CONSERVATION IN THE ECUADORIAN AMAZON CAMACHO-BENAVIDES, CLAUDIA I.

This paper aims to document and understand the role of home gardens in medicinal plant conservation (MPC) in a Kichwa community (Arajuno) of Pastaza province, Ecuadorian Amazon, comparing them with institutional gardens held in the same region. Methods used included semi-structured interviews, free listing, garden surveys and direct observation, providing information on the number and identity of medicinal plant species, and on the social and environmental factors involved in medicinal plant management. A comparison between conservation strengths and weakness of both home and institutional gardens allowed examining the stability of each garden for MPC in the long term. Although home gardens were found to have relatively few medicinal species (47) in comparison to institutional gardens (122), home gardens do have capacity for MPC in the long term in the communities studied. This is due to: a) the biological and cultural importance of gardens, b) their ecological stability, and c) social characteristics supporting medicinal plant maintenance, such as health needs, a de facto protection of some medicinal plants, a common practice of plant exchange and medicinal-plant-management-knowledge active transmission. MPC in Kichwa home gardens is strongly related to household cultural values and socio-economic circumstances and we must look deeply at such variables to better understand the future of Kichwa home gardens and seriously consider them in any intent of local MPC support.

143. TRADITIONAL KNOWLEDGE, NATURAL RESOURCE MANAGEMENT AND INDIGENOUS RIGHTS: PERSPECTIVES IN THE UNITED NATIONS FOREST POLICY PROCESS NEWING, HELEN

This paper analyses different perspectives on traditional knowledge in the United Nations forest policy process (UNFPP) and discusses implications for collaboration between natural resource managers, conservationists and indigenous peoples. It is based on a) a simple content analysis of key documents in the UNFPP and b) a set of 14 national and 3 regional case studies commissioned by the International Alliance for Indigenous and Tribal Peoples of Tropical Forests (IAITPTF) to evaluate national implementation of international commitments concerning traditional forest-related knowledge. The policy review identifies three overlapping but distinct perspectives on traditional knowledge – as working knowledge systems, as extractable technical information on natural resources, and as commodity. The first is in line with current academic thinking on traditional knowledge as dynamic, evolving and culturally embedded, and implies continued in situ use of traditional knowledge by indigenous peoples. However the case studies found that in many countries indigenous peoples continue to be displaced from their land – including by conservation –

and traditional knowledge is treated as an extractable resource – either for technical input into natural resource management by outsiders, or as a commodity of potential value in bioprospecting. The implications are discussed in terms of both policy development and practice.

144. TOP DOWN MANAGEMENT PLAN INEFFECTIVE: WHAT PEOPLE SAY IN CONSERVATION OF THE LAND CRAB *CARDISOMA GUANHUMI* IN PUERTO RICO GOVENDER, YOGANI

Population numbers of the exploited mangrove crab, *Cardisoma guanhumi*, have been declining since the 1960's. Although the government has implemented a management strategy to prevent the species from becoming extant, population numbers still remain low. The goal of the research was to assess the effectiveness of the current management plan and to develop alternative strategies for conservation of the species. We used semi-structured interviews with local crab hunters to 1) solicit their perceptions for population declines, 2) assess their knowledge of the management plan and 3) ask them for alternative strategies to control population declines. Crab hunters suggestions for population declines include habitat loss and overexploitation. Although most crab hunters are aware of the current management plan, it is not effective because crab hunters felt excluded from the decision making process and there is no enforcement. Since enforcement is the greatest issue facing the crab fishery both in capture and destruction of habitat, we suggest that the new management plan encourage co-management of this natural resource and its habitat. Including the crab hunters in the revision and implementation of the management plan will open communication, outreach and education channels thus improving corporation in conservation efforts.

145. PRACTICE OF CONSERVING RANGELAND BIODIVERSITY THROUGH TRADITIONAL SYSTEM AND RELIGIOUS BELIEFS IN TRANS-HIMALAYAN RANGELAND, UPPER MUSTANG, NEPAL POKHAREL, ANITA, Madhu Chetri

Developing various strategies for the rangeland biodiversity conservation is important for today's critically degraded environment, and there is a growing recognition that the effective rangeland biodiversity conservation needs clear understanding of traditional knowledge of resource management. In order to know traditional system of resource management, a study was undertaken from July 2005 to October 2006 in Upper Mustang, one of the isolated harsh climatic regions of Nepal. Ground truthing data of the seven Village Development Committees (VDCs) were collected to identify seasonal pastures and units. The pasture units were delineated in Topographic map and analyzed by using GIS. Focal group discussion and interviews were taken with the village elite, herders and grazers for assessing grazing rights and use patterns. Altogether 286 different pasture units (area-1,428.33 km²) have been identified in 7 VDCs of Upper Mustang (area -2,567 km²). Thirteen different seasonal pastures have been identified. People have been practicing traditional use right irrespective of the political boundary. Buddhist teachings and traditional cultural beliefs in the region provide many thoughts and aspects which are directly related to the conservation of rangeland biodiversity. Strengthening such type of belief and linking with conservation in future will bring positive results in rangeland biodiversity conservation.

Inventory and monitoring

146. DEVELOPMENT OF A LONG-TEM ECOLOGICAL MONITORING PROGRAM IN NATIONAL PARKS OF THE NORTHERN GREAT PLAINS, UNITED STATES GITZEN, ROBERT, Dan Licht, Nels Troelstrup, Joshua Millsaugh

As part of a nation-wide U.S. National Park Service (NPS) program, we are developing a long-term monitoring plan for 13 parks units encompassing 180,000 ha in the grassland biome of central North America. Program objectives are to track a small set of "Vital Signs" that are indicators of the ecological health of park units and that are high management priorities. Park staff and regional ecologists rated candidate Vital Signs as to their ecological significance, management importance, and feasibility for monitoring. The selected mix of 20 Vital Signs includes fundamental ecological indicators as well as high-priority resources at individual parks. In river systems of this region, a small set of attributes (macroinvertebrate composition, several physical and chemical variables, and flow levels) are sensitive to changes that affect human use of parks as well as aquatic and riparian vegetation and fauna. In terrestrial ecosystems, vegetation composition and land cover are important in their own right and are sensitive

indicators of changes in higher trophic levels caused by natural and prescribed fires, grazing by North American bison and prairie dogs, invasive species, and climatic variation. Therefore, water quality, vegetation composition, and land cover are top monitoring priorities across the 13 parks. Similarly, water quality, invasive plants, and landscape dynamics have been selected most frequently as attributes for monitoring across 270 NPS units throughout the U.S.

147. ASSESSING THE STATUS OF BIODIVERSITY

AUSTIN, MATTHEW, Dan Buffett, Victoria Stevens, Geoffrey Scudder, David Nicolson

Conservation efforts are most effective when they are based on a clear understanding of the status of the entity of interest. While the focus of conservation efforts has broadened substantially in recent decades from game species to a wider range of species, ecosystems and, increasingly, biodiversity as a whole, the availability of status analysis techniques and information has not kept pace. The sheer scope of biodiversity poses significant challenges to assessing its status. A comprehensive approach for assessing the status of biodiversity including consideration of both natural capital and natural capital expenditures will be outlined with examples from its application to British Columbia, Canada. Aspects of natural capital that are considered include: species status, ecosystem status, key elements and global responsibility. Natural capital expenditures are evaluated through the use of a safety net gap analysis and a review of major pressures. A species richness and irreplaceability assessment using over 9,000 species weighted by their global status rank will be presented. A raster-based approach for summarizing and analyzing geospatial biodiversity information will be described. An approach for addressing cross-jurisdictional and cross-realm (i.e. terrestrial, freshwater and marine) values and pressures will be outlined. Methods for presenting status information in a manner that is most useful for informing decision-making will be emphasized.

148. USING AN AUTOMATED COMPUTER RECOGNITION SYSTEM TO IDENTIFY INDIVIDUAL AFRICAN PENGUINS (*SPHENISCUS DEMERSUS*): A NEW PERSPECTIVE ON POPULATION MONITORING

SHERLEY, RICHARD, Tilo Burghardt, Peter Barham, Neill Campbell, Innes Cuthill

African penguins are currently listed as vulnerable to extinction and, at present, when researchers want to monitor a population they use either flipper bands or transponders. With growing concerns about the validity of data produced by bands and transponders and the invasive nature of these techniques, there is increasing pressure to find a new method for identifying penguins. Our system employs real-time computer vision techniques to provide truly non-invasive identification of large numbers of individuals. African penguins carry a pattern of black spots on their chests which appears to remain stable for life. Unique information in these markings is exploited to create a biometric identifier for each bird which can be compared against a population database each time a penguin is filmed or photographed. In a recent field trial, a prototype system using a static camera was able to correctly identify more than 500 individuals from 12 hours of footage, most of which were detected and correctly identified on numerous occasions. The presentation will explain the software underlying the system, report the results from early prototype trials and outline how we are developing the technique to monitor an entire colony on Robben Island. This approach has the potential to vastly improve the level and quality of data available for conservation biologists, and possible extensions of the method to monitor other species and to provide information for behavioural analysis will be discussed.

149. THE ROLE OF DOWNED WOOD IN STRUCTURING AMPHIBIAN, SMALL MAMMAL, AND INVERTEBRATE COMMUNITIES

TURVEY, SHANNON, John Richardson, Melissa Hogg

Observational studies have demonstrated significant, but weak correlations in diversity across multiple taxa, but have generally failed to find evidence of strong across-taxa congruence. However, examples of experimental studies testing for across-taxa congruence as a result of an underlying ecological mechanism are largely lacking. One mechanism that may produce congruence is use of a common habitat element by several taxa. Downed wood is abundant in Pacific Northwest forests and is utilized by small mammals, amphibians, and invertebrates for multiple functions. We used experimental additions of downed wood in a BACI (before-after, control-impact) design to test for congruence in diversity between small mammals, amphibians, and ground beetles due to their common use of downed wood. After one field season, there was no significant effect of treatment on abundance or species richness within any of the three taxa. The amount of downed wood did not impact within-taxon diversity or abundance. Furthermore, neither

abundance nor species richness within any taxon was significantly correlated with abundance or species richness in any other taxon. These results suggest that common use of downed wood as a habitat resource does not lead to congruence in diversity across these three taxa. Furthermore, the potential of one taxon to act as an indicator of habitat quality or of diversity in another taxon immediately post-disturbance may be limited.

150. THE DISTRIBUTION, ABUNDANCE AND HABITAT PREFERENCES OF SRI LANKA SLENDER LORIS, *LORIS TARDIGRADUS* (PRIMATES: LORISIDAE) GAMAGE, SAMAN NALIYA, DEWAKA WEERAKOON, SARATH WIMALABANDARA KOTAGAMA, ASOKA GUNAWARDENA

The Sri Lanka slender loris, *Loris tardigradus* is an endangered primate endemic to Sri Lanka. Currently there are two recognized subspecies viz. *L. t. tardigradus* and *L. t. nycticeboides*. Of these *L. t. tardigradus* inhabits lowland rainforests in the southwestern region of the island while *L. t. nycticeboides* is restricted to the montane forests. This study was undertaken with the objectives of mapping the distribution, estimating the abundance and determination of habitat preference of slender lorises. So far 23 sites were surveyed from 2002 to date, using the line transect method, covering approximately 300 km. Lorises were not recorded in 7 of the 23 sites. In the remaining 16 sites *L. t. tardigradus* was sited at 14 sites (n=122) and *L. t. nycticeboides* in 2 sites (n=3). Abundance was estimated based on sightings of animals/km yielding an abundance estimate of 0.667 for *L. t. tardigradus* and 0.024 for *L. t. nycticeboides*. These results clearly highlight the rarity of *L. t. nycticeboides* in Sri Lanka. While *L. t. tardigradus* was found in both undisturbed and disturbed forests *L. t. nycticeboides* was found to be restricted to undisturbed montane forests. During the past five decades an estimated 80% of the montane forests in Sri Lanka have declined while the remaining forests are also affected by forest dieback which makes *L. t. nycticeboides* a Critically Endangered sub species.

151. BUSHMEAT HUNTING AND BIODIVERSITY CONSERVATION IN THE EASTERN HUMID FORESTS OF MADAGASCAR: PRELIMINARY FINDINGS FROM THE MAKIRA PROTECTED AREA Andrianjakarivelo, Vonjy, NIRINAMALALA RALISON, Christopher Holmes

Much is known concerning rate, extent, and impact of deforestation in Madagascar, and hunting is often cited as a significant additional threat to the island's fauna. However, direct and indirect impacts of hunting have yet to be fully quantified. To better understand bushmeat hunting dynamics in Madagascar's rural communities, and impacts on Madagascar's biodiversity integrity, the Wildlife Conservation Society has initiated a quantitative research and monitoring program in the forests of the Makira Protected Area. This paper will present preliminary results from human disturbance surveys in 10 villages, each paired with the census of two primate transects in neighboring forests. Variation in both hunting effort across sampled villages and densities of targeted lemur species was observed. Hunting effort was influenced by species targeted, and varied with distance from villages. Further analyses suggest associations between hunting effort, human population size and village isolation. Understanding incentives that direct subsistence-based resource-use decisions in biologically diverse ecosystems is essential for implementing effective conservation strategies that protect both biodiversity and human welfare. Makira's ongoing monitoring program will improve such understanding, and likewise inform the development of conservation strategies, thus ensuring local people's support of conservation efforts and advancing Madagascar's conservation agenda.

152. TAKING THE PULSE OF THE PLANET: MEASURING BIODIVERSITY CHANGE FOR THE 2010 TARGET COLLEN, BEN, Jonathan Loh

Global indicators of change using population level measures of abundance have the potential to give accurate, robust and revealing insight into the current elevated rate of biodiversity loss. By 2010, indices such as the Living Planet Index (LPI) have the potential to reveal much about change in vertebrate abundance. However, additional progress can be made by disaggregating such indices to give insight into more specific, and therefore potentially more useful, patterns of biodiversity loss. By decomposing the large LPI dataset, we present indicators of biodiversity change in populations of species belonging to different taxonomic groups, ecosystems, land use types and international conventions. We show that taxonomic

differences in rates of population decline can be masked by overall system level effects. Population level information can further assist in diagnosing causes of decline and reveal how rates vary under different threatening processes. We demonstrate the importance of accounting for underlying data biases, data gaps and the motivations behind original data collection. Combined with other measures of biodiversity change, population based indicators have the potential to reveal much about global trends in biodiversity. Establishing systematic monitoring programmes, and establishing the relationship between these vertebrate trends and the remainder of diversity, is integral to ensuring more useful, and more policy relevant indicators.

Land use planning for conservation

153. A RAPID METHODOLOGY TO SELECT URBAN CONSERVATION AREAS. A CASE OF STUDY: *MAMMILLARIA MATHILDAE* CONSERVATION GARCIA-RUBIO, OSCAR, Guadalupe Malda-Barrera

Mammillaria mathildae is an endemic cactus of Queretaro. Its populations are confined in to two localities in central Mexico, adding up to 178 individuals. It was listed as endangered due to the few individuals remaining and their vulnerability to urbanization. The goal of our research was to look for other populations nearer to the well-known one, in order to develop a conservation strategy to maintain a viable population of *M. mathildae*. Using spatial analysis by distance indices (SADIE) and genetic algorithm for rule set production (GARP) modeling systems the location of new populations was predicted, 5 of which have already been confirmed on field. All populations are endangered due to anthropogenic activities. Only Juriquilla's population (NPA) and the new one found at the Cimatario National Park are under protection. Spatial analysis improved the model generated by GARP, making the process of locating new populations of the cactus more efficient. Using both, SADIE and GARP, the place for reintroduction can be selected, increasing the odds of success in the reintroduction process. Based on these results, we recommend to following in situ and ex situ conservation strategies; the synergy between both can help to restore this severely depleted cactus.

154. DESIGNING CORRIDORS FOR CARNIVORE CONSERVATION IN THE CANADIAN ROCKY MOUNTAINS: MARRYING PATTERN AND PROCESS CHETKIEWICZ, CHERYL, Colleen Cassady St Clair, Mark S. Boyce

Conservation corridors are frequently advocated for conserving threatened wildlife in human-modified habitats. Unfortunately, many corridors are based on binary patterns of habitat (vs. non-habitat) that may not reflect processes of habitat selection and movement needed by the organisms they target. Using a Global Positioning System telemetry system, we developed resource selection functions to describe habitat suitability for grizzly bears (*Ursus arctos*) and cougars (*Puma concolor*) in two fragmented landscapes in the Canadian Rocky Mountains. We also developed step selection functions to characterize movement behaviour of grizzly bears and cougars across these two landscapes. These models illustrated areas of high and low probability of occupancy and movement as well as their proximity to one another. Grizzly bear and cougar movement behaviours were influenced by seasonal soil conditions (grizzly bears), ungulate prey density (cougars), and terrain ruggedness (both). We used these results to identify potential corridors and compared them to current corridor designations. This comparison suggested that several current corridor designations, particularly for grizzly bears, should be modified. This is the first empirical attempt to combine processes of habitat selection and movement for two large carnivores and integrate them with landscape features to design and implement conservation corridors.

155. PROTECTED AREA BUFFER ZONES AND SUSTAINABLE LAND USE: ESTABLISHING RESOURCE MANAGEMENT TRANSFER SITES AROUND THE MAKIRA PROTECTED AREA, MADAGASCAR JAOZANDRY, JEAN JACQUES, Christopher Holmes, Helen Crowley

The government of Madagascar has committed to expand the country's network of protected areas –the 'Durban Vision'. Fundamental to the long-term success of this commitment is partnering with local communities, who are the de facto land stewards, to manage forest resources. The Wildlife Conservation Society, in collaboration with Madagascar's Ministry of Environment, Water and Forest, has been engaged in this effort through establishing the Makira Protected Area. Makira encompasses 371,217 ha of low- and

mid-altitude rainforest surrounded by a 280,000 ha 'green belt' of mixed forest and agricultural lands containing over 120 villages with over 150,000 subsistence-based agriculturalists. To ensure the integrity of the protected area forests the Makira Project emphasizes the sustainable use of this 'green belt' through a program of community-based resource management transfers. To date, 40,529 ha of forest were transferred to 16 associations. This paper will outline the multi-step process through which community-based management associations are created, resource-use plans generated, and benchmarks for sustainable-use assessment set. In view of expanding rural human populations with evident subsistence-dependence on forest resources, these management transfers represent an opportunity to empower local communities by engaging them in the long-term maintenance of productive forest buffers around Madagascar's protected areas.

156. THE ROLE OF WATER QUALITY ON MICROHABITAT CHOICE BY WATERFOWL IN SEWAGE PONDS **OTIENO, NICKSON, Linus Gatimu**

Wetlands are among the most productive but threatened habitats from exploitation for human benefit. Such loss/degradation forces desperate fauna to alternative near-comparable habitats. We investigated the role of water quality on waterfowl microhabitat choice, distribution and abundance of their macro-invertebrate food, in 10 cells of a campus sewerage system in Eldoret, Kenya using standard water quality testing and faunal identification methods. General pollution and nutrient enrichment declined gently downstream as did primary production, biomass and diversity of macro-invertebrates, whose dominance changed little; Chironomid larvae were most abundant in each cell. Macro-invertebrate species richness, initially low, rose then fell downstream to mirror pollution despite abundant primary-production. Ten macro-invertebrate families were delineated. Water temperatures followed ambient levels but initial cells were appreciably hotter. Dissolved oxygen levels rose downstream, opposite BOD. Forty-eight waterfowl species were recorded, richness decreasing generally with clearer water, reflecting the macro-invertebrates pattern though abundance tapered. Conclusively, waterfowl spatio-distribution and microhabitat preference is influenced by water quality and consequently, availability of their macro-invertebrate food. Constructed wetlands like sewerage systems can be a cost-effective multi-purpose tool towards providing alternative sustainable habitat for threatened waterfowl.

157. THE VALUE OF COASTAL ECOSYSTEM SERVICES AS ESSENTIAL CONSERVATION INFRASTRUCTURE **BRENNER, JORGE**

Ecosystems, if sustainably managed and protected, benefit current and future people. The concept of ecosystem services (the flow of benefits from nature to people) provides one novel framework to put forward this vision. The challenge for current and future generations is to understand and account for these benefits in a way that enables a sustainable quality of life for people while also conserving the biodiversity that provides the flow of services. Although ecosystem services science has continued to evolve in the past decade, little has been said on how the natural capital assets can promote an effectively, fairly, and sustainable conservation of the coastal zone. The main objective of this study is to determine how ecosystem services can be considered as "essential natural infrastructure" for biodiversity conservation. Thereafter promote regional efficiency, equity and empowerment in coastal areas. The study provides the rationale for the concept of natural infrastructure for conservation, and determines most relevant links between coastal services provisioning and the regional sustainability processes of the Catalan coast in Spain. Results show how natural infrastructure is a vital part of the stock of facilities, services and equipment that are needed for biodiversity conservation and human well-being in the global coastal zone.

158. USING MAPS OF ECOSYSTEM SERVICES TO INFLUENCE LAND USE DECISIONS IN THE ATLANTIC FOREST **DITT, EDUARDO, Claudio Padua, Susana Mourato, Jonathan Knight, Jaboury Ghazoul**

The remnant Atlantic Forest in the Atibainha reservoir catchment is threatened by urbanization, eucalyptus plantations and the expansion of pastures. Understanding the gains and losses to ecosystem services from these various land use regimes is instrumental to develop incentive mechanisms for conservation. Two such services were considered herein: a) mitigation of sediment yield and b) retention of carbon stocks. These were estimated and valued using present-day characteristics of slope, soil type and vegetation. Similar data were extrapolated from four idealized land-use scenarios, each comprised of homogeneous areas of native

forest, eucalyptus, pasture and urbanization. Valuation techniques and GIS were used to convert ecosystem services estimates in the landscape into economic benefit. The resultant maps revealed that the total value of ecosystem services in different land-use types declines in the following order: native forest, eucalyptus plantation, current land use, pastures and urban areas. These economic-value maps can be used to guide decision makers to develop incentives for forest conservation. These include standardizing penalties for environmental damage and payments for ecosystem services.

159. EXPERIENCES FROM MULTIDISCIPLINARY FRAGMENTATION RESEARCH WITHIN THE BRAZILIAN–GERMAN COOPERATION PROGRAM - SCIENCE AND TECHNOLOGY FOR THE MATA ATLANTICA

Metzge, Jean Paul, Klaus Henle, CHRISTOPH KNOGGE

In Brazil, especially the Atlantic forest region, has been suffering the elimination and fragmentation of forested areas, land degradation and the extinction of species due to the expansion of agricultural lands and urbanisation processes. A multidisciplinary Brazilian-German scientific cooperation program Science and Technology for the Mata Atlântica has been established for a funding period of at least 7 years in order to provide a scientific basis and new tools for regional conservation management. The results of various studies at the Atlantic plateau of São Paulo on the effects of fragmentation and landscape configurations on vegetation structure, biodiversity patterns and population characteristics of birds, small mammals and amphibians are processed in different modelling approaches and are considered for the refinement and validation of new methods for the selection of priority sites for conservation. Our experiences show that international scientific cooperation programs may contribute essentially to the development of scientific based conservation planning providing a sound base and new decision tools for management. For an effective implementation of the results in applied conservation co-operations with NGOs and conservation administration have been established to facilitate capacity building, environmental education and the improvement of socioeconomic perspectives and land tenure of the local human population.

160. LAND COVER CHANGE AND THE CONSERVATION STATUS OF VEGETATION TYPES IN COASTAL KWAZULU-NATAL

JEWITT, DEBBIE, Peter Goodman

Coastal KwaZulu-Natal is here defined ecologically by 9 coastal vegetation types which occupy a strip of land between 10 and 30 km wide running the length of the province. This area is important as it is situated in the centre of the Maputaland-Pondoland-Albany biodiversity hotspot. A recent land cover and conservation status analysis has revealed that of the 9 vegetation types, 3 are Critically Endangered (less than their target amount still in tact), 2 are Endangered and 4 (all forest types) are least threatened. The primary land-uses in the region are sugarcane (16.6%), plantations (7.4%), urban areas (5.1%), rural subsistence areas (4.4%) and cultivation (1.3%). An attempt to analyse land cover change was made by comparing 3 land cover datasets (1994/5, 2000 and 2005). However, despite standardisation between the datasets no meaningful change detection could be made, primarily due to the differences in image resolutions which ranged from 500m to 20m. This is counter to the current perception that maintains that there continues to be rapid land transformation in the study area. The study highlights the danger of using 'non-standardised' data for land cover change detection.

Mammal conservation

161. DEVELOPMENT OF A FIELD KIT FOR MONITORING HORMONE ACTIVITY IN FREE-LIVING AFRICAN ELEPHANTS (*LOXODONTA AFRICANA*)

FREEMAN, ELIZABETH W., F. Nicole Abbondanza, Janine L. Brown

Animal welfare and conservation policies must be based on sound scientific data. Hormone analyses are frequently used to support ex situ management of wildlife; however, current techniques are not field-friendly. In situ hormone monitoring typically involves exporting biological samples from range countries to a laboratory for processing. This is expensive, time consuming and often logistically difficult. Using samples from captive elephants, we are developing assay kits for non-invasively assessing steroid hormone levels in wild animals. Our rapid technique is stable under field conditions (high temperatures and humidity) and provides qualitative hormone data without the need for expensive equipment. This kit has been tested in both laboratory and simulated field (zoo) settings and successfully distinguishes the phases of the elephant

estrous cycle. It will be further tested using fecal samples from free-ranging elephants in June 2007. Upon successful validation, we will embark on a long-term study to measure the effects of age, social rank, and precipitation on ovarian activity in free-ranging elephants. Although developed for elephants, this technique should be adaptable to studying other steroid hormones in a variety of species. As such, it could transform how we study the biology of endangered species under field conditions and provide new tools for making sensible conservation management decisions based on science.

162. JAGUAR RANGE REDUCTION IN SOUTHEAST MEXICO: THE 1940-2000 PERIOD

HIDALGO-MIHART, MIRCEA GABRIEL, Daniela Valera-Aguilar

During the last 50 years the jaguar historical distribution has been largely reduced. In Southeast Mexico, jaguars presented an extensive distribution, but the economical and social events that occurred in the area (e.g., human population growth, cattle ranching and agricultural expansion, oil industry development) considerably reduced the jaguar populations. To model this reduction in a portion of southeast Mexico (Tabasco, northern Chiapas and western Campeche), we interviewed around 400 people who could have information about the time in which the last jaguars were killed in the region, obtaining 51 geographically referenced reports (skins, skulls, photographs or trustable references) in the area. We combined these records with historical human and environmental variables to develop historical (1940-1990) and present jaguar potential distribution models using Desktop GARP. We found that, from a potential range of 40800km² in the area in 1940, only 16600km² (40.68%) could still be potentially occupied in 2000. The most important reductions in jaguar range were during the period of 1960 to 1980, when the habitat was reduced from 38000km² to 20000km², probably due to the governmental plans that were carried out to expand the human activities in the area. Present jaguar range in the area is restricted to flooded sites where agriculture and cattle ranching is limited, but the expansion of the oil industry in these areas could threat the remaining potential habitat for jaguars.

163. HUMAN DIMENSIONS OF THE CONFLICTS BETWEEN PEOPLE AND JAGUARS (*PANTHERA ONCA*) IN BRAZIL

MARCHINI, SILVIO

Efforts to protect jaguars have been based upon ecological aspects of the species, especially those relative to its feeding ecology; predation on livestock, in particular. This strictly ecological and economic approach will do little to protect jaguars where hostility toward the species is found to be socially and culturally ingrained. Vitrally, the goal of my research was to identify the factors – besides the ecological and economic ones – that explain variation in jaguar persecution and assess their relative importance. Questionnaires and interviews were used to quantitatively assess knowledge, beliefs, attitudes and social norms toward jaguars, as well as socioeconomic and demographic variables (e.g. age, education, income). Approximately 400 high school students on the Amazon agricultural frontier and 300 landowners in three regions of Brazil - Amazon frontier, Pantanal and Atlantic Forest – were assessed. I found that livestock depredation is often the proximate cause of persecution. However, the rather great variation in tolerance to depredation is explained mainly by cultural background (e.g. frontier migrants vs. “pantaneiros”) and education. These findings suggest that effective strategies to resolve human-jaguar conflicts should combine measures to decrease depredation (e.g. changes in husbandry practices) and education and communication interventions to increase tolerance to depredation on a site-by-site basis.

164. LARGER CARNIVORE STATUS AND CONSERVATION IN WEST TOROS MOUNTAINS, ANTALYA PROVINCE SW TURKEY

TAMER, ALBAYRAK, Giorgos Giannatos, Ali Erdogan

West Toros Mountains with its large protected territories considered one of the most important faunal areas in Turkey especially for larger mammals. Methods used to access local carnivore status include systematic questionnaires, transects for signs and intensive photo-trapping by baited cameras. The cameras were used in a sample area 173 km² in Termessos NP and surround at 28 locations and captured 1024 trap days of data. Four species of larger carnivores found in the study area. The protected cedar highlands Ciglicara and Elmalı Forest hold few lynxes and small number of wolves probably a pack, while the bear has been eradicated probably in early 80's. The presence of a small number of caracals, one of the least known rare cats in Turkey, was verified with the photocamera survey in Termessos NP and the adjacent protected forest. This caracal population is most probably isolated since it is surrounded by high mountains, large

urban area and intensively used landscape. The lynx population in cedar highland area is low and probably isolated with very few sightings and small area of available habitat for such a wide ranging species. The wolf presence is also low but the species looks widespread in Turkey.

165. ELECTRIC FENCING TO MITIGATE WILDLIFE-HUMAN CONFLICT: A PILOT STUDY INVOLVING COMMUNITY PARTICIPATION IN WYANAD WILDLIFE SANCTUARY, SOUTHERN INDIA
MADHUSUDAN, ANNADANA SATYANARAYANA IYER, Balu Venkataraman Arun, Raman Sukumar

Measures taken by forest managers to contain wildlife-human conflicts often fail, in part because the affected communities are not consulted before implementing such remedial measures. We attempted a participatory approach with an affected community in Ramballi village in Wyanad Wildlife Sanctuary, Kerala, India. A solar powered, high voltage, electric fence was designed and erected after consultations and an agreement with the farmers. The villagers put up the electric fence under the supervision of a committee and 14 villagers were trained in fence maintenance. The fence was generally effective against species like wild pig, deer and elephant, with the exception of habitual crop raiding elephants (solitary males). Elephant incursions increased with time (from 7 in 2001 to 32 in 2003 with a single animal accounting for 85% of raids in 2003). The community continues to maintain the fence and an exit strategy is being formulated to ensure the continued use of this mitigation method. The study showed that an electric fence alone would not stop habitual crop raiders from entering the fields. Additional protection in the form of patrolling and watch during the harvest season is needed to deter the elephants. We strongly advocate participatory approaches for sustained success of conflict mitigation measures.

166. DETERMINING THE PRESENCE OF MAMMAL SPECIES WITHIN THE CHAPARRI PRIVATE RESERVE OF NORTHWESTERN PERU USING CAMERA TRAPS
RENZO, GIUDICE, Robert Williams, Iván Vallejos, Javier Vallejos

The Equatorial Dry Forests of north-western Peru are a global conservation priority but are relatively little studied. Between 2004 and 2006 we used camera traps to study the mammalian fauna of the Chaparri Private Reserve. Fifteen digital camera traps were placed at sites with high probabilities of capturing photos of mammals, such as paths and pools, and places where footprints and scats were frequently found. We confirmed the presence of 9 mammal species inside the Reserve including the endangered Andean Bear (*Tremarctos ornatus*) and the near-threatened Puma (*Puma concolor incarum*) and Pampas Cat (*Oncifelis colocolo*), as well as confirmation of the continued presence of Ocelot (*Leopardus pardalis*). We could also identify individual Andean Bears from facial and neck markings allowing seasonal movements and some home range information to be gathered and a minimum population estimated. Activity patterns confirmed that Andean Bears in the reserve are entirely diurnal, in contrast to various predictions of nocturnal activity. This information will contribute in assessing the base line information regarding the conservation status of mammal populations in the area and their long term monitoring.

167. CONSERVATION STATUS OF LARGER CARNIVORES IN MOLE NATIONAL PARK, GHANA
BURTON, COLE, Cletus Balangtaa, Moses Sam, Justin Brashares

The conservation of large carnivores represents a critical challenge for wildlife managers. This is particularly true in West Africa, where carnivore populations are poorly known but suspected to have severely declined. Mole National Park (MNP) in northern Ghana is thought to be key to the long-term survival of large carnivores such as lion, leopard and spotted hyena in West Africa. Nevertheless, no previous carnivore assessment has been undertaken in the park. We used camera traps, spoor surveys and local knowledge to assess the status of carnivores and their prey in and around MNP. Fifty camera traps were deployed over 1283 camera-trap nights and we surveyed 58 km of transects and completed 20 village questionnaires. Results confirm the presence of 31 mammal species, including the following larger carnivores (in decreasing order of abundance): spotted hyena, leopard, African civet, caracal, and side-striped jackal. Lions were not detected, but park patrol records and questionnaires suggest they are present at low density. Among prey species, olive baboon, bushbuck, warthog and waterbuck are among the most abundant, while larger ungulates (e.g. buffalo, roan antelope) appear to be relatively rare. Camera-trap evidence indicates that

hunting pressure is high within MNP, and interviews and market surveys suggest that large carnivores are killed for skins and as threats to livestock. More effort is needed to protect these regionally significant carnivore populations.

168. CHEMICAL COMMUNICATION IN FAMILY GROUP INTERACTIONS OF AFRICAN ELEPHANTS (*LOXODONTA AFRICANA*)

ESPOSITO, RHEA, Thomas Goodwin, L.E.L. Rasmussen, Bruce Schulte

African elephants (*Loxodonta africana*) are a sexually dimorphic species in which males and females carry out divergent lifestyles. Females live in flexible social groups where the size of the group varies over time, whereas males are generally solitary. The fission-fusion social system exhibited by female elephants is found in many other intelligent social mammals, yet the dynamics of group interactions are not well understood in these systems. The functional unit of elephant fission-fusion society is the family, which consists of related females and their offspring. These families interact with other elephant families at varying frequencies, with relatedness often determining interaction levels. This study examined which individuals from within the family group were most likely to initiate interaction with extra-group members. We hypothesized that juvenile male elephants would interact most often with non-family members, since they are more likely to encounter unfamiliar elephants in adulthood. We further hypothesized that female-initiated contact would be chemosensory based while male-initiated contact would be play-aggressive based. Family groups at Addo Elephant National Park, South Africa were studied from January to June of 2007 using continuous focal behavior observations. By understanding what mediates family group interactions in African elephants, we may be able to improve conservation and management at the family to population level.

169. TESTING THE EFFICACY OF A CHILI – BASED REPELLENT TO DETER CROP DAMAGE BY ASIAN ELEPHANTS (*ELEPHAS MAXIMUS*) IN INDIA

Chelliah, Karpagam, KANNAN GOVINDARAJ, Annadana Satyanarayana Iyer
Madhusudan, Nair Abhilash, Nagaraja Baskaran, Raman Sukumar

Chili-based repellents, using various delivery systems, to control elephant depredation of agricultural crops have been in vogue over the past decade in Africa. We experimented with the efficacy of this repellent at three locations (Buxa, Wyanad and Hosur in India) representing a gradient of high to low rainfall. Chili and tobacco powder mixed with used engine oil was applied to ropes encircling agricultural fields of 1.7-5.5 km perimeter, and elephant approaches monitored for 2-3 months during the main cultivation season in late 2006. Unlike in some African experiments, Asian elephants did cross the rope on several occasions. The chili rope was more effective (c.80% reduction in intrusion) in the low rainfall region as compared to medium-high rainfall sites (c.50%). Female-led herds were far more deterred (95-100% reduction) than were solitary males (c.50%). Chili fences have the potential to reduce intrusions by elephants but have to be used judiciously to obtain the best results. To prevent elephants from being habituated the fence could be put up when the maximum raids occur, just after the rains have ceased when the cereal crop is usually in flowering or grain stage. More rigorous testing of this repellent is needed to draw conclusive results.

170. EFFECTS OF REMOVING MAN-MADE WATER SOURCES ON DESERT BIGHORN SHEEP

CAIN, JAMES W., Paul R. Krausman, John R. Morgart, Brian D. Jansen, Martin B. Pepper

The construction of perennial water sources for wildlife is one of the most common wildlife management activities in arid and semi-arid regions. In the southwestern United States, water is often considered a primary factor limiting the distribution and productivity of desert ungulates, including desert bighorn sheep (*Ovis canadensis mexicana*). Thus, wildlife management agencies have invested significant resources in the construction and maintenance of perennial water sources. Despite the considerable investment in the construction of wildlife water sources, relatively few resources have been dedicated towards monitoring their effects on wildlife and the efficacy of these water sources remains largely undetermined. We used a Before-After-Control-Impact study design to determine the influence of water catchments on movement rates, home range area, animal distribution relative to water sources in the Sierra Pinta and Cabeza Prieta Mountains in the Cabeza Prieta National Wildlife Refuge, southwestern Arizona, U.S.A. We did not detect a significant treatment effect on movement rates, home range area, or distribution. In addition, movement rates and home range area were associated with annual and seasonal precipitation. The lack of a significant treatment

response during hot, dry seasons and the relationships between home range area, movement rates and precipitation suggest that forage conditions played a larger role than did the presence of the man-made water sources.

171. HABITAT SEPARATION OF THE BLACK AND BLUE WILDEBEEST IN THE CENTRAL GRASSLANDS OF SOUTH AFRICA

HELM, CHANTAL, Johann Bothma, Gretel Van Rooyen

Black and blue wildebeest are ecologically similar and diverged from a common ancestor 1 million years ago. Interbreeding between the two types is possible and the offspring are fertile. The unnatural confinement of the two types of wildebeest together in South Africa is common. It is expected due to their ecological similarity, that the black and blue wildebeest would be unable to coexist without competing in such areas of confinement. The habitat separation of the black and blue wildebeest was therefore assessed by logging all observations of both types of wildebeest in the study area and recording a set of habitat factors at each observation. Each observation consisted of 43 variables and a subset of these was submitted to linear logistic regression analysis using a stepwise selection procedure, in order to create models which could be used to determine which factors would separate the habitat of the two types of wildebeest. When examining the data for the overall study period the logistic regression identified 12 predictor variables. The variable that contributed the most to the separation of the habitat of the two types of wildebeest was distance to shade. The blue wildebeest strongly preferred habitats where the distance to the nearest shade was much less than what the black wildebeest preferred. Therefore areas that have a good balance between open grassland and open woodland could allow for the coexistence of both types of wildebeest without competition.

172. PRELIMINARY STUDY OF BUSHMEAT HUNTING IN A HUMAN POPULATION GRADIENT IN CAMEROON, AFRICA

WEINBAUM, KAREN

The Food and Agriculture Organization has called the unsustainable hunting of bushmeat “one of the most important food security and biodiversity conservation challenges” in Central Africa. The human population gradient represents the future trajectory of change in land use, bushmeat consumption, and biodiversity if human population growth continues at current rates. In this preliminary study I conducted wildlife transects (n=35 km), hunter-follows (n=14), and socioeconomic interviews (n=43) in four villages in a gradient of human population density (from peri-urban to remote) in southern Cameroon. Results reveal that mammalian diversity increases with remoteness (number of species increases from 9 to 21 with increasing remoteness). Hunter-follows reveal that people invest more time to hunting in more remote areas, and interviews highlight that bushmeat is a more important source of income in more rural areas, and is more often consumed. Fish is consumed more often than bushmeat, however, and is reportedly disappearing along with wildlife. These preliminary results highlight the importance of protein security to address both biodiversity and livelihood issues in Central Africa.

173. THE DISTRIBUTION OF PHYLOGENETIC DIVERSITY OF MEXICAN MAMMALS: ITS IMPLICATIONS FOR CONSERVATION

MATA-ZAYAS, ENA, Miguel Franco

Mexican mammals are facing problems of conservation. If choices have to be made, phylogenetically more differentiated assemblages should merit conservation over less differentiated ones. The objective of this research was to determine the distribution of phylogenetic diversity of Mexican mammals to identify priority areas for conservation. We analyzed a database (from CONABIO), for 415 species in 9 orders. A system of land cells of 30' x 30' was employed, recording the presence/absence of each species in each cell. Species Richness (SR) and Indices of Biodiversity based on relatedness of species were calculated. These were: Total Phylogenetic Diversity (PD), Average PD (AvePD), Total Taxonomic Distinctness (TD), Average TD (AveTD) and Variation of TD (VarTD). We found that both PD and TD were positively correlated with SR. The distributions of TD and PD values revealed different patterns. TD follows more closely the distribution of SR than PD. The most diverse areas were found across the Volcanic Belt and the tropical South-East region of the country. Although closely correlated, PD and TD measures account for the phylogenetic diversity concealed in the simpler SR index. AveTD shows a “stabilising” diversity at high values of species richness. On the other hand, AvePD displays a declining diversity with increasing SR. We suggest that deviations from the main trends in all these measures provide more realistic measures of the worth of each area in terms of diversity.

174. ELEPHANT DIETARY RESPONSES TO LIMITING RESOURCES IN THE EASTERN KAROO, SOUTH AFRICA

MINNIE, LIAAN, Marietjie Landman, Graham Kerley

Elephants have a wide range of impacts on ecological processes. These, however, are rarely quantified across different habitats, which may vary in resource availability and may be limiting to elephant populations. We investigated the preference and seasonal variation in the use of plant species in the diet of an elephant population in a landscape which is characterised by limited forage in terms of species richness and abundance, and is subjected to extreme winter and summer conditions. We hypothesize that they rely on a few plant species, especially during the winter. Sixty-six plant species were identified in the diet (less than half than in more productive landscapes), of which 17 species comprised 84%. With the exception of *Acacia karroo* and *Heteropogon contortus*, these 17 species were preferred. During winter, *A. karroo* comprised 30% of the diet, and this species serves as a “stepping stone”, despite being winter/drought deciduous and comprising only 13% of available forage. Although these elephants exhibit some seasonal dietary shifts and preferences, we predict that this population is vulnerable to *A. karroo* phenology in dry winters, and that the dominant dietary plant species are at risk of over-utilization in this resource limited landscape.

175. ESTIMATING HABITAT CAPACITY FOR RE-INTRODUCED BLACK RHINOS

SHAW, JO, Norman Owen-Smith

The recent increase in black rhino (*Diceros bicornis*) numbers has prompted the reintroduction of populations to enclosed areas within their former range. The success of these new populations is partially dependent upon reliable estimates of the habitat capacity of these areas. However, the capacity of these habitats to support black rhino may change after reintroductions due to browsing impacts upon vegetation communities. In order to estimate habitat capacity for black rhino introduced to Tswalu Kalahari Reserve in the Northern Cape of South Africa, we recorded plant species use, availability and rhino movements along feeding tracks. Five plant species contributed over 80% of the diet throughout the year. Nutritional content of these key species was analysed to estimate rates of nutrient gain achieved by black rhino in different habitats. Thus far, this population has performed well, but this may change if browsing impact reduces the availability of key woody species for the dry season. Simulated browsing stimulated short-term compensatory growth by a key dry season browse species. Development of a metaphysiological model will allow exploration of the effect of future habitat changes on the carrying capacity for black rhino. We emphasise the need to consider the longer-term consequences of herbivore impacts upon vegetation when calculating habitat capacity and provide an example of the value of conservation modelling for management purposes.

176. SPILLOVER OF CANINE DISTEMPER VIRUS FROM FREE-RANGING DOGS TO INDIAN FOXES IN CENTRAL INDIA

VANAK, ABI TAMIN, Aniruddha Belsare, Matthew Gompper

Domestic dogs can be a reservoir for parasites that spill-over and cause declines of wild carnivore species. Evaluating the risk of disease spill-over requires estimating contact rates and proportion of the population that are susceptible, infectious, and immune. We measured contact rates based on overlap of home range of dogs and Indian foxes over 12 months in a protected grassland habitat in central India. Foxes and dogs were also serologically monitored for exposure to Canine distemper virus (CDV) and Canine parvovirus (CPV). Over 95% and 69% of dogs (n=43) were CDV IgM+ and IgG+ respectively, indicating enzootic CDV. For CPV, 61% and 97% were IgM+ and IgG+. Among foxes, 17% (n=25) were IgM+ (39% IgG+) for CDV and 13% were IgM+ (13% IgG+) CPV. All CDV IgM+ foxes died within one month of testing, while no disease related deaths were recorded in dogs during the same period. All tagged foxes (n=16) had overlapping 95% kernel home ranges with that of tagged dogs (range 1-6, n=20) varying between 2.5% and 95.5% of the foxes' home ranges. Together, these data suggests that CDV and CPV are enzootic in dogs, that interspecific contact rates are sufficient for parasite transmission, and that differential mortality of infected foxes and dogs exists to shared viruses. Therefore, dogs represent a risk to fox populations in this region. Based on the results of this study the Maharashtra government has initiated a vaccination and population control program for dogs in the study area.

177. LIVESTOCK PREDATION TACTICS AND RETALIATORY KILLING OF LARGE CARNIVORES IN THE TARANGIRE-MANYARA ECOSYSTEM, NORTHERN TANZANIA
KISSUI, BERNARD

Human-carnivore conflicts from livestock depredation threaten carnivore conservation. This study assesses the pattern of livestock predation by lions, hyenas and leopards in the Tarangire-Manyara Ecosystem, Tanzania and compares the impact of retaliatory killing on each species. During a 19 months study, mean 6 ± 7.3 SD lions; 5 ± 12.4 SD hyenas and 1 ± 2.0 SD leopards were killed by pastoralists in 12 villages. Livestock attack events by lions strongly correlated the number of lions killed ($r_s = 0.8068$) but not between attack events by hyenas and number of hyenas killed ($r_s = 0.3310$) or between attack events by leopards and number of leopards killed ($r_s = 0.2874$). Lions' vulnerability to retaliatory killing is due to behavioral differences in livestock predation and to cultural sentiment by pastoralists to lion hunting. Lions attacked cattle at grazing sites during daytime, hyenas and leopards attacked shoats in "boma" (enclosures) at night. Diseases claimed 14% and 23% of total cattle and shoat herds respectively, while 1% cattle and 4% shoat herds were lost to predation. Better husbandry could improve the economy and livelihoods of pastoralists and, by reducing the impact of diseases their tolerance to depredation might increase. Pastoralists would also afford predator-proof building materials for their bomas and the implementation of other conflict mitigation strategies.

178. LACK OF INBREEDING AVOIDANCE BEHAVIOURS IN A SMALL ELEPHANT POPULATION AND IMPLICATIONS FOR THEIR CONSERVATION
GOUGH, KATIE, Graham Kerley

There are an increasing number of small, closed populations of elephants *Loxodonta africana* in southern Africa. We conducted a behavioural study on mate choice and inbreeding avoidance in one such population of elephants (Addo Elephant National Park, South Africa). Elephants have a polygynous mating system with matings usually dominated by older males in the sexually active state of musth. It was found that oestrus females spent proportionally more time with older, musth males but that the frequency of avoidance behaviours did not vary if these males were related or not. Although males disperse from the natal herd at puberty, sexually active males were observed with related receptive females more frequently than expected. Male elephants have a dominance hierarchy that dictates access to oestrus females which may override female choice. This implies that there are no effective inbreeding avoidance mechanisms in this population. It is therefore suggested, that small closed populations be managed as a metapopulation, whereby dominant non-related adult males are provided to conserve the integrity of the breeding population.

179. ASSESSING HEALTH PARAMETERS OF FLORIDA PANTHERS, *FELIS CONCOLOR*, FROM MUSEUM SPECIMENS
WILKINS, LAURIE, Julie Allen, Shelly Flanagin, Joan Brenner Coltrain, David L. Reed

Past studies of museum specimens have shown the Florida Panther exhibits a high incidence of skeletal trauma, osteopathology, and presence of Harris Lines when compared to a non-Florida Puma population. Osteopathologies include the presence of (old) trauma, infection, and arthritis. Harris Lines (HLs), visible in X-rays as bands of mineral deposition that form at the metaphysis of long bones, have been linked to malnutrition, infectious agents, and/or environmental toxins. We investigate these health indicators in a 25-year sample of skeletons that represent the Florida puma population before and after the 1995 reintroduction of Texas Cats into Florida and implementation of habitat management strategies. We explore the relationship of health indicators to life history parameters of age, genetic profile and habitat. Our study demonstrates that HLs remain common in Florida panthers of all ages and that females have significantly more HLs than do males. The high incidence of Harris lines remains enigmatic, although mercury and other heavy metals are known to cause HLs in humans. The presence of osteopathologies, especially arthritis, remains outside the normal limits of a healthy population, but our data suggest a reduction in the expression of trauma, infection, arthritis, and the presence of HLs in animals born within the last 10 years. Museum specimens provide opportunities to assess health of living populations, and through this research, can inform conservation efforts.

180. EXAMINING THE DIET OF THE FLORIDA PANTHER (*PUMA CONCOLOR*) THROUGH STABLE ISOTOPE ANALYSIS OF MUSEUM SPECIMENS

ALLEN, JULIE, Laurie Wilkins, Shelly Flanagin, Joan Brenner Coltrain, Cedric O. Worman, David L. Reed

One of the issues surrounding the conservation of the Florida panther (*Puma concolor*) is prey species management. It is not clear if adequate prey densities are found throughout the range of the Florida panther. An accurate understanding of the diet of the Florida panther is needed to determine the availability of prey species. Previous studies of panther diet have used scat and kill site analysis, which are both biased towards larger prey. Stable isotopes provide an all-inclusive view of the diet because they are incorporated into tissues directly from the prey items. We analyzed the carbon and nitrogen stable isotope ratios in bone collagen from Florida panthers and common prey species from the Florida Museum of Natural History. Interestingly, we found a previously unreported difference in the diet of male and female panthers. Males had a more varied diet and were eating higher on the food chain than females. We found divergent isotope signatures for the males in the northeast of the range, suggesting that they were eating a very different diet than males in other areas. This research illustrates a new tool for exploring the habitat quality of endangered animals.

181. EFFECTS OF INTERANNUAL VARIATIONS OF PLANT AVAILABILITY ON HABITAT USE OF MONGOLIAN GAZELLES

ITO, TAKEHIKO, Mitsuru Tsuge, Badamjav Lhagvasuren, Atsushi Tsunekawa, Seiki Takatsuki

Mongolian gazelles (*Procapra gutturosa*) inhabiting the Mongolian steppe migrate long distances, and conservation strategies for gazelles are required. Since interannual climate variations are great in arid regions it may affect plant productivity and habitat use of Mongolian gazelles. To examine the relationship between interannual variations of plant availability and habitat use Mongolian gazelles, we analyzed the relationship between satellite-tracked locations of three gazelles and normalized difference vegetation index (NDVI) derived from satellite images as an indicator of plant availability in central Mongolia from 2002 to 2005. During winter, relatively high NDVI areas in the gazelles' annual ranges changed yearly, and the gazelles used high NDVI areas each year. During summer, NDVI values were generally lower in 2005 than in the previous two years. Summer ranges in 2003 and 2004 overlapped, but summer ranges in 2005 were located about 50 km north to those. NDVI values were higher on summer ranges in 2005 than those in the previous two years during every summer. These results suggest that interannual variations of spatial distribution of plant availability affects habitat use of Mongolian gazelles, and that conservation strategies considering interannual climate variations are necessary for long-distance migratory species.

182. RURAL COMMUNITY KNOWLEDGE AND ATTITUDES TO ENDANGERED WILDLIFE CONSERVATION IN SOUTH SUMATRA PROVINCE, INDONESIA

PRIATNA, DOLLY, Thomas Maddox, Elva Gemita

Habitat destruction by humans is one of the principle problems in wildlife conservation, particularly when it occurs within areas already designated as conservation areas. Part of the solution for combating this problem is to understand the factors driving people who encroach on protected areas, however such information is scarce due to the sensitivity of the subject. In this poster we present the results from a questionnaire survey of people living inside two protected areas in South Sumatra, Indonesia. We investigate their attitudes towards conservation, conservation authorities and why they decide to move into protected areas. The results show that most are supportive of conservation efforts and are fully aware of the official protection status, but that their perception is that the area they are occupying no longer has value. These results show the importance of the role of wildlife authorities in publicizing the conservation effort and physically demonstrating their belief in the value of local conservation areas.

183. CAPACITY BUILDING OF WILDLIFE MANAGERS IN DEALING WITH WILDLIFE EMERGENCIES

BELSARE, ANIRUDDHA, Vidya Athreya

Indian wildlife managers have to deal with a variety of wildlife emergencies, including human-wildlife conflict, and the response varies depending upon their experience, expertise and the resources available. The response is usually a knee-jerk reaction and there is a high dependence on outside experts. The objective of our work is capacity building of the wildlife department personnel by 1) proper orientation and infusing science in the process 2) demystification of procedures like tranquilization, microchipping 3) standardization of procedures. Initially, in 2004, we trained 5 teams in the state of Maharashtra and supplied each team with a set of remote drug delivery and associated equipments. In 2005, five other states were also incorporated and similar workshops were organized. Wildlife researchers were invited as resource persons for the workshops based on the kind of emergencies encountered in the region. In 2005 and 2006, we assisted the Maharashtra State Forest Department in rescue and treatment of wild animals. Following the training of teams in Maharashtra, successful rescue operations have been carried out by the teams with the help of local veterinarians. A similar project has been initiated by the Madhya Pradesh Forest Department. Recommendations provided to the Maharashtra Forest Department based on the data from PIT tagging (microchipping) has positively influenced the management of human-leopard conflict situation in Maharashtra.

Marine conservation

184. SEABIRDS BEACHED COUNTS AS A CONSERVATION TOOL

TAMINI, LEANDRO LUIS, Rubén F. Dellacasa, Jorge E. Perez Comesaña, Tomás Chalde

Seabirds, especially Procellariiformes, are very vulnerable to fisheries activities by incidental capture. Researches about the impact of fisheries on seabirds are generally focused in onboard observations. These kinds of programme are difficult to carry out with artisanal or small-scale fisheries. By recording the number of seabirds beached and relating these observations with fishery data, it is possible to know the tendency of the fisheries impact on seabirds. Moreover, this information taken along years can be use for understands the natural mortality of seabirds and recognize unusual events (human or no-human related). A research conducted in 6 km of north coast of Argentina (3833'S 5837'W) 22 year ago, recognized 14 species beached of which, two prominent species of penguins were never recorded in 10 years of onboard observations in the zone (1996-2005), and in a three years onboard program (2003-2005), focused on seabirds we only recorded 8 of that 14 species. Moreover, in 24 long walks in this same area conducted during one year; only four species of pelagic seabirds beached were recorded. This depletion in species richness may be explained by changes in the distribution of seabird's populations. We create, within a two-year project, a strong and coordinated network of volunteers for enhance the observation program to confirm the tendency observed.

185. EVIDENCE FOR AN INCREASING INCIDENCE AND SEVERITY OF HARMFUL ALGAL BLOOMS IN THE SOUTHERN BENGUELA CURRENT

STEPHEN, VANESSA , Philip Hockey

Harmful Algal Blooms (HABs) periodically lead to catastrophic mortality over a range of trophic levels; this impacts on fisheries, local species populations, conservation management and human health. Consequently, any increase in frequency and/or toxicity of these events is of concern. Recently this concern has been realised, with reported increases in the frequency of HABs from all continents except Antarctica. This apparent increase is supported by data from the Benguela coast of western South Africa, where, since 1930, there has been a significant increase in the frequency of HABs and a slight increase in their average severity. Since the 1960s there has been a six-fold increase in the number of HABs per decade with the period 1990-2005 experiencing the greatest number of HABs as well as the most severe in terms of associated mortality. The recent occurrence of previously unrecorded HAB-causing species in this region may go some way to explaining this trend and further suggests that the increase is unlikely to slow in the near future.

**186. SEA TURTLES OF THE PALMYRA ATOLL NATIONAL WILDLIFE REFUGE,
CENTRAL PACIFIC: DISTRIBUTION AND HABITAT ASSOCIATIONS**
Naro-Maciel, Eugenia, Katherine McFadden, Peter Ersts, Katherine Holmes, ELEANOR
STERLING

We are studying foraging strategies, habitat use, and ecological roles of endangered sea turtles at the Palmyra Atoll National Wildlife Refuge. In this research we characterized the Atoll's south reef flats focusing on algae, the presumed main diet item of green sea turtles (*Chelonia mydas*), the species most frequently identified at Palmyra. We undertook a multidisciplinary analysis to explore possible relationships between sea turtle and algal distributions along this flat. Our unique approach combined sea turtle count data, algal sampling, and interpretation of satellite imagery. Four turtle surveys were conducted in 2005 and 2006 by 6 - 10 observers who simultaneously covered key areas inside the atoll by kayak or boat. The number of turtles counted varied with visibility conditions (range = 29-120) during the roughly 2-hour surveys, but sea turtles were consistently seen most frequently along the southern flats. We randomly sampled algae via quadrats at three sites along transects on these flats. We found the algal distribution along the southern reef flat to be more sparse and heterogeneous than expected in relation to the frequency in which sea turtles are encountered. We hypothesize that, given the relatively low nutritional value and distribution of many of the algal species identified along the southern flats, the relatively frequent observations of sea turtles along these flats may not be solely due to dietary factors.

**187. GREEN TURTLE RESEARCH AND CONSERVATION IN URUGUAY:
IMPLICATIONS FOR THE CREATION OF THE FIRST MARINE PROTECTED AREA**
LOPEZ-MENDILAHARSU, MILAGROS, Alejandro Fallabrino

One of the most southerly foraging grounds for the endangered green turtle is located in Cerro Verde, Uruguay along the SW Atlantic Ocean. Its irregular rocky shores with abundant seaweed beds attract juvenile individuals year-round. From 2000 to 2005 a total of 161 juvenile green turtles were captured along the area. Samples of recently ingested food items were collected by conducting gastric lavage to 71 turtles. The diet consisted largely of seaweeds, but turtle's prey species from coastal areas were slightly different than those from insular areas. Eight green turtles were fitted with radio transmitters, results indicated that their activity varied seasonally and that some of them remained in the area for extended periods. Overall mean surface and submergence times were calculated. Active periods of foraging occurred mostly during the day, while resting behavior was observed at night and at dusk. The presence of lethargic individuals covered by a great diversity of unusual epibionts during winter and spring evidenced the existence of possible periods of brumation in the region and reinforced the fact that some of the turtles remain in the feeding area even with water temperatures under 15 °C . However, flipper tag recoveries including live captured individuals support the evidence of seasonal migrations to and from subtropical northern latitudes. The creation and role of the first marine protected area in the region will be also detailed.

**188. BYCATCH OF PROTECTED MARINE FAUNA IN PERUVIAN SMALL-SCALE
FISHERIES: RESULTS AND IMPLICATIONS**
Mangel, Jeffrey, Joanna Alfaro Shigueto, PAJUELO MARIELA, Celia Caceres, Paola
Melly, Jeffrey Seminoff, Peter Dutton

Fisheries bycatch of protected marine species has been partly responsible for declines in many populations. While research has focused on commercial fisheries in developed nations, small-scale (or artisanal) fisheries in developing nations have often been overlooked or have proven difficult to monitor given their diverse, under-regulated nature. Since 2003 we have monitored with onboard observers the small-scale Peruvian longline and gillnet fisheries for the take of sea turtles, marine mammals and seabirds. Fishing trips were monitored in two ports. Take varied by port, target species and fishery. Loggerhead turtles were the most common species taken in longlines in south Peru (Mahi mahi season: 0.597 captures/1000 hooks; Shark season: 0.356 captures/1000 hooks) with greens being taken by gillnets in the north. Longline bycatch of seabirds was low (0.004 captures/1000 hooks) but capture in gillnets was more frequent and of a greater number of species (0.15 captures/set). Marine mammal take was essentially limited to entanglements in gillnets (5.4 cetaceans/trip) but 13 animals were also harpooned for use as bait. These results show that small scale fisheries should be considered when assessing populations of marine protected species and when implementing conservation measures at national, regional and global levels. The work also shows that these fisheries can be effectively monitored and can provide valuable information in otherwise poorly described areas.

189. MANAGEMENT EFFECTIVENESS OF A MARINE AND COASTAL PROTECTED AREA IN THE MACARONESIAN BIOGEOGRAPHICAL REGION
DE PABLO, MARIA-JESUS, Jose-Luis Rubio, Ricardo Haroun

The evaluation of the management effectiveness of a protected area provides valuable information for future steps in conservation biology. The approach taken in this study was to analyze a pool of selected performance indicators applied to a marine and coastal protected area situated in the Macaronesian biogeographical region. The methodology used to assess the Chinijo Archipelago Natural Park, a Natura 2000 site, located in northern Lanzarote (Canary Islands, Spain) off NW Africa. Three clusters of performance indicators – biophysical, socio-economic, and governance indicators - were used to address goals and objectives of the Management Plan for the protected area. These indicators seem to be pertinent tools for local authorities to report the key aspects of good practice and governance of the concerned conservation area. In addition, it outlines how the Management Plan of the protected area can be updated, providing references to other relevant information such as the network structure social capital of local communities.

190. EVALUATION OF CULTURAL USES OF SEA TURTLES BY COASTAL POPULATIONS OF BENIN, WEST AFRICA
DOSSA, JUSTINE, Brice Sinsin, Guy Mensah, Philippe Laleye

Sea turtles serve many important cultural functions for the coastal people of Benin, West Africa, and are included in traditional pharmacopeias, traditions and myths. We collected information on the cultural role of sea turtles by surveying 182 people of diverse social backgrounds, including fishermen (146), traditional chiefs (7), traditional doctors (11) and elders with traditional knowledge (18). We found that sea turtles have several important functions for coastal people of Benin, including serving as a source of protein, income, traditional medication, cultural and religious inspiration, and nutrients for marine ecosystems. Human use and development of beaches destroys sea turtle nesting habitat and prevents turtles from occupying the beaches of Benin. Fishermen, who report that turtles frequently cause damage to their nets, kill and discard the turtles at sea, or capture them to sell or eat. They captured 36 sea turtles during my 3 months of observation. This situation results in conflict between fishermen and turtles and deserves particular attention.

191. HUMAN EXPANSION AND CONSERVATION: A CONTRADICTION OR A CULTURAL MATTER?
BADILLA, MANUEL

Lontra felina or chungungo is the only neotropical otter exclusively marine and it is also the smallest species of the genus. This species was driven to near extinction due to the indiscriminate hunting in the 1960s, and together with the lack of knowledge about its biology and the destruction and loss of habitat, it is listed as Endangered by different international treaties. Furthermore, human population enhancement has caused wilderness decline, bringing against human expansion versus conservation. During late 2005 and early 2006, diurnal habitat use of otters, their behavior and anthropogenic impacts affecting them were comparatively assessed in a fishermen village and an isolated area in southern Chile. Between the areas there were evident differences in pick hours of activity and the more frequent behaviors. Hostile human activities in the isolated area would cause otter habitat shifts, making them going far from burrow. According to this, human hostility towards wildlife is a product of lack of awareness rather than human expansion. Finally, this study is a contribution to make of this otter a flag species in local action plans for marine reserves and conservation of biodiversity. It is also part of first steps towards the creation of programs for otter conservation and the protection of the marine ecosystems they depend on.

192. INVESTIGATING CETACEAN OCCURRENCE AND DISTRIBUTION IN AND AROUND THE BAR REEF MARINE SANCTUARY IN SRI LANKA FOR ENHANCED MANAGEMENT

ILANGAKOON, ANOUKCHIKA D

The Bar Reef Marine Sanctuary off north-western Sri Lanka is one of the few marine protected areas in the island. While the Sanctuary and adjacent waters were suspected to be important cetacean habitat a dedicated survey had never been undertaken. In order to fill this knowledge gap and enhance management of the MPA through effective conservation of cetaceans, a survey was undertaken in 2004/2005 to collect the necessary baseline data. Vessel surveys were done each month, using standard line-transect methodology. All cetacean sightings in the Sanctuary, the adjacent Puttalam lagoon and deeper waters beyond were recorded. Eight species of cetaceans including *Balaenoptera acutorostrata*, *Balaenoptera musculus*, *Physeter macrocephalus*, *Kogia sima*, *Peponocephala electra*, *Stenella longirostris*, *Tursiops truncatus* and *Sousa chinensis* were identified in 33 sightings. The first confirmed sightings of *S. chinensis* in Sri Lanka's waters were recorded, while *K. sima* and *P. electra* were sighted off the west coast for the first time. Cetaceans were present within the Sanctuary throughout the year with the northern and central parts being a "hotspot" due to high species richness and year round abundance. This data can be used immediately for management while more detailed studies are suggest for the newly discovered population of *S. chinensis* that is dependent on the Puttalam lagoon which is under intense human use making them vulnerable to a multiplicity of anthropogenic threats.

193. THE FUTURE OF DOLPHINS IN SOUTHERN CHILE: UNCERTAINTY OR OPPORTUNITY?

VIDDI, FRANCISCO, Rodrigo Huckle-Gaete, Sandra Ribeiro, Juan Pablo Torres-Florez

Southern Chile is home to a high diversity of small cetaceans, including the endemic Chilean dolphin (*Cephalorhynchus eutropia*), and the Peale's dolphin (*Lagenorhynchus australis*). Both species are poorly known and are listed as Data Deficient. Since 2003, marine surveys and group follows have been developed to understand the ecology of dolphins and identify the anthropogenic impacts affecting them. Data analyses have revealed that dolphins are strict habitat selectors, preferring specific environmental variables to perform their essential behaviors. However, the fast and extensive expansion of salmon farming in southern Chile is overlapping with dolphin important habitats. Farming causes water eutrophication, boat traffic (which affects dolphin behavior), and pollution. Furthermore, first records of skin lesions on dolphins might be a sign of a degrading marine environment, and also a potential evidence of a more global environmental problem, such as ozone depletion. The future of dolphins might be uncertain if the rate of habitat loss remains unchanged. Nevertheless, dolphins as flagship and umbrella species are currently assisting in the design of a marine protected area in the region. Undoubtedly, the uncertainty on the future of dolphins might be changed, and in this way become an opportunity to conserve not only emblematic species such as cetaceans, but unique coastal marine ecosystems in southern Chile.

194. Withdrawn

195. MPA EXPANSION IN SOUTH AFRICA: A SANPARKS CHALLENGE

OOSTHUIZEN, ANÉ

SANParks is committed in terms of the WSSD to expand conservation areas in South Africa. SANParks is traditionally a terrestrially focused conservation agency, however recent legislation have placed more emphasis on including marine conservation areas. Several National Parks situated on, or close to, the coast are expanding to include marine and estuarine areas. Currently the main impediment in effective marine conservation in South Africa is the lack of enforcement of marine legislation and management capacity. SANParks is in a unique position to expand their practical conservation expertise into the marine environment to make MPAs linked to the National Park system effective in their conservation. Currently six National Parks are inclusive of a marine or estuarine area, with a further three to five planned. This will contribute to SANParks as a leading marine conservation organisation in the country. However several challenges such as capacity, funding and legal mandate need to be overcome before this goal will be realised within the organisation.

196. ETROPHICATION AND OVERFISHING ARE DIRECTING THE STRUCTURE OF THE PELAGIC ECOSYSTEM IN THE NW BLACK SEA

VASAS, VERA, Christiane Lancelot, Véronique Rousseau, Ferenc Jordán

Among the most important current threats for temperate coastal communities are eutrophication and overfishing, which can eventually lead to a collapse of the ecosystem. In this study, we have used qualitative structural network analysis to assess the joint effects of nutrient loading and overfishing on the highly disturbed pelagic area of the NW Black Sea. Literature data on historical time series of different food web components were assembled and a possible scenario of community structure changes was established. Based on theoretical considerations, top predators and subsequently every second trophic level are expected to increase their biomass in response to eutrophication. In the NW Black Sea however, the four-step trophic chain (phytoplankton-zooplankton-planktivorous fish-carnivorous fish) has been shortened by the overfishing of large carnivores as early as 1966, and thus the increased nutrient loads since the 1970s supported higher biomass of phytoplankton and planktivorous fish. The exotic jellyfish *Mnemiopsis* burst out after the overfishing of anchovy in 1988, and soon outcompeted other fish species. Finally, the exotic *Beroë ovata* was introduced to the ecosystem and after 1999, the original four-step food chain was actually replaced by the phytoplankton-zooplankton-planktivorous jellyfish-carnivorous jellyfish chain. We propose that the natural state of the ecosystem can be restored only when fish stocks has recovered.

Plant conservation

197. MINIMIZING THE IMPACTS OF LOGGING ON UNDERSTORY PLANT SPECIES OF SEASONAL FORESTS

WOLF, AMY, Robert Howe,

Plant species richness in northern temperate forests is highest in the understory, where regionally the number of herb and shrub species can be at least an order of magnitude higher than the number of canopy tree species. Harvesting trees from these forests may influence the composition of understory plant assemblages by providing gaps for shade intolerant species, compacting the soil, modifying local hydrology, and differentially affecting the population dynamics of competing species. These impacts of logging on understory plants can be affected by the timing and method of tree harvest operations. We compared understory plants in sites that were logged during summer with paired sites that were logged during winter. Winter-logged sites maintained higher numbers of regionally sensitive species, although the overall numbers of species were not significantly different. In both summer logged and winter logged sites, higher numbers of non-native and pioneer plant species were found near logging roads. These results suggest that well-planned harvest strategies might reduce the negative impacts of logging on understory plants, especially species that are vulnerable to impacts of long term forest management.

198. DEMOGRAPHY AND CONSERVATION OF THE ENDANGERED BARRENS WILLOW OF THE LIMESTONE BARRENS OF NEWFOUNDLAND, CANADA

ROBINSON, JULIE, Luise Hermanutz

The Limestone Barrens of Newfoundland is a globally rare ecosystem that harbors a number of designated endemic plants; one such plant is the Barrens willow *Salix jejuna*, a dominant woody shrub of the barrens. Our research aimed to provide baseline biological information that will aid in ensuring the persistence of this species and its unique habitat. Determination of population age structure indicates a lack of individuals in young <5 yrs and old >20 yrs age classes. Lack of young plants and low numbers of seedlings in the wild (ave. 0.1 / m²) suggests seedling recruitment may be rare or episodic. Germination tests indicate that seed has annual variation in germination success; 80% in 2004 and up to 43% in 2006; and there is very low survival when seeds are planted on naturally occurring substrates in situ, possibly contributing to low natural seedling establishment. Clonal growth occurs with lateral branches establishing by adventitious roots and then breaking away from the parent plant. In time, the main root collar complex of the parent plant decays, leading to the absence of older individuals. Our research suggests clonal growth is the primary method of population sustainability in at least 3 of 8 populations studied. These results have direct implications on conservation strategies for this species such as, changes to monitoring protocols and improvement of reintroduction procedures.

199. WOODY PLANT SPECIES DIVERSITY IN A MULTIPLE LAND-USE WOODED SAVANNA, CENTRAL UGANDA
KALEMA, VETTES, Ed Witkowski

Woody species diversity and richness was studied in grazed, cultivated and charcoal production land-use types in a wooded savanna of Nakasongola; using seventy five (0.1ha) modified-Whittaker plots, to contribute to the basis for their better management and conservation. A total of 1633 individual woody species representing 78 species from 56 genera and 31 families were recorded. Species richness and Fisher's alpha diversity are relatively low spanning 1-20 individuals per 0.1 ha, and 0.26-26.78 respectively. Both species richness and alpha-diversity differed significantly between the land-use types, being lowest for the grazing. However, mean species richness was highest for the cultivation (10.42 ± 0.87), while alpha-diversity was highest for the charcoal production land-use type (9.39 ± 1.39). Analysis of similarity (ANOSIM) also showed that community species composition is significantly different among the land-uses (Global RANOSIM = 0.18, $p = 0.001$). All the measures of beta-diversity consistently showed higher beta-diversity for the grazing land-use type, suggesting a more heterogeneous spatial species distribution. Beta-diversity results corroborated with SIMilarity PERcentages (SIMPER) analyses results, in that within land-use type average similarities were quite low spanning 13.99-21.14%; and pair-wise average dissimilarities between land-use types were relatively high spanning 81.39-89.22%. These results suggest the influence of an anthropogenic disturbance gradient. There is need to implement conservation strategies that will halt the increased loss of tree cover in all the land-use types, since trees are an important aspect of woodland diversity and sustainability of most dryland ecosystems.

200. EX SITU CULTIVATION OF *COMMIPHORA WIGHTII*: AN ENDANGERED MEDICINAL PLANT OF ARAVALLI RANGES IN INDIA
SHARMA, KIAILASH CHANDRA , Pawan Kasera

Commiphora wightii (Burseraceae) exudes oleo-gum resin through stem bark which is effective in the treatment of obesity, arthritis and many diseases in Indian system of medicine. The plant becomes endangered due to overexploitation by the inhabitants of Aravalli region during the last two decades. In order to cultivate and conserve this plant, viable seeds collected from the natural sites were grown in plots (10 x 10 m) in soil mixture with an equal proportion of sand: clay : farm yard manure (FYM) with different treatments of hormones and nutrients. Maximum seed germination (40%) and plant growth was observed under nursery conditions. Ceradik, hexameal and ceradik +NPK treatments maintained high survival percentage under field conditions. The results of air-layering experiment revealed that ceradik and guggal solutions (600 – 1000 ppm) enhance survival under field conditions. Growth performance was found better for plants raised through stem cuttings. Cuttings (20 cm length and 10 mm diameter) treated with IBA and guggal solution (750 ppm) showed 85% survival with maximum plant height and collar diameter. The protocol worked out in the present study was applied to develop the stands successfully in agro-medicine farming.

Population dynamics

201. THE USE OF REMOTE CAMERA TRAPS TO ESTIMATE DENSITY OF FREE-RANGING CHEETAHS IN NORTH-CENTRAL, NAMIBIA
MARKER, LAURIE, EZEKIEL FABIANO, Matti Nghikembua

Designing effective conservation programs is dependent on the availability of reliable density estimates and population trends. The elusive cheetah has been difficult to census using conventional methods. Remote camera trapping appeared suitable for monitoring cheetah abundance in a three month study using 14 camera traps within the Waterberg Conservancy farmlands in north-central Namibia. Two cameras per trap were set at cheetah areas (ie. marking-trees, roads). Individuals were identified using spots. The effective sampling area (ESA), was established using the mean maximum distance moved (MMDM) by animals captured more than once ($n=6$), equaling 5.61, and the radius of a cheetah minimum home range size ($MCP = 250\text{km}^2$) was 8.91. Fourteen cheetahs were photographed (460 photos) in 142 captures, and 1302 trap nights (2.83 per cheetah picture). Program CAPTURE showed that goodness-of-fit models Mh and Mb best fitted the data ($X^2=11.10$, $df=14$, $P<0.68$ and $X^2=13.22$, $df=18$, $P<0.79$ respectively), and the model selection algorithm identified the Mbh model estimator as the best abundance estimator for cheetahs, followed by Mb and Mh. The ESA using the MMDM method was of 510km^2 with a density of 21 cheetahs/ 1000km^2 (SD +39.52), and a density of 12 cheetahs/ 1000km^2 (SD +12.94) using the radius

approach ($r = 960\text{km}^2$), this being more representative given the cheetah's large home range size (ave. 1600 km^2).

202. VIABILITY OF THE LAKE RESERVE MODEL IN THE BRAZILIAN AMAZONIAN FLOODPLAIN FOR MAINTAINING STOCKS OF *COLOSSOMA MACROPOMUM*: A MARK-RECAPTURE EXPERIMENT

Costa, Luiz, Ronaldo Barthem, ANA LUISA ALBERNAZ

Increasing exploitation of fish stocks in floodplain lakes of the Brazilian Amazon basin has caused conflicts between commercial fleets, that supply fish for cities, and small-scale fishermen who live around the lakes. To resolve to these conflicts and to protect stocks, lake reserves were informally created. The lake reserve model is based on the idea that exploited lakes will likely be repopulated by receiving fish of conserved ones. However, this model was created and is being applied without knowledge of the population dynamics of target species. In this study we investigated the potential for repopulation of lakes by the tambaqui (*Colossoma macropomum*), one of the most valuable food species in the region. In a mark-recapture experiment, 3524 fish were marked in 10 floodplain lakes in the Mamiraua reserve. Data were used to estimate tambaqui density in lakes under different exploitation regimes, and to provide information on dispersion among lakes. The most conserved lakes presented higher tambaqui densities. Marked fish were recovered in nearby lakes, indicating that for the lake reserve model to be viable, it is important to select a set of unexploited lakes connected to the exploited ones. However, since more than 90% of captured fish were young (length $<55\text{ cm}$), it is also necessary to estimate the proportion of tambaqui populations, and respective size classes, that can be removed from lakes without compromising future stocks.

203. INCREASE IN POPULATIONS OF SYMPATRIC SPECIES OF FUR SEALS AT MARION ISLAND

HOFMEYR, GREG, Marthán Bester, Azwianewi Makhado, Pierre Pistorius

Intensive harvesting prior to the 20th century brought most species of fur seals close to extinction. Since the cessation of most forms of direct exploitation, many populations have increased substantially, some approaching carrying capacity. The population of Subantarctic fur seals *Arctocephalus tropicalis* at subantarctic Marion Island ($46^{\circ}54\text{S}$, $37^{\circ}45\text{E}$), and the much smaller sympatric population of Antarctic fur seals *A. gazella* have both experienced considerable growth in recent years. We examined recent trends in abundance to determine whether either of these populations has reached carrying capacity. Pup production was assessed during the 2003/04 breeding season and compared to past censuses. The Subantarctic fur seal population has increased at a mean annual rate of 5.2% over the last 10 years, approximately half the rate recorded between 1951 and the late 1980's. The Antarctic fur seal population grew at more than three times that rate over the same period (17.0%). Neither population has therefore reached carrying capacity. Since the diets of the two species are similar, we suggest that the dissimilarity in population growth between them is due to differences in the availability of preferred terrestrial habitat and the effects of density dependant pup mortality. Together with the neighbouring Prince Edward Island, this island group supports populations of approximately 150 000 Subantarctic fur seals and approximately 5 800 Antarctic fur seals.

204. TOWARDS SUSTAINABLE HARVESTING OF MARULA IN THE SAVANNA WOODLANDS OF ZVISHAVANE, ZIMBABWE

NGORIMA, GABRIEL T

The aim was to determine the availability of marula *Sclerocarya birre* trees for the harvesting of nut oils, through determining abundance, population structure and regeneration capacity, within the context of the socio-economic and biophysical dimensions of villages in Zvishavane, Zimbabwe. Household interviews revealed that there was no association between level of household wealth status and the household's use of marula trees. There was a significant difference in marula densities between arable and non arable land uses. There is however a need to determine the annual quantity of harvestable marula fruits and the sex ratio of marula trees (a dioecious species) on this particular site, as a prelude to developing sustainable harvesting quotas, so that harvesting rates do not exceed the capacity of populations to replace the individuals extracted. Finally a long-term monitoring and evaluation of socio-economic and environmental impacts of marula commercialisation is required in order to achieve sustainable resource utilisation in the region.

Protected area planning and design

205. RESERVE DESIGN IN A SPECIES-RICH BUT DATA-POOR REGION: ESTABLISHING CONSERVATION PRIORITIES FOR THE THREATENED AND ENDEMIC BIRDS OF COLOMBIA

VELASQUEZ-TIBATA, JORGE, Catherine Graham, Paul Salaman

Knowledge of spatial patterns of biodiversity is a necessary input for systematic conservation planning over large areas. In Colombia, a country which holds the world's most diverse avifauna, knowledge on the distribution of most of these species is lacking. Current protected areas seem to be insufficient to halt the current trends of endangerment and therefore there is an urgent need to map the distribution of these species as well as to identify areas that are critical for their conservation. We developed a methodological framework that uses a combination of expert opinion and data to model species distributions with limited point localities and to report the uncertainty in the developed models and in the resulting sets of potential conservation areas. Priority areas identified are located primarily in the Andes as well as in the inter-Andean valleys. These areas cover a total of 11% of Colombia's surface, and if they were protected would represent all 235 species considered in this study and increase its representation targets a further 88%. Concentrations of threatened species at particular localities never exceeded more than 8 species, suggesting that conservation of Colombia's threatened birds might require extensive protected areas. Our results also highlighted areas of importance for future surveys, which include localities where recent ornithological surveys have found new species and therefore future fieldwork in these areas might still reveal undescribed taxa.

206. THE EFFECTIVENESS OF THE GLOBAL PROTECTED AREA NETWORK IN CAPTURING BIRD GEOGRAPHIC RANGES

CANTU-SALAZAR, LISETTE, Kevin J. Gaston

The importance of protected areas for in situ conservation of biodiversity is widely recognized. However, the effectiveness of such areas in this regard, remains much debated. We present the first analyses of the representation of the geographic ranges of all known, individual bird species within the current global protected area network. We used a database of distribution maps for 9661 extant, recognized bird species, which were overlaid on two protected area maps constructed using the 2005 World Database on Protected Areas to determine the proportion of each species' range protected. The first map included all protected areas with complete information in the database, and the second map only included those areas with IUCN management classifications I to IV. As predicted, a low proportion of the breeding geographic ranges of the majority of bird species occur within protected areas. Peaks in the numbers of species with poor coverage of their geographic ranges include several biodiversity hotspots. Our results clearly indicate that the geographic ranges of most bird species are not yet widely covered by the protected area network, especially for threatened and rare species.

207. CREATING A PROTECTED AREA IN MADAGASCAR: THE CASE OF BONGOLAVA CORRIDOR

ADRIANARISATA, MICHELE, Luciano Andriamaro, Rollande Finoana, Harison Rabarison, Harison Randrianasolo, Zo Lalaina Rakotobe

Madagascar committed to tripling the surface of protected areas during the World Parks Congress in Durban in 2003. Among high priority sites is the Bongolava corridor. We describe the process followed for creation of the Bongolava protected area. In addition to courtesy visits, biological inventory and socio-economic analysis were conducted by Conservation International/ Madagascar and its partners to evaluate the importance of the creation of Bongolava protected area. A local association called " Fikambanan'i Bongolava Maintso" was created to do a campaign for public awareness on protected areas. We then mapped land occupation with local participation to establish the Bongolava zoning and management plan. Results such as biodiversity richness and proposed zoning were shared with local authorities before asking for approval from the Ministry of Environment, Water and Forests for temporary protection of Bongolava. Findings show that this corridor of dry forest with *Dalbergia*, *Commiphora* and *Hildegardia* is characterized by its species richness and high rate of species endemism. Temporary zoning for conservation and development actions are defined. The corridor provide also an important ecological services. The conservation zone is composed of 506 plant species, 79,48% of which are endemic to Madagascar.

Bongolava is also home to some threatened fauna species such as *Erymnochelys madagascariensis* (Critically Endangered) and the Madagascar Pygargue (*Haliaeetus vociferoides*) (Critically Endangered). Recently, new lemur species called *Microcebus bongolavensis* was found in this corridor. In September 2006, Bongolava was granted temporary protected status. Next steps include finalizing the official zoning and establishing the management structure to implement the participatory management plan.

208. THE OPPORTUNITY COST OF CONSERVING AMPHIBIANS AND MAMMALS IN UGANDA

CHIOZZA, FEDERICA, Carlo Rondinini, Luigi Boitani

Over the past 25 years, the area of land under legal protection has increased substantially, covering 12% of the planet's terrestrial surface. Protected areas impose significant opportunity costs on local communities, particularly in developing countries, where livelihood depends strictly on land use and agricultural activities. Incorporating socio-economic data into area-selection methods may reduce many existing conflicts between local people and biodiversity conservation issues. We present a systematic reserve selection for 353 Ugandan mammals and amphibians using habitat suitability models as estimates of the area occupied by each species. We incorporated cost of land based on data on profit from agriculture and livestock production. In addition to existing protected areas, approximately 34,300 km² of land is irreplaceable to achieve the protection target for amphibians and mammals. The overall opportunity cost of conserving these priority sites amount approximately to 370 million US\$ (2005 value), corresponding to US\$ 10,792 per km². The majority, located in the Western and Eastern regions and overlapping with the Eastern Afromontane hotspot and the Albertine Rift, hold high rural population density. Even if we explicitly accounted for socio-economic factors in the conservation plan, we could not remove conflicts entirely. This underlines the importance of designing conservation areas integrated into the landscape and supporting local lives and livelihoods.

209. RESEAU DE LA BIODIVERSITE DE MADAGASCAR (REBIOMA): DESIGNING A NEW PROTECTED AREA NETWORK

RAZAFIMPAHANANA, ANDRIAMANDIMBISOA, Andry Rakotomanjaka, Alison Cameron

At the fifth World Parks Congress, in September 2003, in Durban South Africa, the President of Madagascar stated his intention to triple the existing protected area network of Madagascar to ~6 million hectares. The aim is to maximize biodiversity conservation, but the critical issue is to take into account different land use constraints in order to allow for socio-economic development. Previously we used modeled species distributions (from Maxent, GARP, and DOMAIN) to assess biodiversity conservation priorities, using the conservation planning software Marxan. Now we have refined our conservation planning analysis using Marxan, Zonation, and GIS tools to produce a map showing potential zones for conservation. This map has been annexed to the decree inter ministerial Mines and Forests to demonstrate to the mining resource administrators the zones of importance for Biodiversity. Further to this we now also explore methods for zoning individual protected areas.

210. CONSERVATION PLANNING IN CANADIAN GRASSLANDS: INTEGRATING FOCAL SPECIES RESPONSES TO GAS DEVELOPMENT AND GRAZING INTO SITE SELECTION

BJORK, ROBIN, Scott Nielsen, Reed Noss, Ken Vance-Borland

The Great Sand Hills of Saskatchewan, Canada, a 2000 km² native remnant of grasslands, shrublands, wetlands, and active sand dunes, provides refuge to many rare species but is threatened by increasing natural gas development and livestock grazing. We assessed local biodiversity conditions and identified areas of conservation priority as part of a Regional Environmental Study which also included social and economic assessments. Our methods integrated results of field research, imagery analysis, and predictive spatial modeling using conservation planning software. We used a case-control field sampling design to measure effects of three surface disturbances—gas well pad sites, livestock watering holes, and roads—on probability of occurrence of focal species and range health condition. Spatial predictions of species occurrence and range health condition provided the primary inputs to a site-selection algorithm (MARXAN) to develop scenarios that met quantitative targets and generated spatially-explicit gradients of biodiversity value. Twenty-four sites covering 19% of the study area (373 km²) were proposed for conservation, a

potential doubling of protected area. Sites were prioritized for conservation action according to biodiversity value and opportunity costs. Implementation strategies were considered from the outset of the project within a framework that gives due consideration to social, cultural, and economic values.

211. SENSITIVITY OF CONSERVATION PORTFOLIOS TO THE INCLUSION OF HABITAT FRAGMENTATION IN A SYSTEMATIC CONSERVATION ASSESSMENT VISCANTI, PIERO

Persistence of biodiversity features is one of the main objectives of reserve systems. One of the ways to include persistence of biodiversity features in a Systematic Conservation Assessment (SCA) is to consider habitat fragmentation while evaluating the contribution of each Planning Unit (PU) to a conservation goal. To evaluate the sensitiveness of a SCA to the simulation of habitat fragmentation and single out the PUs more likely to be affected I compared two different conservation portfolios, each one based on an habitat suitability map for small steppe's passerines. "S1" map consider only the landcover, "S2" introduce a buffer of non-habitat along the main roads. The portfolios were assembled using MARXAN, (20 runs) the more efficient one was chosen. The efficiency of the portfolios drops of the 8% from S1 to S2. The 77,6 % of PU's are common to both portfolios. The differences in the conservation score of a PU (n° of portfolios out of 20 that contain that PU) between the two maps is 609 PUs (16,5% of the total). Most of the differences map out of the road's buffers. The result is due to the sensitiveness of the irreplaceability value of a PU to the amount of biodiversity feature available in the rest of the planning region. This results suggest that predicting the effect of the fragmentation on a SCA is not straightforward and overestimation of efficiency of a portfolio can be significant if we don't consider it.

212. HAS THE EXPANSION OF SOUTH AFRICAN NATIONAL PARKS RESULTED IN AN EFFICIENT RESERVE NETWORK OR NOT? KNIGHT, MICHAEL, Stephen Holness, Peter Bradshaw

Since South African National Parks (SANParks) was establishment in the 1920's, a total of 22 national parks have been proclaimed, conserving a total of 3.6 million hectares in all nine of the country's biomes. The reasons for establishing these parks have changed over time. Initially park establishment was driven by political and species conservation paradigms, later a greater ecological focus was applied, and now a more systematic conservation approach is followed. In order to meet its international obligations, South Africa has set an initial national target of 8% of its land surface and 20% of its marine areas to be conserved within protected areas by 2010. The last ten years has witnessed the conservation of a further 500 000 ha and proclamation of five new national parks. However, has this increase in conservation lands seen a reciprocal increase in ecological representativity over time or not? We examine the change in representativity and efficiency with time. Challenges to emerge from the expansion programme are proving the efficiency of the reserve network in the light of distorted conservation legacies and balancing the need to create an efficient and representative network of parks with other social and economic constraints.

213. MOIST TROPICAL FOREST PROTECTED AREAS: A GLOBAL PERSPECTIVE JOPPA, LUCAS, Scott Loarie, Stuart Pimm

Protected areas play an important role in preserving global biodiversity. As such, we need to understand what threats these areas face and how differing designations and geographic locations affect the impact of these areas on the landscape. Here we present a global analysis of the status of all protected areas in moist tropical forests. Using the World Database of Protected Areas, the Global Land Cover 2000 database and the European Space Agency's ATSR World Fire Atlas, we analyzed land cover and fire occurrence inside and outside of protected areas. All protected areas of similar IUCN categories were grouped. We found that both human-modified land cover and fire occurrence change significantly with protected area categories and geographic locations. Additionally, the two variables show similar trends. These results provide important insights into what vegetation types are being protected and how protected area boundaries influence land use. An understanding of these issues is necessary to achieve success in protected area design and management.

214. CORRELATION PATTERNS OF SPECIES RICHNESS AND LOCAL RARITY AT A REGIONAL SCALE: IMPLICATIONS FOR PROTECTED AREA DESIGNATION

HENDERSON, ANN, Michelle Lee, George Angher, Major Boddicker, Marius Burger, Patrick Campbell, Sally Lahm, William McShae, Carrie O'Brien, Olivier S.G. Pauwels, Francisco Dallmeier, Alfonso Alonso, James Comiskey, Javier Icochea, Sergio Solari

Species richness and rarity are often used as ecological criteria for conservation planning, as in using richness hotspots for reserve selection. Since collecting adequate data on the richness and distribution of multiple taxa is usually infeasible, decisions are often based on proxies of biodiversity, often taxonomic subsets. While studies at a global scale have revealed that taxa subsets can correlate to overall biodiversity, there are insufficient data on correlation at a regional scale, which is often the scale at which conservation decisions are made. Here we use detailed, regional-level data of species richness for trees, small and large mammals, birds, amphibians and reptiles from two understudied tropical regional areas in Africa and South America to assess correlation of richness and rarity among multiple taxa. Our data indicates that some taxa subsets may show potential in indicating for overall biodiversity. Proxies of biodiversity richness and rarity can inform conservation planning, especially in tropical areas, where limited resources for biodiversity assessment have led to a paucity of data.

215. OPTIMISING CHOICES IN OFF-RESERVE MANAGEMENT USING THE MARZONE SOFTWARE

WATTS, MATTHEW, Carissa Joy Klein, Charles Steinback, Romola Stewart, Ian Ball, Hugh Possingham

Marxan is the world's most utilized tool in terrestrial, marine and coastal reserve design (Ball and Possingham 2000). It allows planning units of a region to be reserved or not reserved and to have a single fixed cost. MarZone expands this capability by allowing planning units to exist in the spectrum between reserved and not reserved, and take on a matrix of costs, more closely modeling real world zoning exercises. We have modified Marxan to incorporate these new capabilities, dealing with greater social and economic complexity and reality in natural resource management planning. Natural resource managers face decisions characterised by multiple objectives, multiple stakeholders, and conflicting objectives. We show how to avoid the juxtaposition of conflicting land/sea-uses by maximizing the achievement of biodiversity objectives and minimizing the disruption to resource uses and management costs using MarZone. We illustrate this method with case studies, showing how it can be applied to management decisions in terrestrial, marine and coastal regions across the globe.

216. AN OFFSHORE CLASSIFICATION FOR BIODIVERSITY CONSERVATION PLANNING ON THE EAST COAST OF SOUTHERN AFRICA

LIVINGSTON, TAMSYN, Jean Harris, D Schoeman, Cloverley Lawrence

The waters of the east coast of the South Africa are shaped by the interplay of the strong southward flowing Agulhas and Madagascar currents, which generate marked temperature differentials and strong gyres and upwelling cells, the influence of which are modified by a strong inshore river inflow influence from 64 estuaries and a seafloor incised by deep canyons. Much research has been done on near-shore systems, whereas the offshore biodiversity is largely unexplored. This is reflected in the level of protection: existing marine protected areas along the coast of the province of KwaZulu-Natal are limited to sensitive inshore areas of special interest (i.e. coral reefs) while offshore biodiversity is afforded zero formal protection. In this study geophysical mapping, coupled with remote-sensing biophysical data, is used to classify the offshore environment according to benthic-pelagic "profiles", and thus to map areas of similarity. Data at a scale of 1x1km from satellite imagery of sea surface temperature, chlorophyll and turbidity are combined with a comprehensive bathymetry layer, sediment data and reef density data in a multivariate analysis. These have generated offshore environmental domains, an ecosystem classification system, being applied and tested for systematic conservation planning.

217. "COMING, READY OR NOT!" – CONSERVATION MANAGERS' READINESS TO RESPOND TO THE THREAT OF WILD TIGER POACHING WADMORE, ALISON

A 2004 media survey of over 50,000 respondents in 73 countries selected the tiger as the favourite animal. Despite widespread popularity and a considerable amount of conservation attention and funding, this flagship species is in deep trouble in its natural habitat. Of three key threats: habitat loss, prey depletion and commercially organised poaching, the last is the most immediate due to potential rate of decimation. This study investigates tiger poaching from a socio-economic perspective, to complement existing ecological research, and examines the readiness of conservation managers to respond. Local community involvement is of particular interest, where attitudes may range from poacher to protector. The aim is to provide an ongoing threat alleviation tool by defining a poaching risk assessment and mitigation framework, based on analysis using a Bayesian decision network to model key influencing factors, enabling sensitivity analysis to identify optimal choices. Data collection is underway to populate nodal probabilities. Both quantitative and qualitative data sources are sought to build an evidence based model that a) identifies incentives and deterrents motivating behaviour in poaching scenarios; b) studies the effectiveness of management approaches in tiger protection and law enforcement. Adopting this risk management method is a crucial component to holistically inform strategies and policies in tiger conservation, thereby improving the return on future investment.

218. TRANSFRONTIER CONSERVATION PLANNING IN THE MAPUTALAND CENTRE OF ENDEMISM, SOUTHERN AFRICA NHANCALE, BRUNO, Robert Smith, Linda Dobson, Peter Goodman, Wayne Matthews, Ara Monadjem, Cornelio Ntumi, Nigel Leader-Williams

The Maputaland centre of endemism is an area of 17,000 km² that falls within Mozambique, South Africa and Swaziland. The conservation value of this region is globally recognised but its biodiversity is threatened by an expansion of commercial and subsistence agriculture and the over-harvesting of natural resources. In response, a number of institutions are helping to establish state, private and communally managed protected areas, ecotourism ventures and game reserves (PAs), based around a Transfrontier Conservation Area concept. These projects need to fit within an integrated planning framework so, together with our project partners, we have developed the Maputaland systematic conservation planning system. This system includes distribution and representation target data for 110 conservation features, consisting of 44 landcover types, 53 species and 13 ecological processes. It can be used to identify where new conservation areas should be established and, by incorporating data on agricultural transformation threat, also minimises conflicts with the agricultural sector. Our initial assessment found that the present PA system meets targets for 48% of the conservation features and identified that an extra 5,000 km² of land is needed to ensure that all these features are effectively conserved.

Recovery of endangered species

219. RECOVERY OF THE MAURITIUS PINK PIGEON *COLUMBA MAYERI*: AFTER TWO DECADES, WHAT HAVE WE LEARNT? SWINNERTON, KIRSTY, Carl Jones, Yousoof Mungroo, Nancy Bunbury, Shivananden Sawmy

In 1987, the Mauritius Pink Pigeon was Critically Endangered with 10-15 individuals existing in the wild. As a result of an intensive recovery and conservation program, the species was down-listed to Endangered in 2001 and the wild population is currently estimated at 350 birds. The recovery program comprised captive-breeding, reintroduction and translocations, habitat protection and restoration, and intensive management of wild populations including supplemental feeding, nest protection, predator control, and disease management. Equally important has been the implementation of a long-term population monitoring program to evaluate the species' response to management, the overall success of the recovery program, and to understand the dynamics of reintroduced and wild populations in order to develop long-term conservation strategies. Factors that limit both reintroduced and wild populations include seasonal food shortages, predation by introduced mammals, avian disease and inbreeding effects. In addition to the species' conservation management, input from a wide range of international expertise and consistency of support from local and international partners have also contributed significantly to the program's success.

220. ANALYSIS OF CRITICAL MARINE FORAGING HABITATS OF MARBLED MURRELETS IN PACIFIC RIM NATIONAL PARK RESERVE OF CANADA
Robinson, Cliff, PIPPA SHEPHERD, Trevor Haynes, Karin Bodtke

The Marbled Murrelet (*Brachyramphus marmoratus*) is a small seabird that nests primarily in coastal old-growth forests and forages in nearshore marine waters. It occurs from southern Alaska to California and is listed as a Threatened under both Canada's Species at Risk Act and the US Endangered Species Act (WA, OR and CA populations only). Marbled Murrelets (MAMU) are threatened by extensive logging in their breeding habitats and by fisheries by-catch, oil spills, and prey species impacts in their foraging habitats. We undertook a study to identify critical foraging habitat for MAMU in Pacific Rim National Park Reserve along the coast of British Columbia. We collected 4 years of data (2003-2006) on: 1) MAMU distribution and abundance, 2) distribution and abundance of two major MAMU prey fishes: the Pacific sand lance (*Ammodytes hexapterus*) and the Pacific herring (*Clupea pallasii*), and 3) oceanographic and nearshore habitat characteristics. While overall MAMU abundances varied among years, we found consistent spatial patterns (hot spots) of MAMU abundance within the study area. Preliminary logistic models showed that slope and complexity of the sea bottom, tidal velocity, and stratification of surface waters are significant predictors of MAMU presence. We are building and comparing several alternative models of MAMU foraging habitat based on these predictors and forage fish data. Results will inform park managers and recovery planners.

221. RELAXING OUR DEFINITION OF SUITABLE HABITAT FOR AN EXTREME HABITAT SPECIALIST, THE FLORIDA SCRUB-JAY (*APHELOCOMA COERULESCENS*)
DAVISON, MARITA, John Fitzpatrick, Glen Woolfenden

The challenge of protecting habitat for imperiled species amidst continuing, excessive habitat alteration constrains our definition of suitable habitat. Certain endangered species persist on modified habitat, especially where their native habitat is largely destroyed. I examined reproductive success, habitat selection, and foraging efficiency of Florida Scrub-Jays (*Aphelocoma coerulescens*, hereafter FSJs) along an interface of modified and native habitat. Over a 19-year period, FSJs were equally successful at producing young in regenerating pasture (modified habitat) and native scrub. Production of fledglings and yearlings were not statistically different between pasture and scrub, but consistently trended higher in pasture. Focal individuals selected for pasture in their overall daily activities, and foraged equally frequently in both habitat types. Foraging efficiency of focal individuals was significantly higher for small prey items in pasture. Alteration of native FSJ habitat is ongoing; thus, a key step for FSJ conservation is to determine the set of habitat features suitable for sustaining viable populations in an increasingly modified landscape. These results suggest that regenerating pasture can provide suitable habitat for FSJs, at least when situated near reservoirs of native scrub. Definitions of suitable habitat for this narrowly habitat-limited species should therefore be expanded to include areas of old pasture containing regenerating oak shrubs.

222. ATTITUDES AND PERCEPTIONS OF LOCAL COMMUNITIES TOWARDS THE TRANSLOCATION OF BLACK RHINO (*DICEROS BICORNIS BICORNIS*) IN NORTHWEST NAMIBIA
URI-KHOB, SIMSON, Jeff Muntifer, Michael Hearn

Namibia retains nearly one third of the world's remaining black rhinos (*Diceros bicornis*), including the unique desert-adapted subspecies *Diceros bicornis bicornis*. Recovery from rampant poaching in the 1970s and 80s has been steady but slow with growth rates in core breeding areas recently becoming stagnant. Thus, translocation has been proposed to assist recolonization within the historical range hopefully catalyzing growth rates while expanding community-based rhino tourism incentives in the region. Community attitudes and perceptions towards black rhinos in five communal conservancies within the Kunene region were assessed to evaluate community support. Overall, a high proportion of respondents in all communities were found to be positive towards the translocation of rhino. Positive attitudes tended to be associated with education, households that profit from the conservancy benefit sharing strategy or work in the tourism industry. Households that did not receive any benefits from wildlife, and incur only losses to livestock and crops from wildlife due to elephants and predators characterized negative respondents. These findings suggest that a successful black rhino translocation initiative must involve tangible benefits being

directed towards local households. This re-enforces the important role incentive-driven conservation strategies play for increasing household-level conservation values and conflict tolerance in rural communities in northwest Namibia.

223. CHARACTERISING AND PREDICTING RHINO DISTURBANCE: UTILITY OF APPLYING A NOVEL MODELLING APPROACH TO INFORM NON-INVASIVE RHINO TOURISM POLICY IN NAMIBIA

MUNTIFERING, JEFF R., Kapoi Kasona, Michael Sibatani, Michael Hearn

Tourism is one of the fastest growing global economic sectors, with nature-based tourism comprising a majority of that sector. Namibia has pioneered community-based conservation strategies that include nature-based tourism. Palmwag Rhino Camp, Kunene Region, is providing tourists with a unique rhino tracking safari on foot while the accruing tourism income creates local jobs while supporting monitoring costs for an endangered species, the desert-adapted black rhino (*Diceros bicornis bicornis*). However, irresponsible viewing practices may threaten the sustainability of the operation. A statistical modeling approach was employed to (1) identify viewing variables that significantly characterized black rhino disturbance events and (2) provide predictive models under various viewing scenarios to inform a science-based viewing policy. Viewing variables and associated rhino disturbance levels were captured during forty-three independent rhino viewing events. A logistic regression model identified rhino initial behaviour, approach distance and viewing time as significant disturbance predictor variables. The predictive model was validated by correctly classifying 70% (9 of 13) of subsequent independent viewing events. The model may be employed to project viewing guidelines under targeted disturbance probabilities levels. The approach shows promise for providing a science-based foundation to inform non-invasive black rhino tourism viewing policy in northwestern Namibia.

224. LINKING RESOURCE SELECTION FUNCTION MODELS AND POPULATION PARAMETERS TO IDENTIFY BLACK RHINO CORE BREEDING AND PRIORITY RECOVERY SITES

MUNTIFERING, JEFF, Basilia Shivute, Rick Tingey, Michael Hearn

The recovery of the largest unprotected free-ranging population of black rhino (*Diceros bicornis bicornis*), located in Namibia's arid northwest Kunene region, currently lies idle due to frustrated recolonization and a stagnant growth rate. Moreover, uninformed development in the current range may threaten this population's security and survival. Biological management (translocation) of this subpopulation has been proposed to assist recolonization within the historical range, to catalyze growth rates in core breeding areas, and to expand community-based rhino tourism in the region. We used GIS-based resource selection function (RSF) models to characterize suitable black rhino habitat and predict priority rhino conservation areas and translocation sites within the region. Using visual observations of breeding females between 2000 – 2005 from systematic patrols, RSF models predicted that breeding areas were more likely to occur nearer to perennial springs and major riverbeds, at higher elevation and gentler slopes. Extrapolating the model correctly classified 77% of black rhino locations within predicted suitable sites. Strong correlations existed between spatially-explicit cumulative RSF values and estimated rhino density and fecundity. Our findings suggest that a GIS-based RSF modeling approach is a promising tool for establishing a science-based foundation to inform black rhino management and development strategies in northwest Namibia.

225. USING EXPERIMENTAL REINTRODUCTIONS TO RESOLVE THE ROLES OF HABITAT QUALITY AND METAPOPOPULATION DYNAMICS IN DECLINES OF SPECIES IN FRAGMENTED LANDSCAPES

ARMSTRONG, DOUG, Nikki McArthur, Kate Morgan, Susanne Govella, Yvan Richard

If metapopulation dynamics are thought to account for a species being absent from patches of habitat, the obvious acid test is to reintroduce the species to those patches. Successful reintroduction would seem to corroborate the "metapopulation dynamics hypothesis", whereas failed reintroduction attempts would imply that the species' absence was actually due to poor habitat quality. However, for such experiments to be informative we believe that: (1) there need to be reintroductions to enough patches to allow for random variation, and (2) sufficient data are needed to assess whether vital rates are similar for previously-unoccupied and previously-occupied populations, and to test whether immigration is lower for isolated patches. We have now reintroduced New Zealand robins to 12 unoccupied forest patches that we estimated

to have suitable habitat, and results to date have been mixed. We successfully established robins in most patches, and reproductive success has been slightly higher in previously-unoccupied patches, supporting the metapopulation dynamics hypothesis. However, some patches have had high post-release dispersal (implying they were not empty due to isolation), and our initial survival data in new patches suggests it may be lower than in previously-occupied patches, supporting the "habitat quality" hypothesis.

226. ECOLOGICAL CONDITION AND CONSERVATION STATUS OF *TAXUS BACCATA* L IN AN AUSTRIAN GENE CONSERVATION FOREST

DHAR, AMALESH, Herwig Ruprech, Raphael-Thomas Klumpp, Harald Vacik

English yew (*Taxus baccata* L.) is a slow growing, evergreen, dioecious and wind pollinated conifer tree species in temperate forests. Now a day it has been catalogued as an endangered and prone to extinction in Austria as well as many other parts of Europe. We examined the distribution and population dynamics of English Yews based on the natural population in an Austrian gene conservation forest. The investigated area is Beech dominated mixed forest that consisted of 15 different tree species. The estimated density of the Yew in the study plot was 492 individuals / ha (DBH 5 or >5 cm). The sex ratio of the Yew population was female biased and the average seed weight was 63.92 g. The health condition was relatively good. The yew population was sensitive to herbivore browsing and light competition, and slow to recover from disturbance. Yew attained a medium basal area (12 %) on this site. Conservation of Yew at a forest level may require well-managed reserves and long-term rotations between harvest events. Protection from the herbivore and reduction of competition are key factors to enhance the long-term viability of the species.

227. INCREASING INBREEDING RESULTS IN DECLINING SEMINAL QUALITY, PREGNANCY SUCCESS AND LITTER SIZE IN THE ENDANGERED BLACK-FOOTED FERRET, *MUSTELA NIGRIPES*

SANTYMIRE, RACHEL, Eric Lonsdorf, Colleen Lynch, Paul Marinari, Julie Kreeger, David Wildt, JoGayle Howard

Rescued from near extinction with only 18 animals remaining in 1985, the black-footed ferret (BFF) is managed and bred intensively ex situ to provide animals for reintroduction. Data obtained during semen collections for artificial inseminations (AI) have revealed a gradual decline in sperm traits over time that may be a manifestation of inevitable inbreeding depression in a small, closed population. To evaluate, we investigated the effects of inbreeding on sperm traits, pregnancy rate and litter size after AI. Ejaculates (n = 53) from 31 pedigreed males with various inbreeding coefficients (0.023 to 0.195) revealed a wide range in sperm motility (SM; 35 to 80%), sperm forward progression (FP; scale 0 – 5; 5 = best; 2.0 to 3.5), sperm concentration (SC; 5 to 100 x10⁶/ml), normal sperm (NS; 0 to 78%) and normal acrosomes (NA; 4 to 100%). Using backwards stepwise regression, we determined that of all sperm traits, FP, SC and NS were each significantly correlated to pregnancy success (P₂ = 0.3509; P₂ = 0.17; P = 0.011). In conclusion, increased inbreeding over time is associated with declining seminal quality, which may have profound effects on female reproductive success and the future of BFFs.

228. THE DUGONG IN EASTERN AFRICA: BALANCING ON THE BRINK OF EXTINCTION

Muir, Catharine, JEREMY KISZKA

Dugongs (*Dugong dugon*) are threatened throughout their range. In eastern Africa, historical data indicate that dugongs were relatively common in the past but their numbers are now severely depleted. A dugong assessment was conducted in the region in 2004/5 through literature reviews, interview surveys and opportunistic sightings. Results indicate that dugongs still occur, but populations are small, isolated from one another and may not be viable. The main contemporary threats are entanglement in inshore artisanal gillnets, seagrass destruction, disturbance by boat traffic and inadequate law enforcement. Several dugong initiatives have since been undertaken including aerial surveys in Mozambique, Tanzania and Mayotte and interview surveys in the Comoros archipelago. A regional dugong Memorandum of Understanding on their conservation has also been drawn up and a workshop convened on ways to mitigate the threat to endangered marine species, including dugongs, from incidental catches. Recommendations from these initiatives include: restricting threatening fishing gears in dugong habitat and providing alternative livelihoods; public awareness campaigns; population and habitat assessments; training in research and conservation techniques; and establishing community-managed dugong sanctuaries. Regional cooperation

is imperative to coordinate efforts and target resources, and several projects are now under consideration to contribute to the recovery of dugongs in eastern Africa.

229. USING NON-INVASIVE HORMONE MONITORING TO EVALUATE SUCCESS OF AFRICAN WILD DOG REINTRODUCTIONS IN SOUTH AFRICA

GUNTHER, MICAELA SZYKMAN, Steven Monfort, David Wildt

The endangered African wild dog has been extirpated from much of its historical range, and fewer than 5,000 free-living individuals remain. Our research has three principal objectives: 1) study reintroduced wild dog groups throughout the reintroduction process to better understand the factors that influence individual and pack health, stress, reproductive success and survival; 2) develop an improved understanding of ecosystem features necessary for supporting self-sustaining populations of wild dogs; and 3) to create a second viable population of wild dogs in South Africa. Non-invasive hormone monitoring via fecal sample collection is a great conservation tool for monitoring the health of wildlife populations as it does not disturb study animals and provides repeated measures for individuals over long periods of time. Analysis of several hundred samples from over 50 known wild dog individuals indicate that alpha members of the pack respond differently to social and environmental stressors than do their related offspring, and most individuals are able to recover from these stressors in a relatively short period of time. Overall, we believe that a combination of noninvasive monitoring techniques, conventional field methods and international collaborations can improve the understanding of population ecology and ultimately advance the conservation of populations and ecosystems.

230. POPULATION AND RECOVERY OF AND MANAGEMENT OF A CRITICALLY ENDANGERED PLANT *KNIPHOPHIA LEUCOCEPHALA*

CHURCH, BRIGITTE, Peter Goodman

Kniphofia leucocephala is a critically endangered plant species with only one known extant population occurring in a wetland of 13 ha in extent. The wetland is a bottomland remnant of Maputaland Coastal Grassland which has been widely transformed by alien plantations. The recovery management activities commenced when the known number of flowering individuals in the wild did not exceed 24. A comprehensive target based recovery plan which included onsite management of fire, grazing, hydrological processes, ex situ propagation and trial population establishment was developed and successfully implemented in cooperation with local land management authority. The number of reproductive individuals in the population increased by at least 160% since the intervention began. Two attempts at establishing new populations at potentially suitable sites have been made yielding inconclusive outcomes. Future challenges for the complete recovery and delisting of *K. leucocephala* are: 1. an improved understanding of the reproductive and dispersal biology of the plant; 2. the availability of suitable wetlands within the species' former range for the establishment of supplementary populations; and 3. a continued collaborative partnership between conservation authorities and land managers.

231. SAVING THE JAMAICAN IGUANA, A COLLABORATIVE APPROACH

ROBINSON, ORLANDO

Considered by many to be one of the most endangered rock iguanas in the world, The Jamaican Iguana has been slowly clawing its way back. The animal actually thought to be extinct from as far back as 1948, when the last known captive specimens died, was given a second chance when local herpetologists rediscovered it in 1990. Since then the conservation world has taken the fate of the species very seriously and the combined strength of local conservation groups and international organizations has seen the commitment of over fifteen years of conservation efforts. Collectively, they have gathered empirical data on the lizards current distribution and conservation threats and have approached the task with a multifaceted strategy of headstarting, public education and political lobbying. Successes have seen the first captive breeding after 14 years, repatriation and integration of headstarted females and protection of its natural habitat

**232. IMPLEMENTING VICUNA CONSERVATION IN THE FACE OF TRADE
LIBERALIZATION: STATE, COMMUNITY, AND MARKET RELATIONS IN APURIMAC,
PERU**
MAXWELL, KEELY

In Peru's Apurimac Region, vicuna *Vicugna vicugna* share marginal puna ecosystems with politically and economically marginalized rural communities. Both human and camelid populations are recovering—the former from years of Shining Path and military violence; the latter from overpoaching for its valuable fiber. In 1993, the Peruvian government granted usufruct rights over this endangered species to select rural communities, which were to keep the animals in 1000ha corrals and use an Inca technique to sustainably harvest vicuna fiber. Since 1994, CITES has allowed international fiber trade under strict government supervision. Peru heralds this collaborative state-community management and subsequent vicuna population increase as a success. However, community benefits and species recovery have been limited. Based upon ethnographic fieldwork, I analyze the dynamics of state-community relations to determine what underlying social & political factors have allowed this partnership to work yet also hindered its accomplishments. I examine state-community negotiations over territorial authority, wildlife management techniques, the distribution of conservation costs and benefits, and market access and pricing. An added twist is a recent policy that liberalizes the fiber trade. This policy may transform vicuna from wildlife to commodity and brings consequences for the species' status, property rights, state-community relations, and community development.

Societal-driven conservation

**233. NATURE CONSERVATION AND ECOTOURISM IN THE KWANIBELA
PENINSULA ADJACENT TO THE ST. LUCIA WORLD HERITAGE SITE, KWAZULU-
NATAL, SOUTH AFRICA**
DELCROS, GWENAELLE, François Durand

The St-Lucia System in KwaZulu-Natal is the largest estuarine system on the African continent and forms a critical habitat for several species and communities. Approximately 15 000 people live on the KwaNibela Peninsula bordering the St. Lucia Wetlands World Heritage Site. KwaNibela contains large stands of indigenous sand forest. The forest habitat is threatened by slash-and-burn clearing for dwellings and subsistence agriculture. This study shows that exotic plant species aggressively invade the disturbed areas and that the ecology is further encroached upon by the introduction of cattle and goats. Poaching in the sand forest and adjacent World Heritage Site is a common phenomenon and has contributed greatly to the near-complete eradication of large game in KwaNibela. In order to conserve not only the sand forest habitat, but also the surrounding World Heritage Site, it is necessary to implement a viable management plan which will give the tribal community an alternative source of sustenance that would benefit from the surrounding habitat while conserving it. The local community is involved in the conservation of the area by means of consultation and education. Several local ecotourism guides have been trained and environmental education programme will be

**234. LOCAL COMMUNITY PARTICIPATION IN FOREST MANAGEMENT AT KIKUYU
ESCARPMENT FOREST IN KENYA: VITAL LESSONS LEARNT**
KARIARA, JULIUS

Recent years have witnessed acceptance of the necessity of adoption of participatory forest management in Kenya for conservation purposes. The current Kenyan forest law and policy reflects participatory forest management through negotiated agreements. The Kijabe Environment Volunteers (KENVO), a model project established by the Kikuyu Escarpment community in 1996 adopted participatory forest management in the region. The paper presents the major lessons learnt from the participatory forest management project from practical field experiences spanning 6 years in Kikuyu Escarpment forest by examining the actual situations and events on the ground and drawing conclusions that can be replicated/transferred elsewhere in Kenya and East and Central African region. The paper reviews the project experiences from materials gathered, reviews, community forums, and documented cases in the region. Vital lessons on conflict resolution, stakeholder's involvement, trust building, communication, long and short-term interests, capacity building and legal frameworks have been learned. For better stewardship of the process the lessons learnt

will be useful to Participatory forest management practitioners in East and Central Africa and other areas starting or embarking on the process.

235. SEA TURTLE CONSERVATION IN KENYA: A COMMUNITY BASED APPROACH WAMUKOTA, ANDREW

A PRA process was implemented between November 2003 and December 2004 to enhance local community's participation in the conservation and management of turtles and their habitats in Kenya. The project carried out among 23 communities along the 600km long Kenyan Coastline sought to collect information on the status of marine resources and draw a roadmap for community based conservation. Data collection employed transect walks, resource mapping, seasonal calendars, time lines and trend lines. Data was analyzed through ranking, scoring and descriptively. The exercise resulted in a community action plan (CAP) for the conservation and management of sea turtles and their habitats. The CAP was based on contributions and analysis by various social actors. Marine fisheries were cited as the basis of livelihood and also the most immediate threat to sea turtles in Kenya. Sea turtle populations were shown to have declined in six sites by between 25-75% due to habitat degradation occasioned by destructive methods of fishing, demand for trade and consumption of marine turtle products as well as growth of coastal population and tourism. Recommendations include provision of quality environmental leadership, enhanced institutional capacity, establishment of more community based conservation groups and facilitation to encourage alternative means of livelihood.

236. CONSERVATION JUSTICE IN METROPOLITAN CAPE TOWN, SOUTH AFRICA: A CASE STUDY OF THE MACASSAR DUNES IN THE CAPE FLATS FERKETIC, JEFFREY, John Silander, Andrew Latimer

Conservation justice aims to devise sustainable conservation methods that yield tangible benefits for indigenous and underdeveloped communities. Given its location in the impoverished Cape Flats region of Cape Town and its unique ecological value, the Macassar Dunes Conservation Area warrants a conservation justice approach. Here, we compare the attitudes towards conservation of the following four key stakeholder groups of the Macassar Dunes: paid professional conservators, unpaid volunteer conservators, and residents from two different impoverished communities living near the conservation area. The interests of each stakeholder group were assessed by individual structured interviews focusing on conservation projects in the region. The data culled from these interviews suggest that despite disparity among groups in needs and perspectives, there is great potential for conservation projects to deliver tangible benefits to all stakeholder groups. A belief in conservation is universal across stakeholder lines. But contrasting needs and perspectives of the four groups lead to conflicting views on specific issues such as the erection of fences, the appropriateness of commercial development, the sustainability of the conservation projects, and the benefits for impoverished communities. An understanding of different stakeholder groups' specific needs and interests is thus essential for successful implementation of urban conservation projects.

237. CONSERVATION OF THE GOASO WATERSHEDS IN GHANA, A PARTICIPATORY APPROACH TO SUSTAINABILITY COSMAS, LAMBINI, Kombat Sakab

Watersheds provide the main source of livelihood for most rural communities in the country. As a result, these researches was conducted with the aim of contributing to the knowledge on the status of the watersheds and identify existing strategies, opportunities and constraints to sustainable management of the watersheds in the Goaso Forest District in collaboration with the key stakeholders. Data was obtained using various research methods such as questionnaires, focus group discussions, observations and desk studies. The findings of the team include the following: Two main watersheds were identified in the forest district, namely, the Bia and Tano watersheds. The main human activities that take place are farming, fishing, logging and charcoal production. The quantity and size of fish had reduced. The quantity of the Tano watershed has reduced and the quality (in terms of smell, taste and colour) of the Bia watershed has degraded as compared to some time past. Several watershed management strategies were identified in the district, with the main ones being the maintenance of buffer zones between farms and river, planting of trees around the water bodies and educational programmes for the sensitisation of the community on the need to protect the water bodies. Several recommendations including the under listed were proposed. Education on

management, strengthening of the collaborative management linkages and enactment of specific laws to protect the watersheds.

238. EFFECTS OF DEMOGRAPHIC CHANGES ON NATURAL RESOURCE UTILIZATION AND AVAILABILITY WITHIN THE SOUTHERN RANGELANDS OF KENYA TOME, SALATON

In the rangelands of Kenya, population increase and the introduction of new technologies have altered the traditional usage of natural resources. As it relates to water, these changes have altered how and why it is used, and consequently its effect on population distribution patterns, livelihood strategies, and wildlife conservation. In order to assess the environmental ramification of these demographic changes, the distribution of the population was obtained through GIS mapping of residential structures and their effects were obtained by surveying the local residents using questionnaires. The region is having a higher than average annual population increase which from the maps generated it was evident that there was a substantial clustering around permanent and artificial water sources. While most respondents were Maasai (82%) and mainly practiced pastoralism (88%), the study indicated a recent in-migration of other ethnic groups to the area that predominantly practiced agriculture (73%). These findings suggest that the growing population has been consuming the area's natural resources at an unsustainable rate and that little is being done to reverse this problem. There is also a general lack of appreciation and understanding among residents for the environmental implications of population growth. Education on the effect of demography and effective resource management strategies must be implemented in order to prevent further degradation of natural resources.

Spatial ecology and conservation

239. DIFFERENCES IN MOVEMENT AND AREA USE IN ASIAN ELEPHANTS: A COMPARISON BETWEEN DRY AND DECIDUOUS FOREST ELEPHANTS IN ASIA LEIMGRUBER, PETER, Melissa Songer, Danielle Shanahan, Eric Wikramanayake, Jennifer Pastorini, Prithiviraj Fernando

Sri Lanka is more densely populated and has less remaining habitat than Myanmar. However, Asian elephants (*Elephas maximus*) occur at higher population densities in Sri Lanka's dry forests than in Myanmar's moist deciduous forests. This seems to contradict the general understanding observation that habitat loss is the major cause of Asian elephant declines. Some hypothesize that moist deciduous/evergreen forests provide insufficient food to support high elephant densities. To test this hypothesis, we compared movement data from six GPS-collared elephants, three in Myanmar and three in Sri Lanka. We predicted that elephants in moist deciduous forests have to cover larger areas to satisfy their foraging requirements. We used 95% kernel home ranges to estimate area requirements. Home ranges were small in both forest types, ranging from 20 to 74 km². We found no significant differences in home range size or daily movement between forest types. Habitat type and productivity alone cannot explain differences in elephant densities between the two ecosystems. Other threats such as poaching or capture for working camps, may strongly influence elephant densities. Comparative studies of wild Asian elephant populations across the species' range are essential to improve our understanding and future conservation planning.

240. PREDICTING THE INFLUENCE OF LAND DEVELOPMENT ON BROWN HYENA *PARAHYAENA BRUNNEA* MOVEMENT AND ACTIVITY WIESEL, INGRID

Brown hyenas *Parahyaena brunnea* occur at medium to high densities along the southern Namibian coast. Their coastal home ranges are large (several 100 km²) and they travel 20 to 30 km per night. Carrion and prey are found along beaches and at mainland Cape fur seal *Arctocephalus pusillus pusillus* colonies resulting in localized food distribution. Within the proposed park's management and development plan, the coastal area is defined as a Managed Resource Protected Area (IUCN category 6), allowing the use of the natural resources of this area to meet local and national development needs. The goal of this study was to establish the importance of the coastal area for brown hyenas, to assess the impact of development on hyena movement and activity, and to develop effective mitigation strategies. Six brown hyenas were fitted

with GPS collars in three different coastal areas to monitor their activities, movements and changes in these. Temporal and spatial use of the coastal area was high. However, once land development commenced, individual brown hyena activity was low in construction areas, but high in human settlement areas. An influence on foraging success could not be detected (as seal colonies are excluded from land development). Environmental Management Programmes are therefore adjusted regularly to review disturbance and conflict related issues such as waste disposal strategies.

241. ASSESSING CONSERVATION PRIORITIES OF MEXICAN TROPICAL MONTANE CLOUD FOREST (TMCF) FRAGMENTS USING MICROENDEMIC SPECIES

PONCE-REYE, ROCIO, Robert Pressey, Victor Hugo Reynoso-Rosales

TMCF is one of the world's most vulnerable ecosystems due to its high levels of biodiversity and endemism, its historical natural fragmentation, and its excessive rate of loss from human activities. The main objectives of this project are to evaluate the conservation priorities of different fragments of Mexican TMCF based on microendemic (restricted to very localized areas) and other narrowly distributed species and to propose new conservation areas that will minimize the loss of these species. The focus on microendemic vertebrates and plants will help to understand, not just the fine-scale patterns of spatial turnover in species composition, but also the vicariance processes that generated these species and, presumably, will continue to generate biodiversity. Detailed project design and reconnaissance field work are underway. The presentation will introduce the project, discuss details of project design and methods, and report on preliminary field work. The expected outcomes of this project are: (1) Improved understanding of the patterns of biodiversity in TMCF fragments and the evolutionary processes leading to microendemism; (2) Explicit, tested methods for considering both biodiversity pattern and evolutionary processes in conservation planning; (3) Specific recommendations for conservation of TMCF fragments and generic lessons for other habitats and regions; and (4) Ways of involving a wide variety of stakeholders, in applying effective conservation action on the ground.

242. FLORIDA SCRUB-JAY POPULATION VIABILITY UNDER DIFFERENT SCENARIOS OF HABITAT MANAGEMENT AND LAND ACQUISITION

STITH, BRAD, John Fitzpatrick, Marita Davison

The Florida Scrub-Jay, *Aphelocoma coerulescens*, is a Federally threatened species restricted to patchily distributed Pleistocene sand deposits in the peninsula of Florida, U.S.A. Scrub-Jays are extremely habitat-specific and adapted that frequent fires to maintain open habitat structure. Jay populations have declined drastically in recent decades owing to habitat destruction and fire suppression. We used an individual-based, spatially explicit population model to evaluate the viability of scrub-jay populations in Sarasota County, Florida, under a progression of scenarios ranging from a "status quo" option with limited habitat management, no land acquisition, and no translocation to a "highly optimistic" option with aggressive management, maximum land acquisition, and intensive translocation. For each scenario, we also modeled different dispersal capabilities to reflect uncertainty about movement behavior. Model results showed that the "status quo" scenario resulted in low occupancy rates and unacceptable extinction probabilities. Habitat management on existing preserves was the most important variable, while land acquisition was less important. Translocation was valuable only in 2 subregions where jay populations were nearby in adjacent counties, and only under assumptions of high dispersal ability. We recommend that financial and human resources be directed primarily towards habitat restoration and management on existing preserves.

243. MODIS/NDVI BASED DETECTION OF DROUGHT INDUCED VEGETATION DIE OFF IN WESTERN NORTH AMERICAN ECOSYSTEMS

YUHAS, ANDREW, Louis Scuderi

Vegetation mortality can be attributed to many factors including drought-induced water stress and insect infestations which exploit these stressed trees. Reduction of cover and reduced health are identifiable in remotely-sensed multispectral satellite images. A suite of images from NASA's MODIS sensor was used to calculate change in the Normalized Difference Vegetation Index (NDVI) during the 2000-2006 the North American growing seasons. Fluctuations in NDVI over this period show a significant decline in vegetative health in this temperate region. Historically, dieoff has been reversed through regeneration as climate conditions return to a normal regime. However, recent western North American drought and associated vegetative change do not shown signs that this change is reversible, an indication that the shifts being

observed are long-term, or too severe for recovery to occur. Loss of vegetative habitat in temperate latitudes due to drought is a growing global problem, and these occurrences will have serious negative effects on native plants and animal species. Patterns of change similar to those found in the western United States have also been observed in other climatically sensitive mid-latitude ecosystems worldwide. Global observations of the spatial pattern of temperate forest vegetation can be used to develop a precise picture of vegetative health in marginal temperate regions and how it is reacting to global climate change.

244. SAVANNA FIRE IGNITION RESEARCH EXPERIMENT (SAVFIRE): EFFECTS OF POINT VS PERIMETER IGNITIONS ON FIRE MOSAICS

GOVENDER, NAVASHNI, Winston Trollope, Chris Austin, Alex Held

A recent development in the use of fire in large conservation areas like the Kruger National Park, is the hypothesis that the desired biodiversity of the overall ecosystem will be promoted by controlled burns applied as point ignitions instead of perimeter ignitions (block burns). At this stage benefits associated with controlled burns applied as point ignitions are untested hypotheses. An urgent necessity thus exists to determine whether point ignitions do in fact result in a greater fire mosaic of different types and intensities of fires compared to areas burnt as perimeter ignitions and at what scale. Preliminary results from treatments (500ha vs 2000ha) suggest that fire mosaic patterns are most strongly influenced by the prevailing weather conditions at the time of ignition. This project attempts to determine the threshold area and weather conditions required for similar fire patterns and mosaics resulting from a point ignition and perimeter ignition. It is envisioned that such an investigation would promote the improved use of controlled burning in conservation areas, achieving their objective of promoting biodiversity in the national parks system and wild life areas in South Africa thereby benefiting ecotourism and its positive effects on poverty relief.

245. ANALYSIS TOOLS FOR ELEPHANT TRACKING DATA

WALL, JAKE, Iain Douglas-Hamilton

Save the Elephants (STE), a conservation organisation based in Samburu, Kenya, has been tracking elephants using GPS since 1998. Through the use of modern tracking technology, researchers have had a unique view of the spatial movements of 72 elephants on an hourly basis. This volume of information has resulted in a database of over 1 million recorded elephant positions which has necessitated the development of special techniques for data analysis. We present here new tools developed within the ESRI ArcGIS environment to analyze animal tracking data. Several tools associated with data management have allowed STE to access and filter collar data in a more streamlined fashion. A new 'range-use' tool has also been developed that allows us to calculate a 'time-spent' raster which is a refinement of traditional point density methods. We believe this approach provides a more accurate view of elephant behaviour. A 'range-expansion' tool has been developed that allows us to study whether an elephant's home range can be determined by the available recorded data. A 'corridor' tool has also been developed to automatically identify elephant movement corridors.

Urban area conservation

246. TREE DEFICIT IN THE URBAN ENVIRONMENT OF RIO DE JANEIRO CITY, BRAZIL, AND A PROPOSAL OF A MANAGING PLAN OF GARDENING WITH NATIVE SPECIES

BERGALLO, HELENA GODOY, Adilson R Santos, Carlos F. D. Rocha

Our study on native and exotic tree species in Rio de Janeiro City, Brazil, showed that exotic invasive species (84.7%), markedly dominate the urban area. In the present study, we estimated tree deficit in the gardening urbanization in the city, according to the pattern expected if the original gardening plan was properly followed (10 m spacing between trees). We sampled a total of 1701 streets, recording the tree species and the number of exotic and native individuals along 300 m of extension of the street. Higher tree density was usually associated to districts with inhabitants having higher economical resources. Of the streets sampled, 66% had no tree planted with a total deficit estimated in 869,260 trees for the city. Based on our data, a new model of gardening to Rio de Janeiro city is proposed using solely native species in order to change, in long term, the present model dominated by exotic species. Other aspects have also to be considered, such as, esthetical and species resistance ones. However, for a successful change of gardening

model it is crucial a valorization of native species by the population through environmental education programs, and by stimulating and increasing native species production and selling.

247. PUBLIC PARTICIPATION AND PARTNERSHIPS FOR THE CONSERVATION MANAGEMENT OF THE COASTAL BLACK-HEADED DWARF CHAMELEON (*BRADYPODION MELANOCEPHALUM*) POPULATION

ARMSTRONG, ADRIAN

The black-headed dwarf chameleon *Bradypodion melanocephalum* is endemic to KwaZulu-Natal and the coastal population of this species is confined to the central coastal region, mainly below about 150 m a.s.l. The eThekweni municipal area occurs in the centre of this population's distribution, and the rapid infrastructural development in and around Durban is a grave threat to the population's existence. Applications for development of black-headed dwarf chameleon habitat are received fairly regularly by Ezemvelo KZN Wildlife for comment, which is an indication of the threat to existing sub-populations through habitat destruction, fragmentation and isolation. Public participation in black-headed dwarf chameleon surveys has indicated that the probably largest remaining single sub-population of the black-headed dwarf chameleon (approximately 2000 adults) in the eThekweni municipal area occurs on the Airports Company of South Africa's Durban International Airport eastern precinct, and this land has been proposed for sale for light industrial development. Translocation of dwarf chameleons from construction sites to suitable habitat elsewhere can be successful, providing adequate time and resources are available for: 1. finding and securing suitable habitat for restoration; 2. implementation of the translocation; 3. monitoring of the translocated sub-population, and; 4. management of the restored habitat. The translocation and monitoring of dwarf chameleons from a construction site in Bellair, Durban, to nearby partially restored habitats by more than 50 members of the public in co-operation with the eThekweni Municipality and the Cato Manor Development Association (now disbanded) is given as an illustration of the process.

248. NELSON MANDELA BAY METROPOLITAN OPEN SPACE SYSTEM: CONSERVATION CHALLENGES IN A DEVELOPING CITY

MARTIN, PAUL

Nelson Mandela Bay Municipality, Port Elizabeth, South Africa is the largest urban area in the Eastern Cape with a population of 1.3 million growing at 2% p.a., 42% unemployment and a housing backlog of 60,000. It is an area of globally important biodiversity, being located at the interface of the Cape Floristic and Albany World Biodiversity Hotspots with five of South Africa's seven biomes being represented, particularly fynbos and thicket. The challenge was to develop a spatial open space plan representative of the metro's biodiversity that maximized social and economic opportunities and took account of future development needs. The original vegetation types and ecological processes were mapped, together with those areas permanently transformed, to produce a GIS based plan indicating priority conservation areas. This biodiversity plan is a core component of Council's Spatial Development Framework that guides future developments. Despite a relatively low level of conflict between development needs and the biodiversity plan, numerous challenges remain to balance the local imperative for economic growth, development and poverty alleviation against global biodiversity concerns. Key to this is ensuring that natural open space adds value to adjacent communities and landowners, rather than being perceived as waste land and a threat. Implementation strategies include modifying environmental impact requirements, re-zoning land, encouraging conservancies and compatible economic activities, landowner incentives and education and awareness.

249. HABITAT RESTORATION AND MANAGEMENT OF WETLANDS AND NATURE PARKS IN KAOHSIUNG CITY, TAIWAN

HSU, MINNA, Govindasamy Agoramoorthy

Park managements of a heavy industrialized city is essential as Kaohsiung's population around 1.51 million and its harbor is one of the four largest in the world. To establish a wetland corridor in connection of Lotus Lake, wetland restorations were on progress in the past five years. Currently, city wetlands including Chouchai Wetland Park, Banping Lake, Neiweiipi and Flood Detention Wetland Park have reconstructed for biodiversity conservation, education and ecotourism. However, the planning for Shoushan Nature Park at Mt. Longevity has no progress since 1998. More than 800 species of plants were found at Mt. Longevity and 61 of them were endemic to Taiwan. The natural population of Formosan macaques that inhabits Mt. Longevity has 18 troops and more than 800 individuals. The habitat destruction and tourism contributes

significantly for the forest fragmentation and human-monkey conflicts. Trapping and translocations of macaques were performed but the survival and recovery rates for those released macaques were low due to the lengthy stay in captivity. Therefore, habitat management to establish Shoushan Nature Park with protected core habitat from further destruction and to restore the damaged and human encroached forest areas around Mt. Longevity are crucial to maintain the biodiversity of Kaohsiung.

250. ECOLOGICAL INFORMATION IN THE POLITICAL DECISIONMAKING OF URBAN LAND-USE PLANNING YLI-PELKONEN, VESA

When new housing is planned in green areas, planners must ensure that the necessary biodiversity surveys are conducted to determine the conservation value of an area. The objective here was to examine what factors determine the importance of ecological information in political decisionmaking of urban land use in Helsinki, southern Finland. Results from the interviews of politicians and city officials show that ecological information becomes more important if there are protected elements connected with a plan area, contacts and appeals from plan participants, strong media attention or if a decisionmaker focuses more on the issue due to personal interests and values. The decisionmakers interviewed were generally satisfied with how ecological information is presented, although aspects related to the validity of information and lack of ecological monitoring data on implemented projects were recognized. The significant conservation values and related ecological information receive priority in the urban planning process and usually pass through the decisionmaking system, but parts of green areas that are less significant in a conservational sense are more easily ignored. Balancing the weight of recreational and cultural values may be one of the most difficult tasks for decisionmakers to handle.

Wetland conservation

251. SITE SELECTION IN DYNAMIC LANDSCAPES: A PROBABILISTIC MODEL TO PROTECT HYDROSERES IN THE PANTANAL WETLAND Drechsler, Martin, REINALDO LOURIVAL, Emily Nicholson , Hugh Possingham

Given the importance of habitat heterogeneity in the principles and practice of conservation planning, it is odd that landscape dynamics have not been a central theme in conservation planning. We address this deficiency by developing a probabilistic method that allows landscape dynamics to be incorporated into the conservation planning process. We apply our methods to the Pantanal, a 210 thousand km² wetland between Brazil, Bolivia and Paraguay. We coupled a hydrological to a biological succession model, under limited budgets, formulated in the literature as the maximum set coverage problem, using the simulated annealing algorithm. We considered 2 scenarios model exploration; in the first, flood events between sites were independent, while in the second they were spatially auto-correlated. Surprisingly, correlated floods had no effect on the performance of the reserve selection strategy. We found that the influence of spatially correlated floods is overwhelmed by the biological succession, since the transition-time between states buffers the stochasticity in physical states. We demonstrate that the relationship between site age and observed species community is not deterministic, such that for a given site age several species communities can be observed with some likelihood.

252. POPULATION ESTIMATION OF THE ALAOTRAN GENTLE LEMUR (*HAPALEMUR ALAOTRENSIS*), MADAGASCAR RALAINASOLO, FIDIMALALA, Jonah Ratsimbazafy, Richard Young

Since 1994, Durrell Wildlife Conservation Trust (DW) has conducted eight censuses at Lake Alaotra to monitor population trends of the marsh-living *Hapalemur alaotrensis*. This species is threatened by marsh burning and hunting. It is considered one of the most threatened lemur species in Madagascar and one of the 25 most threatened primates in the world. From 2004 to 2006 we estimated abundance using Distance Sampling of observations from canoes along canals in marshes at four sites: Anororo and Andilana west of the lake and Ambodivoara and Andreba to the east. The total area of those sites covers more than 85% of the entire Alaotra marshes. Results of the survey indicated that the population of this species remained stable during the last three years; respectively 5069 individuals in 2004, and 5012 in 2005 (2006 data is still being analyzed, but appears similar to previous years). Relative abundance fluctuated between sites,

despite general overall population stability. Durrell's efforts during the last eight years have contributed to the conservation of this species by reducing lemur hunting.

253. HABITAT DISTURBANCE AND INVASION OF NON-SWAMPY SPECIES INTO THE MYRISTICA SWAMPS OF WESTERN GHATS, INDIA TAMBAT, BHAUSAHEB, G. N Chaithra

Freshwater *Myristica* swamps are integral part of wetland ecosystems, dominated by members of the family Myristicaceae. They have high watershed value and occur at lower altitude, thus forms ideal habitat for cultivation of plantation crops. Swamps supports specific community, which is altered due to anthropogenic disturbances viz., diversion of water, illegal felling, encroachment, etc. We compared the community structure and species composition of disturbed and undisturbed swamps in the central Western Ghats. In each swamp (n=18), various demographic and diversity parameters were measured by laying 100m² quadrats. The vegetation composition of adjacent non-swampy habitat was recorded by laying 10 X 50m transects (from periphery of the swamps to upland conditions). The results indicated species richness and diversity of swamps increased with disturbance. Frequency distribution of girth class of stems was different for disturbed and undisturbed sites. Jaccard's dissimilarity index indicated disturbed swamps share greater similarity with the adjoining non-swampy habitat, maybe due to invasion of species into the swamps. Further, regenerating individuals and sapling density of obligate swampy species was significantly lower in disturbed swamps. In summary, anthropogenic disturbance affect the ecological integrity of swamps, which facilitates invasion of non-swampy species and affects survival of obligate swampy species.

254. DISCOVERY OF NEW FLOATING MARSH AREAS IN PARANA RIVER DELTA, ARGENTINA: FINDING UNKNOWN AND ESSENTIAL HABITAT FOR ENDANGERED MARSH DEER DAlessio, Santiago, Bernardo Lartigau, PABLO HERRERA, Gustavo Aprile

The localization of floating marsh areas in Parana River Delta, has been a recent discovery for this wetland. Floating marshes are mats of vegetation which move vertically responding to changes in water level. In this delta inhabits the southern population of the endangered marsh deer (*Blastocerus dichotomus*), the largest cervid of South America. Evidence has been recorded about the use of floating marshes by deer as a shelter during extraordinary floods. On these periods, water rises covering the islands and many deer die by drowning or are easily hunted. Islanders affirm that decades ago floating marshes were widely spread in the region, but the drainage of islands to enlarge forestry lands destroyed most of them. After discovering and studying the main floating marsh of the region, the project team carried out a new survey to localize unknown floating areas in the wetland. Using satellite images, flights and terrestrial surveys, new floating areas were found in undisturbed islands. The protection of these areas is considered a critical step to assure the long-term conservation of this population of marsh deer. The information generated by this survey is being used to design new conservation strategies for marsh deer and these floating ecosystems.

Appropriate intervention levels for management of large African ecosystems

WORKING WITHIN THRESHOLDS: INTEGRATING SCIENCE AND MANAGEMENT IN LARGE TERRESTRIAL ECOSYSTEMS

DU TOIT, JOHAN, Harry Biggs

About two decades ago, some visionary ecologists brought ecosystem theory into African wildlife management by promoting the notion that selected components of large protected areas should only be managed when they begin to drift over “limits of acceptable change”. While this makes much sense, problems lie in identifying (a) what those limits are and (b) what trajectories of change can be predicted for selected ecosystem components (plant communities, animal populations, drainage systems, etc). In recent years, studies have revealed that ecosystem change usually follows non-linear trajectories, and that desired states within ecosystems can hover close to thresholds of comparatively rapid and irreversible change. Challenges for scientists include determining what those thresholds are for selected regimes, what the drivers of change (slow variables) are, what indicators (fast variables) to monitor, and what management actions could be employed to keep the system from exceeding thresholds of potential concern. Challenges for managers include trusting and understanding the scientists, and being prepared to implement science-based interventions. We will present and discuss the above issues in the context of one large protected area (Kruger) where managers have adopted the threshold concept, and we will use examples from other savanna ecosystems in southern and eastern Africa to illustrate state-changes across thresholds.

ECOLOGICAL PRINCIPLES GUIDING MANAGEMENT INTERVENTIONS IN AFRICAN ECOSYSTEMS: LESSONS FROM SMALL TO MEDIUM SIZED PROTECTED AREAS IN KWAZULU NATAL, SOUTH AFRICA

Goodman, Pete, SUSAN JANSE VAN RENSBURG

Natural landscapes are being transformed and fragmented by human activity. The need for managing fragmented areas effectively to meet conservation targets is therefore increasing. The smaller a natural area becomes, the greater the likelihood of natural processes being disrupted, presenting specific challenges for conservation management. In KwaZulu Natal (KZN), South Africa, most protected areas are small to medium sized (<1000km²), situated in a fragmented landscape and are often surrounded by human activity. The management challenges emerging from this situation led to the development of “Process Based Management” principles which guide decision making for appropriate interventions and scale of intervention for conservation management. These principles revolve around reinstating or simulating natural ecological process and scaling these to the appropriate levels within the confines of a protected area boundary. This approach has been successfully integrated into conservation management in KZN since the early 1980's, providing specific examples including; meta population management of wild dog, white rhino dispersal sink strategies and water management that will be presented. The importance of clarifying area-specific management objectives, integrating research with management and identifying tools available to management are highlighted. We suggest that these principles are equally applicable to large systems where natural processes have been disrupted.

THE LONG-TERM PROTECTION OF AFRICAN ECOSYSTEMS: HARD OR SOFT BOUNDARIES?

KIKOTI, ALFRED, Grant Hopcraft

Encroachment around protected areas has resulted in an increase in human-wildlife conflicts, forcing protected area management to mitigate the impacts of these potential conflicts. Two major approaches have been used to date. On one hand, hard edges such as fences aim at eliminating conflicts entirely by completely separating protected areas and surrounding communities.

Alternatively, approaches initiated by UNESCO and other institutions aim at creating buffer zones where humans and wildlife share access to resources creating soft boundaries around protected areas. We evaluate the costs and benefits of hard versus soft boundaries for protected area management by reviewing several case studies from African ecosystems. We argue that buffers are the most cost-effective way at reducing human-wildlife conflict in developing nations particularly if the buffer areas are managed as mutual risk zones. We use examples from on-going studies of zebra, wildebeest and elephant from Northern Tanzania to look at movement in relation to human-induced risk, as well as human encroachment in relation to wildlife-induced risk and conclude that areas around protected areas should be managed for mutual risk rather than for mutual resources. In the long-run, the effective management of human-wildlife conflict depends on effective land-use planning, strong zoning policies with adequate enforcement, and long term commitment from governments and stakeholders.

MANAGEMENT INTERVENTIONS: WHY AND WHEN ARE THEY ACCEPTABLE? DEMBE, EZEKIEL, M Karen Laurenson

This paper reviews the type and justification for management interventions in large African Ecosystems in the last 50 years. Management interventions have generally fallen into a number of broad categories. One of the most widespread interventions has been the provision of waterholes for wildlife, which has fundamentally altered ecosystem dynamics in many areas of southern Africa. Fire control and management has taken place across the continent, mainly to prevent the destruction of certain vulnerable vegetation types. Scientific grounds have been used to justify culling and translocations, particularly historically. The supposed maintenance of a desired stasis and balanced ecosystem has apparently justified large culls in some areas. Prevention of disease transmission to and from domestic livestock has been attempted through culling, fencing and vaccination. Intervention to mitigate the threats rare and endangered species are frequent, and have included reintroductions or augmentation of small populations, treatment or prophylaxis for disease, culling of predators and the removal of hybrid individuals or exotic species. Mitigate of the human impact on non-threatened species, for example removing wire snares, is a common reason for intervention animals have also been euthanized, treated or translocated when animal welfare issues were impacting visitor experience. Management philosophies have developed considerably in the last 50 years, with changes in management priorities, globalisation and changing attitudes to animals in society. Interventions that were acceptable 50 years ago, such as culling for research sampling, are now rarely justified and animal welfare issues have increased in prominence.

WHAT ARE THE CONSEQUENCES OF ANIMAL-ORIENTATED INTERVENTION? BORNER, MARKUS, Richard Hoare

Human interventions in African ecosystems orientated towards animals themselves are most usefully classified as major or minor actions in the long term. Major interventions affect the populations of key ecosystem species and tend to operate on long timescales; minor interventions are targeted at relatively low numbers of individuals but their effects are more immediate. At the larger ecosystem scale: population regulation exercises are potentially major with long-term consequences; removal of 'problem animals' is relatively minor; reintroductions of rare or locally extinct species, whilst often high-profile, is a relatively minor - except with keystone species; veterinary interventions can have major consequences if they involve abundant or key species or target pathogens causing epidemics; research interventions like immobilization of individual animals are relatively minor. The most important pre-requisites for animal intervention are information showing the prevailing level of understanding of ecosystem processes and the capability for subsequent collaborative monitoring and evaluation by biologists and managers. Also, a relevant policy framework should exist and ethical considerations should be addressed. Opponents of well-planned, legal interventions should consider how the effects of illegal interventions, principally animal poaching, have been massively greater.

TRADE-OFFS BETWEEN SIZE AND HETEROGENEITY OF PROTECTED AFRICAN SAVANNA AREAS

MANONGI, FREDDY, Han Olff

Increasing human population densities, changing local economies and globalization are increasingly driving land use changes across African. This puts increasing constraints on protected areas, where formerly continuous ecosystems become fragmented, migration routes are cut off, and wildlife populations may decline below critical densities. In addition, climate change may induce a mismatch between the current location of protected areas and the optimal conditions that host high biodiversity. These developments pose the questions about the minimum size of protected savanna that still enabling such areas to maintain their key functions and biodiversity. The minimum size of protected areas depends on i) the exchange in ecosystem services and organisms that an area receives from its surrounding, ii) its position along main environmental gradients (climate, soil fertility), iii) its inherent spatial heterogeneity arising from topographical, soil and geological variation and iv) heterogeneity that arises through the actions of biota. We discuss the trade-offs between these factors. Can regions with more inherent spatial heterogeneity host smaller reserves with the same biodiversity, can more productive areas host smaller reserves, and, can smaller areas be sustained in areas with lower intensity of surrounding land use? Answers to these questions result in viable biodiversity conservation strategies across the African savanna biome.

HUMAN INTERVENTIONS AND WATER: THEIR CONSEQUENCES IN PROTECTED AREAS UNDER AFRICAN ARID ENVIRONMENTS

GERETA, EMMANUEL, Angela Gaylard

The old saying that "water is life" has never been challenged because it is the truth. Life without water will perish. All living organisms depend on water for their body mechanisms to function, hence, their survival. In most African arid environments, water is always abundant in the wet season (rain season). The discharge rates are generally high. The problem arises during the dry season. The water discharge rates tend to decrease significantly. This is the time water needs become crucial. In the protected areas in most African countries human interventions have been avoided on the belief that nature will take care of itself. This has been going on since time immemorial. The protected areas are now being used as economic ventures through tourism. These protected areas especially national parks provide nature tourism. The revenue accrued from tourism is ploughed back into the parks to support conservation. This philosophy has changed the thinking that processes in the parks should be left alone for nature to take its course. The result to this is now human interventions that will allow animals to be easily seen when tourists visit these parks. The major element of human interventions has been provision of water to wildlife through digging of dams, creation of ponds and other means. This presentation will highlight the advantages and disadvantages associated with such interventions and discuss whether that should be the way to go in conservation of our natural resources.

LONG TERM ECOSYSTEM DYNAMICS AND THE IMPLICATIONS OF HABITAT ORIENTED INTERVENTIONS

MDUMA, SIMON, Alan Kijazi, Norman Owen-Smith, Anthony R.E. Sinclair

Long-term studies in many parts of the world highlight their value in understanding ecosystem dynamics. It is now generally accepted that ecosystems are continuously changing. Old ways of managing tended to keep systems in one predetermined state and this has led to some serious ecosystem consequences.

However, managing for change require us to distinguish between natural change and man-induced change. The former can be managed to allow change to happen whereas the latter is

managed to reduce change. The main perturbation that provided insight to the system dynamics was the change in the wildebeest population due to the removal of an exotic virus, rinderpest. This quasi-natural experiment showed how different components of the ecosystem are integrated. We demonstrate multiple ecosystem states through long-term changes in wildebeest and their herb layer food supply interacting with elephants, fire and tree populations. The complex ecosystem behaviour involving slow and rapid change and multiple states only became apparent over a period of several decades. This information has direct application to management and conservation. There is no a priori need to control and maintain only one natural state. However, well understood unnatural change could require management intervention at the ecosystem level. Examples from Serengeti highlight the problems faced in Africa and elsewhere.

Conservation and human rights: exploring key promises, challenges and questions

GUIDELINES AND TOOLS FOR ADOPTING A HUMAN RIGHTS APPROACH TO CONSERVATION CAMPESE, JESSICA

Despite mounting interest in a “human rights approach” to conservation, there is little consensus on the form and content of such an approach for scientists, practitioners, or conservation organizations. Drawing on broad research, including very recent papers submitted for this symposium and for publication in a special issue of Policy Matters to be launched at the symposium, this presentation will review and illustrate possible policy guidelines and implementation tools for a human rights approach. The presentation will distill a concrete and practical framework, suitable for the discussion and possible adoption by scientists, practitioners and organizations that, through their work, affect the livelihoods of indigenous and local communities in biodiversity-rich environments.

RIGHTS-BASED APPROACHES AND SCALING UP: NEW APPROACHES IN COMMUNITY CONSERVATION SPRINGER, JENNY

Rights-based approaches and “scaling up” – both spatially and by addressing overarching policy and governance issues – are two related trends in community conservation and natural resource management. Rights-based approaches seek explicitly to promote the realization of human rights; in the context of conservation, rights to participation and land and resource rights are particularly prominent concerns. Orientations towards scaling up have emerged as part of large-scale conservation approaches and also from lessons regarding the need to address broader policy, institutional, and economic factors constraining or enabling community conservation. Drawing on examples of field experience in the Amazon, Central Africa and elsewhere, the paper identifies a range of strategies emerging at the intersection of rights and scale issues, including in relation to land and resource rights, institutions and governance, traditional knowledge and increasing access to conservation-related benefits.

CONSERVATION AND ETHNIC CONFLICT IN BURMA: WORKING TOWARDS SOCIALLY-BASED ENVIRONMENTAL ENGAGEMENT NOAM, ZAO

Burma (Myanmar) has the unfortunate distinction of being the country with the longest running civil war in the world, and blessed, as well as cursed, with plentiful, world-renowned natural resources. In addition, Burma is home to numerous ethnic minorities, mostly living along its vast frontier regions bordering its neighboring countries (Thailand, China, Bangladesh and India). It is precisely this threatening combination of rich, valuable natural resources and great ethnic diversity that has contributed to the long-lasting political unrest in Burma, and which has begun to be shaped into an ethno-ecological crisis. The recluse Burmese military dictatorship, continuing

regime corruption, flagrant human-environmental rights abuses, and a divided international community on engagement vs. isolationism all contribute to the difficulties of doing conservation in Burma. This paper/presentation will examine the ethnic political situation in Burma, and its forms of on-going resistance, mapped onto the landscape of conservation. The case studies and recommendations hope to illustrate ethically- and socially-based, long-term solutions to protecting Burma's environment and the people that rely upon it for their livelihoods.

ENGAGING AND INVOLVING COMMUNITIES IN LANDSCAPE-SCALE CONSERVATION: A CASE STUDY FROM THE CAPE FLORISTIC REGION SANDWITH, TREVOR

South Africa's Cape Action for People and the Environment Programme (C.A.P.E.) seeks to conserve the globally significant biodiversity of the Cape Floristic Region, while ensuring that people are involved and benefit from conservation opportunities. Often the product of top-down conservation planning, strategy formulation and implementation, landscape scale bioregional programmes run the risk of negatively impacting human rights at the local level. In this case study, the protection of land and tenure rights in the Baviaanskloof Mega-reserve illustrates the complexity of the task to ensure that community rights are not negatively impacted. It also examines the nascent efforts to ensure that rights to a healthy environment and livelihoods in a burgeoning biodiversity-based economy are enhanced, that governance of conservation programmes responds to the demands of the new democratic order in South Africa, and that effective participation and from grass roots to programme level is enabled.

THE HISTORY OF CONSERVATION EVICTIONS IN BOTSWANA: THE STRUGGLE CONTINUES MAGOLE, LAPOLOGANG

Botswana has, over time since the colonial era, designated large tracks of land as national parks, forest reserves, and wildlife management areas. While this is a laudable act of conservation, as its proponents claim, it is the continual removal of people, especially minority Koi San groups, from their land which causes concern. Not only are the evictions a violation of human rights, they also serve to impoverish these communities and cause them to be dependent on Government and NGO hand outs for their livelihood. Historically, resistance to these evictions has brought more suffering to the evicted communities and their supporters; that is until the popular Central Kgalagadi Game Reserve (CKGR) eviction, where the Government decision to evict a San group from the park was successfully challenged in court.

ROLE OF PARLIAMENTS IN PROTECTING ENVIRONMENT-RELATED HUMAN RIGHTS JAIRETH, HANNA

The presentation will focus on the potential and limitations of the involvement of parliaments in the protection of environment-related human rights. Factors will be identified and discussed which enhance and constrain positive outcomes for human rights protection. The risks and benefits of a focus on parliamentary intervention rather than other governance sites will be noted and illustrated on the basis of selected examples from Australia.

IP MANAGEMENT: RIGHT TO SELF-DETERMINATION COMPLIMENTED BY SUPPORT OF
STATE, NGOS, AND PRIVATE SECTOR
PIDO, MICHAEL

Although the rights of the indigenous peoples (IPs) to participate in environmental conservation are duly acknowledged in the Philippines, the modalities of such participation vary considerably. This paper describes the rights exercised by the Tagbanua, an IP group, in participating to develop a monitoring and evaluation (M&E) program to evaluate the effectiveness of management of the Coron Island Ancestral Domain (CIAD) in Palawan Province. The CIAD is the first Philippine ancestral domain being managed by the IPs that has both terrestrial and marine areas. Their aim to promote sustainable development and protection of the CIAD is the manifestation of their rights to self-governance and self-determination. The Tagbanuas acknowledged, however, the assistance provided by the local and national governments, non-governmental conservation organizations, academe, and the private sector in developing its M&E program to assess the effectiveness of its management. Hence, the rights of the Tagbanuas to govern their ancestral domain are complemented by the participation of other stakeholders to enhance their capacity building for management, developing strategic partnerships, and promoting multi-disciplinary approaches for effective governance, among others.

PARTICIPATORY TOP-DOWN IN COMMUNITY BASED NATURAL RESOURCES
MANAGEMENT POLICIES IN MADAGASCAR
POLLINI, JACQUES

In 1996 the Malagasy government issued the GELOSE law, a legal framework to transfer natural resources management rights to local communities. Despite being inspired by laudable and even “revolutionary” intentions, recent studies show that application of this law can be problematic. At times, it can enhance intra-community conflicts and even result in perverse environmental consequences. This paper offers some hypotheses to explain such problems. First, despite the initial objective of “community empowerment”, the legal framework obliges communities to be represented by a “modern”, “democratic” structure called COBA, generally foreign to local traditions and mores. This can be socially disruptive and lead to breakdowns in traditional governance systems. Second, the main reason why GELOSE is being implemented today is for “conserving” natural resources, where “conservation” is understood in the sense of western cultures. The paper discusses these hypotheses via an analysis of the history and content of the GELOSE legislation, and of the scientific and political discourses and practices associated with it. It is argued that the Malagasy legislation, policies, and field-based practices should become more “flexible” and give more value to traditional experience. This would genuinely strengthen community institutions such as the fokolonona

USING A RIGHTS BASED APPROACH TO PROMOTE SOCIAL EQUITY IN CONSERVATION
IN UGANDA
FRANKS, PHIL

Rights based approaches provide a lens and a tool-box for understanding and addressing issues of governance and specifically the underlying causes of poverty, environmental degradation and injustice related to power. This presentation illustrates the application of this approach within CARE International and specifically in CAREs Rights, Equity and Protected Areas programme in Uganda, emphasising procedural rights of access to information, participation and justice. The strengths and weaknesses of this approach will be reviewed in comparison with human rights approaches that focus on substantive human rights, demonstrating that working with procedural rights can often be a more practical and effective entry point in terms of both social and conservation impacts.

Coping with impacts of AIDS on conservation in Africa

IMPLICATIONS OF HIV/AIDS FOR THE CONSERVATION OF COMMON PROPERTY RESOURCES

TWINE, WAYNE, Lori Hunter, Laura Patterson

This presentation summarises ongoing research on population, health and the environment, including AIDS impacts in a poor rural South African population. The setting is the field site of the Wits/MRC Agincourt Health and Population Unit in the rural northeast of South Africa. Field surveys (n=240-300), with a sample stratified by household experience of recent adult mortality, quantified use of natural resources and food security. Supplemental qualitative interviews were conducted with a sub-sample of "mortality" households. Results indicate that adult mortality has substantial implications for household resource use. Importantly, if the deceased had been a breadwinner, households frequently become more reliant on biodiversity as natural resources were substituted for more expensive alternatives (e.g. purchased food or household energy). These findings suggest that biodiversity exploitation in communal lands may rise due to the AIDS pandemic, and therefore substantiate the importance of conservation strategies for communal property resources as an important aspect of AIDS mitigation.

EXAMINING HIV: AN ELEPHANTINE EPIDEMIC IN THE CAPRIVI

DeMOTTS, RACHEL

While the link between HIV and conservation is often discussed, causal relationships are not always quick to come to light. This paper investigates how increasing HIV infection rates and AIDS deaths relate to community-based conservation and livelihood strategies in the Caprivi Region of northeastern Namibia. An area with a well-established conservation programme, Caprivi's NGOs and government agencies are struggling to effectively address the spread of the pandemic in a region where nearly 48% of adults over the age of 25 are HIV-positive. While the increased strain of caring for the sick may lead to greater reliance on readily available natural resources, the relationship between HIV and conservation is complex and must be more closely examined to offer deeper insights. To fully understand these linkages, the paper analyzes how conservancies – community-based conservation initiatives in Namibia – are responding to the disease by integrating it into conservation work in the region. This includes examining changes in the way that HIV and AIDS are discussed in local communities, discussing strategies being used in the context of conservation initiatives to combat the spread of the disease and promote access to testing and care, and bringing to light the experiences of individuals and families struggling with HIV and AIDS. This locally-based perspective will be situated within the larger context of other HIV and AIDS programmes in the Caprivi Region to show both successes and barriers in better addressing the epidemic.

EXAMINING THE LINKAGES BETWEEN AIDS AND BIODIVERSITY CONSERVATION IN COASTAL TANZANIA

KALANGAHE, BARAKA, Elin Torell

In Tanzania, AIDS is not only a health issue, but a challenge to development, manifesting itself through increasing poverty and intensified socio-economic imbalances. Poverty and gender inequality are both strongly connected to the spread of HIV, where poverty often drives women to unsafe sexual encounters. Women are doubly hit, because more females than males are infected and women are also the primary care givers. Because HIV/AIDS often affects people in their prime working ages—between ages 25 and 45— the epidemic affects agricultural productivity and natural resources. This presentation will summarize the findings of the Population, Equity, AIDS, and Coastal Biodiversity (PEACE) project regarding linkages between AIDS and coastal biodiversity in eight coastal villages in the Bagamoyo and Pangani Districts in Tanzania. The

project has found that AIDS drives faster rates of resource extraction and use, increases gender inequality, lowers the health and capacity of the labor force, and impedes individuals' ability to maintain viable livelihoods. The presentation will further describe coping strategies taken by families struck by HIV/AIDS (e.g. unsustainable tree cutting for fire wood and charcoal) and explain some of the measures initiated by the project to prevent and mitigate the negative impacts of HIV/AIDS on biodiversity conservation.

OVERVIEW OF THE IMPACTS OF AIDS ON CONSERVATION CAPACITY AND COMMUNITY BASED NATURAL RESOURCE MANAGEMENT MAUAMBETA, DAULOS

Conservation is facing challenges of poverty, high population and more recently, HIV / AIDS, among several issues in Sub Saharan Africa. There are established linkages between HIV/AIDS, livelihoods, human capacity and conservation. There is increased uptake of natural resources such as timber for coffins, firewood used during funeral and related ceremonies; traditional medicines to treat opportunistic diseases; increased use of wild foods; changes in land use as agricultural practices change with falling capacity for heavy labor; and changes in access to natural assets where widows and orphans cannot inherit resources. In some cases, graveyards are expanding into previously farmed or conserved areas and conservation funds are diverted to HIV/AIDS related costs. Conservation has witnessed loss of both traditional knowledge and human capacity at all levels of the society and increased vulnerability of community-based natural resource management programs as communities lose leadership and capacity. Conservation Organizations should find solutions to: Relieve unsustainable harvesting to support community livelihoods; Develop their capacities, adapt natural resources management training programs and increase involvement of the youth in conservation so that they take management roles in future; Collaborate with other sectors such as health and agriculture who are better equipped to deal with the pandemic.

HIV/AIDS AND CONSERVATION WORKFORCE CAPACITY IN SOUTHERN AFRICA: PERCEPTIONS OF CRITICAL IMPACTS, BARRIERS, AND MITIGATION STRATEGIES CASH, JENNIFER, Stephen F. McCool

The HIV/AIDS pandemic permeates all aspects of southern African civil society including the ability of organizations to practice conservation. The purpose of this research is to understand how management perceives HIV/AIDS influencing their southern African conservation organizations workforce capacity to meet their missions. Research goals include: (1) identify perceptions of the impacts of HIV/AIDS on workforce capacity; (2) elucidate barriers to addressing these impacts; and (3) explore mitigation strategies. Data collection involved two stages: (1) semi-structured interviews of managers and scientists (n=23) to better understand impacts and barriers; and (2) a panel of key experts (n=30) within southern African conservation agencies ranked impacts according to their perceived severity, using an iterative, Delphi approach. Impacts identified include loss of experience-based knowledge, difficulty in planning for the future, and increases in human resource costs. Barriers to addressing these impacts include gender issues, lack of awareness, staff housing and stigma associated with the disease. Mitigation strategies must address impacts and barriers within a southern Africa context. This research provides perspectives from current conservation management and human resources to direct and catalyze mitigation strategies.

UMZI WETHU: A CASE STUDY OF CONSERVATION SUPPORTING AIDS ORPHANS & VULNERABLE YOUTH IN SOUTH AFRICA
MUIR, ANDREW, Julie Anton Dunn

The Umzi Wethu Training Academy for Displaced Youth is an initiative of the Wilderness Foundation in South Africa (WFSA) providing the certified vocational training and internships that qualify AIDS orphans and vulnerable youth for guaranteed jobs in parks and game reserves in the Eastern Cape, where ecotourism is growing at a pace of 10% per year. Umzi Wethu provides a secure, nurturing home base, complete with healthcare, nutrition, and counseling, for over 50 youth job trainees who are disadvantaged, stigmatized and at risk because of poverty and HIV/AIDS. Some are homeless and reside at the academy; others commute from home where they may be a child head of household. Umzi Wethu is changing the destiny of these youth and the family members dependent on them, from assured destitution to economic advancement and social leadership embracing environmental values. Wilderness trail experiences build character, transfer indigenous knowledge of plants and animals from elders, and generate conservation ethics. WFSA has 20 years of experience of running social programs for black youth within South African parks and leads implementation of the founding Umzi Wethu. WFSA consulted with over 35 partners, leading experts in the fields of ecotourism, education, health, and social services to develop the program.

PRACTICALITIES OF MAINSTREAMING HIV/AIDS INTO COMMUNAL CONSERVANCIES IN NAMIBIA
KURZ, VELIA

This presentation will outline the current situation and approach taken to mainstreaming HIV/AIDS into the Communal Conservancies program in Namibia by the Namibia Association of CBNRM Support Organizations (NACSO). NACSO is an umbrella organization supporting CBNRM initiatives in communal conservancies that has the potential to reach one tenth of Namibia's population. However, the success of the conservancy program is threatened by the devastating impacts of HIV and AIDS. Resulting illness and death is causing loss of manpower, skills, expertise, management, household income, program breakdowns, political challenges, and changes in use of natural resources. Conversely, the program is impacting the epidemic: for example by raising income which provides increased access to alcohol and unprotected sex, and attracting migrant workers who may bring in HIV to remote communities. The existing CBNRM program offers a unique conduit through which HIV/AIDS awareness and prevention can be cascaded from the NGO to the conservancy and community levels. Conservancy activities can also help buffer some of the economic impacts of AIDS on households and orphans. Practical activities of the program will be outlined at NGO, conservancy and community level, followed by a review of the advantages of this approach and the main challenges.

Declining populations of large mammals in African protected areas: establishing the causes

WHAT HAS CAUSED THE NEAR-EXTINCTION OF ROAN ANTELOPE IN KRUGER PARK?
OWEN-SMITH, NORMAN

Caughley (1994) noted how the discipline of conservation biology has developed much theory for assessing the viability of small populations, but not for what makes populations become small or how to rectify the problem. The difficulty is that the causes of population declines may be multiple and interactive. I illustrate this using as a case study the substantial decline by roan antelope in Kruger National Park to numbers threatening local extirpation of this species from the park's fauna. Roan numbers declined from over 400 in 1986 to under 30 by 1996. Candidate causes included low rainfall, habitat deterioration, competition from zebra, elevated predation from lions, disease outbreaks and stress associated with immunization against anthrax. Demographic data revealed that the decline was associated with a substantial elevation in adult rather than juvenile

mortality. This ruled out malnutrition and hence low rainfall or competition as a direct cause, for theoretical reasons. Instead an increase in the abundance of lions, and hence in predation risk, following an influx of zebra seemed directly responsible. However, habitat deterioration associated with persistently low rainfall probably contributed to the increased risk. Changes in zebra and hence lion abundance followed the augmentation of surface water sources, aimed at buffering rare antelope against drought. More fundamentally, widened water distribution reduced the spatial heterogeneity that had formerly enabled the rarer antelope species to persist in regions with lower predation risk due to reduced abundance of staple lion prey. Management intervention needs to be directed towards this most fundamental cause in order to be effective.

TWO DECADES OF DECLINE IN MEDIUM-SIZE UNGULATES IN HWANGE NATIONAL PARK (ZIMBABWE): CONFRONTING HYPOTHESES

FRITZ, HERVE, Simon Chamaille-Jammes, Marion Valeix, Nolwenn Drouet-Hoguet, Felix Murindagomo

In Hwange National Park, the elephant population was culled and maintained stable up to 1986, and has more than doubled since then. Meanwhile, eight out of the thirteen ungulate species regularly counted (five browsers and three grazers) have decreased. These trends call for an urgent understanding of the mechanisms involved, and in particular the possible role of elephants. We launched several focused studies to explore possible mechanisms, including climate change analysis, landscape-scale habitat change, micro-habitat use modification induced by elephant, competition for water, as well as indirect predation effects. The results of these studies, although not all are totally completed, do not find strong evidence for direct impact of elephants on other species. The effect on habitat and resource in key resource areas around waterholes remains to be completed. We also suggest that predation, particularly by hyaena after a possible population boost induced by elephant culling operations, may have severely impacted medium sized-herbivores. The analysis of climate data shows a dramatic increase in dryness in the Hwange ecosystem, and the similarities in trends and timing of ungulate species in Hwange and Kruger raise the question of an over-riding regional climatic effect in these semi-arid ecosystems.

SHIFTING DISTRIBUTION AT THE EDGE OF THE RANGE: RARE ANTELOPE IN THE KRUGER NATIONAL PARK

CHIRIMA, JOHANNES, Norman Owen-Smith

Three antelope species; sable (*Hippotragus niger*), roan (*Hippotragus equinus*) and tsessebe (*Damaliscus lunatus*) reached the southern limit of their historical distribution in Africa within the borders of the Kruger National Park. Aerial censuses have showed that all the three species declined substantially in abundance after 1986. Rare antelope species have persisted mainly in the northern half of the park where abundance of other species appeared generally lower than elsewhere. We estimated and compared their distribution ranges before (pre-1986) and after they declined (post-1992) using local nearest-neighbour convex-hull (k-NNCH) techniques on Aerial Surveys data. Sable showed no change in distribution range extent, but a slight increase in range fragmentation. Tsessebe showed progressive reductions of ranges sizes and eventual disappearance of the range south the Kruger Park. Roan showed disappearance of 4 small isolated herds including a northern subpopulation. The findings suggest there were no distribution range pattern shifts as expected from climate changes for these rare antelope species. General habitat deterioration from recurrent and prolonged droughts may be responsible for the observed rare antelope species decline. Another factor that possibly contributed to the declines was the expanded distribution of predators following increased abundances of other herbivores related to surface water provision in formerly dry rare antelope ranges.

DID PREDATOR RESTORATION CAUSE SELECTIVE UNGULATE DECLINES IN LAIKIPIA DISTRICT, NORTHERN KENYA?

GEORGIADIS, NICHOLAS, Festus Ihwagi, Nasser Olwero, Stephanie Romanach

Laikipia is a dry savanna region where wildlife shares the landscape with humans and livestock. Between 1990 and 2005, five of nine wild ungulate species suffered protracted declines on properties receiving the greatest conservation investment. Of ten potential causes examined, only an increase in predation was consistent with the timing, synchrony, duration and composition of observed ungulate declines. The principal factor causing predators to increase was a change in land use from cattle ranching, under which predators and plains zebras were severely suppressed, to wildlife conservation and ecotourism, which prompted a 5-fold increase in plains zebra abundance, and created a demand for living predators. Plains zebras ultimately comprised more than half the available prey biomass, and supported a substantial predator community, but were limited by rainfall and density, not by predators. We infer that increasing predation caused predation-susceptible prey species to decline via apparent competition. Suppression and then restoration of predators to Laikipia provided insights into the 'top-down' effects of predation on a large herbivore community that were similar to previously reported responses by prey communities to predator manipulation in Kruger and Serengeti NPs. All featured one or a few numerically dominant herbivore species, which were primarily limited by rainfall and density, supporting a predator community that in turn limited the abundance of other prey species. In each case, predation had a detectable effect on only a subset of prey species, reducing the evenness component of prey diversity. Apparent competition may structure large mammal predator-prey communities more commonly than is typically supposed.

EFFECTIVENESS OF ANTI-POACHING IN THE SERENGETI ECOSYSTEM

LOIBOOKI, MARTIN, Ray Hilborn

Beginning in 1977, due to an economic crisis in Tanzania, funds for antipoaching in Serengeti National Park were dramatically reduced, and there was an explosion in poaching. This led to the near extinction of black rhino, and dramatic declines in elephants and buffalo. We reconstruct the history of funding for antipoaching, and antipoaching patrols to estimate the history of poaching effort in Serengeti National Park. We show that reduction in antipoaching activity coincided with major increases in poaching, and that increased antipoaching coincided with declines in poaching intensity. Anti poaching activities since 1990 have led to substantial recoveries of elephants, buffalo and a small but increasing rhino population. The historical impact of poaching on other species is variable, with poaching at historical levels not a conservation concern for wildebeest, zebra or Thompsons gazelle, but poaching has had a significant impact on local populations of some other species.

CHANGES IN LARGE HERBIVORE POPULATIONS IN A PROTECTED DYNAMIC WETLAND ECOSYSTEM; THE OKAVANGO DELTA, BOTSWANA

BONYONGO, MAPAPI CASPER

The Okavango Delta, one of Africa's most protected ecosystems supports diverse, but declining large herbivore populations. Aerial counts from 1989 indicate that populations of 11 species have declined from 1995 to 2006. The causes of the declines are largely not understood because they are multi-factorial and interactive nature. Potential causes include legal and illegal off-take, predation, and habitat fragmentation, drought, low birth rate, juvenile and adult mortality. I assess the possible causes by comparing population trends of the herbivores whose populations are declining with (i) the trends in populations of key predators, (ii) trends in rainfall and flood size and (iii) trends in legal and illegal hunting. As a wetland with two moisture regimes, one from the annual rainfall (November to March) and the seasonal flooding (May to September), the Okavango Delta is highly productive in both woody and herbaceous biomass which roles out forage resource limitation due to drought as a cause of the declines. Due to effective anti-

poaching mechanisms in place, and the low hunting quotas, off-take from both legal and illegal sources is minimal. Adult and juvenile mortality could not be determined due to lack of demographic data. This leaves the predation pressure as a possible hypothesis explaining the decline in ungulate populations in the Okavango Delta. Ground surveys revealed that lion populations in the Okavango Delta have been increasing since 1996, the same time which herbivores started declining. Management of large herbivores therefore requires an in-depth understanding of the population dynamics of their major predator and the predator/prey interactions.

THE COMMON WILDEBEEST: THE KEYSTONE SPECIES THAT WAS ESTES, RICHARD, Rod East

Migratory *Connochaetes taurinus* populations formerly dominated semi-arid/mesic savanna ecosystems from southern Kenya to the Orange River in northern South Africa. A combination of morphological, physiological, social and reproductive adaptations made it the keystone species in its preferred habitats. But specialization for a migratory existence and water-dependence made it highly vulnerable to human interference. This presentation is based mainly on an unpublished country-by-country survey of wildebeest populations I wrote in 1967, updated to 2005 by the late Rod East, plus field studies of this antelope over the last 40 years. Already by the 1960s human interference had disrupted the migrations of some of the major populations, notably the Eastern white-bearded (*C.t.albojubatus*) populations of Kenya and Tanzania, Kalahari populations of Botswana and Namibia, and Lowveld populations of Zimbabwe and Transvaal. Fencing has had the greatest impact, especially cordon fences (as in Botswana) that block migratory routes and prevent access to water. Virtually all the down-sizings of wildebeest populations are consequences of increasing human population. The common denominator of declining populations is loss of refuges essential during severe drought. The one ecosystem still defined and dominated by wildebeest is that of the Serengeti. Transboundary Natural Resource Management Areas could restore and safeguard several migratory ecosystems.

POPULATION DYNAMICS OF ZEBRA, SPRINGBOK AND WILDEBEEST IN ETOSHA NATIONAL PARK, NAMIBIA TURNER, WENDY C, William C. Gasaway, J. Werner Kilian, Wilferd Versfeld, Kathleen T. Gasaway, Norman Owen-Smith

Populations of plains ungulates in Etosha National Park, Namibia declined significantly from the mid-1970s through the 1980s. These declines have been attributed to fencing of the reserve and the effects of drought, anthrax mortality and predation. Concern over the viability of these populations prompted the initiation of a twice-yearly monitoring program of group composition for the plains ungulates: Burchell's zebra, springbok and wildebeest. Using these data from 1990-2006, we re-evaluate the dynamics of these populations and assess the relative importance of bottom-up and top-down forces in driving population changes. We examine how the proportion of juveniles to adult females and juvenile survival vary in relation to annual rainfall and Normalized Difference Vegetation Index (NDVI), both proxies for forage abundance, and anthrax mortality and predation, where possible. Each population responds differently to bottom-up forces at a one-year lag, with population growth related positively, negatively or with no statistical relationship to changes in the forage proxies. Despite the variation in population response to rainfall and NDVI, all three species show an increase in population size over the past 16 years, perhaps coinciding with a release from drought conditions.

IDENTIFYING THE CAUSES OF DECLINE IN AFRICAN LION POPULATIONS USING A GIS META-ANALYSIS LOVERIDGE, ANDREW, Susan Canney, Graham Hemson, Penny Morris, Claudio Sillero-Zubiri

Populations of African lions are thought to have declined substantially over the last few decades. We use a GIS based analysis to predict the distribution of current lion populations and the threats they face across Africa. We extracted data on lion numbers and ranging behaviour, prey availability, rainfall, human density and livestock density from the literature and from existing GIS data layers. The positive relationship between herbivore density and rainfall has already been established. We show that lion density in protected areas is closely related to prey biomass and that lion home range size is negatively correlated with prey biomass. Using a GIS, we use this relationship to identify sites where lion density was lower than predicted by rainfall and prey density. We correlate this deviation with factors that impact the survival of lions such as human populations and livestock density. Expanding human and livestock populations, prey depletion and habitat conversion may be the key factors responsible for declining lion numbers. Lion populations are most vulnerable in low rainfall areas where home ranges are large due to low prey density. To safeguard viable populations of lions, Protected Areas in arid regions need to be comparatively larger than those in more mesic parts of the continent.

STATE SPACE AND SEMIPARAMETRIC MIXED MODELS FOR TIME SERIES OGUTU, JOSEPH O, Hans-Peter Piepho

State-space models play a central role in time series analysis. Biological time series, which present trend, seasonal and cyclic fluctuations, can be well described by such models. In addition, biological experiments and surveys often have a relatively complex design structure calling for special attention. It is straightforward to account for design effects in a mixed linear model framework. We show how simple state-space models can be cast as a standard mixed model, providing the transition matrix of the state equation has a simple form. This opens up the opportunity for refined modeling of time series data involving complex blocking and treatment structures. Conversely, the state-space model gives rise to a special class of variance-covariance structures. Thus, integrating state-space components into a mixed model broadens the class of variance-covariance structures that may be employed to model serial correlation in longitudinal data. Semiparametric generalized linear mixed models (SGLMMs) are another flexible class of models for time series data that can accommodate nonlinear and disparate trend patterns and non-normal data with many zeros and missing values. SGLMMs further allow simultaneous testing of fixed effects for significance and spline smoothing of time series using automatic smoothers, such as the radial smoother covariance structure, equivalent to an approximate low-rank thin-plate spline. Multivariate SGLMMs allow for serial autocorrelation in individual ti

RAINFALL INFLUENCES ON UNGULATE POPULATION ABUNDANCE IN AFRICAN SAVANNAS BHOLA, NINA, Joseph O. Ogutu, Hans-Peter Piepho, H. T. Dublin, Robin Reid

Rainfall is the prime climatic factor driving the population dynamics of African savanna ungulates but few studies have comprehensively analyzed its influence on the abundance of multiple species assemblages of African ungulates at a variety of temporal scales. We report relationships between rainfall and changes in age and sex structured abundance of seven ungulate species monitored monthly for 15 years using vehicle ground counts. Abundance was strongly and nonlinearly related to rainfall and these relationships varied among species and age classes. Rainfall exerted both cumulative past and immediate effects on abundance, with older topi *Damaliscus korrigum*, warthog *Phacocoerus aethiopicus* and waterbuck *Kobus ellipsyprimnus* responding to longer lags than younger animals. The abundances of newborn calves were best correlated with monthly rainfall averaged over the preceding 4-6 months for all species but the migratory zebra for which a 2-month average provided the best fit. The cumulative late wet-season rainfall was the best predictor of abundance for most species. Strong seasonality in abundance was apparent for topi and warthog with highly seasonal birth pulses and the migratory zebra. Zebra, impala and hartebeest (*Alcelaphus busephalus*) showed weak seasonality in births. Births peaked between August and December for most species, implying that mating and

lactation occurred in the wet season when food is most plentiful. Pronounced seasonality in birth pulses for warthog and topi obliterated otherwise strong relationships between abundance and rainfall when both month and rainfall were included in the same trend model. Aggregated density produced relationships with rainfall that were most similar to those for adult age classes, emphasizing the importance of demographic monitoring to reliably revealing the effects of rainfall on ungulate abundance.

IMPACTS OF LAND USE CHANGES ON WILDLIFE AND LIVESTOCK POPULATIONS IN THE WILDEBEEST DISPERSAL AREA OF MAASAI MARA AND ATHI KAPUTIEI ECOSYSTEM
SAID, MOHAMMED Y, David Nkedianye, Robin Reid, Shem Kifugo, Joseph Ogutu, Suzanne Serneels, Helen Gichohi, Patrick Wargute

The Maasai Mara and Athi-Kaputiei ecosystems are key wildlife areas in Kenya that supports the large movements of migratory wildebeest and zebra population. However, recent trends in wildlife show a declining population in a number of key species in these ecosystems. We have noted the general loss of large herbivore population arise from modification of habitats or the complete conversion of habitats from one state to another. The rates of habitat modification and fragmentation are greatest in Athi Kaputiei an ecosystem outside the metropolitan urban city of Nairobi. The species that are affected significantly are the resident wildebeest (decline by more than 70%), and the large antelopes such as the eland and hartebeest. We also noted moderate declines in the smaller antelope species such as Grant's and Thomson's gazelle in both the study area. We conclude that the changes in land tenure and land use are accelerating the rate loss of some of the key species in the study area. The land and wildlife policies need to address issue of land use planning and management of conservation areas by local community as to ensure the sustainability of some of the key wildlife habitats in Kenya.

Developing marine protected area networks: biological, socio-economic and technical challenges in the 21st Century

CONSERVE A CORAL, SAVE A SNAIL, OR FORFEIT A FISH: USING SPECIES SURROGATES IN CORAL REEF CONSERVATION PLANNING
BEGER, MARIA, Sheila McKenna, Hugh Possingham

Conservation planners aiming to protect coral reef biodiversity are usually faced with a scarcity of biodiversity data as a basis for their management decisions. Thus, they often utilise surrogate taxa to represent reef biodiversity in reserve design. In five Indo-Pacific regions, rapid ecological assessments produced species lists of fishes, corals, and molluscs from 167 sites. Based on these lists, we test the suitability of taxa as surrogates of reef biodiversity. Firstly, we evaluate how well each taxon can represent the other taxa in a marine reserve system selected by a greedy algorithm relative to reserve systems selected by chance. We then test if cross-taxon congruence patterns can predict these surrogacy patterns, determining congruence with a linear regression of dissimilarity values between pairs of sites. No taxon that we examined can be considered a reliable conservation surrogate for the other groups that always represents other taxa significantly better than random reserve choice. Sites selected based on hard corals represented the other taxa in a reserve system worse than randomly selected sites. Although we found high cross-taxon congruence between fishes and corals, and between corals and molluscs for some regions, cross-taxon congruence was not a reliable indicator of surrogacy value. We conclude that on Indo-Pacific coral reefs one can only be sure that a target taxon is efficiently represented when data on that taxon are used to select a reserve system.

THE ROLE OF MARINE PROTECTED AREAS IN THE MANAGEMENT OF TEMPERATE REEF FISHES: IMPLICATIONS FOR LONG-TERM ECOLOGICAL RESEARCH AND MONITORING

GOTZ, ALBRECHT, Sven Kerwath, Paul Cowley, Angus Paterson

An investigation into size, density and community structure of temperate marine fish in a medium-sized marine protected area and adjacent fishing grounds on the south coast of South Africa is presented. Randomly stratified underwater visual census and controlled angling were used to investigate the ichthyofauna at protected and exploited sites in the study area. Roman (*Chrysoblephus laticeps*), the principle reef fish species targeted by the fishery, showed significantly higher densities within the protected parts of the study area (cpue: 4.3 fish per angler hour) as compared to the exploited area (cpue: 3.4 fish per angler hour), correlating strongly with the observed fishing pressure. Furthermore, fishing pressure reduced age-at-maturity and sex change but increased the condition of roman. Sonar tagging experiments revealed a small home range of roman (1,000m²), however, females extended their home range during the spawning season (10,000m²). Using movement and life-history information, an individual based model (IBM) showed the potential of roman populations to enhance adjacent fisheries through spill-over. In conclusion, the potential of cpue assessments for long-term monitoring of reef fish is evaluated in the light of high levels of natural variability recorded in a large marine protected area over eight years.

DEFINING COMMUNITY COMPOSITION ON ROCKY SHORES FOR CONSERVATION PLANNING

BRANCH, GEORGE, Laura Blamey, Ruth Branch

Modern coastal conservation planning relies on the development of objective criteria to evaluate the relative merits of different areas for conservation. Two different approaches have been adopted in developing such criteria - the hotspot and habitat approaches. In this paper we advocate a hierarchical approach to defining where conservation is necessary. As a first step, major biogeographic provinces need to be defined. As a second step, habits within those provinces have to be defined. To exemplify, we use rocky shores on the west coast of South Africa to examine the extent to which they can objectively be divided into discrete habitats, and conclude that based on wave action a division into three types of habitat is necessary to span all communities present on rocky shores. We then test the validity of our classification by using physical proxies to distinguish these habitats, and employ independent sampling to validate our classification. Finally, we develop algorithms to partition the coast into units corresponding to these habitats. Using this information, we culminate the talk with a discussion of the rival merits of the hotspots and habitat approaches, and conclude that the latter is more versatile and less biased than the former.

ADAPTING SYSTEMATIC DECISION SUPPORT METHODS TO NATURAL RESOURCE MANAGEMENT PLANNING PROBLEMS

STEWART, ROMOLA, Matt Watts, Trevor Ward, Hugh Possingham

To reduce the complexity of natural resource management (NRM) decisions to a manageable level many decision-makers are turning to systematic decision support methods (DSS). These methods typically comprise analytical techniques used for conservation evaluation which, when applied to clearly stated objectives, synthesise information of varying levels of complexity and provide for an informed decision that explicitly recognises the trade-offs involved. To help NRM decision-makers effectively and efficiently deliver NRM management objectives through systematic NRM planning, we have develop improved procedures and software to allow managers to examine complex planning issues involving socio-economic and conservation trade-offs, and help set on-ground priorities for management. We will discuss software development, which focused on extending the capabilities of Marxan, a well established systematic planning tool developed by Australian researchers and now used globally for conservation planning in

marine and terrestrial systems. The Marxan algorithm has been substantially upgraded to be able to define multiple zones (user defined) and to accept into the cost structure a matrix of multipliers that relate the cost of a planning unit to the type of zone it is in (i.e. the form of management), set in terms of user defined cost parameters. The functionality of the algorithm will be demonstrated using a case study in Western Australia to illustrate the application of a decision-making framework to complex spatial problems of most relevance to coastal NRM issues.

MARINE BIODIVERSITY AND BIOGEOGRAPHY OF SOUTH AFRICA GRIFFITHS, CHARLES

This presentation aims to document known marine biodiversity of South Africa, to estimate the validity of existing estimates and to describe geographic patterns of species richness, endemism and range restriction around the coast. Species counts are based on museum and literature records and distribution and endemism patterns analysed for 13 major taxa for which sufficient data exist. A total of 11 980 marine species have been recorded from South Africa, of which 32% are endemic. Comparing relative proportions of various taxa with similar lists for Europe suggests that only some 60% of the macrofaunal species actually present in South Africa have been described, taxa with smaller body sizes and from deeper waters being particularly under-reported. Analyses of distributional data show that several taxa, including fish, decapod Crustacea and Gastropoda, increase in diversity towards the east, whereas Amphipoda, Isopoda and Polychaeta are most species rich in the south-west. When all taxa are summed the Atlantic coast emerges much less species rich than the Indian Ocean coast. Rates of endemism vary greatly between taxa and peak in the South and South-West. Narrow range restricted endemics peak strongly at the borders between major biogeographic provinces, suggesting that these ecotonal areas are particularly important for conservation.

RESILIENCE AND RESERVE DESIGN: TURNING THEORY INTO TOOLS GAME, EDWARD, Matthew Watts, Hugh Possingham

To achieve what we desire of them, marine reserves must be successful in maintaining the structure and functioning of the ecosystems they encompass. There can be no assurances however, that those areas currently targeted for protection will not continue to degrade due to factors beyond the scope of local management. It is clear that if climate change induced mortality and the risk of other catastrophic occurrences are not explicitly addressed much of the investment made in managing site specific threats through the creation of MPA networks will be in vain. Using a modified version of the popular reserve design software MARXAN, we demonstrate a new conservation planning approach that explicitly considers the threat of catastrophic events and properly trades this risk off against reserve cost and biodiversity value. As an example we tackle the problem of mitigating the threat catastrophic coral bleaching events pose to protected coral reefs on the Great Barrier Reef, Australia. We show, first, that consideration of such events can drastically alter conservation priority and substantially improve the resilience of marine reserve networks. Second, our quest for equity between conservation features may come at a substantial cost in terms of persistence. And third, that the improved resilience a habitat gains by being protected in a reserve will in itself have a significant bearing on conservation priority.

INTEGRATING TERRESTRIAL, FRESHWATER, ESTUARINE AND MARINE CONSERVATION PLANNING GOODMAN, PETER

KwaZulu-Natal is one of South Africa's nine provinces occurring on the eastern seaboard immediately south of Mozambique. From the South African perspective, the province is characterised by generally high rainfall, largely fertile soils and high population densities, and

consequently human pressure on biodiversity is great. The province straddles the tropical/subtropical gradient, an altitudinal gradient from sea level to 3440 m a.s.l. and is situated in the centre of the Maputaland-Pondoland-Albany biodiversity hotspot. Independent systematic conservation plans have been developed for the terrestrial, inland water and estuarine systems in the province and a marine plan is currently under development. Owing to the high human pressure on land, water and other natural resources, and in the interests of minimising conflict with other land uses, conservation recommendations emanating from these plans need to be integrated and efficient. Independent plans have been integrated around a premise of downstream causation from terrestrial to freshwater aquatic and estuarine ecosystems. The primary catchments associated with mandatory and negotiated estuaries are used as a first filter for the selection of negotiated subcatchments for the conservation of representative samples of aquatic biodiversity. Similarly, mandatory and negotiated aquatic subcatchments are used as the primary filter for the selection of negotiated terrestrial planning units. In selecting representative samples of marine biodiversity, we define a zone of marine influence around each estuary, and use these in association with their mandatory or negotiated status as the first filter for the selection of representative marine sites.

RESULTS OF REEF SURVEYS AND ASSOCIATED RESEARCH RELEVANT TO MANAGEMENT OF THE GREATER ST LUCIA WETLAND PARK SCHLEYER, MICHAEL, Louis Celliers, Alke Kruger

Corals in South Africa are found primarily in the Delagoa Bioregion in the Greater St Lucia Wetland Park (GSLWP). Biodiversity surveys have provided information on the coral communities and their susceptibility to damage, needed for development of a zonation plan for their sustainable use. There are 18 coral communities on the reefs, in a gradient from north to south. Recommendations were made to modify current sanctuary zonation to meet the GSLWP biodiversity target of 40% for the protection of representative communities. Usage zones were categorised from diver training areas to those suitable only for advanced and experienced divers, with appropriate diving limits. The data have been incorporated with geophysical and socio-economic information in an interactive database for conservation planning and development of the GSLWP. Monitoring has yielded valuable information on coral community dynamics and climate-related bleaching. Sea temperatures have attained the bleaching threshold, leading us to hypothesise the probable future of these coral communities in the face of climate change. This may initially encourage hard coral growth but will adversely affect the reefs in the long-term. Diminishing recruitment success has emerged as a further silent climate-related effect. The combined results, together with further initiatives, will contribute to ecosystem models that will facilitate development of conservation and management strategies for the reefs, including risk assessment.

SYSTEMATIC CONSERVATION PLANNING FOR PELAGIC ECOSYSTEMS GRANTHAM, HEDLEY, Jane Alpine, Lynnath Beckley, Eddie Game, Alistair Hobday, Amanda Lombard, Hugh Possingham, Robert Pressey, Anthony Richardson

Pelagic ecosystems form a significant and vital component of the ocean's productivity. They are also heavily exploited and are currently the focus of numerous ecosystem-based management exercises. Despite this there is an absence of systematic conservation in the pelagic realm, both within exclusive economic zones and the high seas. We discuss what is important to conserve pelagic ecosystems and the techniques that aid in selecting conservation areas. For the Benguela current of south-western Africa, we demonstrate several approaches that support the design of conservation areas that contain areas of high productivity and low temporal variability, but driven by dynamic pelagic processes characteristic of large areas of the ocean; near shore up-welling, meso scale eddies and frontal systems.

FROM ULVA TO ISLANDS: LESSONS LEARNED FROM MARINE CONSERVATION
PLANNING AT DIFFERENT SCALES
LOMBARD, AMANDA, Jean Harris

The three dimensional nature of the ocean, and a paucity of spatial biodiversity information, pose special problems for marine conservation planning. In addition, much of the ocean's biodiversity moves over varying distances, and physical and biological processes operate over vastly different scales. The use of physical surrogates for unmapped biodiversity remains largely untested, and the monitoring and mitigation of threatening anthropogenic and climatic processes is not well developed. Most marine protected areas do not extend very far offshore, and offshore areas and the high seas are open to continuing and increasing threats. Using examples from South Africa, we investigate a number of approaches to these problems, and illustrate the importance of mapping and understanding scale-dependent patterns and processes before attempting to design marine protected areas that can be effectively implemented and managed. Fine-scale studies in the KwaZulu-Natal Province provide evidence of high beta diversity in the intertidal environment as well as shallow and deep reefs, highlighting the danger of indiscriminate use of physical surrogates. Medium-scale analysis of the country's intertidal environment illustrates the importance of correctly defining inshore bioregions, and a broad-scale conservation plan for the Prince Edward Islands in the Southern Ocean emphasises the need to understand movement patterns of wide-ranging top predators as well as the positions of oceanic fronts.

RESPONSES OF FISH POPULATIONS WITH DIFFERENT MOVEMENT BEHAVIOUR TO
FISHERY CLOSURES IN MARINE PROTECTED AREAS
ATTWOOD, COLIN, Sven Kerwath, Paul Cowley, Bruce Mann, Tor Naesje

Displacing fishing activity from marine protected areas (MPAs) can result in spectacular local recoveries of exploited fish populations, but this conservation mechanism may not suit all species, and the effect on fisheries is largely untested. Fish movement patterns determine whether fish will remain in a particular zone, and the extent to which protected fish can re-populate depleted areas. We studied fish movement patterns of several coastal species in South Africa. Populations that hold home-ranges respond well to spatial protection, but many have a substantial fraction of errant individuals that may colonise vacant habitat. MPAs protect spawner-biomass of species that shift from residency in juveniles to migration in adults. In one migrant species we found a resident fraction that responded well to spatial protection. Some species show no tendency to hold home-ranges and individuals move throughout large but defined areas. The strength or persistence of some populations is linked to the presence of substantial refuges or MPAs. The majority of over-exploited species in South Africa are resident. MPAs sustain the fisheries of resident fish, but at sub-optimal levels in the absence of control on effort. MPAs may be attractive to open-access fisheries of migrant or nomadic species. Effort reductions should accompany area closures, and stock assessments will need to account for the unavailability of 'protected fish' and size-dependent movement behaviour.

CONTINENTAL SCALE MARINE CONSERVATION: SOME PERSPECTIVES FROM WESTERN
AUSTRALIA
BECKLEY, LYNNATH

Australia has a vast Exclusive Economic Zone and the federal government has committed to a National Representative System of Marine Protected Areas. To this end, using demersal fishes and geomorphology as surrogates for benthic biodiversity, a national marine bioregionalisation has identified 41 provincial bioregions. However, the individual state governments have jurisdiction over coastal waters (out to 3 nautical miles) and all have different legislation and processes for marine biodiversity conservation. For example, in Western Australia, a selection committee that drew on expert knowledge, identified 60 candidate areas for conservation, and coastal marine parks have been established in some of these areas. Recently, Fox & Beckley

(2005) systematically investigated priority areas for marine conservation in Western Australia by using hot spot, biogeographic and complementarity analyses based on the distributions of neritic fish species. Comparison of these results against the existing and proposed marine protected areas in the state Australia indicates some inefficiency as well as the necessity for increased conservation effort along the north (Kimberley) and south coasts of the state. Overall, selection processes for marine protected areas in coastal waters of Australia vary considerably between states and each protected area established usually represents a hard-fought compromise between conservation priority, political expediency and stakeholder interests.

FAST TRACKING OFFSHORE MARINE PROTECTED AREAS IN SOUTH AFRICA SINK, KERRY, Colin Attwood, Deon Nel, Mandy Lombard, Jean Harris

Less than 0.5% of South Africa's EEZ falls into MPAs and the establishment of offshore MPAs is a priority. A proposed network is being cooperatively identified in consultation with stakeholders from commercial fishing and mining. The objectives are to meet biodiversity conservation targets, contribute to fisheries sustainability and reduce inter-sector conflict. Four constraints to offshore MPA proclamation were identified; commercial interests, stakeholder non-consultation, lack of scientific evidence and compliance concerns. Literature reviews illustrate that these challenges may be overcome by innovative approaches that include scientific support, stakeholder involvement, stewardship, co-operative research and monitoring and effective compliance plans. Catalysts for offshore MPA proclamation elsewhere are reviewed. In South Africa, a systematic conservation planning approach is being implemented with mapping of offshore biodiversity pattern, process and pressures. We report on stakeholder influence and models for improved offshore protection. Increased trawl catches by a South African company adjacent to a MPA in Argentina, generated incentive for local MPAs. An entrepreneurial partnership with a mining company to identify volunteer unmined areas is also discussed. Government alone cannot effect the changes required to conserve offshore ecosystems and innovative thinking, flexible action and creative partnerships are needed to develop new modes of collaborative conservation.

SEAPLAN: A FINE-SCALE PILOT STUDY FOR MARINE CONSERVATION PLANNING ON THE EAST COAST OF SOUTH AFRICA

HARRIS, JEAN, Vuyiswa Radebe-Mkhize, Tamsyn C. Livingstone, Amanda T. Lombard, Kerry Sink, Cloverley Lawrence

A key challenge in conservation planning is the scale of classification and mapping of biodiversity, and the spatial resolution of data used for gap analyses. Many exercises undertaken to date provide overview assessments (coarse scale) and recommendations that are difficult to apply at the (finer) scale at which management interventions operate. Further, the use of habitat surrogacy in marine conservation planning requires testing. In this study, fine-scale (100m interval) field mapping along 640 km of the east coast of South Africa is used to classify the shoreline biodiversity at a habitat and biotope level. Over 64 biotopes and 28 intertidal habitats are identified. The offshore environment is classified into environmental domains (benthic-pelagic profiles) at a resolution of 1x1km units using remote-sensing biophysical data and benthic geophysical bathymetric data. Criteria for incorporation of fish species in conservation planning have been developed and list of relevant species generated, for which habitat specific spatial distribution has been mapped. The seamless inshore-offshore conservation plan incorporates mapping of threats, and the spatial intensity and habitat specificity thereof. Gap analyses using this fine-scale data to examine the risk of under-representation of key and/or sensitive biodiversity elements when habitat classifications are developed and used at coarse scales.

USING SURROGATES TO INCORPORATE LARVAL CONNECTIVITY INTO MARINE RESERVE NETWORKS

BODE, MICHAEL, Helen Fox, Lance Bode, Paul Armsworth

Larval connectivity (the exchange of juveniles between otherwise independent coral reef fish populations) greatly complicates the planning of marine reserve networks in coral reef ecosystems. Reserve networks must ensure that demographically significant larval exchange is maintained between the protected reefs in the system. This is difficult even when bio-physical models can offer some information about connectivity patterns, but in many study areas, no connectivity information is available. Using modelled connectivity patterns on the Great Barrier Reef, we investigate the performance of marine reserve networks that incorporate connectivity by targeting reefs that have particular, easily measurable properties (connectivity surrogates). As a test species, we use *Plectropomus leopardus*, a commercially important fish stock throughout the Indo-Pacific, that has recently been classified as threatened. We show that while some connectivity surrogates create reserve networks that perform no better than random expectation, others yield consistently good returns for both conservation and fisheries. Surrogate performance is robust to variation in the beneficial effects of reserves, in the total reserve proportion, and also in the morphology of the reef system itself. Our results indicate that the use of surrogates may allow larval connectivity to be incorporated into marine reserve planning, even in data-poor conservation situations.

Developing the vision for the global Island Programme: conservation challenges and solutions in the Western Indian Ocean islands

CONSERVING MADAGASCAR'S FRUIT BATS: A CHALLENGE FOR BIOLOGISTS, GOVERNMENT AND COMMUNITIES

RAZAFIMANAHAKA, JULIE, Daudet Andriafidison, Radosoa Andrianavoarivelo, Paul Racey, Richard Jenkins

Maintenance of wild populations of Madagascar's three endemic species of fruit bats is a major challenge to conservation biologists. Although these bats are threatened species they are classed as game and can be legally hunted for sport, subsistence and commerce, with certain restrictions. In reality, the law is widely ignored and hunting occurs throughout the year and there is growing evidence of population declines and roost desertion because of over-exploitation and forest clearance for agriculture. The important ecological services, such as seed dispersal and pollination, provided by these bats are also in jeopardy. We advocate a 5-point conservation plan for Malagasy fruit bats that includes (i) implementing and augmenting wildlife legislation (ii) the inclusion of bats roosts in new protected areas (iii) defining their landscape requirements (iv) education and training for local communities and professionals and (v) quantifying their ecological role. After years of neglect in Madagascar, fruit bats are beginning to receive attention from conservation biologists, due mainly to a capacity building programme for Malagasy students established in 1999. With the ongoing project to expand the protected area system in Madagascar, there has never been a better time to improve establish a conservation plan for the fruit bats.

RESTORATION OF CRITICALLY ENDANGERED BIRD SPECIES IN MAURITIUS

Jones, Carl, VIKASH TATAYAH, Kirsty Swinnerton

A conservation programme for the critically endangered birds of Mauritius has been in operation for three decades. Eight species have been subject to conservation action; Mauritius Kestrel *Falco punctatus*, Pink Pigeon *Nesoenas mayeri*, Echo Parakeet *Psittacula eques*, Mauritius Fody *Foudia rubra*, Rodrigues Fody *Foudia flavicans*, Rodrigues Warbler *Acrocephalus rodericana* and Olive White-eye *Zosterops chloronothos*. All have responded positively and three species have been down-listed and a further two are likely to be down-listed in the near future. The populations have been restored by increasing productivity by clutch and brood manipulations and by captive

breeding and reintroduction projects. Free-living populations have been managed by predator control, supplemental feeding, the provision of artificial nest -sites and habitat management and restoration. The time taken to restore these populations has taken decades and all species will require some long- term management. In the presentation we illustrate how Critically Endangered species can be recovered and examine the need for a long-term commitment for the restoration of endemic island species. Many island endemic species will require conservation management for the foreseeable future if we want to maintain viable free-living populations.

RESTORATION OF ROUND ISLAND, MAURITIUS

Jones, Carl, NICOLAS ZUEL, Vikash Tatayah

Round Island, a 216 ha island off Mauritius is known for its important communities of reptiles, plants, seabirds and invertebrates. The island has retained much of its diversity since it never had rats, but it did have exotic populations of goats and rabbits until these were eradicated in 1979 and 1986. These herbivores damaged the plant community and caused widespread erosion and soil loss. As a consequence of this the island has lost its hardwood community and also the endemic burrowing boa *Bolyeria multocarinata*. Round Island was the last place in Mauritius where giant tortoises *Cylindropsis* sp. were recorded. This presentation will highlight the efforts to restore the island, the restoration of the hardwood community by introducing 10,000 plants of 50 species. Detailed food web studies on the reptile community are demonstrating how these are important for pollinating plants and distributing seeds. It is hypothesised that Giant Tortoises maintained a grazing climax community of grasses and herbaceous plants that is now disrupted and declining due to the absence of any herbivores on the island. Plans will be outlined about the proposed introduction of Aldabra Tortoises on the island to act as analogues to replace the now extinct *Cylindropsis* tortoises.

PARTICIPATORY ECOLOGICAL MONITORING IN MADAGASCAR: EXAMPLES OF CENTRAL MENABE DRY FOREST AND ALAOTRA WETLANDS

ANDRIANANDRASANA, HERIZO, Joanna Durbin, Anselme Volahy, Richard Lewis, Francisco Rakotombololona, Jonah Ratsimbazafy

Since 2001 Durrell Wildlife has been working with the local communities and regional public services to annually collect data on key species, habitats and the threats to the biodiversity. This is being done in the wetlands of Lake Alaotra and the dry forests of Menabe in areas where the local communities have been given the legal rights to environmentally manage the neighboring natural habitats (public-domain lands). These are areas of important biodiversity but also areas which the locals depend on for various needs. Monitoring teams are typically 7-17 people including all three partners. Following collection in a particular locality the data is discussed during a public meeting in the village and copies given to all partners. The results of the monitoring are used in an environmental inter-village competition whereby prizes (development projects) are linked to how well each community has managed their locality. The involvement of the villagers in the monitoring is generating a change of behavior favorable towards conservation and the local development. Pressures have decreased in both sites except fires are still occurring in Alaotra and the respect of the strict conservation zones defined in their site management plans was improved. Our work has shown that participatory ecological monitoring is a feasible and advantageous approach to refine conservation actions in developing countries like Madagascar.

STRATEGIES FOR THE CONSERVATION OF PTEROPUS LIVINGSTONII

MOUTUI, MOHAMED, Brent Sewall, Ishaka Saïd, Nassuri Toilibou, Daoud Attoumane, Saindou Toumani, Cheikh Ibouira

Endemic to the Comores, *Pteropus livingstonii* is considered to be Critically Endangered. The population is thought to be approximately 1200 bats with most found in seven different colonies. It is dependent on native forest of which over 75% has been lost in the last 30 years. There are no terrestrial reserves in the Comores. Action Comores is working with the local communities and island governments to develop specific plans for reserves that will be beneficial to bat and forest conservation, be sustainable, and have broad support. Ecological data was collected at the seven sites and socio-economic data at the 10 villages that impact these roost sites. Villagers are proposing that a system of integrated reserves are created that will allow human access but will limit forest exploitation. Though legally defined as state land, in fact land-tenure issues are complex with traditional rights and usage overlapping public domain lands. We propose developing a system of varying co-management regimes whereby individual, village, government, and non-governmental partners agree to a set of roles and responsibilities for reserve management. Based upon our results, we recommend different conservation objectives for each site. A varied approach enables conservation efforts tailored to the unique conditions existing at each site, and allows for experimentation with different methods.

CENTRE FOR BIODIVERSITY CONSERVATION- CBC MADAGASCAR, APPOINTED TO PROTECT BIODIVERSITY IN THE INDIAN OCEAN HOTSPOT

RANDRIANASOLO , H.H, L. Andriamaro , A.F.A. Hawkins , A.R. Mandimbihaja, H. Rabarison, Z.L. Rakotobe

Conservation International's mission is to protect ecosystems, biological diversity and all ecological processes that maintain life on the planet and to demonstrate that humans can live harmoniously with nature. Since 2002, CI Madagascar developed the Centre for Biodiversity Conservation. Whereas before we were primarily a field operator, we now act as catalyser, donor, capacity developer and technical advisor. Our aim is to have the best national skill under one entity then work with a number of partners in the field to effectively conserve biodiversity. Geographically, CBC is working in Madagascar, the Comoros, Seychelles, Mauritius and la Reunion. This region is considered as one of the 34 hotspots worldwide. With local and international partners in each country, CBC activity is focused to protect all sites considered of high biodiversity priority, the Key Biodiversity Areas. 164 KBA have so far been identified for Madagascar. Since its existence, the CBC has allocated more than 300 grants to 143 partners including students, researchers, universities, national and international NGO, governmental agencies and foundations. Such grants include biological inventories, threatened species assessments, ecotourism evaluation, monitoring of the critically endangered *Pteropus livingstonii*, identifying and setting up of forestry and marine reserve in Comoros, captive breeding of the critically endangered *Zosterops chloronothus* in Mauritius, and developing the monograph

CONSERVATION BIOLOGY AT LA RÉUNION ISLAND: OVERVIEW AND PERSPECTIVES

Strasberg, Dominique, Stéphane Baret, Vincent Boullet, Alain Brondeau, ERWANN LAGABRIELLE, Thierry Pailler, Mathieu Rouget, Julien Triolo, Joël Dupont

Although they remained unoccupied by man till the beginning of the 17th century, the Mascarenes islands have experienced the rapid transformation of native habitats and the consecutive extinction of major species. This pattern was exacerbated by the early invasion of introduced animals and plants. Conservation of ecosystems has been a main challenge in La Réunion where large remnants of native vegetation still occur. During the last ten years, field research and conservation activities have been significantly developed by different institutions. At the local scale, we have improved results transfer from research to management practices that should better integrate ecological processes that control invasions and biodiversity dynamics. At

the island scale, we have recently mapped habitat diversity and transformation. This preliminary assessment has served as a basis to identify priorities at the municipality level. The major issue for 2007 concerns the implementation of a national park covering almost half of La Réunion island. At a broader scale, survival of Mascarenes biotas depends on adequate conservation on each island combined with a conservation planning strategy at the regional level.

SEABIRD CONSERVATION AND ISLAND MANAGEMENT IN THE WESTERN INDIAN OCEAN LE CORRE, MATTHIEU, Etienne Bemanaja, Rachel Bristol, Vikash Tataya, Chris Feare

The western Indian Ocean holds 24 species of seabirds totaling more than seven million pairs. However this part of the world has been poorly studied in the past. As a consequence, previous reviews are not precise enough to identify the trends and authors have emphasised the need for further researches. Since the last 15 years, considerable efforts have been made by various teams from the western Indian Ocean to update data on seabirds. We are currently building a regional database including all islands or islets of the western Indian Ocean in order to update knowledge on seabirds at a regional scale. The database is hosted at the Marine Ecology Laboratory of the University of Réunion Island and (to date) holds 250 islands or islets from Seychelles, Madagascar, Comoros, Mayotte, Réunion, Mauritius, Rodrigues, Iles Eparses, Mozambique, Tanzania and Kenya. The database is not completed yet but we can already extract some important patterns. Less than 2% of the islands are free of any man-induced disturbances. Most islands are threatened by a range of factors including introduced predators, poaching, egg harvesting, habitat destruction, light-induced mortality. The islands also differ in socio-economic characteristics which in turn influences the use of seabirds by people. On most islands seabirds represent an important source of economic input (through poaching, egg harvesting, ecotourism, ...) but these uses are not always sustainable.

ISLAND CONSERVATION IN THE SEYCHELLES: ACHIEVEMENTS AND CHALLENGES Rocamora , Gérard, DIDIER DOGLEY

Seychelles comprises c.155 islands and atolls. It is probably the best preserved western Indian Ocean country (few extinctions recorded since first settlement in 1770's, 47% of the territory legally protected). It has a wealth of endemic species of fauna and flora, seabird colonies and turtles nesting beaches of international importance, and rich coral reef communities. Main threats include Alien Invasive Species, poaching or overexploitation of marine resources, and alteration of natural habitats due to housing or touristic developments. Seychelles has fine examples of well managed nature reserves, or critically endangered bird recovery programmes. Since 1997, island rehabilitation activities have developed, mainly on small islands belonging to private owners or NGOs working in partnership with government. Latest examples include the FFEM project *Rehabilitation of Island Ecosystems* and the eradication of Black rats from North Island (201ha). Control of exotic vegetation and replanting of native trees, conservation introductions of threatened animals and continued scientific monitoring are part of the process. Future challenges include extending such programmes to large granitic islands, and to outer (coralline) islands where biodiversity inventories, monitoring programmes and wardening are much needed. Integrated land use plans combining strictly protected areas with ecotourism, exclusive private residences or fly-fishing zones are envisaged to finance conservation costs.

Economic growth, biodiversity conservation, and the Society for Conservation Biology

PERCEPTIONS AND REALITIES OF LAND DEGRADATION IN ARID NAMIBIA WARD, DAVID

We examined the perceptions and realities of land degradation in a communal ranching area, Otjimbingwe, in arid Namibia. It is commonly perceived that large-scale degradation of Otjimbingwe has occurred due to a mixture of improper pastoral practices and pressures induced

by high human population growth. We sought to determine whether the inhabitants perceived land degradation to have taken place and whether their perceptions were consistent with empirical data on environmental quality. We also wished to determine whether these pastoralists had management strategies to help them withstand the harsh environmental conditions in which they live. All respondents perceived that the environment had become degraded and claimed that this was due to a decline in rainfall, which is inconsistent with long-term records. There is also little evidence of a decline in plant cover and soil quality. No overall pastoral strategy exists in Otjimbingwe. Options for management are limited due to a variety of external and internal pressures such as high population growth, high immigration, restricted water availability due to dams constructed upstream and limited movement opportunities for livestock in drought periods.

THE SOCIAL PURPOSE OF PROFESSIONAL SCIENTIFIC SOCIETIES ROSALES, JON

The role of professional scientific societies in addressing the relationship between economic growth and biodiversity conservation is in its infancy. Some of these societies have studied the relationship extensively. The Wildlife Society, the US Society for Ecological Economics, and the North American Section of the Society for Conservation Biology have passed position statements on economic growth. Similar positions are under consideration in the American Fisheries Society, American Society of Mammalogists, Society for Range Management, and several smaller professional societies. Position statements are just the beginning of concerted and intentional efforts to address economic growth's impact on the environment. From the statements, professional assessment work must follow along with intentional work in the policy arena. This process – identifying a problem, studying the problem, describing the problem, and advocacy for change – are traditional roles that professional societies have engaged in for over a century. These are social roles professional societies play. This is how professional societies add social meaning to their work. This is how professional societies pursue their stated missions while simultaneously contributing to the betterment of the human and non-human condition.

THE HIMA: AN ANCIENT CONSERVATION PRACTICE FOR THE FUTURE? Serhal, Assad, Amer Saidi, SOUMAR DAKDOUK, Bassima Khatib

For over 1500 years, the Hima system is possibly the oldest known organized form of conservation in the Arabian Peninsula and Islamic countries stretching from North Africa to Central Asia. During the past 30 - 40 years, centralized government protected area systems dominated over decentralized Hima system- resulting in relatively little benefit to the local communities. The Hima practice is being revived to be used as a viable complementary option to nationally designated protected areas. The ultimate goal for the IBA program implemented through the BirdLife Partnership is the conservation of these important biodiversity sites, their management could be within categories ranging from strict conservation to community based schemes. The ancient Hima concept is being revisited to determine how it could be tailored to the 21st century- while also considering related cultural heritage and indigenous knowledge. A central question is whether revival of the Hima is indeed a practical option? This system must be done in a selective rather than wholesale manner while complementing national policy. The loss of this system will take with it a trove of native knowledge and benefit enshrined in the region's heritage. If revived properly this system could offer ecological sustainability, economic viability, and acceptance by the local people. The Hima system a unique synthesis of tradition and modernity could be a tremendous step towards conservation in the region.

ECONOMIC GROWTH, LAND USE CHANGE, AND BIODIVERSITY CONSERVATION IN MALAWI

MLOTHA, McARD JOSEPH

Malawi remains one of the poorest countries in the World with a per capita income of US \$220 and over 60 percent of the population living below the poverty line. It is difficult to predict the economic future of Malawi because the country's economy depends on agriculture and a rate of population growth is estimated to be more than three times the growth rate of the economy. The combination of increasing population and poor economic status in Malawi exerts heavy pressures on biodiversity and natural resources. These pressures originate from increasing demand for more land, more food production and wood fuel energy. Advancements in science and technology such as the use of Geographic Information science (GIS) has made it possible to closely monitor changes in the landscape and erosion of various natural resources. This paper discusses economic growth, land use change, and biodiversity conservation in Malawi with a focus on social structure and political influence. Furthermore, the paper identifies key factors and indicators of economic growth and their relation to sustainable livelihood and development. Food Agricultural Organization argued that economic and social activities are the main determinants of demand for natural resources especially forest goods and services. Land use change studies in Malawi have shown that increased deforestation and environmental degradation is threatening biodiversity and national economic development.

THE STEADY STATE ECONOMY: PUTTING NATURE IN ITS PLACE

CHRISTIAN, MAX

As societies strive for greater human well-being on a finite planet, economic growth- as defined by increasing production and consumption- will be logically subject to limits. Species loss, resource depletion and global warming can be grouped in the context of constraints to unfettered economic growth. The steady state economy, characterized by stabilized levels of population and resource throughput, offers an alternative vision to growth-dependent economic development. A brief overview of the historical and theoretical underpinnings of the steady state economy will be presented, along with a comparison of alternative indices of economic welfare that delineate "uneconomic" growth and qualitative improvement in human welfare. Comparisons of historical exploitation records will also illustrate how the nature of certain resources and services precludes them from being incorporated into markets to reflect scarcity, let alone ecological sustainability. The presentation will conclude with an exploration of policies that could promote strategic changes in the relative prominence of economic sectors, focusing on a carbon tax, for transitioning toward a more sustainable economy.

PROSPECTS FOR BALANCING ECONOMIC GROWTH WITH BIODIVERSITY CONSERVATION IN THE PROTECTED AREAS OF NEPAL: A CASE STUDY OF ROYAL BARDIA NATIONAL PARK, NEPAL

THAPA, SHOVA, Sigrid Stagl

Resource exploitation by the communities living around the protected areas has motivated strict rules and regulations for biodiversity conservation. However, strict rules that limit resource use from the park has resulted in resource use conflicts between local people and the park. Resource use conflicts elsewhere and in Nepal not only limit economic development of communities, but also results in biodiversity loss and degradation. Thus, this research aims to explore the clash between economic development and biodiversity conservation at Royal Bardia National Park, Nepal. A comparative case study approach was applied for an in-depth analysis of three villages. Qualitative data about the policy and institutional context of the Park were collected at the community level through community workshops. At the household level 358 questionnaire surveys were conducted covering the socio-economic information. Livelihoods of communities were dismantled due to wildlife interference, to surplus which communities were involved in illegal

resource extraction from the park. Different socio-economic features such as distance, land-holding and problems related with park had a significant impact on the illegal resource extraction. To promote conservation with development, it is suggested that communities' priorities are considered rather than societal development, with site specific rules together with opportunities for economic activities.

Ecosystem consequences of fishing

OMNIVORY AND CONTRASTING TROPHIC CASCADES IN LAKES VS. THE OCEAN SHURIN, JONATHAN, Blake Matthews, Russell Markel, Stefan Dick

Widespread declines of predatory pelagic fishes may have broad-scale implications for marine ecosystems as well as global chemical and energy cycles, but these are poorly understood. Trophic cascades (indirect effects of predators on primary production via herbivores) are well documented in lake pelagia, but examples from marine plankton are relatively few and recent. A meta-analysis of trophic cascade experiments found that the response of phytoplankton biomass to planktivorous fish manipulations was consistently larger in freshwater than the ocean. One possible explanation for this disparity is that omnivorous copepods that dominate marine systems dampen top-down control while herbivorous cladocerans in lakes exert strong grazing effects on phytoplankton. We tested the plausibility of this explanation by examining the relationship between body size and trophic position of marine and freshwater zooplankton using stable isotopes of nitrogen ($\delta^{15}\text{N}$). We found that the slope of the line relating size to trophic position was similar between lake and marine zooplankton throughout British Columbia, Canada. This result suggests that the prevalence of omnivory and its association with size does not differentiate marine and freshwater plankton. Thus, either the strength of trophic cascades is equivalent in marine and lake ecosystems, or some other feature of these environments promotes stronger cascading effects of planktivorous fish in freshwater than in the ocean.

FISHING THE GULF OF ALASKA MARINE FOOD WEB: ARE THERE THRESHOLDS RELATED TO FUNCTIONAL RESPONSE?

GAICHAS, SARAH, Garrett Odell, Robert Francis, Kerim Aydin

Evaluating ecosystem consequences of fishing is problematic, especially in large marine habitats where little is known about species interactions. We developed a dynamic food web model of the Gulf of Alaska marine ecosystem with over 120 functional groups to explore a range of potential predator prey functional responses and to determine how fishing might affect ecosystem dynamics. "True" functional response parameters describing predator prey interactions in this ecosystem are unknown and difficult to measure; but these parameters strongly influence model behavior. We generated millions of potential ecosystems by selecting functional response parameters randomly from wide ranges. We considered an ecosystem "successful" if all species coexisted for 50 years. Then, we simulated different fishing intensities on each system, and measured the fraction of successful ecosystems among millions of randomly constituted instances. We found that, absent heavy fishing, the model Gulf of Alaska tolerated an extremely wide range of variation in functional response parameters for nearly all species, implying substantial system level robustness to changes in the details of individual species interactions. However, there is a clear threshold effect between moderate and heavy exploitation rates where fishing damages the robustness of the ecosystem. Beyond this fishing threshold, it became difficult to prevent extinction, and system attributes differed greatly from moderately fished systems.

REVERSING PHASE SHIFTS THROUGH THE INTERACTION BETWEEN FISHERIES MANAGEMENT AND FOOD WEB MANIPULATION IN CORAL REEFS

McCLANAHAN, TIM

This study reports on efforts to reverse the degradation of reefs that have undergone phase shifts, where the two dominant degraded phases are reefs dominated by sea urchins and brown algal. The establishment of fisheries closures and direct reduction of sea urchins have been undertaken in efforts to reverse sea urchin domination. Park establishment results in reversal of sea urchins but the time scale can be as long as 15 years and highly sensitive to the species that dominate, rapid reversal for the small-bodied *Echinometra mathaei* but slow reversal for large-bodied *Echinothrix diadema*. Physical removal results in temporary improvements in reefs but can also result in movement into the brown algae phase or recolonization by sea urchins unless persistent and accompanied by fisheries closures. Algal reduction was attempted by the addition of sea urchins and physical removal. The addition of sea urchins in parks was ineffective as predators quickly ate them in less than one week. Physical removal resulted in temporary changes and increases in fish numbers and grazing but reversal again to the original state can occur in less than six months if herbivores are not present in sufficient numbers to retard recovery. We present a model of coral reef phases and the conditions that create the phases and how they might be handled by management. Permanent reversals are not possible without changes in the drivers that cause the reversal.

DISASSEMBLING POSEIDON; CASCADING EFFECTS OF REDUCING CONSUMER POPULATIONS IN THE SEA

SALOMON, ANNE, Steven Gaines

The reduction of dominant consumers by fishing has become increasingly recognized as a paramount factor altering marine food web dynamics and ecosystem processes. Empirical evidence suggests that indirect effects resulting in trophic cascades can dramatically alter community structure and primary production in both tropical coral reefs and temperate kelp forests. Furthermore, recent evidence suggests that overfishing can have cascading effects in pelagic marine ecosystems. We examine the conditions under which cascading effects should be expected, the extent of their broader ecosystem repercussions, and the ecological mechanisms that may perpetuate irreversible change among alternative states. By modifying the strength and character of ecosystem processes such as predation and herbivory, overfishing can have profound consequences on essential components of ecosystem resilience. Effective conservation strategies and ecosystem-based management necessitate a thorough understanding of the ecological consequences of fisheries removals, particularly within the context of varying large-scale forcing functions (i.e. oceanographic oscillation events and anthropogenic nutrient loading). Given the increasing demand for seafood, climate change and continued coastal development, a major challenge to marine conservation research over the coming decade will involve understanding the ecosystem-level effects of fishing, natural predation, changing oceanographic conditions and their synergistic effects. Ultimately, this will demand knowledge of the feedbacks within and between ecological, social and management systems.

BEHAVIORAL EFFECTS OF FISHING ON CORAL REEFS

MADIN, ELIZABETH, Steven Gaines, Robert Warner

The community-level consequences of predator removal and the mechanisms behind them are poorly understood in many marine systems. Much attention has been focused on increases in densities of prey species as the principal mechanism causing changes in community structure. However, an entirely different pathway exists by which predator removal could fundamentally alter marine ecosystems: changes in the behavior of prey species. The Line Islands represent a gradient in human influence that ranges from nearly pristine coral reefs to ones with key upper trophic levels functionally removed. We used the two endpoints of this system to ask whether

prey fishes behave differently over a gradient of predator biomass. We quantified behaviors of a suite of prey fishes spanning different functional groups, focusing on behaviors that are subject to a risk-reward trade-off and have potentially important community-structuring effects. Prey fishes exhibit demonstrable shifts in their behavior over the gradient of predator biomass. In particular, time spent foraging versus sheltering and patterns of movement over feeding areas differed significantly between the endpoints of this gradient. Our findings demonstrate that removal of predators may strongly affect prey species' behavior and the resultant benthic community structure in ways not predicted from simple relative abundance changes.

THE UPS AND DOWNS OF TROPHIC CONTROL IN CONTINENTAL SHELF ECOSYSTEMS Frank, Kenneth, Brian Petrie, NANCY SHACKELL

Investigators have lamented that studies involving exploited marine ecosystems have reached no consensus on how animal abundances and productivities are controlled, with apparent demonstrations of both top-down and bottom-up controls. Long time series of scientific survey data, underpinning the management of commercially exploited species, is now being widely utilized in the diagnosis of potential structuring mechanisms of marine food chains. Data from twenty six studies in eighteen exploited ecosystems in the North Atlantic, against a backdrop of latitudinal gradients in species richness and temperature, were used to illustrate the existence of pronounced geographical variation in the type of trophic forcing. While very cold and species-poor areas may readily succumb to top-down control, frequently leading to the formation of trophic cascades, warmer areas with more species may oscillate between top-down and bottom-up control dependent on exploitation rates and temperature regimes. Given that top-down or bottom-up control reflects not only resilience to fishing, but also the underlying level of exploitation, we develop a quantitative relationship linking exploitation, species richness and ocean climate variability. The analysis provided a direct measure of the limits to fishing necessary to prevent top-down forcing, leading to the potential development of trophic cascades, in different marine systems.

COLLATERAL EFFECTS OF SEA OTTER EXTIRPATION AND RE-INTRODUCTION ON TEMPERATE MARINE REEF FISH POPULATIONS MARKEL, RUSSELL, Stefan Dick

Extirpation of top predators that initiate trophic cascades can have substantial collateral effects on populations dependent upon producer-derived resources, but these effects have received little attention. Kelp forests worldwide provide critical nursery habitat for many temperate reef fishes and are often regulated by the abundance of herbivorous sea urchins. We investigated the effects of sea otter *Enhydra lutris* extirpation on juvenile black rockfish *Sebastes melanops* populations, via sea urchins *Strongylocentrotus franciscanus* and kelp forests *Macrocystis integrifolia*, along the west coast of Vancouver Island, Canada. We compared juvenile black rockfish recruitment rates, density and growth, and the abundance of juvenile rockfish predators and prey, between sites with and without sea otters. Where otters are present we found that urchins are rare, *Macrocystis* forests are up to 50 times larger, and juvenile black rockfish densities are more than five times greater than at sites where otters are absent. However, visual surveys also revealed higher densities of both juvenile rockfish predators and prey in small *Macrocystis* forests where otters are absent. We conclude that extirpation of otters indirectly reduced *Macrocystis* forests to remnant patches of sink habitat, resulting in compressed communities with substantial implications for interaction strength and, therefore, juvenile black rockfish growth and survival.

THE EFFECTS OF FISHING ON CORAL REEF COMMUNITIES: EVIDENCE FROM EXPERIMENTS, OBSERVATION AND META-ANALYSIS SMITH, JENNIFER

The activity of fishing across the globe is known to cause widespread declines in both target and non-target species. However, whole ecosystem consequences of overfishing are less well understood. On coral reefs extirpation of fishes (most notably herbivores) has been shown to cause significant changes in benthic community composition where reef building corals are often replaced by fleshy algae. Here I will provide evidence for the negative effects of fishing on reef communities using several different approaches. First, results from a long-term experiment has shown that fish removal can significantly alter both the structure and the function of benthic reef communities but that restoration of herbivore populations can rapidly shift the community back to a healthy state. Second, data from a large-scale survey across the Line Islands in the central Pacific clearly indicates that benthic communities decline in coral cover and ecosystem resilience with increasing fishing pressure. Lastly, the first meta-analysis on the effects of fishing on benthic reef communities shows that regardless of region, herbivore loss enhances fleshy algal abundance and preclude coral dominance. Finally, overfishing can severely affect both the structure and function of coral reef ecosystems but with proper management, restoration and recovery may be possible.

SETTING AN ECOLOGICAL BASELINE FOR CORAL REEFS: INSIGHTS FROM THE NORTHERN LINE ISLANDS SANDIN, STUART

Most insights into the ecology of coral reef communities are derived from studies of anthropogenically-impacted systems. As such, we lack both a fundamental understanding of reef functioning without human disturbance and an ecological baseline for conservation and restoration efforts. To address this lacking, we quantified the biodiversity and trophic structure of the coral reef communities, from microbes to sharks, around four of the northern Line Islands in the central Pacific Ocean. Within one biogeographic region, these islands span a broad range of anthropogenic disturbance, from intense fishing pressure and nutrient input to essentially pristine with no historic human influence. Anthropogenic disturbance affected the reef ecosystems in two principal ways. (i) Local human impacts, in particular fishing, directly reduced the total biomass and changed the trophic structure of the fish community, and indirectly increased algal biomass and incidence of coral disease. (ii) Global human impacts, in particular climate change, appear to have reached even these remote reefs causing coral mortality. However, we found that the ability of reefs to recover from global warming events is increased through the reduction of local impacts. The information synthesized in this multidisciplinary study will guide the management of both healthy and degraded coral reef systems.

OVERVIEW OF THE EVIDENCE FOR TERRESTRIAL TROPHIC CASCADES: DO GENERALITIES EXIST? GRUNER, DANIEL

I use case studies and meta-analyses to review the assertion that trophic cascades – indirect positive effects of carnivores on plant biomass – are less prevalent on land relative to aquatic systems. Terrestrial trophic interactions are decoupled by reticulate multi-channel food web structure, by selectively feeding consumer individuals with body sizes smaller than their resources, and by slow turnover of recalcitrant organic matter and detritus with high carbon:nutrient ratios. Most experimental tests of terrestrial trophic cascades have manipulated insectivorous vertebrates or invertebrates and have documented species-level cascades, where the indirect effects of predators are shown for one or a few plant species. Large endothermic herbivores, many of which carry symbionts that can process C-rich or defended plant tissues, can have dramatic impacts on vegetation biomass, productivity, diversity and composition. However, ecosystem-scale experimental tests are vanishingly rare in terrestrial systems. Indirect evidence for ecosystem-wide cascades driven by large bodied carnivores comes from time series analysis, correlative analysis of biomass patterns on islands varying in predator density, and by piecing

together data from herbivore exclusions and historical vegetation records. A global 'natural' experiment of top predator extirpation is underway, presenting both the opportunity and the urgency to understand cascading indirect effects over large temporal and spatial scales.

CASCADING EFFECTS OF REDUCING APEX PREDATORS FROM A TROPICAL ECOSYSTEM IN THE GULF OF CARPENTARIA, AUSTRALIA
GRIFFITHS, SHANE P, Thomas A. Okey

Cascading effects emerge commonly from trophodynamic models of marine biological communities when fisheries or other disturbances are simulated to increase or decrease from status quo levels. Such modelling explorations can provide provocative insights into the ecological effects of fishing, or climate changes, or other disturbances on whole community levels, as well insights into the structure and regulation of biological communities. A key challenge in such modelling explorations is to adequately simulate factors that would dampen such cascading effects in the real world, and to adequately combine these modelling endeavours with empirical studies that explore these dynamics independently. An example is described using a trophodynamic model developed for the Gulf of Carpentaria, Australia to explore the impacts of shark depletions caused by finning from illegal foreign fisheries. Model simulations using various scenarios indicate trophic cascades that may adversely affect legal domestic fisheries and the broad ecological community, if they really do manifest.

Examining the link between biodiversity and human health

INTERDISCIPLINARY RESEARCH INITIATIVE TO EXAMINE THE LINKS BETWEEN BIODIVERSITY AND HUMAN HEALTH
ROMAN, JOE, Montira Pongsiri

Research on the links between biodiversity loss and the emergence and reemergence of infectious disease can have an important impact on how we manage the services provided by natural ecosystems. The National Center for Environmental Research at the U.S. Environmental Protection Agency has initiated a new interdisciplinary research program to study the links between changes in biodiversity and risks to public health. The initiative is aimed at characterizing the underlying mechanisms of disease emergence using an interdisciplinary approach, involving experts in public health, ecology, social sciences, and remote sensing. Case studies to be discussed include the role of biodiversity in diluting the transmission of vector-borne diseases to humans; habitat alteration and increased risk of vector-borne diseases such as malaria; spatial analysis of the correlation between biodiversity loss and the emergence of new diseases; possible applications of new knowledge for observation and early warning systems; biological invasions and the spread of infectious diseases; and the potential effects of climate change on biodiversity and human health. Research questions will be identified that can advance knowledge and yield findings that can be used by managers to protect both health and environment.

ANTHROPOGENIC DISTURBANCE AND DISEASE TRANSMISSION AMONG PEOPLE, PRIMATES, AND DOMESTIC ANIMALS IN KIBALE NATIONAL PARK, WESTERN UGANDA
GOLDBERG, TONY, Thomas R Gillespie, Innocent B Rwego, Colin A Chapman

Infectious diseases transmitted among wild non-human primates, people, and domestic animals represent a growing threat to wildlife conservation, as well as to human and animal health. The Kibale EcoHealth Project is a multidisciplinary study of the ecology of infectious disease transmission among people, primates, and domestic animals in western Uganda. Primates in disturbed forest fragments are undergoing extinction, and this is accompanied by increased contact rates with people and their domestic animals. Gastrointestinal helminth and protozoan infection prevalence and intensity are higher for primates living in disturbed forest fragments than for primates living in undisturbed forests, and goats and sheep are likely sources and conduits of

infection. Molecular analyses indicate that people interacting with primates in disturbed habitats are at increased risk of exchanging bacterial pathogens with those primates. The magnitude of the risks of disease transmission among primates, people, and domestic animals appear to depend upon the degree of disturbance of the habitats in which these species interact. These results should be generalizable to other locations where people and primates interact in fragmented landscapes, and they provide guidance for conservation strategies aimed at improving human health, domestic animal health, and the health and conservation of wild primates and their habitats.

ADDRESSING WILDLIFE, LIVESTOCK AND RELATED HUMAN AND ECOSYSTEM HEALTH ISSUES IN SOUTHERN AFRICAN TRANSFRONTIER CONSERVATION AREAS

Cumming, David, MICHAEL KOCK, Steven Osofsky

Transfrontier conservation area (TFCA) development in sub-Saharan Africa provides an exceptional opportunity to more comprehensively evaluate the interface between wildlife, livestock, human communities and varied social-ecological systems in terms of health and the provision of ecosystem goods and services; and in so doing to work towards sustainable improvements in human health and livelihoods from local to regional scales. Furthermore, there is an opportunity to establish a framework that fosters a synergistic partnership between farmers, natural resource managers and researchers on one hand, and government and non-governmental agencies involved in animal and human disease control, conservation, agriculture and rural development on the other. Issues fundamental to sustained TFCA success include: a. What are the alternative scenarios for the development of these large semi-arid areas covering a wide range of land-use and tenure systems? b. The various trade-offs that each plausible scenario would entail, namely, those among (i) alternative land uses, (ii) alternative production and livelihood options, (iii) the consequences of alternative development options on biodiversity conservation and ecosystem goods and services, (iv) the consequences of alternative disease management strategies and investment choices for livelihood options, and (v) the risks of alternative development choices or paths to achieving sustainability.

TB, OR NOT TB? UNDERSTANDING THE ROLE OF ZOONOTIC TUBERCULOSIS AT THE WILDLIFE, LIVESTOCK, HUMAN HEALTH INTERFACE IN AFRICA

GEOGEHEGAN, CLAIRE, Wayne Getz, Mark Robertson, Jacques Godfroid, Elissa Z Cameron

Mycobacterial tuberculosis (TB) is an ancient pathogen with a global distribution that leads to ~3 million deaths per annum. As > 90% of Africans have potentially been exposed to the bacteria, controlling the spread of TB is a priority both for public health and regional development. Furthermore, the concomitantly high incidence of HIV/AIDS and mortality due to TB/HIV co-infections has had a dramatic impact on communities, social development, and economic systems throughout sub-Saharan Africa, leading to concern for the long-term viability and success of regional conservation programmes. Although efforts to monitor and control tuberculosis in wildlife populations have increased over the past decade, the role and transmission of zoonotic TB in wildlife, livestock, and human populations have received little attention and remain poorly understood. As 80% of populations live in areas external to disease-control measures and health services, quantifying the practical risk factors and potential for TB transmission is now crucial for planning successful conservation programmes and ensuring biodiversity health. This paper reviews the latest research on bovine tuberculosis (BTB) in Africa, and outlines the risk and implications of zoonotic disease on conservation, community health, and park management in an era dominated by HIV/AIDS and the development of trans-frontier parks.

HEALTH FOR ANIMALS AND LIVELIHOOD IMPROVEMENT (HALI) IN THE RUAHA ECOSYSTEM, TANZANIA

CLIFFORD, DEANA L, Rudovick Kazwala, Peter Coppolillo, Dominic Kambarage, Titus Mlengeya, Jon Erickson, Jonna A.K. Mazet

HALI is a stakeholder-driven research and capacity-building program to assess the effects of zoonotic disease and water management on animal health, biodiversity and livelihoods in the Ruaha ecosystem, Tanzania. This biologically diverse and economically important region is seriously threatened by seasonal drying of the Great Ruaha River. Primary drivers reducing river flow are uncontrolled agricultural water diversions and intensive livestock grazing. Restricted water flow, degraded water quality, and increased interactions between livestock and wildlife may facilitate disease transmission and illness in animals and people, thereby reducing livestock productivity, wildlife tourism potential, and threatening sensitive species. Specifically we will 1) determine the prevalence and transmission ecology of bovine tuberculosis, brucellosis, and water-borne pathogens among wildlife, livestock, and pastoral communities; 2) assess the effects of water management and quality on the presence, abundance, and severity of disease; 3) assess how water management and disease affect the health and economic livelihoods of agropastoral and pastoral communities; and 4) identify and recommend measures to mitigate the effects of zoonotic diseases and water limitations on rural communities. This ecosystem-level health approach can serve as a model for other regions where water availability is diminishing and zoonotic diseases are impacting rural communities sharing resources with wildlife.

EARTH AND SOCIETY INITIATIVE: INTEGRATING RESEARCH, EDUCATION, AND OUTREACH IN EMERGING DISEASE AND ECOSYSTEM HEALTH

GILLESPIE, THOMAS, Tony Goldberg

The Earth and Society Initiative in Disease Emergence and Ecosystem Health coordinates research, education, and outreach activities of a diverse assemblage of University of Illinois centers, programs, laboratories and individuals whose interests converge at the interface of emerging infectious diseases, anthropogenic environmental change, and biodiversity conservation. Initiative research projects examine such diverse topics as how and why anthropogenic changes to tropical forests place people, livestock, and wildlife living in such ecosystems at increased risk of pathogen exchange; microbiological and environmental influences on coral black band disease, and cultural and ecological drivers of infectious disease emergence. Initiative education and outreach programs strive to improve biodiversity and health through international training and capacity building in epidemiology. In addition, the initiative's EnviroVet Program works to provide professional and graduate students with skills and expertise to identify and solve environmental problems that affect the health and well-being of people, domestic animals, wildlife and ecosystems.

SCAVENGERS - A SENSITIVE ECOTOXICOLOGICAL INDICATOR AT THE WILDLIFE-HUMAN-LIVESTOCK INTERFACE

KOCK, RICHARD

Secondary poisoning of wildlife is usually associated with rodenticides, herbicides, pesticides and environmental contamination with metals and hydrocarbons. More recently pharmaceuticals in the environment have become a concern. Diclofenac, a non-steroidal anti-inflammatory drug for use in humans and domestic animals has shown that environmental contamination with drugs and other biologically active substances can impact all biotic levels. The affected species in this case were the *Gyps* vultures in Asia. This ongoing event has opened a new chapter of concern in eco-toxicology, conservation, veterinary and human medicine. The delay in recognizing environmental contamination in any species is a concern, especially as drugs become generic and hard to control. Environmental indicators are necessary to give early warning of a problem. Scavengers are a useful group of animals in this context as they seek out every opportunity to gain food from human or domestic animal waste (including carcasses) and are high up in the food

web, acting as bio-accumulators of toxins. They may show evidence of biologically active substances through altered physiology, pathology, and changing population demography.

Food webs: The ultimate scientific challenge to conservation biology

PARASITES DOMINATE FOOD WEB LINKS

LAFFERTY, KEVIN, Armand Kuris, Andy Dobson

Parasitism is the most common animal lifestyle, yet food webs rarely include parasites. The few earlier studies have indicated that including parasites leads to obvious increases in species richness, number of links, and food chain length. A less obvious result was that adding parasites slightly reduced connectance, a key metric considered to affect food web stability. However, reported reductions in connectance after the addition of parasites resulted from an inappropriate calculation. Two alternative corrective approaches applied to four published studies yield an opposite result: parasites increase connectance, sometimes dramatically. In addition, we find that parasites can greatly affect other food web statistics, such as nestedness (asymmetry of interactions), chain length, and linkage density. Furthermore, whereas most food webs find that top trophic levels are least vulnerable to natural enemies, the inclusion of parasites revealed that mid-trophic levels, not low trophic levels, suffered the highest vulnerability to natural enemies. These results show that food webs are very incomplete without parasites. Most notably, recognition of parasite links may have important consequences for ecosystem stability because they can increase connectance and nestedness.

FUNCTIONAL LINKS AND ROBUSTNESS IN ECOLOGICAL NETWORKS

ALLESINA, STEFANO, Mercedes Pascual

The structure of interactions in food webs is critical to questions of secondary extinctions. Early on, MacArthur (1956) proposed that high complexity results in a multiplicity of pathways connecting each consumer to the producers, decreasing the effects of prey fluctuations on their predators. Although this argument was proven wrong from the perspective of local stability (May, 1972), it must be re-evaluated in light of recent advances on the more general question of robustness and secondary extinctions. Secondary extinction refers here to the loss of a species in response to a previous extinction event. Most studies of robustness have focused so far on the role of the highly connected species under the assumption that they are the most important players in the network. We revisit here MacArthur's argument with an approach that identifies the contribution of links to robustness. The algorithm separates connections that create alternative pathways from producers to focal species from those that play no functional role and can be severed without altering robustness. Results show that around 90% of the links in empirical webs do contribute to network robustness. This proportion appears constant across a variety of systems. It follows that any disturbance of an ecosystem modifying its pathways will reduce its robustness with a 90% probability. Results also show that local quantities, such as the number of links of each species, are inadequate measures of species' importance.

FOOD WEBS AND ECOSYSTEM SERVICES: HOW DO THEY COLLAPSE?

DOBSON, ANDY

How do food webs collapse? Predictably, or at random, as the rivets pop out of the superstructure? If they collapse predictably, will ecosystem services collapse in predictable ways? Do food-webs collapse in the opposite way they assemble? Is there any evidence for food-web hysteresis? I think these are probably the key questions for Conservation Biology in the 21st Century; yet they hardly appear on anyone's radar screen. In this talk I'll provide a mixture of theoretical and empirical answers to some of these questions; I'll partly draw on the information presented in the other talks in the symposium, but mainly to emphasize that the next generation of studies in conservation biology need to consider an understanding of trophic interactions and

food-web structure as central to the development of long term management strategies for natural communities and habitats. Hopefully this will stimulate some discussion to conclude the symposium.

QUANTIFYING THE IMPORTANCE OF SPECIES: KEY PLAYERS IN INTERSPECIFIC INTERACTION NETWORKS FERENC, JORDÁN

Various species are of different importance in maintaining ecosystem functions. One major aspect of importance is how large is the overall effect of the focal species on all other members of the community. This is not easy to quantify but we may expect important species to be in critical positions of interspecific interaction networks. I call these species topological keystone species. I present (1) network analytical techniques for determining topological keystone species in real food webs, (2) the statistical relationships between available methods and (3) how positional importance in networks can be quantified also for groups of species. Although network analysis is of limited value (for not considering population dynamical parameters), its strengths are that it is a holistic, quantitative and predictive approach to help setting conservation priorities. I suggest that if the reality of network-based, structural models will be improved in the future, we can shift the focus of conservation efforts from rarity to importance.

FOOD WEBS: HOW DOES NATURE CONSTRUCT THEM, AND CAN WE CONSTRUCT NEW ONES? Pimm, Stuart, GARETH J. RUSSELL

We present a simple framework for allowing species relationships in a food web to evolve, and examine the implications of this for food web development. These relationships are represented by a strategy matrix. The familiar interaction matrix of the generalized Lotka-Volterra model is derived from the strategy matrix by a function inspired by game theory. The framework requires only four, global parameters: a trophic efficiency constant, a cooperation benefit constant, and two cost multipliers representing the relative cost of using a given strategy in any given interaction. We demonstrate that the framework successfully reproduces both theoretical and experimental results in one- and two-species systems. The goal of the framework, however, is to be straightforwardly scalable to multi- species communities. We examine whether assembling and evolving model communities exhibit, as emergent properties, any of the characteristics of real food webs, such as right-skewed abundance and degree distributions. The ability to explain how and why communities develop certain properties over time is of immediate relevance to the increasing number of conservation efforts that attempt to preserve ecological and evolutionary processes.

THE CAUSES AND CONSEQUENCES OF MARINE MAMMAL POPULATION DECLINES IN SOUTHWEST ALASKA ESTES, JIM A, D.F. Doak, A.M. Springer, T.M. Williams

In recent decades, populations of harbor seals, northern fur seals, Steller sea lions, and sea otters have declined markedly over a large area of the North Pacific Ocean and southern Bering Sea. Food webs provide a useful construct for exploring the causes and consequences of these changes. We focus on the functional significance of large apex predators as keystone species via top-down forcing, trophic cascades, indirect food web effects, and spatial linkages across ecosystems. We take this perspective because the sea otter decline appears to have been caused by increased killer whale predation, leading in turn to a sea urchin population explosion, the resulting kelp forest collapse, and a variety of physiological, behavioral and demographic responses to these changes in other consumers. The seal and sea lion declines are reasonably well described but more poorly understood. Patterns observed in sea otters and kelp forests

provide a useful template for understanding the proximate causes and consequences of the pinniped declines. Ultimately, the pinniped and sea otter declines have been ascribed at one time or another to three quite different causal factors: climate change, fisheries, and whaling. We describe the purported mechanisms and summarize the alleged evidence for each. Finally, we use a demographic/energetic modeling approach to further evaluate arguments for and against the whaling hypothesis. Specifically, we explore the dietary range over which a population of transient killer whales and its marine mammal prey would be sustainable, now and before whaling. We conclude that the food web dynamics is highly sensitive to relatively small dietary changes in killer whales; the predator-prey system involving transient killer whales and their marine mammal prey is unsustainable without large whales or some non-mammalian prey resource; and the spatial scale of significant food web linkage is vast, perhaps including the entire ocean basin.

THE STRUCTURE AND ROBUSTNESS OF COEVOLUTIONARY NETWORKS BASCOMPTE, JORDI

The mutualistic interactions between plants and the animals that pollinate them or disperse their fruits have molded the organization of Earth's biodiversity. Recently, it has been shown that these interactions can form complex networks involving dozens and even hundreds of species. These coevolutionary networks are highly heterogeneous, nested, and asymmetric. I will follow by exploring to what extent past evolutionary history conveyed in the phylogenies of plants and animals can explain these network patterns and the robustness of the network to species extinctions. Because phylogenetically similar species tend to play similar roles in the network, extinction events trigger non-random coextinction cascades. This implies that taxonomic diversity is lost faster than expected if there was no relationship between phylogeny and network structure. These results illustrate how the simultaneous consideration of phylogenetic information and network structure can aid in the conservation of biodiversity.

TERRESTRIAL TROPHIC CASCADES OPERATE THROUGH MULTIPLE PARALLEL PATHWAYS TERBORGH, JOHN

Habitat fragmentation is a subject that has attracted the intense interest of conservation biologists for more than 30 years. Distracted by the nearly irresistible analogy of habitat fragments to islands, investigators have tended to focus more on the physical parameters of a given system – fragment size and isolation – than on biological mechanisms that are distorted by area restrictions and altered dispersal. Recently created islands in a hydroelectric reservoir, Lago Guri, Bolivar State, Venezuela, provided isolated fragments of tropical dry forest in which to study the cascading effects of predator loss on simplified trophic webs. Area restriction in the absence of predators results in profound distortions of consumer guilds, some becoming underrepresented (pollinators, seed dispersers) while others become overrepresented (seed predators, herbivores). Distortions in these guilds can cascade to the producer level via both direct and indirect pathways, primarily affecting plant recruitment with less immediate effects on plant mortality, composition and biomass. These results suggest that habitat fragmentation leads inexorably to the unleashing of trophic cascades and the simplification of ecosystems, although the pace and extent of change is scale dependent and likely to be regionally idiosyncratic.

Freshwater conservation assessment, planning, governance and management

CATCHMENT NETWORKS FOR THE CONSERVATION OF FRESHWATER FISH SPECIES: AN EVALUATION OF SELECTION CRITERIA

DARWALL, WILLIAM, Kevin Smith

Freshwater ecosystems are one of the most threatened. Conservation planners need to identify and prioritise where limited resources for conservation of freshwater biodiversity might be most effectively applied. A key requirement is to identify which sites, or in this study catchments, should be included in a network to be managed for species conservation. We evaluate selection criteria for building such networks. The study is based on datasets for the distribution and threatened status of freshwater fishes endemic to Eastern and Southern Africa and to the Mediterranean Basin. Quantitative thresholds for two selection criteria based on irreplaceability (restricted range species) and vulnerability (species assessed as threatened according the IUCN Red List Categories and Criteria) are applied and the nature of the resulting catchment networks is evaluated. Regional networks of catchments, selected through inclusion of catchments holding species with distribution ranges of less than 1,000 km² and/or species assessed as Critically Endangered and/or Endangered, cover an average of 25 % of the total land area in each region. The high proportion of catchments included in the networks tells us that, on the basis of these two criteria, considerable effort must be directed into catchment management for species conservation if we are to maintain the diversity of freshwater fishes.

POLICY FRAMEWORK FOR CROSS-SECTOR COHERENCE AND COOPERATION IN CONSERVING FRESHWATER ECOSYSTEMS

ROUX, DIRK, Jeanne Nel, Peter Ashton

The mandate for managing and conserving freshwater ecosystems is commonly distributed among several government agencies in different spheres or tiers of government, resulting in inevitable overlaps. This situation gives rise to gaps and inconsistencies in management and regulation frameworks, particularly since many of the agencies tend to operate independently within their area of mandate. Without a concerted effort to achieve vertical (from global to local levels) and horizontal (across relevant sectors at each of the levels) coherence in intent and actions, the current downward trend in the state of inland water ecosystems is likely to continue. A facilitated process was designed to engage national-level agencies and departments of government with responsibilities spanning the fields of water resource management and protection, biodiversity conservation, sustainable use of agricultural resources, and integrated development planning. During the engagement process, a remarkable convergence in thinking led to the development of a hierarchical policy framework that links a national goal for freshwater conservation, through a set of cross-sector policy objectives and implementation principles, with operational policy recommendations. This paper reflects on the outcomes of a cross-sector policy process, including the reality of different policy contexts, the role of best available science, and the need for understanding cooperation as a strategy.

INCORPORATING NATURAL PROCESSES INTO FRESHWATER CONSERVATION ASSESSMENT AND PLANNING

NEL, JEANNE, Dirk Roux, Lindie Smith-Adao

Conservation plans that focus only on species and habitats conserve only a snapshot of the biodiversity that currently exists. If this biodiversity is to persist and evolve naturally over time, it is also necessary to consider the underlying natural processes that maintain and generate this pattern. This is particularly true of freshwater ecosystems, where the maintenance of biodiversity pattern depends on how well upstream, downstream and upland processes are managed. Natural processes take the form of ecological processes (those processes which maintain ecosystem structure and function) and evolutionary processes (those processes which maintain lineages and

generate biodiversity over the long term). This paper will examine some of the key ecological processes that are necessary to maintain to conserve freshwater biodiversity effectively. It will then discuss how some of these natural processes can be given due consideration in freshwater conservation plans by (i) mapping spatially explicit processes to depict critical management zones in which adverse impacts need to be particularly well-managed to maintain ecological connectivity and integrity; and (ii) building processes into the design of a conservation portfolio by considering ecological condition and connectivity. The paper will draw on case studies within South Africa to provide examples.

PLANNING FOR BIODIVERSITY CONSERVATION ON THE AMAZON'S VÁRZEA FLOODPLAINS: EXPLORATORY ANALYSES OF ALTERNATIVE SCENARIOS PRESSEY, ROBERT, Malcolm Ridges, Ana Albernaz, Matthew Watts

Our work on conservation planning for the várzea (whitewater) floodplains of the lower and middle Amazon is attempting to deal with biodiversity pattern and process. Biological data in the várzea are sparse and highly biased geographically and taxonomically. Therefore, to provide a consistent picture of biodiversity pattern, and based on literature and advice from experts, we developed a spatial framework of surrogates that reflect the major factors known to determine species distributions in the region. The framework is a system of floodplain subdivisions based on major longitudinal zones, local variation in flood depths, structural vegetation units, river confluences, and areas influenced by small, lateral catchments. Three other fixed surrogates are intended to reflect the processes of species movements between the várzea and associated environments. These are the várzea interface with *terra firme*, *terra firme* biogeographic subregions defined by river barriers, and lateral blackwater and clearwater tributaries. We added design requirements related to compactness of conservation areas and cost surfaces reflecting proximity to existing reserves and deforestation. To test the utility of the surrogates and the design requirements, we developed 320 conservation scenarios and compared them quantitatively according to various criteria. The results will inform work to refine the surrogates and guide subsequent interactive planning involving stakeholders in the region.

THE INTERFACE BETWEEN SYSTEMATIC CONSERVATION PLANNING AND ADAPTIVE MANAGEMENT – APPROPRIATE GOVERNANCE OF MONITORING AND EVALUATION BIGGS, HARRY, Kevin Rogers, Stephen Holness

Systematic conservation planning, although now widely used, tends to produce plans that are handed over as blueprints for ongoing management - without any real attempt at ongoing feedback, learning or adaptation. At the same time, some serious attempts at implementing strategic (forward-looking) versions of adaptive management in existing conservation areas and catchment surrounds, especially in a freshwater context, treat the management of ecosystems as an activity taking place in an unplanned environment, or at least, in a land mosaic not benefiting from or requiring modern systematic conservation planning. This disjunct between these central themes or tools of conservation suggests that the two processes will benefit from better meshing. This paper will deal with monitoring and evaluation as linking techniques to embed adaptive management, so that both the systematic planning itself and its unfolding sequelae in the landscape, can be considered adaptive. Conversely, it will examine how existing adaptive management techniques applied in freshwater conservation can be strengthened by improving their systematic planning basis. Examples will be used, drawn mainly from the lowveld area of north-eastern South Africa, to show how difficult but important it is, to attain such aspirations. Although it is fairly obvious how the interlinkages should promote this unification, governance proves key to implementation.

DESIGNING PROTECTED AREAS TO CONSERVE RIVERINE BIODIVERSITY: LESSONS FROM A HYPOTHETICAL REDESIGN OF THE KRUGER NATIONAL PARK

ASHTON, PETER, Devlyn Hardwick, Liesl Hill, Neels Kleynhans, Juanita Moolman, Jeanne Nel, Dirk Roux, Bob Scholes

The process of designing Protected areas (PAs) to include appropriate representatives of all ecosystems is becoming increasingly sophisticated, though PAs seem to be less effective at adequately representing aquatic biota. This study examined the conservation of riverine biodiversity within seventeen drainage regions formed by five perennial rivers flowing through the Kruger National Park (KNP) and two seasonal rivers contained within the KNP. Physical river types, fish species and invertebrate families were used as biodiversity surrogates. Conservation planning software was used to select an optimal set of planning units to represent and maintain riverine biodiversity. The current extent of the KNP has a particularly poor spatial configuration when assessed against the objective of conserving riverine biodiversity. Several alternative designs were examined but current realities suggest that these options are only theoretical since there is little opportunity to include these land parcels within a formal Protected Area (PA). This study has shown that while PAs can reduce riverine habitat degradation and biodiversity loss, they are only partially successful in efforts to conserve representative samples of riverine biodiversity. Explicit conservation visions, targets and strategies need to be included in integrated water resource management plans.

REGIONAL FRESHWATER BIODIVERSITY CONSERVATION PLANNING: DEFINING VISIONS FOR SUCCESS AND MEASURES OF CONSERVATION STATUS

HIGGINS, JONATHAN

Visions for freshwater biodiversity conservation success focus limited and critical conservation resources. These visions provide a suite of lakes, streams and wetlands that contribute to conserving the biodiversity representative of a freshwater ecoregion, basin or other regional assessment units in an efficient and connected configuration. Abundance and distribution goals for selected species and representative ecosystems (conservation targets) determine what is necessary to achieve success, and shapes the vision. A solution set for a conservation vision is developed through evaluating biodiversity condition and landscape context, threats, and current management and protection activities across the planning region. The Nature Conservancy has developed a framework for evaluating conservation status and has piloted applications to terrestrial biodiversity. This framework calculates levels of effective conservation through combining measures of biodiversity status, threats and conservation management intent and effectiveness. I will present an approach to apply this framework to a freshwater biodiversity vision to calculate the proportion of aquatic biodiversity and habitat under effective conservation. I will also show how these measures can be used to evaluate the potential regional contributions of different strategies to improve the conservation status of biodiversity and habitats.

DO FRESHWATER AND TERRESTRIAL PRIORITIES OVERLAP IN CONSERVATION ASSESSMENTS?

AMIS, MAO ANGUA, Rouget Mathieu, Lotter Mervyn, Jenny Day

Systematic conservation planning seeks to prioritize ecosystems for conservation action in the face of limited resources. However, conservation planning procedures do not often take a holistic approach in identifying priority areas across ecosystems. In this study, we tested different scenarios for integrating the assessment of freshwater and terrestrial assessments. We also determined the degree of spatial overlap between freshwater and terrestrial priorities. Some of the parameters tested for each scenario include, their potential to achieve set biodiversity targets, total area required and the cost of the conservation portfolio. Jaccard's coefficient of dissimilarity was used to compare the different scenarios. It was found that assessing freshwater priorities alone using sub-catchments as planning unit was the most efficient in capturing both

freshwater and terrestrial priorities. Overall we found a 20% overlap between freshwater and terrestrial priorities. It's thus recommended that conservation planning in multiple ecosystems should first aim at capturing areas where there is a spatial overlap between priority areas in the different ecosystems.

USE OF BENTHIC MACROINVERTEBRATES TO ASSESS THE CONSERVATION STATUS OF STREAMS AND RIVERS IN THE ALBERTINE RIFT REGION OF UGANDA KASANGAKI, AVENTINO, Vincent Resh, Lauren Chapman, Willy Gandhi, Pabious Otika, Richard Muhabwe

Streams and rivers in Uganda are undergoing rapid degradation, yet there are no standard methods for measuring and monitoring the ecological health of these fragile ecosystems. In collaboration with the Ugandan Wildlife Authority, we therefore trained park rangers in rapid bioassessment methods to assess the ecological health of wadable streams in five protected areas and surrounding areas within the Albertine Rift region of Uganda. In addition, rangers were trained to carry out habitat assessments to link terrestrial and aquatic ecosystem change. Metrics calculated from the data reveal that ranger-collected data can be used effectively to assess the status of freshwater resources in protected areas at low cost. For example, metrics such as number of taxa and EPT were efficient at separating sites according to level of stream degradation. And, high habitat assessment scores were an indicator of good quality stream habitat. We conclude that metrics derived from benthic macroinvertebrates may be a valuable tool for assessing the conservation status of streams and rivers and for revealing important linkages between terrestrial and aquatic ecosystem health. However, the metrics need to be standardized to be applicable over a large scale. Given the fact that protected area rangers are spread throughout the country, ranger training programs present an opportunity to effectively monitor the health of freshwaters over a large area with minimal costs.

FRESHWATER PROTECTED AREAS: OXYMORON, SOLUTION, OR BOTH? ABELL, ROBIN, Michele Thieme

Protected areas (PAs) have traditionally been a core strategy for terrestrial biodiversity conservation, and they have emerged more recently as important in the marine realm. PAs have typically been absent from discussions of freshwater biodiversity conservation. Given freshwater systems' embeddedness in the larger landscape and the need to manage entire watersheds, the highly connected nature of many systems, and human requirements for access to water resources, freshwater PAs have often been dismissed as impractical or a distraction from larger integrated river basin management (IRBM) efforts. A 2006 workshop of international experts addressed the questions of whether, when, and how PAs can contribute to freshwater biodiversity conservation, and concluded that there is untapped potential for this type of place-based strategy. This presentation will address key questions related to freshwater PAs, including whether standard PA definitions should be modified for freshwaters; whether freshwaters are adequately represented within existing PA networks; whether existing PAs actually conserve the freshwaters within them; what types of place-based strategies might qualify as freshwater protected areas; how PAs fit within IRBM efforts; and how freshwater, terrestrial, and marine biodiversity might be conserved simultaneously through integrated PAs.

FRESHWATER CONSERVATION PLANNING METHODS TO DATE VANCE-BORLAND, KEN

Concepts and techniques of systematic regional assessment and planning for sustaining biodiversity have advanced considerably in recent years, but most research on the topic has focused on terrestrial species and ecosystems. However, it is unlikely that lakes, wetlands, and hierarchical, dendritic stream networks, with species and ecosystem processes so distinctly

different from their terrestrial counterparts, can be adequately assessed and conserved using only those methods developed for terrestrial ecosystems. Conservation planning for freshwater systems is immature in comparison to that for terrestrial systems, in part because of a paucity of freshwater biodiversity data and in part because of underdeveloped methodology. I give examples of recent freshwater conservation planning and suggest needed advances in several areas including: 1) aquatic biodiversity pattern (needs high-resolution stream mapping, remote sensing techniques for freshwater systems, spatial statistics for stream networks, species and habitat distribution modelling); 2) aquatic ecosystem processes (longitudinal and lateral connectivity, natural disturbances); 3) threat assessment (spatially explicit population viability analysis, trans-boundary flows, blockages to functional connectivity); 4) conservation network design (conservation planning software for stream networks); and 5) implementation (integration with terrestrial and marine planning).

IDENTIFYING MANAGEMENT PRIORITIES FOR RIVERINE LANDSCAPES: INTEGRATION LINKE, SIMON, Robert L. Pressey, Robert C. Bailey, Richard H. Norris

Based on observed and modelled distributions of invertebrates in the Australian state of Victoria, conservation value was measured by calculating irreplaceability for 1854 subcatchments. We estimated it with a bootstrapped heuristic reserve design algorithm, which included upstream-downstream connectivity rules. Irreplaceability (I) was then linked to condition (C) and vulnerability (V) to create the ICV-framework for river conservation planning. Condition was estimated using a stressor gradient approach (SGA), in which GIS layers of disturbance were summarised to three principal axes using principal components analysis (PCA). The main stressor gradient – agriculture – classified 75% of the study area as disturbed, a value consistent with existing assessments of river condition. Vulnerability was defined as the likelihood that land use in a catchment would intensify in the future. Hereby current tenure was compared to land capability. If a catchment would support a land use that would have a stronger effect on the rivers than its current tenure, it was classified as vulnerable. When integrating the three estimators in the ICV-framework, seven percent of catchments were identified as highly irreplaceable but in degraded condition. These were flagged for urgent restoration. Unprotected, but highly irreplaceable and highly vulnerable catchments that were still in good condition made up 2.5% of the total area. These catchments are prime candidates for river reserves.

AQUATONES AS PRIORITY NODES FOR A FRESHWATER CONSERVATION NETWORK VIERS, JOSHUA H, Joshua A. Israel

Conservation of freshwater ecosystems and ecological services requires a systematic yet flexible network of nodes to ensure biological and hydrological connectivity. At present, conservationists are faced with prioritizing freshwater protection areas with little or no a priori information on measures of biological or functional diversity. This management paradigm poses serious challenges. Based on first principles, we suggest aquatones – transitional aquatic habitats that are expressed over space or time from site to riverscape scales – as priority nodes for developing aquatic conservation networks. Aquatones include tributary junctions in rivers, littoral habitats in lakes, and salinity gradients in estuaries. Aquatones can be scaled to include transitions from pool to riffle, changes in hydraulic stream order or geomorphic regime, and changes in zoogeography. Aquatones are by definition transitional in both space and time, thus we expect higher beta diversity in classes of organisms. Aquatones, along with concomitant ecosystem processes, promote diverse life history strategies and is the foundation for biocomplexity. This is exemplified by locally adapted organisms exploiting spatial and temporal variability, thus aquatones provide the variability necessary to sustain viable populations in the face of rapid evolutionary changes. We propose that networks of hydrologically connected aquatones meet the challenge of identifying what and where to conserve aquatic biodiversity.

THE DEVELOPMENT OF A "CATCHMENT TO COAST CONSERVATION STRATEGY" FOR THE CAPE FLORISTIC REGION, SOUTH AFRICA
DE VILLIERS, PIERRE

The importance of developing and implementing integrated catchment management strategies has been recognized globally. Broad based stakeholder involvement is essential. A starter document aimed at introducing the concept within the Cape Floristic Region was developed identifying key stakeholders and highlighting existing conservation initiatives as well as impacted and threatened ecosystems. An initial technical workshop was held to assess and focus the process. During this workshop it was suggested that initially all existing catchment based GIS data should be assimilated. The role out phase should include a catchment prioritization process using specific pre determined criteria (e.g. the role a naturally functioning catchment can play in sustaining the life cycle of threatened freshwater and marine species). It was noted that estuaries form the link between terrestrial, freshwater and marine ecosystems. Estuary management plans could therefore act as drivers of the management processes within each catchment. Catchment management plans should be implemented with the aim of attaining the regional and local biological and social goals. Monitoring programmes need to be developed to monitor management interventions. These can focus on the monitoring of indicator species or charismatic flagship species. Local authorities need to be capacitated and trained with the final outcome being catchment management plans implemented at a local level but functioning within a regional or national context.

The Human Dimensions of Conserving Marine Ecosystems in the Western Indian Ocean Region

WHAT MANAGERS DON'T KNOW ABOUT RESOURCE CONFLICT AMONGST FISHERS: A CASE STUDY OF MSAMBWENI ARTISANAL FISHERS IN KENYA
KIMANI, PATRICK

A study was conducted in Msambweni in Kenya to investigate relationship between use of the ringnet fishing gear and its possible targeting of fish spawning aggregations. The major goal of the study was to understand what fishers knew about the aggregations, if the ringnet gear targets them and relationships between artisanal fishers and the ringnet fishers. Artisanal fishers appeared very discontented about ringnet fishers whom they want banned from fishing their waters for alleged misconduct. They accuse them of overfishing, destroying habitat, competing for limited fishing grounds, intimidating local fishers and displacing and destroying fishers' gears. Ringnet fishers, largely a migrant group, land their catch at Gazi village, while they fish in Msambweni. Local fishers have tried to remove them without any success, since the gear is not outlawed, but its mode of deployment is the source of conflict. This article attempts to characterize the problem and the view of the different stakeholders. The Fisheries authorities seem to have not noted the weight of the conflict and how it contributes to break of law-and-order in fisheries management at the local level. The Conflict also challenges effectiveness of the newly created Beach Management Units meant to manage conflict, regulate, control and manage fisheries and marine resources at the local level. Findings from this study will be useful in contributing ideas on regulation of the ringnet gear and conflict management.

THE POVERTY TRAP: HOW SOCIOECONOMIC FACTORS INFLUENCE EXIT FROM A DECLINING FISHERY
CINNER, JOSHUA, Tim Daw, Tim McClanahan, Selina Stead

Many communities in the Western Indian Ocean depend on fishing for income and subsistence livelihoods. However, in many areas fish catches are declining due to factors such as overfishing and the use of destructive fishing gears (such as beach seine nets and dynamite). Understanding how fishers may respond to declines in catch is a critical aspect of conservation planning. Four

hundred fishers in Kenya and Tanzania provided open-end responses to questions about their socioeconomic conditions, perceived condition of the fishery, and hypothetical responses to further declines in the fishery. Most fishers believed that the fish catch was declining, but had a range of strategies for dealing with further declines, including continuing fishing at the same level, fishing harder, changing gears or location, reducing effort or exiting the fishery. As expected, the proportion of fishers that would exit the fishery increased with magnitude of hypothetical decline in catch. However, the fishers that would remain in the fishery with a dramatic 50% reduction in catch were poorer fishers with few alternative employment options. Capital investment in the fishery, the proportion of fish catch sold, and other socioeconomic factors did not appear to be significantly related to staying in a declining fishery.

PERCEPTIONS AND FUTURE SCENARIOS OF PEOPLE'S DEPENDENCE ON CORAL REEF FISHERIES IN THE WESTERN INDIAN OCEAN

Stead, Selina, Josh Cinner, Tim Daw, TIM McCLANAHAN

Over one thousand individual face-to-face semi-structured interviews were conducted in communities throughout four countries (Kenya, Mauritius, Seychelles and Tanzania) during 2005 and 2006, to determine the perceptions and ability of people to reconcile conservation needs with sustainable livelihoods in the context of climate change, particularly coral bleaching. Most (>80%) of those interviewed perceived a decline in the number of fish in the sea and attributed this to pollution and over fishing. In the Seychelles, climate change and fish behaviour were frequently cited to play a role and this was confirmed by ecological fieldwork. In all countries, fishers and non-fishers demonstrated a good level of awareness of the laws and regulations related to conservation tools like MPAs, although non-compliance was evident and in some countries there was more focus on the effects of gear. Nonetheless, fisher's future scenarios to changes in resource abundance suggested realistic assessment of their options that were influenced by poverty and other economic incentives in their study sites.

INTEGRATING SOCIO-ECONOMIC MONITORING IN COASTAL MANAGEMENT IN THE WESTERN INDIAN OCEAN

WANYONYI, INNOCENT

Coral reefs form the basis of the livelihoods of hundreds of thousands of people in the Western Indian Ocean region; providing food and income through extractive uses such as fishing, and non-extractive uses such as tourism. For numerous poor coast households whose dependence on marine resources is very high, coral reef fisheries are often a last economic resource. Despite their importance, coral reefs in the Western Indian Ocean are under threat due to climate change, destructive fishing, pollution, sand mining, etc. Managing marine resources is about managing resource users' attitudes and behaviour rather than resources themselves. It is increasingly recognised that for resource management to be effective in the long term, MPA and fisheries management need to adapt and respond to changes in marine resource users' socio-economic context. The Socio-economic Monitoring Initiative for Coastal Managers of the Western Indian Ocean (SocMon WIO) equips coastal and marine resource managers to better understand the users' socioeconomic context, to better integrate this information in their decisions and adapt to socioeconomic changes. There are 10 sites participating in SocMon WIO initiative and this will expand to 2 more beginning 2007. These sites include three managed by MPAs, three ICM sites and four co-management or sites of special importance.

HARVESTING HIGH VALUE MARINE RESOURCES IN THE RURAL AREAS OF SOUTH AFRICA: IMPLICATIONS FOR GOVERNANCE AND PROSPECTS FOR POVERTY ALLEVIATION

RAEMAEEKERS, SERGE, Gugu Calvo-Ugarteburu, Peter Britz

Rural people living in coastal communities of the Eastern Cape Province in South Africa have been historically marginalised from the formal fishing sectors and associated economic benefits, and many are dependent on the non-commercial utilisation of natural resources to meet basic needs for livelihood. However, high value marine species such as abalone (*Haliotis midae*) and rock lobster (*Panulirus homarus*) have been targeted increasingly for commercial gain, and a largely illegal fishery has developed. National Government is currently seeking to regulate these fisheries into subsistence and small-scale commercial sectors, and aims to issue individual rights to those fishers identified in collaboration with the local fishing forums by 2007. Interdisciplinary case study research in several communities has allowed the development of a spatially referenced database, integrating i) stock assessments; ii) community-catch monitoring data; iii) independent fishery surveys; and iv) socio-economic livelihood datasets of the individual fishers and their households. The high resolution of this database illustrates the effort levels and their effect on the various fishing locations, and explains the behaviour of the individual fishers from a socio-economic perspective. Using this data we show how the national implementation process has to date been largely top-down driven, and that the current policies for small-scale fisheries management are still far from being in line with the realities on the ground.

ORGANIZING PEOPLE TOWARDS CO-MANAGERIAL ARRANGEMENTS: THE CASE FOR SMALL-SCALE COASTAL FISHERIES IN TANZANIA

MEDARD, MODESTA, Haji Machano

Community participation is increasingly being introduced as a condition for development aid in the resource management as part of the democratization process. As a result of such condition, there has been growing recognition among conservationist, managers and scientist that no management schemes will work unless it enjoys the support of human behaviors it is intended to affect. Evidence show that if a fishing community accepts the regulatory measures the responsible agency will gain legitimacy with reduced non-compliance behavior. This paper provides stakeholders perceptions from Rufiji, Mafia and Kilwa Districts in the process of establishing co-management through the formation of institutional and organizational arrangement between the government and resource users. The ideas focused on designing institutional structure, stakeholder's composition, roles and responsibilities, area of operation, leadership qualities and membership styles. The paper concludes that, organizing resource users to overcome managerial and social economic conditions are key in solving management crisis in fisheries sector.

IMPLICATIONS OF SOCIOECONOMIC FACTORS AND COMMUNITY PERCEPTIONS INFLUENCING CORAL REEF CONSERVATION IN SW MADAGASCAR

EPDS, MINNA, Andriamalala Gildas

The aim of this study was to conduct a baseline socioeconomic assessment and to investigate which socioeconomic factors influences attitudes and perceptions of marine resources and their implications for the management of a multi-stakeholder Marine Conservation Project in SW Madagascar. This study presents results from two household surveys: (1) socio-economic status, (2) community perception and attitudes on marine resources, their condition and non-use values, as well as awareness of and compliance to marine resource rules and regulations in three remote fishing villages. The surveys were supplemented by focus group interviews on marine activities and management initiatives. The findings indicated a very homogenous society where wealth was not an important socioeconomic variable influencing perception of marine and coastal resources.

However, there was a direct relationship between community power structures and perception. The focus groups showed great disparity between different age groups and a significant difference between genders. The study concludes that understanding community attitudes and perceptions is vital for successful implementation of marine resource management initiatives and needs be incorporated in the design and planning stage and coupled with awareness raising activities targeting specific groups. These should preferably be complemented by feasible alternative livelihoods that fit into current community social structures and style of life.

THE IMPACTS OF POVERTY ON COASTAL RESOURCE MANAGEMENT KENYA OCHIEWO, JACOB

This study was conducted at the informal settlements around Mikindani on the Tudor Creek and Ngomeni fishing village in Malindi District. The objectives of the study were: (1) to assess the sea-use patterns, (2) establish the ecosystem goods and services from the surrounding marine environment, and (3) suggest relevant policy recommendations. The study established that the marine resources are facing over-exploitation. Local people now have to travel longer distances to harvest ecosystem goods for their livelihood and income. The communities around Mikindani and Ngomeni depend heavily on the marine resources for their livelihood and income. It emerged that perceived poverty is a major determinant of sea-use patterns. It has resulted in indiscriminate harvesting of marine resources. At Mikindani, the following goods are harvested: mangrove poles, fuelwood, shrimps, crabs, fish, medicine and honey. Some mangrove areas serve as sacred sites. At Ngomeni, the local community harvests fish, and shrimps. There are laws regulating harvesting of mangroves and fisheries but enforcement is weak. Furthermore, local people have failed to comply with existing regulations. It is only the sacred sites that have remained unexploited. As sea-use patterns change, beach management units have come up to assist in managing the fisheries resources. It is recommended that the involvement of the local communities be strengthened. Sacred sites have remained unexploited indicating how belief systems

Making conservation actions more effective: linking key concepts of adaptive management and systematic conservation planning in an evidence-based framework

RESTORING ALTERED FLOW REGIMES: AN EVIDENCED-BASED APPROACH FROM THE NATURE CONSERVANCY

Warner, Andy, Tom Fitzhugh, Brian Richter, Tosha Comendant, Daniel Salzer, TIM TEAR

Ecologists have recognized river flow regimes as “master variables” for sustaining ecological health and associated ecosystem services. Alteration of natural river flow patterns – due to dams, direct diversions, groundwater pumping, and land use conversion – has become one of the most globally pervasive stresses on freshwater species, as well as species dependent on connected floodplain, wetland, and estuarine habitats. Natural resource managers have also come to recognize the importance of flow, which has spawned a rapid growth in flow restoration efforts during the past 10-15 years. However, the complexity of hydrology and its relationship to biological, water quality, and habitat conditions creates substantial challenges for scientists as they attempt to guide decision-making for both flow protection and restoration. Inconsistent methods of monitoring and analysis of ecological responses also make it difficult to measure effectiveness across systems. The recently developed hydrologic framework referred to as environmental flow components (EFCs) has been successfully applied in guiding river-specific flow restoration efforts. This case study will highlight the use of EFCs in guiding water resource decisions, assessing ecological response, and supporting adaptive management. The Nature Conservancy’s Indicators of Hydrologic Alteration (IHA v7) software, which analyzes flow records around these EFCs, will be demonstrated and case studies of its application provided.

IMPROVING CONSERVATION EFFECTIVENESS THROUGH ADAPTIVE MANAGEMENT SALAFSKY, NICK

A key question facing all conservation practitioners and organizations is: “Are our actions effective in achieving our conservation goals?” We must answer this question at both the level of individual projects and across our discipline in order to be able to adapt and change our actions over time, learn about which actions work and do not work, and convince our donors and society that conservation is a worthy investment. Over the past few decades, there has been growing convergence in many fields of human endeavor towards project-cycle based adaptive management as the primary method for answering this question. The conservation organizations involved in the Conservation Measures Partnership (CMP) all apply some form of project cycle management to their work. The CMP took these different systems and created a common version, the CMP Open Standards for the Practice of Conservation. In this presentation I provide an introduction to the Open Standards, illustrate how they have been used around the world, and provide an introduction to Miradi, a new software program being developed to help implement these standards. I then show how these standards and this software, coupled with linked databases of conservation projects and practice, provide the foundation for true evidence-based conservation to occur, both within projects, and across the field of conservation.

MANAGEMENT OF ELEPHANTS AND BIODIVERSITY IN ADDO ELEPHANT NATIONAL PARK, SOUTH AFRICA: EVIDENCE-BASED PRACTICE – SOMETIMES! KERLEY, GRAHAM, Michael Knight

The Addo Elephant National Park was proclaimed in 1931 to conserve elephants, but had no elephants or surface water. This was addressed by providing borehole water and driving the elephants into the area, but the population was not secure until fenced in 1954. Early management focused on the elephants and included small habitat expansions. Parallel to this was the realization of the importance of biodiversity and the extent of threats to biodiversity, with the resulting shift in focus from single species to biodiversity planning and conservation. Inherent to elephants are both the risk they pose to biodiversity and the complexities of small, confined populations. Demonstrated genetic homogenization was addressed through the introduction of bulls. The lack of density dependence indicates that population growth, and resulting high densities, remains a challenge, due to significant impacts on biodiversity and conflicts with tourism objectives. Management responses have been the establishment of botanical reserves, systematic expansion of habitat and the export of individuals, with culling currently not an option. Habitat expansion remains an urgent priority, but is exceedingly expensive due to land and fencing costs and has societal limits. We conclude that accumulated evidence can guide the biodiversity-based management paradigm through the identification of the most effective management options, and should be used to test the outcomes of management interventions.

MAKING CONSERVATION ACTIONS MORE EFFECTIVE- WHAT'S IN THE TOOLBOX? PULLIN, ANDREW

A number of key developments in conservation management have sought to improve the effectiveness of conservation actions by taking a more systematic approach to decision-making and action planning. Three examples of such developments are Adaptive management, Systematic Conservation Planning and Evidence-Based Practice. They have in common the objective of using previous knowledge of effectiveness of past actions to help plan future actions. They also have a growing literature base and history of application. But, until now, these approaches have developed in comparative isolation, partly because they have been tested by different research groups and collaborative networks working on different problems on different continents. Consequently, these approaches could easily be viewed as alternatives that are incompatible. This introduction to the symposium looks at the relationship between these developments and examines the idea that they are all part of a larger family of evidence-based

approaches seeking to forge partnerships between conservation scientists, practitioners and stakeholders to increase effectiveness of conservation programmes. If these approaches are compatible, what are the links, how can the links be made explicit, and how can we ensure that a holistic approach achieves greater conservation gain than the sum of the parts?

MAKING CONSERVATION MORE EFFECTIVE – PUTTING THE PIECES TOGETHER SUTHERLAND, WILLIAM

The objective of this talk is to describe how conservation practice could potentially be improved by combining various components including adaptive management, systematic conservation planning and evidence-based conservation. This should lead to much more efficient and effective practice. It seems inevitable that funders will demand more transparent reflective approaches that synthesise global experience to improve practice. I will describe some options for further developments.

FIRE MANAGEMENT IN KRUGER NATIONAL PARK, SOUTH AFRICA VAN WILGEN, B.W., N. Govender, H.C. Biggs

This case study reviews a long-term fire experiment in the Kruger National Park, South Africa, established in 1954 to support fire management. Recent analyses show that fire treatments affected vegetation structure and biomass more than species composition, and were most dramatic in treatments that deviated most from the existing fire regime. These included extremes of fire frequency (annual burning, or fire exclusion), or burning in the summer wet season. Since the inception of the experiment, paradigms in savanna ecology have changed to encompass heterogeneity and variability. The design of the experiment, reflecting the understanding of the 1950s, does not cater for variability in fire return intervals or seasons. As a result, the experiment has had a minor influence on changes in management policy. The experiment was nonetheless successful in advancing understanding, and it has an ongoing and important role to play in developing a predictive understanding of savanna ecology. The experiment is accordingly being adapted to investigate the interactions between fire, herbivory and variable rainfall.

INVASIVE WEED MANAGEMENT IN AUSTRALIA AND SOUTH AFRICA GRICE, ANTHONY C

Invasive alien plants are a significant problem globally. They displace native species, disrupt important ecosystem processes, and can significantly reduce the ability of ecosystems to provide a range of goods and services. In several parts of the world, significant programmes have been developed to address this problem. South Africa's "Working for Water" programme and Australia's Weeds Co-operative Research Centre are good examples. Experience has shown that the management of invasive species can be complicated by a number of factors. These include: Conflicts of interest where the invasive species has both beneficial and detrimental attributes. Examples include black wattle (*Acacia mearnsii*), an important forestry tree in South Africa, and Gamba grass (*Andropogon gayanus*), an important pasture grass in Australia. A lack of information on impacts. While it is generally accepted by ecologists that invasive alien plant species have detrimental impacts, until recently there has been little concrete data to support these contentions. Recent research is starting to change this. Management is sometime carried out to achieve non-ecosystem goals, such as the creation of employment opportunities in control programmes in South Africa. This case study will highlight how some of these challenges are being addressed. The approaches include comprehensive and co-ordinated studies to document the full suite of impacts, economic studies to quantify the effects of the impacts, and the use of GIS-based technologies to prioritise areas for control operations.

Mapping the economic value of nature: incorporating ecosystem services into conservation planning

ECOSYSTEM SERVICES AND CONSERVATION PLANNING
RICKETTS, TAYLOR

Nature provides a wide range of economic benefits to people. These ecosystem services provide compelling arguments for conservation and can lead to novel sources of funding through markets and other payments. Conservation planning efforts, however, have largely focused on patterns of biodiversity and threats, typically excluding relevant information on ecosystem services. Incorporating this information can help to locate areas important for both human livelihoods and biodiversity, as well as areas of trade-off between them. In addition, maps of ecosystem services can identify key “suppliers” and “consumers”, suggesting efficient and equitable payments to fund conservation. Drawing on case studies from several regions and at various scales, I illustrate these concepts and provide a general introduction to the symposium. I also discuss key challenges to incorporating economic costs and benefits into conservation planning, including the paucity of spatially-explicit data, modelling flows of services from source areas to consumers, and the differing scales over which services confer benefits to people. Overcoming these challenges and incorporating ecosystem services into conservation planning can help decision-makers to optimize investments over the twin goals of conservation and human welfare.

SYNERGIES AND TRADEOFFS BETWEEN HYDROLOGICAL SERVICES AND BIODIVERSITY
ACROSS SUB-SAHARAN AFRICA
BURGESS, NEIL

Patterns of biodiversity in Africa are increasingly well mapped and priority areas for conservation have been identified for both terrestrial and freshwater habitats. In comparison the patterns of distribution of ecosystem services are much less well known, and the priority areas for the provision of services have not been identified. In this presentation we will use a new hydrological database to identify the areas of water provision in Africa and then compare these with the known patterns of terrestrial or aquatic biodiversity. Our focus will be on how ecosystem services such as water supply can be used as an additional argument to support biodiversity conservation across Africa.

AN OPERATIONAL FRAMEWORK FOR MAINSTREAMING ECOSYSTEM SERVICES INTO
LAND USE PLANNING
COWLING, RICHARD

Effective safeguarding of those components of wild nature that deliver services for people requires that the spatial aspects of these services are incorporated into land use plans undertaken by local organizations. Planning for ecosystem services should be a normative process that is ultimately co-ordinated by societal values. Assuming this context, I provide two pointers for an operational framework for mainstreaming services into land use planning. My first point is that the initial step of the planning process should be an assessment of human behaviour, organizational capacity and institutional effectiveness within an administratively demarcated planning domain. Second, the knowledge thus gained must define the approach for researching the ecology and economics of that subset of services that have a level of stakeholder support deemed adequate for effective implementation of safeguarding actions. In this sense, the role of scientific research is to provide knowledge that is comprehensible and compelling to stakeholders. Research that ignores local preferences, capacities and institutions, and excludes local decision-making organizations, is unlikely to influence strategy development and lead to implementation. I conclude by presenting a general framework for safeguarding ecosystem services that incorporates these two points.

TO WHAT EXTENT HAVE ECOSYSTEM SERVICES BEEN INCLUDED IN CONSERVATION PLANS?

EGOH, BENIS, Mathieu Rouget, Belinda Reyers, Andrew Knight, Richard Cowling, Albert van Jaarsveld, Adam Welz

A call has been made for conservation planners to include ecosystem services into conservation assessments. The motivation behind this call is the need to develop an integrated approach to meeting different conservation objectives and a shift in focus towards human well-being. There is currently no widely accepted approach to planning for ecosystem services. This study contributes towards the development of this approach through a review of the extent to which ecosystem services are included in conservation assessments. The review included 88 studies randomly drawn from 476 studies. Of these only seven had included ecosystem services. Thirteen studies had referred to ecosystem services as a rationale for conservation without including them. The majority of assessments were based on biodiversity pattern data while 19 used data on ecological processes. Of the 19 assessments, 11 used processes, which could be linked to services. Ecosystem services have witnessed an increase in attention in conservation assessments since the year 2000. The majority of studies included cultural services, followed by regulatory, provisioning and supporting services respectively. We conclude by discussing the opportunities and constraints for integrating ecosystem services into conservation assessments and highlight the urgent need for an appropriate framework for planning for ecosystem services.

MANAGING MOBILE ORGANISMS PRODUCING ECOSYSTEM SERVICES IN CHANGING LANDSCAPES: THE CASE OF POLLINATION

KREMEN, CLAIRE

Many ecosystem services such as pollination are delivered by organisms that depend on habitats that are segregated spatially or temporally from the location where services are provided. Management of mobile-agent-based ecosystem services requires consideration not only of the local scale where services are delivered, but also the distribution of resources at the landscape scale, and the foraging ranges and dispersal movements of the mobile agents. For pollination services, I present several conceptual models and summarize the key results from recent synthetic analyses, both to illustrate the current state of knowledge in this field, and to identify remaining knowledge gaps that still need filling in order to develop spatially-explicit management plans. I conclude with a case study of pollination services in a landscape in California. Evidence from descriptive studies of pollination services to crops and manipulative experiments on bee productivity across a landscape gradient suggests that local and landscape factors interact strongly in determining bee population abundances and pollination services. The spatial and temporal distribution of floral resources is a key element. Based on these data, we are currently manipulating floral resources locally to restore pollination services in an adaptive management framework. Spatially-explicit models will be used to identify optimal configurations for floral resource restoration.

GLOBAL-SCALE MAPPING OF ECOSYSTEM SERVICES: IMPLICATIONS FOR CONSERVATION PRIORITIES

NAIDOO, ROBIN, Andrew Balmford, Robert Costanza, Brendan Fisher, Rhys Green, Trent Malcolm, Taylor Ricketts

Global conservation priorities are usually dictated by some combination of biodiversity value and degree of threat. The spatial concordance of ecosystem services (i.e., the economic benefits that nature provides to people) and biodiversity remains poorly understood, despite having important implications for the justification of conservation priorities. Here, we map the provision of 5 ecosystem services at ½-degree resolution over the terrestrial surface of the earth. We mapped these first in their native biophysical units, and then used valuation methods to express services

in monetary terms. Ecosystem services were generally poorly correlated in space with ecoregion-level biodiversity; species richness, species endemism, and threatened species each had correlation coefficients < 0.5 for all services. A similar lack of concordance was found when priority ecoregion rank (using irreplaceability measures from a prioritization exercise with the world's mammal species) was regressed against ecosystem services. Finally, current conservation priority schemes captured ecosystem services to varying extents: the dollar value of ecosystem services was higher in Global 200 and Biodiversity Hotspot ecoregions, and lower in Last of the Wild ecoregions, than randomly-drawn ecoregions. These results suggest that conservationists should be wary of assuming that priority areas for the conservation of biodiversity will capture ecosystem service hotspots, and vice versa.

EVALUATING PAYMENT STRATEGIES FOR ECOSYSTEM SERVICES: IMPLICATIONS FOR DELIVERY OF BIODIVERSITY, CARBON SEQUESTRATION AND MARKETABLE COMMODITIES

Nelson, Erik, STEPHEN POLASKY, David Lewis, Andrew Plantinga, Jeff Camm, Eric Lonsdorf, Heather Tallis

Landscapes produce multiple outputs of value to society, ranging from marketable commodities to (mostly) non-marketed ecosystem services (e.g. habitat for species, carbon sequestration, water purification). The provision of ecosystem services depends on the amount and spatial pattern of land uses. Landscapes are often dominated by small parcels of privately-owned land which could provide ecosystem services with public goods characteristics. A payment scheme may be needed to improve the efficiency of private land provision of services given that landowners typically are not compensated for providing these goods. Using the Willamette River Basin of Oregon, USA as an illustration, we analyze consequences for ecosystem services (biodiversity conservation, carbon sequestration and commodity production) of policies providing incentives to landowners: i) to retire land from commodity production for conservation reserves, or ii) to convert their land from one commodity-producing use (e.g. crops) to another (e.g. forest). We compare ecosystem service values generated from land use patterns generated by these incentive policies with values generated if a central planner could dictate land-use to maximize joint service production. We also describe the trade-offs among the three ecosystem services produced in the landscape, both among the land use patterns generated by an incentive policy and those patterns generated by the service-maximizing central planner.

RESTORING DEGRADED LANDSCAPES FOR ECOSYSTEM SERVICE DELIVERY: PROSPECTS FOR A SEMI-ARID AFRICAN ECOSYSTEM

Powell, Mike, ANTHONY MILLS, Richard Cowling, Christo Marais, Charlie Shackleton

Subtropical thicket (ST) is a unique, ancient vegetation type largely restricted to the Eastern Cape, South Africa. Intensive goat pastoralism reduces plant cover and C stocks and has resulted in pervasive degradation. Restoration requires active intervention, particularly in xeric ST. Carbon storage in intact ST is akin to temperate forests (c. 245 t C ha⁻¹); with *Portulacaria afra* (a canopy dominant) sequestering C rapidly (c. 4 t C ha⁻¹ yr⁻¹). The Subtropical Thicket Restoration Project was launched in 2004 to test the feasibility of using payments for ecosystem services (such as C sequestration) to fund large scale restoration of degraded ST using *P. afra* cuttings. Baseline studies showed that degradation of ST in the Baviaanskloof Mega-Reserve resulted in greater species diversity relative to intact ST. However, a predominance of ephemerals and grasses renders the gain in species of debateable value. Loss of endemic succulents, geophytes, lianas and understorey herbs, and invasion of grasses at a landscape scale, is reason for concern. Survivorship of *P. afra* cuttings was highly variable (0 - 80%). Upfront restoration costs are largely a function of truncheon size and initial spacing (\$1500-\$250 ha⁻¹), with follow up planting costs being a function of cutting survivorship. Preliminary results

indicate that potentially large C gains (c. 40 t soil C ha⁻¹, 0-15 cm; c. 40-50 t C above-ground biomass ha⁻¹) can be accrued by planting *P. afra* in degraded ST.

USING ECOSYSTEM SERVICES TO MAINSTREAM A CONSERVATION PLAN FOR THE GRASSLAND BIOME OF SOUTH AFRICA

REYERS, BELINDA, Jeanne Nel, Benis Egoh, Zuziwe Jonas, Mathieu Rouget

South Africa's grasslands, similar to grasslands of the world, present an enormous conservation challenge due to their linked yet often conflicting conservation and development importance. These landscapes, together with their biodiversity and ecosystem services, support the hub of economic development in the country, which in turn places enormous pressure on the very resources underpinning the development activities and sectors. This complexity and interdependency makes traditional forms of conservation (e.g. protected area establishment) unlikely and often ineffective. The newly established National Grasslands Biodiversity Program has decided instead to focus on mainstreaming biodiversity in production landscapes and sectors in order to find win-win solutions where economic development is sustained by ecosystem services provided by a well-conserved grassland. As a precursor to the program's establishment an integrated conservation plan was conducted which, in addition to the usual focus on terrestrial and river biodiversity, mapped and included ecosystem services into the prioritisation exercise. The assessment highlighted 15 broad priority areas (50% of the biome) together with the reasons for their importance. This information provided useful guidelines on where and with which sector to engage. We conclude with a reflection on the value and challenges associated with this integrated approach to mainstreaming and the role that ecosystem services played in the process.

A REAL-WORLD MAPPING EXERCISE IN THE OUDTSHOORN MUNICIPALITY, SOUTH AFRICA: A CASE FOR AND AGAINST THE ECOSYSTEM SERVICES APPROACH

WELZ, ADAM

The concept of ecosystem services (a framing of ecosystem functions and attributes that emphasises their underpinning of human existence and well-being) is being increasingly used to promote the conservation of ecosystems and biodiversity, as well as in fund-raising for conservation organisations. Although much work has been done on the economic valuation of ecosystem services, very little use has been made of the concept to produce spatially explicit data (maps) designed to achieve specific ecosystem conservation goals within clearly defined land use decision-making frameworks. I present the results of a recent real-world exercise in mapping sources of key ecosystem services of the Oudtshoorn local municipality (Western Cape Province, South Africa) which reveals some strengths of the approach, highlights considerable challenges in the construction of user-friendly maps and questions the effectiveness of the ecosystem services approach in motivating for conservation action.

MAPPING AND EVALUATING ECOSYSTEM SERVICES ACROSS TANZANIA'S EASTERN ARC MOUNTAINS

BALMFORD, ANDREW, Neil Burgess, Mathieu Rouget

The remaining forests of Tanzania's Eastern Arc mountains are among the world's highest priorities for conservation, yet are still being cleared for timber, firewood, and farmland. Alongside their biological importance, these forests also provide valuable ecosystem services to local, national and global beneficiaries, including carbon storage and sequestration, the production of non-timber forest products, and the regulation of water flows (with Dar es Salaam and the country's hydroelectric plants largely dependent on rivers that rise in the Arc). To better understand how land use changes affect these benefit flows we have recently begun a 5-year programme of integrated socio-economic and biophysical data gathering, modeling and analysis.

Inter-linked modules will generate ground-truthed maps of the production and flow of carbon-, water- and biodiversity-related services (in both biophysical and economic units), and of how these may alter under plausible scenarios of land-use and climate change. Combined with spatially explicit data on governance structures and on the opportunity costs of conservation, these analyses will enable us to map out who wins and who loses under alternative interventions, and thereby provide timely guidance to ongoing proposals to set up Payment for Environmental Service schemes in Tanzania.

DISTRIBUTION OF ECOSYSTEM SERVICES IN LARGE RIVER BASINS: APPLICATIONS TO CONSERVATION PLANNING

WEST, PAUL, Jonathan Foley, Carol Barford, Holly Gibbs, Chris Kucharik, Chad Monfreda

Large river basins are managed to meet multiple societal goals. There is an increasing desire to incorporate ecosystem services into management and policy decisions to meet these multiple goals. Understanding the biophysical quantities of ecosystem services is a critical first step to inform policy or monetary valuation. We used a global ecosystems model and existing data sets to quantify five ecosystem services at a 10-minute resolution for the earth's land surface. These services include flood regulation, water quality, local climate regulation, global climate regulation and food production. This presentation will provide a brief summary of trends across 80 large river basins, describe spatial distribution of services within a subset of the basins, and provide a case study that applies these results to conservation planning. The presentation will emphasize the water-related services. The results of this research will be used to make comparisons among large river basins, inform management of uplands to meet biodiversity and other societal goals, and create datasets that can be used for assessing tradeoffs among ecosystem services.

MAINSTREAMING ECOSYSTEM SERVICES: THE NATURAL CAPITAL PROJECT

SHAW, REBECCA, Gretchen Daily, Peter Kareiva, Steve Polasky, Taylor Ricketts, Heather Tallis, Christine Tam, Barton H. Thompson, Jr

Groundbreaking initiatives have highlighted the value of the goods and services people obtain from natural systems and their crucial role in sustaining economic viability. Despite the global-level recognition that conservation often makes economic sense for society, decision-makers, from individuals to governments, continue to act as if ecosystems have little or no value and loss rates of critical ecosystem services and biodiversity continue to rise. The Natural Capital Project, a new global partnership, is addressing these issues by developing and applying practical approaches to incorporate the value of ecosystem services – economic and non-economic – in conservation and resource management decisions. The project is doing so by first building analytical tools needed for evaluation of ecosystem services and the governance and financial structures that control them. In evaluating many important services simultaneously over broad regions, this is a synthetic approach allows assessment of multiple potential sources of value and the evaluation of the synergies and trade-offs among them, all at scales matching that of resource decisions. These tools are being applied in selected demonstration projects in collaboration with stakeholders to demonstrate the utility of an integrated ecosystem service approach. Finally, the project is developing policy and financial tools, based on analyses and scenarios, and developing support for their adoption to ensure enduring conservation.

BEYOND THE CATSKILLS: THE STATUS OF ECOSYSTEM SERVICES IN CONSERVATION PRACTICE

TALLIS, HEATHER, Rebecca Goldman, Gretchen Daily, Peter Kareiva, Taylor Ricketts

New York City's protection of the Catskill Mountains stands as the ready example of conservation success in the name of ecosystem services. Yet this is just one example of the overwhelming suite of financial mechanisms, policy options and conservation actions that have been applied to

ecosystem service and biodiversity conservation globally. We have compiled a database of ecosystem service projects led by two of the world's largest conservation NGOs, The Nature Conservancy and the World Wildlife Fund. In this database, ecosystem service projects are defined as those that have at least one ecosystem service as an explicit goal or strategy. We will summarize the general state of practice and outline several compelling case studies. We will also describe the ways that ecosystem service approaches vary among biomes and social contexts (GDP, corruption, economic system, etc.) globally. This will be the first systematic analysis of lessons learned from existing efforts to apply ecosystem services in field conservation projects.

Reintroduction of top-order predators

LEOPARD *PANTHERA PARDUS* CONSERVATION IN AFRICA'S RAINFORESTS – THEIR STATUS AND THREATS, AND THE ROLE OF REINTRODUCTION HENSCHEL, PHILIPP

Leopards are the sole large mammalian predator in the African rainforest, and it was estimated that the forests of the Congo Basin alone harbor about 40 % of Africa's leopards. Yet today these forests are witnessing what is widely referred to as the 'Bushmeat Crisis', a phenomenon which is known to have caused local extinctions of several rare primate species and also leopards. This study demonstrates how leopard populations in central Gabon react to the intense competition for wild prey with local hunters. Eight study areas were chosen for this purpose, four of which were protected and four of which were hunted. In all sites leopard population densities were established through camera trapping, and leopard diet was examined through scat analysis. Leopards were found to be absent from one village hunting zone where hunting pressure was most intense, and in the remaining sites densities were 0.9–13.2 individuals per 100 km². Leopard densities were found to significantly increase with growing distance from human habitations, $r = .92$, $p < .01$, as were the abundance of prey, $r = .87$, $p < .01$, and the proportion of ungulates in leopard diets, $r = .94$, $p < .05$. The potential use of reintroduction in sites without large predators is discussed.

MOVING BEYOND THE DESCRIPTIVE: PREDICTING THE RESPONSES OF TOP-ORDER PREDATORS TO REINTRODUCTION HAYWARD, MATT

The charisma of large predators has led to a wealth of knowledge on their ecology. I used this information to create models of the prey preferences of large predators using Jacobs' index to compare what species predators kill compared to the relative abundance of that species in the area. In predator-diverse African ecosystems, large predators prefer to avoid dietary competition but the two most threatened members of this guild have the smallest dietary niche breadth and greatest preferred diet overlap. I use this information to predict the diet of large predators at reintroduction sites, and test these predictions with data collected from those sites. I also use prey preference data to determine predator carrying capacity at reintroduction sites by relating the biomass of preferred prey with predator abundance at sites where this information is known. I then show these predictions are accurate using sites where managers were forced to intervene after indications of predator overpopulation occurred. These methods can be used by wildlife managers to determine what a reintroduced predator will prey upon and how many predators a reserve can support based on the abundance of potential prey species.

GENETIC CONSIDERATIONS IN REINTRODUCTION PROGRAMS FOR LARGE TERRESTRIAL PREDATORS FRANKHAM, RICHARD

Inbreeding depression, loss of genetic diversity and outbreeding depression are the major genetic issues in reintroduction programs. Inbreeding reduces reproduction and survival and loss of

genetic diversity reduces the ability of populations to evolve to cope with environmental changes. Such genetic deterioration is unavoidable in all closed populations, the severity depending on the effective population size (N_e) and the number of generations. Long term mean population sizes for reintroduced large terrestrial predators are typically 200 adults or less, indicating N_e of 20 or less. Such reintroduced populations will have an inbreeding coefficient of a least 22% at generation 10 (approaching that of sib-matings) and have lost 22% of their initial genetic diversity and the genetic deterioration will worsen with further generations. In the long term, the majority of such populations are expected to go extinct for genetic reasons. To avoid such genetic deterioration, several migrants per generation need to be introduced. To avoid outbreeding depression, the immigrants must be from the same species and evolutionary significant unit. If they are taken from within the former continuous range of the species and from a similar environment, the risks of outbreeding depression should be low.

OWNERSHIP OF WILDLIFE AND FINANCIAL INCENTIVES FOR THE REINTRODUCTION OF TOP PREDATORS IN SOUTHERN AFRICA LINDSEY, PETER, Harriet Davies-Mostert

Historically, predators have been persecuted on ranchland in southern Africa to protect livestock. During recent times, ownership of and/or the right to utilize wildlife has been granted to landowners in several countries, causing a shift from livestock to game-ranching. This shift has resulted in increases in wild ungulate populations, but has had mixed consequences for predators. In some cases, ownership of predators has encouraged captive-breeding and "canned hunting". Where wild predators occur on game ranches they are sometimes persecuted to protect ungulates valuable as hunting trophies. Conversely, on ranches used for ecotourism predators have fared well. Predators are a key attraction for tourists, and increasing numbers of ranchers are reintroducing them for this purpose. The introduction of legislation or incentives to encourage neighbouring landowners to form conservancies by removing internal fencing would benefit predators further. Conservancies are conducive to ecotourism as a land use, encouraging tolerance of predators and providing incentives for predator reintroductions. Conservancies are also more able to support viable predator populations, reducing the need for management intervention. The devolution of ownership in countries where wildlife continues to be a state-owned resource (e.g. USA, Australia, Kenya), while encouraging the formation of conservancies and ecotourism as a land use could stimulate similar gains for predator conservation elsewhere.

THE USE OF FEMALE BLACK BEARS WITH NEONATES FOR REINTRODUCTION CLARK, JOSEPH

Interest in American black bear (*Ursus americanus*) reintroduction has increased in recent years. Historically, one of the most successful programs was the reintroduction of 254 bears from Minnesota to the Interior Highlands of Arkansas in the 1960s; that population has grown to >2,500 today. Though successful, the program was marred by long-distance dispersals of released animals, often resulting in mortality. More recent efforts have involved fewer but better monitored animals and managers have used winter-release techniques to improve site fidelity and survival. The winter-release technique involves the translocation of hibernating females, either pregnant or with neonates, the premise being that the adult females are less likely to return because of the presence of young cubs. The technique has since been successfully used in black bear reintroduction efforts in Tennessee, Arkansas, and Louisiana. Advantages of the technique are that homing and dispersal are reduced, survival is increased, population growth is maximized, fewer animals are needed for population reestablishment, there are opportunities for public involvement, and data for viability analyses are easier to collect. Potential applications of the technique for other carnivore species are explored.

A CRITICAL ASSESSMENT OF SOUTH AFRICA'S WILD DOG METAPOPOPULATION STRATEGY AND ITS VALUE AS A TEMPLATE FOR AFRICAN WILD DOG CONSERVATION ELSEWHERE.

DAVIES-MOSTERT, HARRIET, Gus Mills, David W. McDonald

South Africa is unique in Africa in that it has a number of isolated fenced reserves of about 350-1000 km². Since 1998, African wild dogs have been introduced into eight such reserves, with the intention of managing them as a single metapopulation by simulating the natural process of immigration and emigration by artificially moving dogs between areas. By the end of 2005 the metapopulation stood at around 200 individuals. Although the strategy has been successful in terms of enriching species assemblages and stimulating ecotourism, its contribution towards biodiversity conservation has been called into question. This is largely due to the intensive management required to overcome stochastic processes affecting small populations, and which curtails natural population dynamics. In this respect, we judge that the development of larger contiguous areas through conservancy formation, and the establishment of a network of protected areas inter-linked through corridors to aid natural dispersal, hold more promise for wild dog conservation in South Africa than do isolated metapopulation reserves. However, the feasibility of this approach within the current conservation landscape needs to be assessed. Erecting fences for suitable relocation sites is expensive and ecologically unsatisfactory, and other African countries should look towards alternative and less management-intensive approaches to large carnivore conservation.

THEORY AND REALITY OF MANAGING ETHIOPIAN WOLVES IN A METAPOPOPULATION CONTEXT

SILLERO-ZUBIRI, CLAUDIO, Dada Gottelli, Karen Laurenson, Zelealem Tefera, Jorgelina Marino

Ethiopian wolves (*Canis simensis*) are one of the rarest carnivores in the world, with 500 individuals surviving in a few Afroalpine islands, perched on Ethiopia's highest mountains. Against the odds, tiny wolf populations have survived in almost every range of suitable habitat above the limit of subsistence agriculture, with loss of habitat and disease transmitted from domestic dogs the most imminent threats to their persistence. The Ethiopian Wolf Conservation Programme combines in situ protection with long-term population monitoring and an integrated disease management strategy to deliver conservation for this highly endangered canid. Twenty years of research on behavioural ecology, genetics, population dynamics, epidemiology of infectious diseases, and detailed updated information on the status of all surviving populations have provided a good grip on the most relevant aspects of the species' biology and the threats to its survival. We are poised to deliver a realistic, integrated management plan to halt the decline and sustain Ethiopian wolf populations. Such approach should include targeted control of disease in wolves and domestic dogs, selective habitat protection, and managing wolves as a metapopulation via translocation of animals between ranges. We review our current understanding of the behavioural, demographic, epidemiological and genetic considerations required to design such a long-term conservation strategy for Ethiopian wolves across their range.

CARNIVORE SOCIAL BEHAVIOUR AND ITS ROLE IN REINTRODUCTION PROGRAMMES

SOMERS, MICHAEL, Markus Gusset

Reintroductions are becoming increasingly important in conservation management, particularly for large carnivores. Despite the increase in our knowledge of carnivore social behaviour, wildlife managers often disregard this knowledge when reintroducing animals. This is largely owing to reintroduction biology and behavioural ecology not having been brought together much in the literature or conservation management teaching modules. In this paper, we combine these two aspects and outline the importance of considering aspects of social behaviour when reintroducing large carnivores. We have identified two time periods of particular importance: firstly the time in

temporary captivity before release, and secondly the period immediately after release. Prior to release, group composition of the animals to be released is important to promote social compatibility (via mate choice). Holding facilities should thus accommodate species specific needs for social interactions. After release, Allee effects arising from problems in finding suitable mates have emerged as one of the most important restraints in some large carnivore reintroduction programmes. We expect that incorporating these, and other, considerations of social behaviour (e.g. sexually-selected infanticide, reproductive suppression or conspecific attraction) in conservation planning will increase the efficiency and effectiveness of costly reintroduction programmes.

PREDATOR REINTRODUCTION FROM AN AUSTRALIAN PERSPECTIVE: KNOWLEDGE NATION, OR CONSERVATION WASTELAND? DICKMAN, CHRISTOPHER

In 200 years of European settlement in Australia, the continent has suffered the world's highest rate of mammal extinction with 27 species and subspecies lost. Many more species have declined and are at risk of future extinction, and much evidence implicates two species of introduced predators – the house cat *Felis catus* and red fox *Vulpes vulpes* – as the primary cause. The dingo *Canis lupus dingo*, itself introduced some 4,000 years ago, has been identified as a potential constraint on the destructive effects of the smaller introduced predators, but is subject to severe suppression by the pastoral industry due to its attacks on sheep. A case study analysis in the large (325,000 km²) rangeland region of New South Wales suggests that sympathetic management of the dingo in this conservation wasteland would benefit 21 nationally or regionally threatened species of native mammals. Such management should begin in national parks and private conservation areas, and supplant sheep flocks in areas where these are now unsustainable. Transforming ecological knowledge to political action is now the challenge.

DETERMINANTS OF RE-INTRODUCTION SUCCESS IN LARGE CARNIVORES: LESSONS LEARNED FROM ENDANGERED AFRICAN WILD DOGS (LYCAON PICTUS) GUSSET, MARKUS

I evaluated one of the most extensive efforts to date to re-introduce an endangered large carnivore: attempts to establish a managed meta-population of African wild dogs (*Lycaon pictus*) in South Africa. Using an information-theoretic approach, known-fate modelling in program MARK was employed to estimate survival of re-introduced wild dogs and their offspring, and to model covariate effects relative to survival. Multiple a priori hypotheses on correlates of re-introduction success were tested (collated from extensive individual experiences), using different re-introduction attempts as natural quasi experiments. Survival analyses revealed that the determinants of re-introduction success can be reduced to two factors relevant for management, suggesting that wild dog re-introductions should be attempted with socially integrated animals that are released into securely fenced areas, unless measures are implemented to mitigate human-related mortalities outside protected areas. This study illustrates that monitoring and evaluation of conservation efforts, complimented with expert knowledge, forms the foundation of informed decision-making to underpin future management actions with scientific evidence, especially if these actions are controversial.

JAGUAR REINTRODUCTION: NEEDS AND THE SCIENTIFIC KNOWLEDGE NECESSARY TO ACHIEVE SUCCESS SILVER, SCOTT, Linde Ostro

Jaguars range from the northernmost border of Mexico to Northern Argentina, and occupy a variety of diverse habitats, from desert to tropical forest, to wetlands. Their coexistence and interactions with humans take place within equally diverse cultural contexts. This high degree of

diversity poses particular challenges to jaguar conservation management decisions which become particularly apparent when considering the potential for jaguar reintroductions. The proposed talk will focus on three main aspects of jaguar reintroductions. First, assessing the need for jaguar reintroductions to further current jaguar conservation objectives; next, under what conditions a reintroduction of jaguars would be both necessary and desirable; and finally we will suggest some of the biological and socio-cultural information necessary for determining if a jaguar reintroduction may be successful. We will draw on the experiences of other large carnivore reintroductions to help answer some of these questions, and attempt to construct a decision tree for determining the feasibility of jaguar reintroduction programs in the near future.

FACTORING TIGER ECOLOGY INTO WILDLIFE MANAGEMENT IN INDIA KARANTH, ULLAS

Recent demographic data from photographic capture-recapture studies show that densities of reproducing tiger populations can vary from 1-20 tigers/100 km² with annual losses exceeding 20%. The observed tiger range contraction and local extirpation appears driven primarily by depletion of wild ungulate prey from poaching as well as from the depression in habitat quality due to social factors such as excessive livestock grazing, forest product collection. Landscape-level habitat fragmentation due to developmental projects is continually increasing intrusion of these pressures deeper into tiger habitats, thus facilitating poaching of prey and tigers. These pressures, and some conservation successes, are also promoting increased human-tiger conflicts locally. Overall, reproducing tiger populations now probably occupy <15% of their potential habitat of 225,000 km² in India. Given these factors, I submit that conservation strategies centered on reintroduction of tigers or captive-breeding them, have little conservation relevance. I argue that the newly-emerging tiger management philosophy focused on promoting overlap of human settlements with tiger range is unlikely to promote viable tiger conservation. Instead I suggest alternatives that are rooted more firmly in tiger ecology as well as the social realities of India.

RESTORING THE AFRICAN LION *PANTHERA LEO* IN SOUTH AFRICA: BUILDING MEGA-RESERVES FROM GAME PARKS HUNTER, LUKE, Rob Slotow

The lion *Panthera leo* has undergone an extreme reduction of range in recent times and now occupies around 20% of its historical African distribution. South Africa represents a reversal of that trend in which lions are being widely reintroduced throughout the country, chiefly in response to a rapidly growing tourism market. In this paper, we review the scope and success of efforts to reintroduce lions in South Africa. Since 1992, lions have been reintroduced into at least 24 privately and publicly-owned reserves covering a combined land area exceeding 5000 km². Reintroduced lions display high survivorship and successful reproduction which has resulted in rapid re-establishment of the species at all sites where they have been released. Despite short-term relative success, all reintroduction sites are small, enclosed by fences and are presently isolated from other lion populations. To investigate the prospects for promoting natural dispersal, immigration and emigration between reintroduced lion populations, we developed a GIS model that incorporates two major classes of parameters: 1) ecological characteristics such as available habitat and prey, and 2) an index of human influence based on the Human Footprint Model, integrating characteristics such as human density, settlements, roads and presence of livestock. We identify possible corridors to connect lion populations and propose opportunities for the consolidation of isolated and small game parks into contiguous mega-r

SNOW LEOPARDS: IS RE-INTRODUCTION A VIABLE OPTION OR A "CAN OF WORMS?" **JACKSON, RODNEY**

Re-introduction, including the translocation of problem animals, has been advocated as a means for re-establishing extirpated populations of large carnivores. Endangered throughout their range which extends across 12 Central Asian countries, the snow leopard population continues to decline due to poaching for its beautiful fur and high-valued bones, retaliatory killing in response to persistent livestock depredations, and the widespread erosion of its primary prey base, namely wild ungulates. On the other hand, the world's captive population continues to grow vigorously, and hardly surprisingly, some zookeepers advocate breeding of the species for the purpose of re-introducing this solitary felid back into suitable but depleted habitat. This paper discusses the opportunities and constraints of such proposals in light of existing threats, especially with respect to human-wildlife conflict that mandate the release of cats' savvy to the consequences of preying upon livestock. Besides low numbers, a poorly delineated but apparently highly fragmented range, along with other important socio-ecological factors, there are questions of high economic cost associated with transporting, housing, training and subsequently releasing sufficiently well-trained captive-bred or experienced wild-caught cats.

ALTA PLANS FOR AMUR LEOPARD REINTRODUCTION IN THE RUSSIAN FAR EAST: PROBLEMS AND PROGRESS **CHRISTIE, SARAH**

With less than forty individuals left in the wild in the Russian Far East, the Amur leopard is arguably the most endangered big cat on earth. Its present range is hemmed in by the sea, by international boundaries and by human development activities in Russia, with the only real space for expansion dependent on conservation actions on the Chinese side of the Sino-Russian border. In addition, the existing wild population is genetically depauperate, having been at the present size for a minimum of several decades. The captive population numbers about 200 animals in European, Russian and North American zoos, and has been managed for the last decade with a view to producing maximum conservation support in terms of fundraising, awareness generation, production of useful data and skills and of course the genetic lifeboat. It is also notable that the population contains a rogue founder, who was not an Amur leopard. Since 2001 there has been broad consensus among relevant conservationists that a reintroduction at a second site, using zoo stocks, is a necessary conservation action, and the breeding programme in Europe has been managed since then with a view to providing suitable breeding stock by perhaps 2010 as well as increasing the flow of funds. The paper examines the role of the captive population in producing conservation support (more than half the funds raised for this taxon to date have come from zoos), the political process of discussion and planning for reintroduction.

Sharing rights and responsibilities in new approaches to protected area governance

INVOLVEMENT OF CIVIL SOCIETY IN PROTECTED AREAS WITH DIFFERENT GOVERNANCE TYPES **MANNIGEL, ELKE**

Participatory approaches are more and more applied in protected area management. Studies comparing different governance levels concerning effectiveness of civil society involvement are still scarce. Three case studies from protected areas with different governance levels in Brazil are presented here. The areas studied are located in the Brazilian Mata Atlântica, one of the 25 conservation hotspots worldwide. The three areas belong to different governance types: 1. a national park, 2. a state park and 3. a private reserve. Differences of interests and implementation concerning joint management of natural resources by the different stakeholders were assessed and qualified. Methods used were adapted from qualitative social research, such as active and passive participant observation, free dialogues and the analyses of secondary literature. Similarities in understandings of participation were found for four distinct groups in all three

governance types: 1. protected area staff, 2. employees of the headquarters of the protected area institutions, 3. local institutional stakeholders and 4. community residents. Factors influencing participation level were similar in all three areas. Individual factors were especially important in the early phase of the processes. Social factors promoted adaptation of the approaches to local and institutional realities later on. This proved important for long term sustainability of the activities.

SHARED GOVERNANCE IN CONSERVATION OF BIODIVERSITY: COMMUNITY CONSERVED AREA PROTECTING THE ENDANGERED ETHIOPIAN WOLF TEFERA, ZELEALEM

In areas where national parks are unlikely to be economically viable or socially desirable, an alternative approach is required. Community-led conservation initiatives are one possible approach. In this paper, I investigate the indigenous common property resource management system in the Guassa area of Menz in the central highlands of Ethiopia, and the consequences of resource utilisation by the community on the populations of the critically endangered Ethiopian wolf (*Canis simensis*). The area traditionally has been, and still is, a valuable natural resource for the local community that depend on it primarily for thatching grass, firewood and grazing. The indigenous resource management system was structured under an indigenous resource management institution, locally known as the Qero system. The system was based on descent groups from founding fathers who agreed on division of the land in 17th century, and further supported by the authority of the church. The function of the Qero system was the regulation and equitable distribution of natural resources among the user community, and it functioned by enacting and enforcing various bye-laws. The Qero system declined in 1975 following changes in land-tenure and rural land reform introduced following the 1974 revolution in the country. Although the indigenous resource management system was not designed to conserve wildlife, it has certainly allowed the continued co-existence of wildlife with the local community. As perhaps the second largest population of the critically endangered Ethiopian wolf remaining outside the protected area system of the country, the Guassa area represents an interesting model of community led management that has the resilience to adopt changes whenever they happen.

CHANGING THE RELATIONSHIP BETWEEN PARK AND COMMUNITY BY REDEFINING THE PROTECTED AREAS AT LAKE MBURO NATIONAL PARK AND THE RWENZORI NATIONAL PARK IN UGANDA INFIELD, MARK, Arthur Mugisha

The dialogue over how to reconcile the responsibilities of governments and the rights of communities with respect to conservation has governance at its heart and has given rise to the development of a range of mechanisms to deliver greater rights and responsibilities for communities in the management of protected areas. These include co-management arrangements, Community Conserved Areas and private protected areas. Though Sacred Natural Sites are perhaps exceptions, much of the dialogue on protected area governance has mirrored the thinking that underpins more conventional approaches to protected areas by focusing on what protected areas are being protected *from* and presenting a range of benefits as justifications for their protection. Equally important, however, is the discussion of what protected areas are *for*. The 'meaning' of protected areas has been largely defined in terms of economic and scientific values, often distorted to provide powerful imperatives for conservation. However, more truthful meanings are determined by culturally mediated values that link people and landscapes, and sharing the right to determine the meaning of a protected area is a key element of governance. This paper describes an initiative to find practical ways to share the determination of meaning of two protected areas in Uganda. By modifying their management to incorporate values that have cultural resonance for local communities this project is redefining the meaning of these protected areas.

DIVERSIFYING PROTECTED AREA GOVERNANCE AND ADOPTING INNOVATION AS PART OF THE TRIPLING OF PROTECTED AREAS IN MADAGASCAR

RATSIRARSON, JOELISOA, Holy Raharinjanahary, Jeannin Ranaivonasy, Joanna Durbin

In 2003, the Government of Madagascar made a commitment to triple protected areas to cover 6 million hectares. The new Malagasy protected area system aims to manage natural habitats for biodiversity while maximizing benefits, particularly to local people, through substantial areas of sustainable use, sharing benefits from tourism and ecosystem services and conserving cultural heritage. Legislation passed in 2005 enables the full range of IUCN categories and paves the way for shared governance. Although new protected areas currently retain strong Government control, pluralist structures formally sharing management are developing, often with support and participation of conservation NGOs. Areas managed by local communities in contracts with the State are being included in new protected areas, encouraging recognition of rights and voice of local people. Local participation is sometimes provided through Communes, although these have divided loyalties since they also represent the State and have political affiliations. Increasingly, community natural resource management associations are representing interests of local resource users, which better reflect traditional management units and structures. Business interests and private landowners are rarely included in protected area management so far. Varied shared governance institutions are evolving, reflecting local conditions and complexities, with progression towards devolution of power to communities and civil society.

SHARED GOVERNANCE IN CONSERVATION OF BIODIVERSITY: COMMUNITY CONSERVED AREA PROTECTING THE ENDANGERED ETHIOPIAN WOLF

TEFERA, ZELEALEM

Community conserved areas are a sophisticated form of governance for protected areas. The Guassa area of Menz (central highlands of Ethiopia) has always been very valuable for the local communities, which depend on it for thatching grass, firewood and emergency grazing. The indigenous governance system used to coincide with an institution known as Qero, based on descent groups from founding fathers who agreed on dividing the land in 17th century. The Qero system, supported by the authority of the church, ensured the equitable distribution of natural resources among the members of the user communities by enacting and enforcing various by-laws. The Qero system was declared illegal in 1975, following the 1974 revolution, but was picked up by the local communities under changed name and circumstances. This indigenous governance system was not designed to conserve wildlife, but it certainly achieved this goal. Its highly regulated use of natural resources promoted the survival of the rodents that constitute the main prey of the critically endangered Ethiopian wolf (*Canis simensis*). Under the modern version of the system, the Ethiopian wolf is still thriving. The Guassa Community Conserved Area represents a model of community governance that has shown remarkable effectiveness and resilience to political change.

INNOVATIONS IN PROTECTED AREA GOVERNANCE: EXPERIENCE AND LESSONS SINCE THE DURBAN 2003 WATERSHED

Borrini-Feyerabend, Grazia, JOANNA DURBIN

Crucial to conservation effectiveness, sustainable livelihoods and social justice, “governance” of protected areas emerged as a topic of essential concern during the Durban Parks Congress of 2003 and was enshrined in conservation discourse by the CBD in 2004. Since then, governance “types” are slowly becoming familiar to professionals and the public. If co-management and private protected areas are increasingly adopted as mainstream, national policies are often poorly equipped to recognise and support Community Conserved Areas. Analyses and attempts at policy accommodations are underway to “rediscover” and nurture these oldest forms of conservation that risk disappearing along with much else that is historically rooted and culturally

unique in many countries. Besides types, governance “quality” also greatly affects protected area impact and can be assessed by criteria such as participation in decision-making, non-discrimination and fairness, subsidiarity, transparency and accountability, performance, access to justice and—overall—the reconciliation of conservation and human rights. These are complex and controversial topics and it is understandable that progress tends to be slow. Some bold examples of new protected areas legislation and implementation, however, are opening the path and offering important grounds for learning.

PERUVIAN COMMUNAL RESERVES: NATIONAL HERITAGE OR INDIGENOUS TERRITORY? NEWING, HELEN and Emily Caruso

At the 2003 World Parks Congress, Peru was congratulated on its enlightened approach to protected areas co-management, as exemplified in the innovative protected areas category of ‘communal reserves’. Communal Reserves are defined in law as ‘areas destined for conservation of flora and fauna for the benefit of neighbouring rural populations’, and exceptionally for a formal protected area that is recognised in a national system, they should be managed by the local people, under supervision by the state. However, after several years of negotiations on the rights, roles and responsibilities of local people within the collaboration there is much disillusionment with the model, both amongst indigenous representatives and among state officials. This paper will summarise the legislative mechanism for communal reserves and then highlight some recent practical experiences from the field. Barriers to effective collaboration include mismatches between technical, bureaucratic and traditional perspectives on natural resource management; a lack of capacity on the part of both the state and local community organisations; and a state policy of intensification of resource extraction across the Peruvian Amazon, that outweighs the priorities of the protected areas authority. It is argued that in view of such barriers the ‘common ground’ that can provide an incentive for collaboration is currently insufficient to overcome the tension between those who view communal reserves as part of the national heritage and those who see them as inviolate indigenous territory. Some general conclusions are drawn concerning external factors that commonly contribute to the fluctuating intensity of collaborative management efforts.

COLLABORATIVE GOVERNANCE OF PAs IN AREAS OF HIGH POPULATION DENSITY: LESSONS LEARNED FROM EIGHT CO-MANAGEMENT PILOT SITES IN BANGLADESH MAZUMDER, AZHARUL H., Philip Decosse, Darrell Deppert

Bangladesh can be characterized by high population density, rapid economic growth and one of the lowest proportions of its surface under “Protected Area” (PA) status in the world (1.4%). While some populations neighboring PAs can be called “indigenous”, most cannot. Bangladesh is characterized by resource extraction decision-making that operates outside of a transparent legal framework, while generally being executed with collusion of Government and commercial interests at all levels of society, even in relatively remotely located PAs. These factors decimated the PAs in recent decades. In response to this worsening situation and a perceived fear that PAs may be taken away from their jurisdiction entirely, the Forest Department (FD) developed a collaborative PA management program in 2002, and has now implemented the program at five pilot areas covering 22,500 hectares of core conservation area with a surrounding landscape of over 100,000 hectares. The FD recognized that without the participation and benefits sharing with a cross-section of local population, it would be powerless against other interest groups. To date, Government has given official recognition to Councils for the pilot sites, and approved Management Plans, which did not exist before. Both these documents confer considerable rights and responsibilities to the Councils to benefit from the PAs. Implementation of this approach is generating a number of lessons about co-management participant identification, benefits sharing, nature tourism, supporting policy and capacity development of both local stakeholders and the FD.

**A PRELIMINARY PERSPECTIVE ON THE STATUS AND NEEDS OF COMMUNITY
CONSERVED AREAS IN MESOAMERICA, WITH A PARTICULAR FOCUS ON MEXICO.**
Del Campo-Garcia, Carlos, CLAUDIA I. CAMACHO-BENAVIDES, Gary Martin

Within the global effort to understand the current situation and needs of Community Conserved Areas (CCAs), the present study focuses on northern Mesoamerica, and particularly on Guatemala, Belize and the Mexican states of Chiapas, Oaxaca, Yucatán and Quintana Roo. In the case of Mexico, community conservation efforts include: 1) community forestry; 2) community land use planning; and 3) community initiatives of voluntary conservation. Concrete examples of CCA creation include community and ejidal reserves, campesino reserves, symbolic sites, and cultural reserves. In all cases, the interacting stakeholders are: a) communities, through representative institutions; b) environmental NGOs and community development consultants; c) federal government agencies; and in some cases d) international development agencies. After a few decades of work, we can observe a development in which communities are appropriating local conservation processes through training of local technicians and creation of decision making mechanisms relevant to resource use and protection. CCA achievements can be enumerated as follows: inclusion of community responsibility in conservation schemes; higher achievement of conservation objectives; community maintenance of property and use rights; integration of different conservation schemes with landscape management and use; greater suitability of conservation schemes for land owners; and protection of community resources. Nevertheless, there is much work ahead, because the role of CCAs is extending throughout the region. The real contribution of CCAs to biodiversity and environmental services is not known and there is no specific funding mechanism to maintain these protected areas. In addition, there are inherent contradictions between conservation and use in some management schemes and existing institutional and legal recognition is weak.

Sharing the range: elephants, people and biological conservation in Africa

**A TALE OF FOUR REGIONS: THE STATUS, THREATS AND CHALLENGES FACING THE
MANAGEMENT AND CONSERVATION OF AFRICA'S ELEPHANTS ACROSS THEIR RANGE**
DUBLIN, HOLLY

Today, the conservation and management of Africa's elephants are juxtaposed against a backdrop of increasing human populations, habitat loss and fragmentation and resultant increases in human-elephant conflict, poaching for meat and ivory and the negative impacts of their growing numbers on other species and ecosystems in localised areas of concern. The relative importance of these issues and the status of the species vary considerably across its 37 range states. Globally listed as "Vulnerable" on the 2006 IUCN Red List of Threatened Species, with growing numbers in some populations, the future of others hangs precariously in the balance. The distribution of elephants represents the extremes – from small, fragmented populations to large, virtually undisturbed tracts of elephant range. While some elephant populations will likely continue to increase, the exploitation of resources with rapid, concomitant infrastructural developments and civil instability are placing others under continued and growing pressures. Different levels of management capacity and varying domestic and international policies and regulations also impact the range of management options. These important differences present significant challenges for managers and make it difficult to prescribe simple solutions to address the needs of elephants across their range now and into the future.

WATER AVAILABILITY: THE UNDERLYING DRIVER OF ELEPHANT LIFE
SHRADER, ADRIAN, Angela Gaylard

Elephants are water-dependent. As a result, the availability of surface water influences three key aspects of their lives; range use, feeding patterns and population dynamics. During the dry season, elephant home ranges collapse around remaining water sources. If these dry up, elephants can move large distances to relocate around permanent water. Spatially, the

distribution of water determines the pattern of elephant impacts across the landscape. For example, impacts on biodiversity are patchier where water sources are further apart. In areas with seasonal water, the provision of water allows elephants to remain throughout the year. This increase in access to both food and space can lead to an artificial growth in elephant numbers. In addition, the provision of water in enclosed reserves increases the impact that rainfall has on calf survival. We therefore argue that surface water is the underlying driver of elephants as agents of ecosystem change. As a result, elephant conservation and management plans need to incorporate the role of water.

ELEPHANT DEMOGRAPHIC AND BEHAVIOURAL CONSEQUENCES OF STOCHASTIC EVENTS AND MASSIVE HUMAN INTERVENTIONS

Mackey, Robin L, Leigh-Ann Woolley, BRUCE PAGE, Rob Slotow

Elephants demonstrate widely ranging population growth rates (up to 15% p.a.), driven mainly by variation in calving intervals and age of sexual maturity rather than mortality. We investigate through population modeling the consequences of changes in population structure. Natural events such as droughts may result in massive mortality, particularly of juveniles. Massive human interventions such as unselective culling or reintroductions result in younger populations with irruptive growth, and prolonged contraception has the effect of ageing a population. We demonstrate that major changes in population structure leave a legacy for decades. Changes in population structure and demography affect the ecological role and impact of a population, of particular concern when managers aim to reduce the impact of elephants. We assess how changes in population structure affect the well developed social system and associated behaviours of elephants. For example, killing of older females reduces the matriarchal based repository of information and experience; selective killing of older males shifts the dominance hierarchy and increases aggression. Such shifts can increase human-elephant conflict. For long-lived species, such as elephants, demographic changes may leave a legacy of consequence that future generations will have to deal with, and emphasize that interventions should be cautious and considerate of the demographic consequences.

OF ELEPHANTS, PREDATORS AND PLANTS, IN PROTECTED AREAS: A CASE OF CLASSIC TROPHIC CASCADES?

CUMMINGS, DAVID

Elephants have increased from a few thousand to more than 250,000 in southern Africa over the last century. The assumption that present high and increasing numbers of elephants in large protected areas are “natural” (i.e. returning to historical densities, or reflecting longer term natural cycles) is examined through three lenses: (a) food web structure and trophic dynamics, (b) the evolutionary history of proboscideans and their predators, and, (c) empirical evidence of trophic cascades when elephants are protected from human predation. The weight of evolutionary and historical evidence indicates that hominids have been primary predators of proboscideans since the Pleistocene, i.e. for the last 105 to 106 years. The management regimes applied to elephants in protected areas over the last 40 years have provided several unintended, large-scale experiments in community trophic dynamics. Results from these “experiments” indicate that reserves carrying high elephant populations have experienced classic trophic cascades resulting from the exclusion of a primary predator, namely, *Homo sapiens*. If protected areas are to form “benchmark natural areas” for the conservation of biodiversity and ecological processes, including predation, then the presence of a large generalist herbivore, such as elephants, without a primary predator has serious implications for the ecological integrity and management of these reserves.

ECOLOGICAL AND SOCIO-ECONOMIC COSTS AND BENEFITS OF ALTERNATIVE ELEPHANT CONSERVATION APPROACHES

MARTIN, ROWAN

To expand the range for elephants outside protected areas in southern Africa will require powerful incentives to local people on private and communal land. Drawing on case studies in Namibia and Zimbabwe, wildlife as a land use is capable of producing net financial returns greater than US\$7/ha – of which safari hunting contributes some US\$6/ha (85%) and, of this, elephants are responsible for about US\$0.50/ha (8%). Where culling is undertaken to limit elephant population densities, the value of potential ivory sales foregone as a result of CITES amounts to about US\$0.16/ha. These returns are relatively low and it would not be surprising if landholders placed their management emphasis on enhancing the status of other more valuable species – especially given the constraints on elephant management imposed by national governments and CITES. The economic value of elephants in relation to the resources they consume and their undesirable modification of habitats makes them one of the less valuable ungulate species and, in such cases, the best hope for enhancing their survival must lie in the removal of bureaucratic interference by governments and international treaties.

MANAGEMENT OF ELEPHANT OVERPOPULATION: TECHNICAL, POLITICAL, AND WELFARE CONSIDERATIONS

Niskanen, Leo, DAVID BALFOUR

In recent years there has been increasing alarm, especially in southern Africa, over the possible negative ecological impacts of high densities of African elephants (*Loxodonta africana*). While the scientific evidence for the adverse impact of high elephant densities on biodiversity remains inconclusive, concerns over the localized negative impacts of large elephant populations have led to attempts, in a number of elephant range States, to try and reduce elephant densities. The methods that have been most commonly used include range expansion (opening elephant corridors, creating new protected areas, transfrontier parks, etc), manipulation of water supplies, translocation, contraception and culling. The choice of method depends largely on the management objectives for the area or the elephant population in question. However, because of the lack of available range and resource limitations in many countries, as well as strong opposition to some of the more interventionist approaches, non-intervention has become the de facto approach in most of the elephant range States. The main methods and considerations in their use (technical, political, welfare, etc) are discussed.

HUMAN-ELEPHANT CONFLICT: MAIN ISSUES AND POTENTIAL SOLUTIONS

SITATI, NOAH

Human-elephant conflict (HEC) is a pervasive and complex problem threatening the long-term survival of African elephants. HEC is widespread, occurring almost everywhere where humans and people co-exist. As a result of accelerating habitat loss and fragmentation due to increasing human activity, the human-elephant interface is expanding in many parts of Africa. Where the costs of living with elephants greatly exceed the benefits, elephants may eventually be exterminated. The human dimension of HEC is complex and the complaints about elephants by affected communities are often disproportionate to the actual damage caused when compared to many other species of wildlife. The intangible or indirect costs of living with elephants are often perceived to be as high or higher than the economic value of the damage caused. Issues of responsibility for dealing with HEC, particularly the devolution of power to the level of the affected communities are critical in determining the thresholds of tolerance to HEC. In order to successfully manage HEC in the long term, strategies should be put in place that combine land use planning with measures to create an enabling environment for affected communities to reduce the costs of living with elephants while reaping a greater share of the benefits.

A LANDSCAPE APPROACH TO THE CONSERVATION MANAGEMENT OF SOUTHERN AFRICA'S ELEPHANTS

VAN AARDE, RUDI, Sam Ferreira, Jessi Junker, Theresia Ott, Kim Young

Landscape fragmentation ultimately compressed most of southern Africa's elephant populations into conservation areas across several countries. These populations occur in eight clusters of conservation areas and account for almost 70% of Africa's elephants. A metapopulation perspective may accommodate this spatial structuring and allow for a regional conservation plan to moderate local impacts. The viewpoint hinges on inducing local fluctuations while maintaining regional stability in numbers by restoring movement patterns. Ecologically, this calls for asynchrony in population dynamics, dispersal, and the accessibility to vacant habitat patches. Our research suggests that the spatial structuring of elephants is scale dependent. Regionally, elephants favor landscapes close to surface water where human densities or activities are relatively low. Landscape heterogeneity that caters for dietary and thermoregulatory needs dictates local selection. Inter-population differences in demography are functions of local densities, rainfall and management histories. These may explain asynchronous trends with populations increasing, decreasing or leveling off. Inter-population movements are common within clusters, but rare between them. Vacant habitats exist and historical data supports elephant dispersal. The regional management of elephants may thus be modeled as a source-sink metapopulation. This can provide an ecological basis for existing regional conservation management initiatives.

GOVERNANCE AND INSTITUTIONAL SCALE MISMATCHES IN THE CONSERVATION, MANAGEMENT AND SUSTAINABLE USE OF ELEPHANTS

LINDEQUE, MALAN

Complex governance issues emerge when elephants move in and out of protected areas and across jurisdictional boundaries. It is seldom possible to determine where they have come from, how long they will stay or where they will move to, and therefore who should be responsible for making decisions about them. In general, the State owns elephants within a national jurisdiction and is responsible for their protection and management, and if so inclined, to use elephants to generate economic benefits. The problem is that the owners of elephants seldom bear the costs of co-existing with elephants. Unless economic benefits derived from elephants are directed to the people that have to live with elephants, an inherent tension will persist between central Governments and rural communities. States exercise their management responsibilities within national legal and policy frameworks. Increasingly, supra-national frameworks have been created to manage shared elephant populations and have become formalized through transfrontier parks and legally binding bilateral, regional or multilateral agreements or conventions. These have compounded an already complex governance situation. Such additional complexity may significantly diminish the normal rights associated with ownership and seriously compromise incentive-based rural land use systems where elephants are part of a multiple use landscape.

DO ELEPHANTS FIT CLASSICAL PLANT-HERBIVORE THEORETICAL FRAMEWORKS? IMPLICATIONS FOR VALUABLE THREATENED HABITATS

Kerley, Graham, Katie Gough, MARIETJIE LANDMAN

The Addo elephants (South Africa) have been confined in subtropical thicket (Maputoland-Pondoland-Albany hotspot) at high densities for the last fifty years. We ask how they fit classical plant-herbivore models that range from non-interactive (no feedback) to interactive (feedback occurs). There is a demonstrated decline in forage resources (halving plant biomass), but no evidence for density dependence (survivorship, fecundity) in the elephants. However, at all levels of biodiversity, ranging from soil through plants to syntopic herbivores, there are marked

responses to elephants. The lack of feedback response by the elephants conforms to Caughley's non-interactive system, whereas the impacts on plants and other herbivores conforms to Caughley's interferential system, indicating a lack of fit to his theoretical framework. We hypothesize that this pattern is due to the disconnection between annual production and forage availability in these thickets, which are characterised by high accumulated biomass but low annual production, as well as elephants' ability to effectively utilise poor quality forage. The extent to which this is unique to thicket needs to be confirmed. We predict that unchecked elephant populations will eventually lead to a decline in annual production, with a collapse of this plant-herbivore system. This will be too late to conserve associated biodiversity.

ELEPHANT SOCIAL ORGANISATION, FORAGING, AND RANGING: IMPLICATIONS FOR HABITAT DIVERSITY AND MANAGEMENT

Shannon, Graeme, Bruce Page, Kevin Duffy, ROB SLOTOW

Elephants are a key ecological driver, and are singled out for particular attention by managers of savanna systems. Traditionally, management interventions have taken a population level perspective, with population size (equivalent to overall population density) being the key driver in management decision-making. In order to mitigate effects on biodiversity, mass-culling interventions removed elephants in proportion to the current population structure. Sexual dimorphism (very large adult males) results in different physiological requirements, and this, linked with a clear separation of adult males from female breeding groups, has implied differences in ecological inputs. We present data of differences of ecology of male and female elephants at different spatial (plant part, plant, habitat, landscape) and temporal (day, month, season, year) scales. We conclude that male and female elephants are essentially two different ecological species. We interpret these results in terms of ecological impact of elephants on savanna systems, and recommend management interventions be planned separately for male and female elephants depending on the objectives that management are hoping to achieve.

VALUE SYSTEMS, ETHICS AND MANAGEMENT OPTIONS FOR ELEPHANTS: WHOSE VALUES SHOULD PREVAIL?

MABUNDA, DAVID

Management of elephants in national parks must accord with prevailing societal values, and hence requires stakeholder consultation. Stakeholders have divergent opinions, two common positions being: a. Opposition to population control by lethal means; promotion of more expensive non-lethal means such as contraception. b. Acceptance of lethal control as an option that realizes economic benefits from elephant products. Supporters of animal rights favour the former position. The latter position is common among neighbouring communities and protagonists of sustainable use. We commonly look to science to resolve this controversy. In reality natural systems are complex and defy prediction. Science can only outline the risks of elephant over-abundance. People vary regarding tolerance of risks. To animal rightists little could justify killing elephants. Those who bear the economic consequences of over-abundance accept killing more readily. Environmental controversies are commonly decided in favour of people who are directly at risk. While we must minimize risks to neighbours, one cannot generalize. Risk assessments are complex and situation-specific. Each situation merits fair stakeholder consultation, and we regard it as our first duty to facilitate this process.

The poverty / conservation equation

DEFINING POVERTY AND CONSERVATION

BESTON, JULIE, Timothy Boucher

The ways we define poverty and conservation affect the ways we go about helping the poor and conserving nature. The number of people estimated to be poor varies widely with the tool used to

measure it, and different conservation organizations using different prioritization schemes focus on very different parts of the biosphere. Due to these differing ways for quantifying these concepts, setting common goals can be very difficult. Even if definitions and goals are agreed upon, assessing progress toward those goals may be problematic. How do we know when we have successfully improved the quality of life for a community or preserved an ecosystem process? Furthermore definitions of poverty or conservation used by aid organizations may focus on only one aspect of the problem, and very rarely do they take into account the relationship between poverty and conservation. When we ignore these relationships, we risk undertaking activities that may impede progress on other fronts. However, using definitions of poverty and conservation that are complementary, both within and between fields, will allow us both to tap the passions of individuals and do greater good for both the poor and nature.

CONSERVATION OF ECOSYSTEM SERVICES FOR POVERTY ALLEVIATION: PANACEA OR HYPE?

KAREIVA, PETER, Michelle Marvier

The conservation literature is filled with stories about nature reserves that have displaced impoverished local populations, but also with tales of alleviating poverty by protecting ecosystem services and win-win ecotourism projects that help protect biodiversity and enhance local economies. NGO's and international institutions develop funding programs and major global efforts based on which set of stories or studies they believe. We have assembled a database of published reports regarding poverty alleviation, ecosystem services, and conservation projects to ask, what is the weight of evidence in terms of impacts on human well-being, impacts on ecosystem services, and impacts on conservation? In most cases, assessment of impacts is lacking and only indirect measures are offered. Making the most of what little assessment exists, we find that win-win outcomes are very rare, but that success is equally rare among efforts focused solely on poverty alleviation or solely on conservation. The conclusion we draw is that any positive outcome is hard to achieve, but there is the most to gain and little to be lost by seeking those opportunities for win-win outcomes of improved human well-being and conservation success.

DO PROTECTED AREAS ALLEVIATE OR EXACERBATE POVERTY; INITIAL RESULTS FROM A FOUR COUNTRY STUDY

Franks, Phil, RICHARD HATFIELD

This paper will report the initial results of a four country study involving Uganda, Kenya, Thailand and the Philippines assessing the cost and benefits of protected areas at local, national and global levels. Using a combination of social impact assessment and economic analysis the assessment of impacts on local communities aims to more accurately reflect local perspectives. The study will show that local communities often bear a disproportionate burden of the cost of conservation but that this is not always the case and that increased community participation does not necessarily deliver a more equitable outcome, especially from the perspective of poorer groups within the community.

BEYOND NEMO: THE INEQUITY OF THE GLOBAL THREAT TO CORAL REEFS

DONNER, SIMON, David Potere

Coral reef ecosystems worldwide are threatened by human activity, through overfishing, marine pollution, disease and climate change. Scientists are warning that rising ocean temperatures and changes to ocean chemistry caused by increasing greenhouse gas emissions may pose a serious threat to the function and even survival of many of the world's coral reef ecosystems. The environmental community has adopted the colorful, charismatic coral reef as an iconic "flagship" ecosystem. It is good marketing. Who among us would want to be blamed for killing Nemo? In

focusing on the aesthetic attributes of coral reefs, the potential human inequity of the threat posed by global problems like climate change is often ignored. Our global analysis shows that 63% of the 655 million people living within 100 km of coral reefs reside in countries where the per capita GDP is less than US\$5000 and the per capita greenhouse gas emissions are less than one-tenth of the average American. Roughly two-thirds live in more rural settings where they are more likely to be directly dependent on coral reefs for shoreline protection, fisheries and tourism revenue. These human communities would be hurt the most by any long-term decline in coral reefs.

THE WEALTH OF THE POOR: ECOSYSTEM INCOME AND POVERTY REDUCTION MOCK, GREGORY

Income from sustainably managed ecosystems can be a route to poverty reduction. Nature-based income already contributes as much as two-thirds of the income of poor families. But the poor's dependence on nature is often at the subsistence level. To raise this income enough to lift families out of poverty requires a substantial change in governance, empowering poor communities with resource rights. Granting secure tenure rights is usually the first step in enabling ecosystem-based poverty reduction, helping community members to see ecosystems as valuable assets, and providing the rationale for conservation as a community investment. A second step is providing good commercial models to turn the poor's ecosystem assets into sustainable income sources. This means better marketing, formation of producer cooperatives, partnerships with the private sector, and better transportation infrastructure, so that the poor capture a larger share of the value chain of natural products. When these governance and commercial elements come together, the results can benefit both the poor and nature. Since the Namibian government began devolving authority over wildlife management and tourism to locally based conservancies in 1996, game populations have risen several-fold and poaching has declined, while per capita incomes have risen as much as 30 percent in some conservancies.

RESOURCE MANAGEMENT IN CHINA: A NEW APPROACH TO RURAL WELL-BEING THROUGH ECOSYSTEM SERVICES TAM, CHRISTINE

With approximately 200 million rural residents living on less than US\$1/day, high levels of pollution, and increasing desertification, drought, and natural disasters, China currently faces enormous social and environmental challenges. Most of these rural poor live in mountainous areas of western China, within the headwaters of five major river systems of Asia and congruent with critical biodiversity-rich areas. In these areas, ecosystem service programs such as Payments for Environmental Services (PES) have high potential to alleviate poverty, improve environmental conditions, and support biodiversity conservation. I analyze one such program, the Sloping Lands Conversion Program (SLCP), a regional forestry initiative to encourage soil and water retention by investing over US\$50 billion in compensation to farmers for reforestation. While gains have been made in poverty reduction, the program is challenged by (1) ineffective targeting of the most ecologically important lands and impoverished communities, (2) lack of clear long-term financing and sustainability, and (3) unintended social and environmental consequences. Improvement and innovation in mapping of ecosystem service flows, establishment of private markets, and enhanced local participation would increase effectiveness of China's ecosystem service approach to address human well-being and environmental conservation.

**WATER FOR THE POOR: INCORPORATING THE ENVIRONMENT INTO WATER
RESOURCES ASSESSMENT USING THE WATER POVERTY INDEX
SULLIVAN, CAROLINE**

Access to water is a major determinant of human wellbeing. A household without water will always suffer that capacity deprivation which has been identified by Amartya Sen (1999) as a major cause of poverty. At the same time it is recognised that poverty is itself a driver of environmental degradation, and to address such water-related drivers of change, effective water resource assessment is needed, along with a reorganisation of the way water is allocated between different users. Water resources assessment has traditionally been an activity carried out by hydrologists and water engineers. While this has been useful in determining physical resource availability, it does not address the many economic, social and political factors which in reality will determine peoples' access to water. To improve this situation for poor people, a more holistic approach to water resource assessment is required, and a tool to achieve this had been developed in the form of the Water Poverty Index. This provides a means by which community needs can be more clearly prioritised for water managers. In this paper, some applications of the Water Poverty Index are illustrated, along with some discussion of the contribution this can make to better conservation of aquatic ecosystems.

The significance of gender in conservation policy and project success

**GENDER AND CLASS DYNAMICS IN CONSERVATION OF SACRED FORESTS IN VENDA,
SOUTH AFRICA
TSHIGUVHO, THIDINALEI**

Many studies have shown how women's interaction with natural resources was shaped by gender relations and power dynamics within societies that they exist. Generally, studies have revealed women as the dominated group who hold less power and control over their resources, and who in many cases have impacted negatively on the environment not by choice, but by conditions created by the oppressive systems that they live in. In this paper I indicate the role that women in Venda have played in terms of resource conservation. In particular I focus on the conservation of sacred sites, and how the roles of women were differentiated by their class. I further indicate the conservation implications of this dynamics.

**THE GENDERED EFFECTS OF PARTICIPATORY APPROACHES AND INSTITUTIONAL
CHOICES IN MALIDINO BIODIVERSITY COMMUNITY-BASED RESERVE, SENEGAL
BANDIAKY, SOLANGE**

In project design and implementation, relatively little attention has been given to the unequal division of labor, power, and to differences in access to and control over resources between women and men. However, there is no unity in class, gender, ethnicity, and caste in communities. Malidino reserve is a project initiated by the World Bank and the Forestry Service in 1998 with two main objectives: biodiversity conservation in the periphery of the Niokolo Koba National Park and rural poverty alleviation through income generating activities. In their intervention strategies, the World Bank and the Forestry Service have used participatory approaches from the inception to the implementation of the project and created Village Management Committees. The study aims at analyzing how the intervention of external agencies constructs the gendered use of resources and how it influences men and women's institutional and individual empowerment as local actors in biodiversity conservation. The study is based on extensive ethnographic research in the communities living around the reserve, which involved participant observation, interviews, and focus groups. The main conclusion is that participatory approaches do not in and of themselves lead to the effectiveness and gender equity of participation, representation and empowerment in biodiversity conservation.

GENDERING NATURE: CONSERVATION AND THE BIOLOGICAL SCIENCES IN TWENTIETH CENTURY AMERICA
SCHREPPFER, SUSAN R

Based on intensive and extensive reading of primary documents, I have concluded that gender represented a strong determinant within biological conservation and public policy within the United States throughout the twentieth century. While women were only occasionally active in official capacities, either as scientists or public officials, they were a substantial force within the nonprofit and activist sectors of conservation, and influenced public policy at the federal and state levels. These women, along with some men, tended to articulate a distinctively feminine sublime--or domestic perspective--within the conservation movement that proved uniquely receptive to the ecological sciences as well as to the importance of human history within the natural world. This perspective countered the masculine vision of wilderness as a place that was barren, rugged, unpeopled, and desolate--a vision that been criticized as mythic, impractical, and even destructive. The historical feminine voice should be recognized within biological conservation in part so that the public policies and conservation rhetoric of the United States can have relevance to global policy decisions.

COLONIAL AND POSTCOLONIAL POLICIES AND THEIR INTERSECTION WITH GENDER RELATIONS AND ENVIRONMENT IN KENYA
WANGARI, ESTHER

Development policies implemented in the Third World have focused on structural economic reforms, transfer of technology, foreign direct investment and integration of these countries to international trade. However, such policies have shortcomings in addressing the external socioeconomic and political structures that have been the root of global economic disparities and gender equity. Therefore, numerous macroeconomic policies directed in improving sustainable development, have had and continue to have an overall negative impact on population in general and in particular gender relations, environment and health. This paper addresses, colonial and postcolonial policies and their intersection with gender relations, and the environment in Kenya. I argue that the failure of development policies must be viewed within the context of wider historical processes and that merely focusing on macroeconomic policies obscures the social, economic, and political structures that have been contributory to underdevelopment. However, the paper transcends the critique of economic policies and explores ways in which communities and women's activism in tandem with the state are working towards the realization of environmental conservation and, gender equity.

WHY GENDER?
DOBSON, TRACY

Conservation, social and biological scientists increasingly recognize the imperative to work with local people in identifying and addressing conservation challenges. Frequently this aspect of conservation is couched in terms of engaging the "community." Human communities, however, are not composed of homogenous beings, but rather, a number and variety of groups with different goals and interests and different abilities/power bases that they may use to influence or direct conservation outcomes. A singularly significant aspect of human identity to consider in this connection is gender. Gender is expressed in diverse ways in the multiplicity of human communities around the world. It is an important characteristic through which many cultural values and power differentials are played out. Consequently, knowledge of gender dynamics, along with its intersections with ethnicity, class, wealth, religion, in particular locations is critical to

understanding conservation problems and to crafting, implementing and monitoring solutions that will result in the sustainability that conservation scientists hope to achieve.

WOMEN'S CHANGING RIGHTS TO LAND AND WATER RESOURCES: WETLANDS USE IN MALAWI
FERGUSON, ANNE

Malawi, similar to other Southern African countries, recently has revised its environmental and agricultural policies and laws. New land, water and irrigation policies have been approved by Parliament, altering or formalizing resource access and use practices once under customary tenure, as well as introducing new statutory laws and institutions. These reforms may dramatically alter access to critical environmental resources for rural livelihoods. This paper explores the implications of these processes for women's access to plots on smallholder irrigation schemes in wetland areas as plans are made to transfer them to water user associations (WUAs). The paper analyzes the early effects of reform on two large irrigation schemes in Southern Malawi, a matrilineal area. It demonstrates how international and national policies and laws interact with existing institutions and practices, and gendered economic and political hierarchies. While the new irrigation policy identifies women as the majority of smallholder farmers and calls for them to be included as plot holders and members of new associations, new WUA constitutions reflect local histories and informal institutions which work in contradictory ways, and may result in women losing access to these valuable resources.

FOREST CONSERVATION AND GENDER ROLES: CASES FROM EAST AFRICA AND LATIN AMERICA
MWANGI, ESTHER, Ruth Meinzen-Dick

Many studies have demonstrated that understanding gender relations (and in particular women's access and decision making) is crucial for the sustainable management of forests. This paper examines whether the composition of forest user groups in East Africa (Kenya and Uganda) and Latin America (Bolivia and Mexico) influence forest condition as perceived by the users themselves as well as forestry officials. The paper asks a fundamental question: whether forest condition indicators vary under predominantly female vs predominantly male vs mixed forest user groups, how and why. In attempting to answer this question the authors explore differences in type and levels of conflict, forest improvement activities, harvesting restrictions and technologies, and rule making and compliance across the three types of groups. The paper also reflects on the effects of decentralized forest management on user group function and performance.

TRANSGRESSING BOUNDARIES: DECENTRALIZATION AND GENDERED OWNERSHIP AND RIGHTS TO SPECIES AND SPACES WITHIN FORESTED LANDSCAPES IN EAST AFRICA
NABANOGA, GORETTIE NSUBUGA, Emily Obonyo-Kamau, PAUL ONGUGO, JANE NJUGUNA, Abwoli Banana, William Gomba-Ssembajjwe

The perception of people's use of forested landscapes is widely governed by concepts of boundaries associated with land ownership. This approach assumes a homogenous landscape that is gender neutral, where land rights are sufficient for equitable use and conservation of resources therein. However, the people dependant on these landscapes for livelihoods view them as heterogeneous and gendered. Thus, access to resources is characterised by nested and overlapping rights that are politically, socio-economically and culturally prescribed. Its anticipated that decentralisation of forested landscapes could alter the existing gendered rights to resources and influence transformation of current gendered boundaries. This calls for recognition of traditional forest use systems, which entail gendered access delineated by boundaries of nested bundles of rights for different users. Using participatory approaches, studies in East Africa

highlighted the gendered nature of use and access to forested landscapes. Thus, apart from land and tree tenure, the unequal power relations between men and women determine the nested and multidimensional niches in landscapes, further defining multiple use and access boundaries based on gender, space, species, products, use and kinship. It is plausible that proper implementation of decentralization and recognition of gendered resource rights could enhance equity and conservation of forestry resources.

PRODUCTIVITY, PHOTODEGRADATION AND CARRYOVER AMONG MESIC AND SEMI-ARID GRASSLANDS
MASUBELELE, MMOTO , William Bond

Grasslands vary in the amount of dry matter ('carryover') persisting from one growing season to the next. Grasslands with large carryover accumulate fuel over several growing seasons and grassland productivity can decline, resulting in one or two grass species dominating the grassland plains thereby reducing biodiversity unless the litter is burnt off. Here, we explore factors influencing variation in grass litter carryover between mesic and arid savannas. Photodegradation is likely to be more important than microbial decomposition of standing dead litter in the dry season. We compared decomposition rates of different grass species under different shading conditions in a field experiment. The study showed that there were differences in litter disappearance between mesic and semi-arid grasslands with the former more resistant to photodegradation and the latter breaking down more readily in the sun. Thus mesic grasslands accumulate proportionately more carry-over than semi-arid grasslands partly because of the properties of the grass species in each type. The implications from this study are that mesic grasslands have to burn if biodiversity is to be maintained, and that semi-arid grassland does not need fire. The grass species in semi-arid grasslands are highly palatable and can break down easily from the sun, therefore nutrient cycling and hence biodiversity is properly maintained in semi-arid grasslands.

DROUGHT EFFECTS AND FREQUENCY: IMPACTS ON CONSERVATION OF ENDEMIC PLANTS IN FLORIDA SCRUB ECOSYSTEM
SAHA, SONALI, Eric Menges, Margaret Evans, Satya Maliakal-Witt

Demographic responses of endemic Florida scrub plants to fluctuations in soil moisture are analyzed. Periodic droughts are common in scrub ecosystems, and most dominant shrubs have adaptations to drought. However, because the water table is shallow (0.45-1.8 m) and annual rainfall is high (1400 mm), it is not clear how to measure drought severity and whether periodic droughts have important effects on Florida scrub plants. We summarized mortality and relative growth rate for dominant shrubs during a severe drought in 2006. Although most plants had considerable dieback and water potentials below the turgor loss point, very little mortality occurred. Plants that died back had similar growth rates to unaffected plants. This drought event has occurred about once every 7-8 years, based on 74-year rainfall records. In contrast, drought effects for three herb species were relatively strong. In general, growth, fecundity, and recruitment were lower during winter and spring quarters with low precipitation. Droughts have been more frequent in the last 10 years than previously, a potential effect of climate change. Because most of the endemic plants of Florida scrub are subordinate, drought may have important effects on population persistence.

EXPERIMENTAL MANAGEMENT OF PREDATORS AND MESO-PREDATORS IN NEW ZEALAND FOREST ECOSYSTEMS
BYROM, ANDREA , Roger Pech, Grant Norbury, Wendy Ruscoe, Deborah Wilson

Progress in managing threats to native fauna in New Zealand's forest ecosystems is limited by incomplete knowledge of patchiness in the distribution of introduced rodents and the role of top-down regulation of rodent populations. Qualitative analyses of food webs were used to predict which experimental manipulations of ship rats, house mice, brushtail possums and stoats would enable us to test alternative models of trophic interactions between these pest species and their primary native food resources (fruit, seed and invertebrates). Based on these analyses, a large-scale experiment has been implemented that will generate data for multi-trophic interactive models for the dominant species or functional groups of species. In addition, large-area, low-intensity trapping grids are being used to characterise the dispersion of ship rat populations. The most likely result is that ship rat populations will have clumped dispersion particularly in years of low fruit production, and that high-density patches will be associated with fixed locations. Experimental manipulations (e.g. food addition) and modelling will be used to better understand the spatial dynamics of ship rat populations. The outcome from this research will be improved multi-species pest control programmes and up-to-date predictions of locations of ship rat 'hotspots' for spatially-targeted control in New Zealand forests.

CHALLENGING THE CORRIDOR CONCEPT: ISOLATED TREES ALSO PROVIDE CONNECTIVITY IN FRAGMENTED LANDSCAPES
DOERR, ERIK, Veronica Doerr, Micah Davies

Wild animal populations are increasingly forced to survive in fragmented landscapes where their long-term persistence is dependent on dispersal between small remnant patches of habitat. A thorough understanding of dispersal behavior in fragmented habitat will become even more essential as climate change forces species to shift their ranges or perish. Corridors have been widely heralded as solutions to these problems and increasing amounts of conservation effort and public funding are being devoted to corridor establishment and protection around the world. We studied natal dispersal movements of brown treecreepers (*Climacteris picumnus*) in two fragmented landscapes in the wheat-sheep belt of southeastern

Australia, one consisting of woodland patches connected by various types of corridors and one consisting of isolated woodland patches. Rates and patterns of movement between patches were similar in the two landscapes, and while corridors were indeed used in the connected landscape, birds in the isolated landscape were able to use other landscape features, primarily isolated trees or clusters of trees, to cross relative large expanses of agricultural matrix between patches. Detailed data such as these on the use of corridors during natural dispersal movements are rare, and our results suggest that the necessity and cost-effectiveness of corridors may need to be reconsidered in light of possible alternatives.

GENETIC VARIATION OF THE RARE SICHUAN JAY *PERISOREUS INTERNIGRANS* IN WESTERN CHINA

JI, TING, Jacob Höglund, Yu Jing, Yun Fang, Yue-hua Sun

Perisoreus internigrans is one of the least known endemic bird species inhabiting the high mountain conifer forest in western China. The species is qualified as Vulnerable by IUCN as it has a small, declining, severely fragmented population as a result of extensive deforestation throughout its range. The main goal of our research was to evaluate the conservation status of Zhuoni and Jiuzhaigou populations by assessing the genetic variation using six microsatellite markers, and to propose conservation strategies. We examined 25 individuals from the two populations, the bootstrap algorithm was used to reduce the effects of small sample sizes in the estimations of genetic diversity. We found that both populations have suffered recent declines in population sizes, the Zhuoni population showed very low genetic variation, indicating that it might have become fragmented and endangered. While the Jiuzhaigou population did not show any obvious allele losses. Both populations showed excesses of observed heterozygotes and negative FIS. We found a moderate genetic differentiation between the two populations, with a F_{ST} of 0.1393. The severity of the bottlenecks experienced by these two populations and the extent of population connectivity might help to explain the different level of genetic diversity. We suggest that maintaining the existent continuity of conifer forest in Western China is of great importance for conservation of this species.

INTRODUCED FRESHWATER SPECIES IN SARDINIA ISLAND, ITALY: MECHANISMS, EXTENTS AND IMPACTS ON NATIVE FISH COMMUNITIES

ORRÙ, FLAVIO, Angelo Cau

Freshwater species have been introduced according to a variety of purposes in Sardinia: biological control, improvement of wild stocks, ornament, sport, aquaculture, unintentional releases. Alien species have invaded communities of fish species and the balance between the native species has become seriously disrupted. At present only 7 of the 20 freshwater fish species are native, all others have been introduced and represent a number of realized or potential impacts. Negative consequences of introduced aquatic species take place through predation, competition for resources, hybridization and loss of genetic integrity, or through the transfer of parasites and diseases. Our results show that introduced freshwater species continue to invade and disperse, and their establishment and persistence are facilitated by various change elements such as globalization of commerce (i.e., aquaculture, bait trade, aquarium trade), waterway engineering (i.e., canals, dams), land use change (i.e., eutrophication, water withdrawal), climatic changes, and intentional stocking. The study also focuses on the origin, probable mechanisms of introduction and the date and area of first introduction. We conclude that the capacity to deal with the issue depends not only on the development of adequate strategies and tools to detect, prevent, and control introductions and invasions but also on the degree of social and political determination that develops at local level.

THE ROLE OF ENDANGERED SPECIES IN ECOSYSTEM PROCESSES: ASIAN ELEPHANTS AS AGENTS OF SEED DISPERSAL IN SOUTHEASTERN SRI LANKA

CAMPOS-ARCEIZ, AHIMSA, Sampath K.K. Ekanayaka, Asier R. Larrinaga, Udayani R. Weerasinghe, Seiki Takatsuki, Prithviraj Fernando, Luis Santamaria

The global decline of wildlife threatens to disrupt vital, but poorly understood, ecosystem processes. In the framework of a study focused on the role of Asian elephants *Elephas maximus* as agents of seed dispersal in the human-dominated landscapes of southeastern Sri Lanka, we collected elephant dung samples for a period of one year and found seeds in 97% (N=350) of dung piles. Defecated seeds belonged to 55 plant species and included plants from different life forms (trees, shrubs, grasses and lianas) and habitats (monsoon forest, scrubland, open areas and crops), as well as native and invasive species. We also estimated seed dispersal curves combining information from feeding experiments and GPS tracking of wild individuals. Estimated dispersal ranged from one to five kilometers, with a mean dispersal distance of 1075 m (range 712-1749 m) and a maximum dispersal distance of 5164 m. Elephants are efficient seed dispersers in the dry monsoon forests of Sri Lanka, with the potential to enhance the regeneration of abandoned slash and burn fields and to connect patches of forested habitat by means of long distance dispersal. The local disappearance of elephants is therefore likely to result in the disruption of important seed-dispersal processes and may cause dispersal limitation for species with hard-coated fruits (such as *Feronia limonia* and *Catunaregam spinosa*), for which elephants might be the main seed dispersers.

THE NEED FOR VULNERABILITY AND IRREPLACEABILITY TO BE INCLUDED WITHIN MPA PLANNING EDGAR, GRAHAM, Stuart Banks, Brooks Thomas

During negotiations over marine protected area (MPA) boundaries, stakeholders generally attempt to ensure that known or prospective concentrations of economically-valuable resources remain outside the MPA network. Yet MPAs derived through such negotiations can have low value for biodiversity conservation because human activity continues unchanged across the seascape. To achieve equality at the MPA negotiation table, conservation stakeholders require a systematic protocol to objectively identify sites of highest conservation significance within the seascape. An appropriate protocol, previously primarily applied in the terrestrial context, is the 'key biodiversity area' approach, whereby locations holding threatened or irreplaceable biodiversity features (such as Red Listed or narrow-range endemic species, and exceptional congregations of single species) are identified as highest priority sites for protection. We apply this approach within the Galapagos Marine Reserve as part of the current reevaluation of coastal management zones. The majority of identified marine key biodiversity areas (27 of 38) are currently protected from fishing because they lie within the 17% of coastal waters that is presently recognised as 'no-take' tourism and conservation zones. All key biodiversity areas could be protected from extractive exploitation by a relatively minor amendment to the existing zoning scheme, whereby an additional 2% of the coastline is dedicated to conservation.

INVESTIGATING FACTORS ASSOCIATED WITH MAN-EATING TIGERS IN CHITWAN NATIONAL PARK, NEPAL GURUNG, BHIM, David Smith, Charles McDougal, Jhamak Karki

Man-eating is the ultimate expression of tiger-human conflict and is difficult to explain from an ecological perspective. This research was undertaken to investigate systematically the ecological factors and sociological aspects of man-eating in and around Chitwan National Park, Nepal. Data on man-eating incidences were obtained from various sources. Information obtained was verified by visiting the victim's family. In addition, the removal of man-eating tigers was verified from park records and also zoo records. A total of 37 tigers were involved in killing 88 people from 1979 to 2006. The trend of human loss has increased significantly from an average of 1.5 persons per year (1979-1998) to 8.25 per year since 1999. The rising trend is due to the increasing number of people killed in the multiple use buffer zones surrounding the park. Nearly half of the people killed were grass/fodder collectors. Four relevant factors associated with man-eating tigers are identified: (1) injured or aged tigers find it difficult to kill natural prey, (2) an imbalance between tiger and prey base, (3) aggressive tiger behavior, and (4) defensive or accidental killing. A Park authority administers a compensation program to win the local people's support for tiger conservation.

AN OPTIMALITY BASED PREDICTIVE HABITAT USE MODEL FOR WHITE STORKS OLSSON, OLA

Here, I will present a predictive habitat use model for white storks *Ciconia ciconia* in a heterogeneous agricultural landscape. The model is based on an optimality approach. Optimality theory has been successfully applied to the study of animal behaviour for a long time. Behaviours such as foraging, habitat selection and mate choice can often be well predicted under the premise that individuals strive to maximise their fitness. Despite the predictive powers of optimality-based models, such models are rarely applied to conservation problems. The present model is based on the fact that habitat patches vary in quality and occur at different distances from the nest. The foraging birds are thus faced with a trade-off between quality and distance. The model fits data well, and predicts that there is a threshold combination of distances and qualities. Only patches of higher quality, or at closer distances than this threshold will be used. For any given landscape the model generates predicted breeding sites, which in turn leads to a predicted population size in a region. The model can also be used to identify areas with nearly sufficient habitat, which will be priority areas for habitat restoration. The advantage of this type of predictive habitat use model is that it is based on a few parameters that are directly relevant to the animals. Given that the model captures the animals' behavioural decision rules, it is fully scalable and has a high predictive power.

RISKS AND OPPORTUNITIES - CONSERVATION AND STATUS OF ENDANGERED AFRICAN ANTELOPES FISCHER, FRAUKE

The aim of the study is to collect and make freely available information on the status of endangered African antelopes in order to help to develop effective conservation strategies by combining efforts of different partners and point out needs for research and action. Those 17 species listed as critically endangered, endangered or vulnerable on the IUCN red list have been included in the analysis. By screening the available scientific and grey literature and contacting the respective experts most recent information on these species has been collected. Available information differs tremendously between species with some of the potentially most threatened species being the least known. The species have been ranked according to different ecological factors that make them prone to extinction such as global population density, range size,

human induced and natural threats among others. While for some species large knowledge gaps prevent any detailed assessment of their status others could be ranked, giving conservationists an important tool at hand. The SCB will be used as a forum to present those preliminary results and involve additional experts in the ongoing process of the work. The project works closely with the Global Mammal Assessment and the IUCN SSC Antelope Specialist Group.

DERIVING CONSERVATION TARGETS FOR FRESHWATER SYSTEMS

RIVERS-MOORE, NICHOLAS, Peter Goodman, Ferdinand de Moor, Mncedi Nkosi

Systematic conservation planning for terrestrial systems makes use of island biogeography theory and species-area curves to set defensible conservation targets. However, this same approach cannot be applied to river systems, and the current approach makes use of a 20% target value which has become entrenched in the scientific literature. An approach with a theoretical grounding similar to the species-area curve is necessary for setting meaningful targets in freshwater conservation planning. Being longitudinal segments, river length is an equivalent to area. Segment lengths, and their location, become the critical determinants in choosing how much of a river should be conserved. We propose a new methodology, based on established measures of species diversity and river theory. The location of highest alpha-diversity, as related to the river continuum concept, and species turnover along a river's longitudinal axis (beta-diversity), determine where and how long a river segment should be to conserve species diversity. Between-river diversity (gamma-diversity) determines how many river systems should be conserved within each ecoregion, and this relies on a suitable river classification system. We also explore the implications of conserving process (ex-situ and in-situ) to conserve pattern. This approach is applied to a freshwater conservation plan currently being developed for KwaZulu-Natal (RSA).

MONGOOSE PREDATION ON SEA TURTLE NESTS IN BARBADOS, WEST INDIES

LEIGHTON, PATRICK, Jennifer Beggs, Julia Horrocks, Donald Kramer

Mongoose impact sea turtle populations through predation on eggs and hatchlings. We studied the behaviour of mongooses *Herpestes javanicus* foraging at Bath, an important nesting beach for hawksbill sea turtles *Eretmochelys imbricata* in Barbados, West Indies. We combined an experimental approach using artificial nests with analysis of seven years of hawksbill nesting data at this site to identify significant factors affecting nest predation by mongooses and to develop a predictive model of predation risk for hawksbill nests. Mongoose predation was the primary threat to hawksbill nests at Bath, with approximately 30% of nests destroyed by mongooses annually. Mongooses foraging on the beach avoided open areas, and activity was concentrated in and around beach vegetation. Disturbance of the sand was the primary cue for exploratory digging by mongooses, and predation risk was significantly higher for nests closer to vegetation and for shallower nests. We show how our model of predation risk can be applied to reduce mongoose predation through reducing mongoose density in vulnerable locations, nest relocation, and nest protection. This is the first empirical study of factors affecting mongoose predation on sea turtle nests, and is broadly relevant to sea turtle conservation in the Caribbean where introduced mongooses are abundant.

RESERVE SIZE, RELEASE DENSITY AND TRANSLOCATION SUCCESS: BLACK RHINOCEROS MOVEMENTS, ASSOCIATION, INJURY AND DEATH AFTER RELEASE

LINKLATER, WAYNE, Ron Swaisgood

The implications of post-release movement and conspecific encounters for translocation success where reserve size and conspecific density vary are rarely investigated although misadventure and fighting are a common cause of death after release for many species. We describe conspecific association, daily displacement, injury, and death amongst 38 black rhinoceros (*Diceros bicornis*) during their first 100 days after release into 12 Namibian and South African reserves that ranged in size from 670 to 45,000 ha. Black rhino actively and successfully avoided each other in reserves $\geq 18,000$ ha where association rates were almost zero. In smaller reserves ($< 11,500$ ha) and at high release densities (< 20 km² per rhino) association rates became elevated. Injuries to three rhino and two deaths were fight-related and four of these occurred in reserves $\approx 5,600$ ha. Three deaths were of juveniles. Daily displacement did not increase in reserves larger than 8,500 ha but declined with decreasing reserve size indicating higher encounter rates with fenced reserve boundaries. Reserves larger than 18,000 ha should be favoured and reserves smaller than 8,500 ha avoided for black rhinoceros reintroductions. Translocating mothers with calves and juvenile animals should be discouraged where possible.

RECONSTRUCTING THE OBSERVATION PROCESS TO DETERMINE POPULATION TRENDS OF THE CRITICALLY ENDANGERED SAIGA ANTELOPE

McConville, Andrew, Iuri Grachev, Aidan Keane, Tim Coulson, Amankul Bekenov, E.J. MILNER-GULLAND

The saiga antelope is listed as Critically Endangered due to a 90% population decline over the last 10 years. It has been monitored consistently over a 40 year period using aerial surveys, which although lacking confidence intervals, have been taken to reflect real trends. However, decline processes often involve

behavioural and distributional change, not just population reduction. How does observation bias change when the underlying biology changes, and is it possible to reconstruct the observation process to quantify the bias and put retrospective confidence intervals on population estimates? We explore these questions for the saiga in Kazakhstan using a modelling approach based on raw data from surveys in three populations over the period 1990-2006. We show that the major reduction in numbers observed in 2001 remains, but that there is no power to detect change in other years. Hence caution should be exercised when claiming population recovery over the period 2003-2006. Saiga group sizes and spatial distributions have changed markedly over the last 10 years, and this necessitates a reexamination of survey methodologies to ensure cost-efficient and accurate sampling. This case study demonstrates that employing a consistent methodology is not sufficient to infer population trends. It is important to be responsive to changes in underlying biology, account for sources of error and bias, and reassess sampling methods as underlying conditions change.

MORTALITY AND SEEDLING ESTABLISHMENT OF VASCULAR EPIPHYTES ON ISOLATED TREES IN TROPICAL MONTANE PASTURES

Gradstein, Robbert S., FLORIAN A WERNER

Disturbed habitats commonly harbour altered assemblages of epiphytes, but the underlying processes are little understood. We explored the role of mortality and seedling establishment in the maintenance of diversity and floristic composition of epiphytes following disturbance. The study was carried out at 2000 m a.s.l in the Andes of south-eastern Ecuador. We individually marked approx. 1500 vascular epiphytes on isolated remnant trees in fresh clearings and in adjacent forest and recorded survival after one and two years. Additionally, all epiphytes were removed from the lower trunks of 100 *Piptocoma discolor* trees growing isolated in pastures and in forest. After two years we recorded the number and identity of epiphyte seedlings. Plant mortality was greatly increased on remnant trees as compared to forest trees. Mortality rates were highest for hygrophilous fern taxa. Abundance of epiphyte seedlings on isolated trees was significantly reduced, and so were taxon richness and density. Establishment on isolated trees was strongly biased to xerophytic taxa and uncorrelated with distance to forest. Our results show that the selective impoverishment characteristic of local epiphyte assemblages on remnant trees is attributable to the additive effects of increased mortality and reduced recruitment. We conclude that microclimatic deterioration, but not dispersal limitation is the major driving force behind mid-term changes in epiphyte diversity on isolated trees.

COST/BENEFIT ANALYSIS OF THREAT MITIGATION STRATEGIES FOR A RAPIDLY DECLINING POPULATION: THE TASMANIAN DEVIL (*SARCOPHILUS HARRISII*)

HAWKINS, CLARE

When managing a poorly understood threat, resource allocation plans must adapt rapidly as the population declines and we learn more about the threat. The Tasmanian State government's response to emerging Devil Facial Tumour Disease (DFTD) in the Tasmanian devil (*Sarcophilus harrisii*) includes extensive spotlighting surveys to monitor declines, intensive trapping to generate parameter estimates for epidemiological models (to help identify disease control strategies) and a single disease control trial. Spotlighting surveys indicate a 41% overall population decline, and a 90% decline in NE Tasmania where DFTD was first reported. It might now be appropriate to reallocate the majority of monitoring funds to additional disease control trials, with parameter estimates being obtained from control sites. Monitoring solely in NE Tasmania would test whether recovery can occur without artificial intervention, or measure the period between first report and local extinction, supporting management planning elsewhere in the species range. However, replicated monitoring of the earliest affected areas would provide more reliable estimates, and help identify factors that could be manipulated to affect the outcome. More generally, at a stage where a threat is still poorly understood, information acquired from monitoring unmanaged populations may help identify an effective mitigation strategy more swiftly than empirical trials supported by equivalent funds.

INTERACTIONS BETWEEN SEABIRDS AND DEEP WATER TRAWL GEAR: AN ASSESSMENT OF IMPACTS IN SOUTH AFRICAN WATERS 2004-2005

WATKINS, BARRY , Samantha Petersen, Peter Ryan

Direct observations of deep water hake trawl warps on 14 vessels between mid-2004 and end 2005 reported at least 30 birds killed in 190 hours of observations. Most birds were killed when their wings became entangled with the warps when scavenging on offal discard. Mortalities occurred during trawling, shooting the gear and becoming entangled in trawl nets. Mortality rate varied seasonally and depended on the activity of the vessel; mortalities were greater in winter when more birds attended vessels and most occurred during offal discharge. Using a bootstrapping approach to estimate 95% confidence intervals, overall, albatrosses suffered a disproportionately high mortality rate. Based on conservative estimates of effort and offal discharge the total extrapolated mortality is 18 000 (95% CI 8 000-31 000) birds killed annually, of which 85% are killed on warps and 15% entangled in nets. Of the birds killed some 68% are albatrosses, 14% Cape gannets and 9% White-chinned Petrels, all listed as globally threatened or near-threatened. Deploying bird-scaring lines (permit condition July 2006) to keep birds away from the warps is one way to reduce

mortalities. Mitigation trials are underway to assess the efficacy of bird-scaring lines and other possible mitigation devices.

CAN WE ACCURATELY MONITOR ABUNDANCE OF RARE AND ELUSIVE MAMMALS AND DO WE NEED TO?

PLOWMAN, AMY, Andrew Bowkett, Natasha de Vere

Accurate monitoring of target populations may be regarded as a fundamental necessity to plan and evaluate conservation projects. For many species, such as rare and secretive duikers, this is difficult. We have estimated the abundance and/or density of various duiker species in Zimbabwe, Kenya and Tanzania using many methods: drive counts, walked transects counting sightings, dung and spoor counts, territory mapping, camera trapping and hair trapping. Some methods failed to detect our target species (e.g. hair trapping) or detected so few individuals that abundance estimates were not possible (e.g. drive counts and transect sightings). Other methods yielded apparently valid results despite violation of several assumptions (e.g. dung counts). However, we doubt that any of these methods are reliable enough to monitor extremely rare species and propose that other solutions, exploiting new technologies, are needed. For instance, we plan to assess molecular analysis of faecal DNA as a monitoring tool for Abbott's duiker in Tanzania. However, this technique and others exploiting state-of-the-art technology will be very expensive. Will the increase in monitoring accuracy be worth this cost given that most conservation budgets are extremely limited?

IMPROVEMENTS FOR THE USE OF ENVIRONMENTAL SURROGATES IN CONSERVATION PLANNING

ARPONEN, ANNI, Atte Moilanen

Data available for conservation planning is usually scarce. If designing reserve networks is based on known distributions of some focal species, there is no guarantee that other species will be adequately protected. People have suggested using environmental variables as biodiversity surrogates, but it is unclear whether or not this approach actually works. Even though environmental surrogates suffer from some fundamental problems, such as the difficulty of incorporating non-environmental factors that affect species' distributions (historical events, biotic interactions etc.), we show that their performance can be improved from the present situation by addressing some technical issues. We point out that (1) attention should be paid to the effects of selecting a statistical modelling method, (2) in many cases the sampling of the "environmental space" can be more efficient than the commonly used p-median selection, and (3) taking into account potential species richness and turnover gradients in the environmental space can have a considerable effect on the degree of complementarity captured by the reserve network. Following these guidelines improves the performance of environmental surrogate strategies.

A FRAMEWORK FOR ENHANCING EFFICIENCY AND REDUCING RISK IN UNGULATE ERADICATION ON ISLANDS

MORRISON, SCOTT A., Norman Macdonald, Kelvin Walker, Lynn Lozier, M. Rebecca Shaw

Eradication of feral ungulates is an important tool for conservation of imperiled island biota. Yet, the risk that an eradication attempt will fail can be great because of the difficulty of detecting and dispatching the last animals. We developed a framework to reduce this risk and tested it in a program to eradicate feral pigs from Santa Cruz Island, California, USA. Our framework focused on reducing (1) education of individuals and selection of the target population toward greater wariness, (2) replacement, and (3) uncertainty during the course of the program. We report on how seven key attributes of our approach enabled us in 2007 to achieve eradication, with a quantified degree of confidence, in an unprecedentedly rapid timeframe for an island of this size (243 km²). We suggest that the operational and analytical framework demonstrated on Santa Cruz Island can serve as a general model for ungulate eradication, especially as eradication is applied to larger and more complex island systems. The approach helps reduce the risk of the failure due to an inability to detect the last animal, and so reduces much of the investment risk that is inherent in eradication. This framework represents a significant advance in the tools available to conservation practitioners, and as such, can allow for more ambitious restoration goals to be set for island ecosystems, and for more certain and accelerated attainment of those goals.

COMMUNITY SHIFTS FOLLOWING SIMULATED EXTINCTION OF LARGE HERBIVOROUS MAMMALS

PRINGLE, ROBERT

Large-herbivore populations are declining in many parts of the world. Understanding how these declines affect community dynamics is therefore critical to designing remedial conservation actions, especially outside of protected areas, where large-mammal declines have been particularly severe. I documented the abundances of several taxa in the presence and absence of herbivores, using six long-term ungulate-exclusion plots replicated across a landscape-scale gradient in primary productivity on a wildlife-friendly Kenyan cattle ranch. Although there was no discernable effect of ungulates on total arthropod abundance, beetles in particular were 86% more abundant in the absence of ungulates; this indirect effect was apparently mediated by changes in the herbaceous layer. Likewise, the numerically dominant lizard

(*Lygodactylus keniensis*, an arboreal gecko) was 61% more abundant in the absence of ungulates, an effect mediated by changes in both tree density and beetle abundance. Finally, the magnitudes of the direct and indirect effects of ungulates on all taxa were negatively correlated with aboveground primary productivity. Collectively, these results demonstrate strong cascading effects of ungulates and suggest that the most profound community shifts accompanying ungulate declines will be in low-productivity habitats. Thus, managers should prioritize low-productivity areas when considering ungulate-reintroduction programmes and other remedial actions.

HABITAT SPECIALISATION AND THE IMPACT OF CLIMATE CHANGE ON CORAL REEF FISHES MUNDAY, PHILIP

Coral reefs are known for their exceptional diversity of fishes, many of which have a close association with living coral. Climate change is predicted to increase the frequency of disturbances on coral reefs, however, the impact of these disturbances on reef fish communities is largely unknown. I surveyed corals and associated coral-dwelling fishes in Kimbe Bay, Papua New Guinea, in 1996 and again in 2003. The period between surveys was characterised by an increased frequency of coral bleaching and elevated sedimentation that caused a dramatic decline in coral cover on nearshore reefs. Changes in the total abundance of coral-dwelling fishes closely matched changes in the total abundance of corals; however, specialist species lost proportionally more of their populations than generalist species. In addition, specialist species had smaller initial population sizes than generalists, therefore they faced a “double jeopardy” of extinction because their already small populations suffered the most from habitat loss. Generalist species declined proportionally less than specialists because they increased their use of secondary habitats as preferred corals became scarce. Generalists also recovered more quickly after the disturbance because of their ability to use a broader range of coral habitat. These results indicate that fish communities will become dominated by a lower diversity of more generalist species as a result of repeated climate-change induced disturbances to coral reefs.

IDENTIFICATION OF THREATENED MEDICINAL PLANTS IN TRADE: ETHNOBOTANICAL, MOLECULAR AND TAXONOMIC APPROACHES KOOL, ANNELEEN, Hugo J. de Boer, Lars Björk, Abdelaziz Abbad, Gary Martin

Our research in markets of southern Morocco raises concerns that poor taxonomic identification of herbal products obscures the potential threat to local populations of endangered botanical species included in medicinal plant mixtures. An inventory of plants in trade revealed three modes of correspondence between scientific taxa and local botanical categories: relationships of one-to-one equivalence, overdifferentiation and underdifferentiation. We refer to the underdifferentiated categories as ‘generic complexes’, defined as ethnobiological taxa that have a common Arabic or Amazigh name but comprise diverse species, often from distinct botanical genera and families. Underdifferentiation is of concern for conservation because the ambiguous delimitation of membership in generic complexes could lead to the unwitting sale of endangered species mixed with more common ones. Initial research indicates that complexes arise when a highly valued species is progressively substituted by other products that are cheaper, more accessible or less frequently requested. With funding from the Swedish Research Links Programme, we are applying quantitative molecular analysis and DNA barcoding techniques to identify problematic specimens in generic complexes that cannot be resolved with ethnobotanical and taxonomic methods alone. This complementary approach will reveal the proportion of rare and endangered species in generic complexes and plant mixtures on sale in the markets of Marrakech

IDENTIFYING THE MOST VULNERABLE SPECIES: PROSPECTIVE METHODS FOR MAMMALS MACE, GEORGINA, Marcel Cardillo, John Gittleman, Jon Bielby, Kate Jones, Andy Purvis

Population declines and species extinctions are known to be associated with extrinsic human pressures, environmental conditions, and the biological traits characteristic of individual species. In our study of extinction risk correlates of over 3000 mammal species we have characterised the combinations of traits and variables that best predict extinction risk. Our analyses demonstrate significant interactions among variables, as well as highlighting biological traits such as small geographic range size and low reproductive rate that characterise the most threatened species. Our analysis was undertaken globally as well as within mammalian clades and geographic regions. A global model across all species explains nearly a third of variation in mammal extinction risk, and shows biological traits to be more important than external factors. However, region and clade specific models have higher explanatory power. Overall, our analysis shows that both a general model of geographic and life history differences together with clade-specific factors are necessary for building a useful predictive model of mammal extinction. We go on to use clade-specific trait data for mammals to identify regions and taxa that are likely to be vulnerable to human pressures, thus providing a prospective method for prioritising species-based conservation actions.. This approach can be combined with environmental change predictions to provide more precise regional planning priorities.

AVIAN EXTINCTIONS: INTERACTIONS OF CLIMATE CHANGE WITH ELEVATION
SEKERCIOGLU, CAGAH. H., Stephen H. Schneider, John P. Fay

Climatic, ecological, and physiological effects of elevation impose limitations on species' range sizes that are important determinants of extinction risk. We estimate the effect of elevational limits on the extinction risk of land birds, 87% of all bird species. Elevational limitation of range size explains 97% of the variation in the probability of being in an IUCN extinction risk category. A modeling approach, combining elevational limitations, different rates of habitat loss and an intermediate IPCC surface warming estimate of 3.5 °C by 2100, projects approximately 270-580 bird extinctions and nearly 1700 species that will risk extinction. For Western Hemisphere land birds, intermediate extinction estimates based on climate-induced changes in actual distributions range from 1.5% to 16.4% of these species. To improve the precision of climate-induced extinction estimates, there is an urgent need for high-resolution measurements of ongoing elevational shifts. Given the accelerating influence of climate change on species' distributions and conservation, utilizing elevational limits in a tested, standardized, and robust manner can improve conservation assessments of terrestrial species and will help identify those most vulnerable to global climate change.

FOOTPRINTS OF CLIMATE CHANGE ON BIRDS IN SOUTHERN AFRICA: BODY SIZE AND TIMING OF MIGRATION HAVE IMPLICATIONS FOR CONSERVATION
SIMMONS, ROB, Andrew Jenkins, Anthony van Zyl

Predicted changes in bird distributions in southern Africa under climate change suggest that several species will lose ground in the face of increasing temperature and reduced precipitation. Yet empirical support for changes to population size or changes in migration patterns are scarce. Here we review empirical evidence for long term changes in avian ecology under climatic shifts for two species. Colour-marked Peregrine Falcons studied for 18 years on the Cape Town peninsula have slowly increased in population size over the last few years but more interestingly body size has changed too. Both adult male and adult female breeders show significantly decreased body sizes, particularly over the past 7 years when warming trends have been greatest. The change is in accordance with Bergman's Rule indicating a relationship between ambient temperature, latitude and body size. Long-distance migrant Lesser Kestrels from Eurasia have likewise altered their arrival times in southern Africa over the last decade. Birds now (2006) arrive a month later on average than they did a decade ago. As a globally Vulnerable species the mis-match of their arrival with outbreaks of their locust prey is a real possibility for decreased population size. Reasons for their later arrival are unknown. These two examples indicate that climate change can have positive and negative effects on species that share a genus and life style and represent the first reported empirical evidence for southern African birds

A GLOBAL CLASSIFICATION OF FRAGMENTED LANDSCAPES
Jennings, Michael, TIMOTHY BOUCHER, Jonathan Hoekstra

Conversion of natural lands to agriculture, mines, cities and other infrastructure is a primary cause of terrestrial biodiversity loss worldwide. The most commonly used measure of habitat loss is the gross amount of converted land. Landscape patterns of habitat loss, however, vary enormously—being clumped, dispersed, patchy, etc. These differences influence the likelihood of species persisting or becoming extirpated. We present a first-ever classification of landscape structures based on patch parameters important to species persistence: patch density, edge, isolation, contiguity, core area, and total amount of converted land. To do this, we quantified fragmentation metrics for 718 terrestrial ecoregions, covering almost 92% of Earth's land surface at a 1 km² resolution. We then used k-means and nonmetric multidimensional scaling to explore landscape types and assign ecoregions to classes of landscape structure. Our results provide an empirical basis for classifying patterns of landscape fragmentation, which we hope will improve our ability to predict the direction and sequence of biodiversity loss as landscape fragmentation continues.

EMBEDDED ECOLOGIES: TRAJECTORIES OF CONSERVATION REGIMES IN THE OKAVANGO DELTA
HOON, PARAKH

The paper examines the relationship with community conservation and transfrontier conservation approaches in the Botswana's Okavango Delta. Decentralization of natural resource management, especially in its implementation, was characterized by an uneven enforcement of formal rules and contracts, unclear responsibility of decision making between different actors, and the multiplication of clientelistic linkages both between local communities and external actors. Since early 2000 there has been a 'backlash' against community based natural resource management by the central state and district administration. While the future of CBNRM in Botswana remains uncertain, these efforts at 'recentralization' are being taken place alongside the establishment of transfrontier conservation strategies. The interaction between CBNRM and Transfrontier strategies, as well as efforts are introducing this to local communities however, has been unclear and not adequately understood. Using case studies of communities residing around the Caprivi Strip in Botswana and Namibia, the paper contrasts the various logics of institutional coordination evident in

community based and transfrontier efforts. It explains how institutional choices and their outcomes are shaped by the historic unequal power laden relationship between the central state and remote localities who reside in Okavango Delta.

ASSESSING CHANGING RAINFALL PATTERNS IN MAURITIUS AND ITS IMPLICATIONS FOR THE ENDEMIC MAURITIUS KESTREL

SENAPATHI, DEEPA, Emily Black, Fiona Underwood, Malcolm Nicoll, Ken Norris

Climate change and its associated ecological impacts are issues of great concern at present. These changes although well studied in the temperate regions have been rather well less documented in the tropics. However climate change in the tropics has significant impacts especially on endemic and endangered species mainly through variations in the seasonal rainfall periods. Our studies show that there have been long-term changes in the rainfall patterns on the island of Mauritius and statistical modeling of these trends have enabled identification of the factors driving these changes. These changes have potential implications for the ecology of a restored population of the endemic Mauritius kestrel *Falco punctatus* since wetter breeding seasons are associated with a shift towards later breeding, reduced fecundity and lower juvenile survival rates.

COMPETITION OVER CONSERVATION: GOVERNANCE, THE STATE AND NEGOTIATING TRANSFRONTIER CONSERVATION

Buscher, Bram, MICHAEL SCHOON

Over the last decades, multiple institutions have increasingly pursued broader level approaches to conservation, development, and governance. Combining ecological, economic and political motives, Transfrontier Conservation Areas have been proposed to solve historical injustices related to underdevelopment, cooperation and the disjuncture between political and ecological boundaries. Underlying this trend is the assumption that institutionalised transfrontier conservation leads to improved cooperation. In turn, this leads to better conservation outcomes and stimulates regional economic growth. These assumptions, however, remain to be tested. This paper aims to examine the linkage between TFCAs and improved cooperation. Based on 150 interviews over the last 3 years in Southern Africa, we tested the strength of the 'friendship hypothesis' by comparing 3 variables in 2 TFCAs: indicators of the general relationship between the countries; changes in the institutional setting; & the conceptual frameworks used in the partnerships. The cases we examine are the Great Limpopo Transfrontier Park and the Maloti-Drakensberg Transfrontier Conservation & Development Area. Our results show that negotiating friendship and cooperation is not as easy as assumed. The main reasons for this lie in the inexperience of many actors involved in TFCAs with respect to diplomacy and sovereignty. Moreover, our results show that transfrontier conservation often enhances competition between countries.

CHANGING LAND USE AND IMPACTS ON THE WILDLIFE IN THE MAASAI STEPPE OF TANZANIA

MSOFFE, FORTUNATA

The Maasai steppe of Tanzania hosts one of the most important populations of wild herbivores in eastern Africa and the largest population of elephants in northern Tanzania. During the rainy season most of these herbivores, like wildebeest (*Connochaetes taurinus*), zebra (*Equus burchelli*), elephant (*Loxodonta africana*) and buffalo (*Syncerus caffer*), leave Tarangire National park and spread into a wide area of the Maasai Steppe. For more than six months they depend upon the resources available outside the park, which they share with communities of pastoralists and agriculturists. This research work is focusing in addressing the processes (the how and why) related to understanding of the dynamics and mechanisms of land cover conversion and land use change and their consequences on large wild herbivores of the ecosystem. Results of major historical changes related to land use in the study area were framed as "timelines" (Figure 1). The study concludes that government policies related to land tenure and use have played a key role in shaping land use trends since the colonial era; including the exclusion of people from gazetted wildlife reserves and parks.

SOUTHERN AFRICAN ELEPHANT RANGE STATES GAIN CREDIBILITY AT INTERNATIONAL TREATY COPS, BUT IS SUSTAINABLE USE MANAGED NATIONALLY OR INTERNATIONALLY?

ARTEMIS, THIA

Two global treaties were designed specifically to protect endangered wildlife: CITES from the first Earth Summit of 72, and the Convention on Biological Diversity (CBD) from the Rio Summit of 92. Many Southern African Elephant Range States (SAERS) inherited CITES management obligations at independence. Since their ecotourism industries were based on safari hunting of the Big 5, SAERS saw the CITES biennial meetings as negotiations with the enemy, each nation on their own. Whenever CITES Convention of Parties (CoPs) pointed out the need for coordinated counts of border-crossing species, all parties fell back on politically defined 'subspecies' and 'populations', and questioned the data of each national scientific authority. The CBD's non-binding methods in Agenda 21 et al. documents would conserve more species.

There was no regional management of either extractive or non-consumptive ecotourism until the CBD suggested that rights to profit from wildlife should be the subject of CoP discussions. Three SAERS' inputs to the CBD CoPs were much more effective in promoting internationally coordinated, profitable, effective conservation than those put to CITES CoPs. Savanna elephants' ivory is used as an example. Implementation of the CBDs ecosystem approach should be increased to reduce the inefficient work of CITES list-management. The CBD Secretariat should be empowered with national enforcement like CITES had for 35 years. A triaged international prioritization of "checos" is urged.

THE CITES REVIEW OF SIGNIFICANT TRADE PROCESS: DOES IT HAVE A CONSERVATION BENEFIT? JACKSON, WENDY

The Convention on International Trade in Endangered Species (CITES) aims to regulate international wildlife trade in order to minimise threats to the long-term survival of wild plants and animals. When trade data suggest that exports of endangered species may be detrimental, they are subject to the "Review of Significant Trade" process, which operates as a safety net for CITES. Under the process, recommendations are formulated for range States to address high trade levels. Research investigated the trade and conservation impacts of recommendations emerging from this process for two higher taxa (Amphibia and Arthropoda). Results are varied. For example, when recommendations were fully implemented, legal exports decreased or stopped altogether. However, effects on conservation status for both taxa were mixed: approximately 75% remained stable and 25% declined. When recommendations were not implemented, trade in those species was suspended. In these cases, exports stopped or moved to other countries trading captive-bred or ranched species. In all cases the conservation status remained stable. Factors influencing trade levels and conservation status include those related to the design of recommendations, the economic and political situation in range States, and characteristics of the species, such as fungibility, economic value, and cultural importance.

HUMAN ACCESS INTO WILD LANDS AND FAUNAL COMMUNITY INTACTNESS JENNINGS, MICHAEL, Hunter Barcello

The taking of wild animals for commercial meat, pets, and other products has devastated many animal communities around the world. Yet, the direct impacts of [*Homo sapiens economicus*] on faunal communities are not easily monitored and current assessments are generally not available. Evidence suggests that animal communities have been more impacted in areas that are more easily accessed by humans. Thus, human accessibility may be a useful predictor for the susceptibility of animal communities to human impacts. To estimate the geography of human accessibility we modeled and mapped the amount of constraint to human access for each 1 km² area of nonconverted land worldwide as a function of topography, vegetation type and density, and distance from infrastructure. We assumed humans to be ubiquitous throughout existing infrastructure: cities, towns, roads, railroads and navigable rivers. Places that would require a person to travel over steeper terrain, through more dense vegetation, and across greater distances were considered less accessible than flat open areas near towns or roads. This first global 'human accessibility' map provides a set of continuous values that predict the remoteness of nonconverted lands, thus where animal communities may be more or less susceptible to human impacts, and is used to inform conservation investigations.

CHIMPANZEE POPULATION STATUS IN RWANDAS REMAINING MONTANE TROPICAL FORESTS KAPLIN, BETH, Nicole Gross-Camp, Felix Mulindahabi, Michel Masozera, Ian Munanura

We censused chimpanzee (*Pan troglodytes schweinfurthii*) populations remaining in country-regionRwanda and assessed threat levels to contribute to implementation of placecountry-regionRwanda's National Great Apes Survival Plan. We censused Nyungwe National Park (970 km²) and Gishwati Forest Reserve (7km²) using marked nest count method, and Cyomudongo forest fragment (5km²) using cumulative individual identifications. Nyungwe, Gishwati, and Cyamudongo, along with PlaceNameKibira PlaceTypeNational Park in country-regionBurundi, contiguous with Nyungwe, are among the richest habitats in the Albertine Rift region and the only habitats left for chimpanzees in country-regionRwanda and placecountry-regionBurundi. Most nests located during the censuses were in either closed canopy or open canopy forest. Nyungwe supports a population of chimpanzees distributed unevenly throughout the forest. Nearby Cyamudongo fragment has a small group of chimpanzees isolated from Nyungwe; this group is being habituated for tourism. Gishwati forest is heavily degraded due to clearing for agriculture, and supports a small population of chimpanzees surrounded by pastures, villages and agriculture. Chimpanzee populations in placecountry-regionRwanda remain threatened by forest loss, hunting, and conflicts due to crop raiding. We recommend expanding work with local communities to reduce conflict, and periodic monitoring, especially of habituated groups to ensure survival of placecountry-regionRwanda's chimpanzees.

TRADE-OFFS IN CONSERVATION MANAGEMENT SELECTION FOR MULTIPLE SPECIES
VAN TEEFFELEN, ASTRID, Mar Cabeza, Juha Pöyry, Katja Raatikainen, Mikko Kuussaari

In conservation planning, multiple management options are often available per site, for example in habitat restoration and maintenance. Each of these options can have different effects on different species. Decisions on how to manage sites for conservation therefore inherently involves trade-offs between species. We illustrate an optimization method to aid this type of conservation planning problem. The dataset concerns 45 mesic natural grassland sites in Finland and 42 grassland-dependent plant and *Lepidoptera* species, for which vegetation height, managed with cattle grazing, is the main driving force of habitat suitability. The site-action selection algorithm maximizes conservation benefit over all species simultaneously under a cost constraint, while accounting for species representation and complementarity. Depending on the relative priorities given to species, the selected site-specific options, and consequently overall species representations, differ. Through sensitivity analysis this method can help finding robust, and hence cost-effective, solutions in conservation management for multiple species.

CONSERVATION OF A THREATENED MEDICINAL LIANA (*MONDIA WHYTEI*) IN KAKAMEGA FOREST, KENYA
MCGEOCH, LAUREN

Despite intensive efforts to understand the biochemistry and ethnopharmacology of tropical medicinal plants, the conservation status of many important species remains unknown. *Mondia whytei*, a medicinal liana that grows in Kenya's Kakamega Forest, is one such species. Although biochemical studies have begun to illuminate medicinal properties of *M. whytei*, little work has been done on its ecology or conservation status. Local people who harvest *M. whytei* have reported that it is becoming much rarer. The goals of this study were to determine the current status of wild *M. whytei* in Kakamega Forest, assess anthropogenic threats to wild populations, and evaluate an on-farm cultivation project designed to conserve *M. whytei* while generating local income. Results indicated that wild *M. whytei* populations may be experiencing a reproductive collapse driven by harvesting pressure. Although small plants were relatively common, mature, flowering individuals were extremely rare. Plants were largest in areas that were better protected from harvesting pressure. Sustainable harvesting practices could substantially improve the conservation status of wild *M. whytei*. Farmers were optimistic about the cultivation project, but they did not see it as a profitable enterprise. Cultivation of *M. whytei* is not likely to reduce anthropogenic pressure on wild populations unless it becomes more profitable relative to traditional harvesting.

SPECIES RESPONSES TO HUMAN ACTIVITIES: IMPLICATIONS FOR BIODIVERSITY MONITORING
HOWE, ROBERT, Gerald Niemi, Ronald Regal, Nicholas Danz, JoAnn Hanowski, Amy Wolf

Quantitative relationships between the intensity of human activities and probabilities of species occurrence are important for biological monitoring, especially if species are used as indicators of environmental condition or quality. Yet few studies explicitly demonstrate these relationships, and fewer still provide comparative data over large spatial or temporal scales. We describe results from an extensive survey of birds and amphibians in the coastal zone of the North American Great Lakes, where species show a great variety of responses to urbanization, agriculture, and other human activities. Some species exhibit significant geographic variation in the relationship between human impacts and probability of species occurrence. We provide additional examples of species whose responses to human activities have changed over time. These relationships suggest that caution is needed when species are used as environmental indicators. We also suggest that variability in species responses to human impacts may themselves provide meaningful lessons for conservation.

CONSERVATION THREATS DUE TO HOUSING GROWTH IN AND NEAR UNITED STATES
PROTECTED AREAS
RADELOFF, VOLKER, Susan Stewart, Todd Hawbaker, Roger Hammer,

Human populations are growing worldwide, and that causes increasing housing development. In the United States, housing growth is strong both at the urban fringe, and in rural areas where natural amenities, such as lakes or mountains are common. Strong rural housing growth is a potential threat to protected areas. Our objective was to quantify the number of houses in and near U.S. protected areas in the past (1940-2000), and to project future growth (2000-2030). We examined all Wilderness areas (IUCN category Ib), National Parks (II), and National Forests (VI) in the conterminous U.S. Since 1940, >10 million housing units were added within 25km of protected areas, and >1 million were built on private inholdings in National Forests. Wilderness areas witnessed the least housing growth, National Parks the highest growth in their vicinity, and National Forests had the most houses within them. These houses have strong negative effects for the environment, because they remove and fragment habitat, cause erosion, pollute surface waters, introduce exotic pests, and increase predation by pets. Particularly worrying is that housing growth in and near protected areas (19% in the 1990s) exceeded the national average (13%). Future housing growth will thus

exacerbate the problems resulting from houses in and near protected areas, and diminish their value for conservation, unless land use planning and protection efforts are implemented to redirect development.

COMMON-POOL RESOURCE MANAGEMENT DURING CRISIS – FURBEARER USE AND CONSERVATION IN KAMCHATKA, RUSSIA (1977-2001)
RAYGORODETSKY, GLEB

Conventional institutions for managing common pool resources (CPRs), such as strict protection or managed harvest, have evolved during prolonged stable phases of resource aggregation in socio-ecological systems. During the unpredictable phases of rapid restructuring, the conventional institutions may become brittle. Post-Soviet transition illustrates how such institutions lose resilience with consequences for CPRs. I examined changes in population abundance of four furbearing species in strictly protected and harvested areas of Kamchatka, Russia, during the late part of the Soviet (1977-1991) and the first decade of the post-Soviet (1992-2001) periods. The socio-economic crisis of the post-Soviet transition effected Russian institutions for managing CPRs with varied results for furbearers under different regimes. During the stable phase of the Soviet period, both managed harvest and strict protection adequately maintained wildlife populations. During the restructuring phase of the post-Soviet transition, however, only strict protection regime continued to maintain wildlife populations, while under the regime of managed harvest the most lucrative species (sable) declined. Strict protection, therefore, must remain a vital component of any resilient wildlife management strategy. There is a dire need for renewed support by the Russian Government for strictly protected areas in Russia given their role in conserving economically important wildlife such as sable.

EVALUATING EXPERT JUDGMENT IN ENVIRONMENTAL MANAGEMENT
MCBRIDE, MARISSA, Fiona Fidler, Mark Burgman

Conservation and environmental management decisions are often made under considerable uncertainty, and local or expert opinion can play a vital role in ensuring that suitable choices are made. Experts routinely provide information on problem or system structure, but increasingly are also providing more quantitatively based judgments for estimates of uncertainties, model parameters, species attributes, and management impacts. Research in areas such as psychology and risk analysis has shown experts to be susceptible to a range of context and cognitive biases. However, few studies have explicitly evaluated the accuracy of experts and the appropriateness of the various elicitation techniques in the environmental and conservation domains. Here, we assess the ability of experts from a range of environmental and ecological backgrounds in providing useful, unbiased judgments both in their own and other areas of expertise. We make use of a combination of hypothetical, retrospective and real-time scenarios and compare the effects of a number of elicitation techniques. We find considerable differences between individuals in their ability to accurately specify their uncertainty, and large variation in estimate accuracy across different domains. Our results suggest that care should be taken in the use and aggregation of expert knowledge, but that pre-training and careful structuring of the elicitation process will help significantly in improving expert performance.

GLOBAL CONSERVATION OF BIODIVERSITY AND ECOSYSTEM SERVICES
TURNER, WILL, Katrina Brandon, Thomas Brooks, Robert Costanza, Gustavo da Fonseca, Rosimeiry Portela

Habitat destruction has driven much of the current biodiversity extinction crisis and compromises the essential benefits humanity derives from functioning ecosystems. Securing both species and ecosystem services could in principle be accomplished with common solutions. Yet it remains unknown whether, worldwide, the two objectives coincide only under a few 'win-win' scenarios, or broadly enough that joint global strategies for the two can obtain widespread synergy. Here we show that published global priority templates for biodiversity conservation also harbor a disproportionate share of Earth's terrestrial ecosystem service value (ESV). Mean estimated ESV of the 8 individual templates, for example, exceeds that of comparable random areas by 71.6%. Overlap varies among regions, and in areas of high biodiversity priority but low ESV, specialized conservation approaches may be necessary. Overall, however, our findings identify substantial opportunities for simultaneously safeguarding both biodiversity and ecosystem services. Two sensitivity analyses suggest that these results are robust to known limitations and uncertainties of existing ESV data. Capitalizing on the opportunities highlighted here will require identification of synergies at fine scales, the development of economic and policy tools to exploit synergies, and greater recognition and investment from development organizations and governments in the fundamental contributions of conservation efforts to human welfare.

DIRECTING DEVELOPMENT FOR CONSERVATION IN AFRICA: CAN THE TAIL WAG THE DOG?
BRANDON, KATRINA, Margaret Holland, Holly Gibbs

The challenges facing Africa - disease, drought, famine, deforestation, desertification, poverty and poor governance – are closely linked to loss of biodiversity and healthy ecosystems – making them integral to development policies. In June 2006, over 300 representatives from the conservation and development

communities developed the Madagascar Declaration (MD), saying that existing goals for reducing poverty and disease are unreachable without radical changes in traditional aid and development models. What if conservation policies could guide development actions, infrastructure investments, and capital inflows? We provide data on ecosystems services from Africa's protected areas, wetlands and sites of imminent extinction threat, examining what development portfolios and outcomes would look like if conservation came first, including: the economic and job impacts of a fully-funded protected area system based on funding for stored and sequestered carbon, economic incentives for local communities to protect and restore key ecosystems and watersheds, and the impact of infrastructure placed where conservationists want it. Analyses use georeferenced data from multiple, region-wide datasets to demonstrate the feasibility and potential development and poverty reduction returns from biodiversity conservation-centered investments in sub-Saharan Africa.

CONSERVATION IMPLICATIONS OF THE SPATIALLY EXPLICIT FIRE REGIME FOR THE HUMANIZED SAVANNA LANDSCAPE OF SOUTHERN MALI LARIS, PAUL

Savanna fires have long been considered a major force of vegetation change in Africa. Each year vast areas of wooded-savanna are set ablaze. Experimental studies find the tree/grass ratio is a function of fire regime; yet few diachronic studies have examined the spatiotemporal pattern of fires at a scale adequate to determine their impacts on vegetation patterns and habitat. This study uses a series of burn-scar images generated from Landsat drawn from 1972-2003 to determine the spatially explicit fire regime for southwestern Mali in terms of burn frequency, timing, and pattern. The study finds that indigenous burning creates a seasonal-mosaic pattern in which some parts of the study area regularly burn early, others late, while some rarely if ever burn. Burning begins at the onset of the dry season with a flurry of small fires that fragment the landscape in a regular pattern—18% of the patches that burned early do so 50% of the time and 33% do so 38% of the time. The vast majority of the study area (89.3%) was affected by fire at some point during the study period. Areas that rarely burn are of two cover types: settlements and wooded areas. The data suggest that indigenous burning maintains landscape heterogeneity and critical habitat patches. The implications of mosaic burning for biodiversity, conservation, and fire policy are debated.

MOVING PEOPLE. HUMAN MOBILITY, TREE MANAGEMENT, AND LAND CLAIMS IN THE LIMPOPO NATIONAL PARK WITTER, REBECCA

As human mobility persists in post-war, post-independence, and post-apartheid Southern African nations, conservation areas are expanding. The increasing interface between historically mobile people and spatially bounded protected areas, in combination with current plans to resettle people from transfrontier parks, highlights the need to understand the resource management practices of mobile people. Conservation-related resettlement has become a topic of major concern amongst conservation practitioners and a crucial point for practitioners to engage with conservation social scientists and local residents. My dissertation research examines the interactions between established patterns of human mobility, customary land claims, and the current course of conservation-related resettlements on the Mozambican side of the Great Limpopo Transfrontier Park. Through participant observation, life history interviews, and land use mapping, my research assesses how historically mobile residents in the Limpopo National Park establish land claims. Research findings suggest, first, that resident tree management practices signify land claims, and second, that current resettlement policy recognizes neither these customary practices nor the extent of resident resource claims in the park. Participation in the 2007 SCB annual meeting is an opportunity to work with conservation scientists and managers to consider how to integrate these results into conservation decision-making in Southern Africa.

FORESTS PROTECTED BY COMMUNITY COLLECTIVE ACTION: RECONCILING FOREST CONSERVATION AND CONSERVATION PLANNING IN MEXICO DURAN, ELVIRA, David Bray, Alejandro Velazquez

In Mexico, scientists have carried out conservation planning using georeferenced datasets for establishing reserves that do not conflict with human uses. One published study identified two regions of Mexico with large forest masses, in Guerrero and Oaxaca states, suggesting these as possible new reserves. In these same two regions, we carried out remote sensing of land use/cover change and studied the institutional processes at multiple scales that have led to existing forest conservation. We confirm the presence of unfragmented forests under low threat, community and regional collective action, and government policies which led to conservation-oriented rural livelihoods based on sustainable use. Lands initially reported as apt for reserves are common property forests, with existing land uses that include timber production through community enterprises and coffee agroforests. Other community forests in these regions are inaccessible and some have been formally recognized as community protected areas, with payment for environmental services programs in the case of Oaxaca. Conservation planning which does not take into account land tenure and current land uses runs the risk of imposing top-down solutions on effective and existing

community-managed forests. This study contributes to evidence of success of community forests in biodiversity conservation in Mexico and elsewhere.

ADAPTIVE MANAGEMENT OF NATURE TOURISM IN GIANT OTTER (*PTERONURA BRASILIENSIS*) HABITAT, SOUTHEASTERN PERU

HAJEK, FRANK, Jessica Groenendijk, Modesto Challco, Carmela Landeo, Jans Huayca, Christof Schenck

The giant otter (*Pteronura brasiliensis*) has emerged as a focal species for the growing nature tourism business of Peru's Manu National Park and Tambopata National Reserve. Its size, coupled with its diurnal, social and inquisitive habits make it relatively easy to observe, setting it apart from other large Amazon carnivores. However, demographic and behavioural studies of the species have indicated that nature tourism can result in diminished habitat quality and reduced reproductive success, especially in oxbow lakes, the prime otter habitat in the study area. Based on the aforementioned studies, as well as ongoing dialogue between nature tourism and conservation stakeholders, a set of guidelines for giant otter friendly tourism was developed. These guidelines have been put into practice through the implementation of tourism management plans in six oxbow lakes over a 12-year period, and refined by incorporating lessons learnt from a monitoring and evaluation programme. Tourism management in oxbow lakes has led to the normalization of giant otter reproductive success, higher levels of otter habituation to the presence of tourists, and more frequent, longer observations of the species by visitors, when comparing managed and non-managed sites. We therefore recommend that the proposed management guidelines are tested in other areas of the giant otter's range.

ESTIMATING THE OPPORTUNITY COSTS OF BIODIVERSITY CONSERVATION IN A MEGADIVERSITY COUNTRY

OSANO, PHILIP, Mathieu Rouget, Andrew Balmford, Jane Turpie, Wilfried Thuiller

Cost-effective conservation interventions require reliable estimates of costs and benefits. Recent studies have given less priority to land purchase and opportunity costs even though these are critically important for guiding reserve expansion, and in ensuring equitable off-reserve conservation agreements. We used data on 174 recent land purchases to produce a modelled surface of land price across Western Cape Province, South Africa, an area of global conservation importance. In our model, mean annual precipitation, percentage of untransformed land, property area, and topographic diversity were the most significant predictors of overall land price. Observed land prices varied by more than four orders of magnitude (from US\$15/ha to 178 000/ha expressed per unit area of farmland). Modelled land prices were highest in vegetation types previously classified (because of their biological importance and degree of conversion) as Critically Endangered. The estimated annual opportunity costs of retaining natural vegetation on farms in potentially arable areas ranged from US\$0 to 8300/ha/yr, and were again highest in Critically Endangered vegetation types and lowest in the Least Threatened vegetation types. This positive co-variation between biological priority and cost means that explicitly incorporating costs into planning will be essential for attaining optimal returns from conservation investments.

COST-EFFECTIVE PRIORITIES FOR GLOBAL MAMMAL CONSERVATION

JOSIE CARWARDINE, Kerrie Wilson, Gerardo Ceballos, Paul Ehrlich, Robin Naidoo, Possingham, Hugh, Takuya Iwamura, Stefan Hajkovicz,

The objectives of spatial priority setting for conservation should be to locate places where we can protect biodiversity most efficiently and effectively. However, approaches for selecting priority areas at a global scale have only accounted for biodiversity and threat, ignoring economic and social aspects until after priorities are set. We reveal a fine resolution, global-scale analysis of priority areas for mammal conservation that achieves conservation goals whilst incorporating cost-efficiency and minimising conflicts between conservation and other human use. Our analyses show that effective species conservation can occur in places that impose minimal costs because of flexibility in locations for carrying out conservation. We identify global gaps in spending of conservation funds relative to these cost-effective priority places. We thus demonstrate that efficient and successful conservation plans require good economic and social data as well as biodiversity information, and that integration of these three disciplines is essential in achieving conservation goals.

COMMUNITY CONSERVATION INITIATIVES IN ORISSA MISHRA, SWETA

Community Conservation Initiatives in Orissa Orissa has a unique distinction of being one of the few states in India where thousands of local communities are actively protecting and conserving biodiversity along with meeting their own livelihood requirements. These efforts cover a vast array of ecosystems existing on private land, community owned lands, lands whose ownership is disputed, government owned lands etc. Community Conservation Initiatives (CCIs) therefore, play a very crucial role in protection of biodiversity, maintenance of ecological services and gene flow of wildlife as these areas function as corridors between

important wildlife habitats. They also play a very important role in providing thousands of people basic livelihood needs, financial resources, cultural and political identities. Thus CCI can be sighted as community based economic and conservation models, synergizing the links between various ecosystems thus providing larger landscape level integration. Despite their contribution to local economy and ecology these initiatives unfortunately, remain unrecognized formally by the state as areas important for local economies or habitats for wildlife conservation. Lack of such recognition is resulting into destruction of more and more such areas because of mega-mining, commercial leases, urban expansion and other development projects. There is an urgent need to identify CCIs in Orissa and address issues pertaining to these areas so that we can protect them

POVERTY AND CONSERVATION INITIATIVES: IMPLICATIONS FOR PROTECTED AREAS MUYENGWA, SHYLOCK

Protected areas exist alongside communities that are embedded in poverty. Conservation initiatives within these areas have been interpreted as ostracism of local resource use rights and a disenfranchisement of local livelihoods. The Great Limpopo Conservation Area presents a livelihood threat and or enhancement for communities in three countries; Mozambique, South Africa and Zimbabwe. The current study has been undertaken in the Lowveld area in Zimbabwe. It analyses the livelihood options and adaptation strategies following the advancement of the initiative. Results show that in times of severe grazing and water shortage, communities resort to using the park. This increases the risk of zoonotic infections and presents a threat to biodiversity conservation. The balance between conservation and livelihoods can be achieved through a process of negotiation, dialogue and social learning. Conservation initiatives should present communities with a sense of social protection, and protected areas should be modelled as a depository from which these communities can constantly tap in cases of severe livelihood threats. Protected areas therefore, represent a confluence between natural adaptive cycles and how the social pressures impact on adaptability and resilience of such ecosystem

ECOTOURISM AFFECTS LOCAL KNOWLEDGE OF NATURAL RESOURCES AND ATTITUDES TO CONSERVATION IN GRANDE RIVIERE, TRINIDAD WAYLEN, KERRY, E.J. Milner-Gulland, Philip McGowan

Ecotourism is often suggested as a tool for promoting conservation, but evidence for its usefulness is mixed. It is therefore important to know if it affects local perceptions of natural resources and conservation, as these can be important determinants of conservation behaviour. We used rapid rural appraisal and questionnaire-based interviews to investigate the effect of a turtle ecotourism programme on perceptions of conservation in the village of Grande Riviere, Trinidad, focusing on attitudes to the environment in general, turtles and the Critically Endangered endemic Trinidad Piping Guan (*Pipile pipile*). Ecotourism significantly affected perceptions. Villagers showed more support for turtle conservation than for any other wildlife. Moreover, those households directly benefiting from the ecotourism industry had better knowledge of local natural resources, and greater general concern for conservation (not limited to turtles). Other socio-economic factors such as education and income also affected attitudes and knowledge, but the ecotourism effect was still present after accounting for these factors. Hunting was seen as the main threat to wildlife but was also a popular pastime, illustrating the potential for mismatch between attitudes and behaviour, and the need for caution in using attitudinal change as a proxy for behaviour in measures of project success.

THE ROLE OF HUNTING IN HOUSEHOLD EXPENDITURE: A CASE STUDY IN RURAL GABON COAD, LAUREN, Andrea Manica, Andrew Balmford, E.J. Milner-Gulland, Kate Abernethy

Bushmeat hunting is seen as one of the major threats to wildlife in the tropics, at the same time as being a major source of protein and income for many poor rural people. Working in two villages in Gabon, the aim of this project was to investigate the role of bushmeat hunting in rural communities where hunting is the main livelihood option for men. Data on the hunting effort, catch and sales of bushmeat for 76 hunters were recorded daily for 14 months, and cash purchases within the village were monitored over 6 months. Focus groups felt that agricultural income was the main determinant of household wealth. A few hunters, from the richer households, caught the majority of animals. On average, half of hunter purchases were luxury goods, and the higher the amount earned from hunting, the more luxury goods that were bought. Female spend in the village was biased more towards household necessities than male, and increased with the agricultural income of a household and not with the hunting income. Animals caught by hunters were an important food source for the household, therefore hunter incomes did not increase household spending on food. This study is the first to look at the use of bushmeat hunting incomes, and suggests that the role of hunting, and the influence of hunting incomes on the household economy, may be more complex than previously assumed.

CHANGING LAND TENURE, INCREASED BUSHMEAT TRADE, AND THE IMPLICATIONS FOR
WILDLIFE CONSERVATION IN ZIMBABWE
ROMANACH, STEPHANIE, Peter Lindsey, Steven Matema

Zimbabwe is undergoing changes in land use, including a decline in the amount of land used for wildlife due to the re-settlement of wildlife areas with subsistence farmers. We assessed the impact of bushmeat trade associated with the juxtaposition of people and wildlife in Savé Valley Conservancy (SVC) in southeastern Zimbabwe. In the first year of our study, 9,234 wire snares were removed from SVC, and at least 869 animals of 29 mammal species were killed by bushmeat hunters. Sixty-seven percent of animals killed in snares were left rotting in snare lines. Several non-target species were killed in snares, including 8 lions and 11 endangered wild dogs. Incidences of poaching increase during the late dry season, coinciding with nutritional stress among local communities. Data from interview surveys with multiple stakeholder groups indicate that legal (and sustainable) provision of bushmeat during the late dry season could reduce demand for illegally obtained meat. Bushmeat hunting incidences are spatially clumped, occurring primarily in areas neighboring re-settled areas within SVC. The best prospects for addressing the bushmeat trade in SVC lie in re-aligning land uses to separate wildlife and farmlands, and providing re-settled and neighboring communities with an economic stake in the wildlife area.

LINKAGES BETWEEN BIODIVERSITY CONSERVATION AND POVERTY ALLEVIATION: LESSONS
FROM THE GEF-WORLD BANK PORTFOLIO
RICHARDSON, KAREN, Kathy MacKinnon, Phi;ip Hazelton

The World Bank has financed over 400 biodiversity conservation projects and many of these have attempted to reconcile the legitimate development needs of local communities with the conservation objectives of protected areas and other conservation landscapes. We examined 20 projects that had received 5 or more years of financing to assess potential 'win-win' scenarios for biodiversity conservation and poverty alleviation. Using a framework to record the determinants and dimensions of poverty in each project, as well as the contribution of the project towards elements of well-being, we found that the best scenarios for 'win-win' outcomes were those that provided incremental value to biodiversity protection. These included projects with: a) direct feedback mechanisms such as payments for ecosystem services, b) solid commitment to and understanding of the value of biodiversity conservation as a national priority, c) high-value products that can assist local populations in accessing real markets; d) consideration for 'next generation opportunities' that were consistent with biodiversity conservation; and e) awareness campaigns that include information on the importance and provision of ecosystem goods and services. Our analyses also showed that generally benefits to local communities provided supplementary rather than alternative livelihoods so efforts for poverty alleviation did not always lead to conservation. Lastly, few projects demonstrated long term enabling conditions.

CAN RURAL COMMUNITIES SUPPORT ELEPHANT CONSERVATION?
PARKER, GUY

Human-wildlife conflict is commonplace across Africa, creating high costs for rural communities. This causes intense animosity towards wild animals and casts a shadow over the future of their conservation, especially outside protected areas. Community-based conservation schemes generate revenues that attempt to offset the costs of conflict with wildlife, but rarely are such schemes objectively assessed. In this research the perceptions of rural farmers towards elephants are investigated in two CAMPFIRE Districts of northern Zimbabwe. The influence of elephant-generated revenues, and of conflict, upon farmer's attitudes towards the elephant is assessed. This research reveals that revenues are able to engender support for elephant conservation, but only where they are sufficient and consistent. Key problems with the mechanism for revenue disbursement are identified and the means for devolving benefits are discussed.

HOW MANY ANIMALS SHOULD WE SAVE? EXAMPLES OF SETTING POPULATION TARGET LEVELS
FROM AFRICA, ASIA AND THE AMERICAS
SANDERSON, ERIC, Peter Coppolillo, Karl Didier, Amanda Fine, Michale Glennon **WITHDRAWN**

CHANGING LIVELIHOODS AND THE AFORESTATION OF THE NQABARA LANDSCAPE
DE KLERK, HENNING

Diachronic analysis of land cover change with the aid of historic aerial photographs indicate that the landscape of Nqabara, a rural area along the Wild Coast of the Eastern Cape of South Africa, has been undergoing dramatic transformation over the last 50 years. In the 1960s the landscape of Nqabara was comprised of approximately equal proportions of grassland, cultivated fields and forest. Currently more than eighty percent of land cover consists of forest, woodland and wooded grassland. The changes in the vegetative cover of the landscape have emerged from and articulated with complex changes in people's livelihoods and patterns of dwelling. The main changes in livelihood have been declining levels of homestead agricultural production since the 1940s, deteriorating opportunities for long-distance labour

migrants since the mid-1980s, and increasing importance of local entrepreneurship since the mid-1990s. These changes have been accentuated by altered settlement patterns as a result of the forced relocation of homesteads during the 1970s under the policies of Betterment and have altered people's movements through and patterns of activities in the landscape. The spatial components of changing patterns of livelihood and dwelling have created an abundance of patches in the landscape favouring the establishment of indigenous as well as exotic woody plant species and thereby catalysed a process of landscape transformation.

LAND REFORM AND FORESTRY: AN ANALYSIS OF ENVIRONMENTAL ISSUES IN MANICALAND PROVINCE, ZIMBABWE MARISA, LOVEMORE

The rapidity and intensity of the land acquisition and redistribution in the early part of the new millennium was a new phenomenon. The Land Acquisition Act: 2001 legalised the fast track land reform that wholesomely changed land use patterns in the country, including Manicaland Province, the forestry hub of Zimbabwe. The study found out that as fast as it was, the land reform ushered in new environmental challenges that should be dealt with so as to engender sustainable natural resources management. The preponderance by resettled farmers to engage in agricultural activity vis-à-vis forestry has led to environmental degradation like increased soil erosion and deforestation. Despite the fact that plantation timber has provided an important economic activity essentially based on profitable and rational exploitation of human and natural resources, commercial forestry companies have lagged behind in coming up with effective policies that integrates surrounding communities in resource access and utilisation. I concluded that a synergy of relations ingrained within an integrated approach is the mainstay for stakeholder participation in sustainably managing land and forestry, at national and local levels.

LOWERING FUELWOOD USE WITH ENERGY EFFICIENT STOVES TO IMPROVE PROTECTED AREA MANAGEMENT—HOW MUCH DO THE STOVES REDUCE CONSUMPTION? SONGER, MELISSA, Myint Aung, Khaing Khaing Swe, Thida Oo, Peter Leimgruber

Fuelwood and charcoal provide energy for heating and cooking for an estimated 40 percent of the world's people and since 1960 fuelwood consumption has increased 250 percent. This consumption adversely affects biodiversity and the world's carbon balance. Resulting fuelwood shortages can cause hardship for people with no access to alternative energy sources. We interviewed 784 households in villages bordering Chatthin Wildlife Sanctuary (CWS), Myanmar, to assess costs and benefits of using fuel-efficient stoves. CWS supports the last viable population of Eld's deer (*Cervus eldi*) but the sanctuary's forests have been steadily decreasing. Interviews were designed to learn about people's fuelwood collection practices and attitudes toward the sanctuary. We also quantified yearly fuelwood consumption for 50 selected households half with and half without stoves. Our results demonstrate a 24 percent reduction in the fuelwood required per person for households using the stoves. These results show that increased usage of fuel-efficient stoves would reduce impact from fuelwood collection slightly. However, increasing human populations and consumption require additional conservation strategies beyond fuelwood efficient stoves, such as community forestry.

EAT IN OR TAKE OUT? WHY ARE EQUATOGUINEAN VILLAGERS HUNTING? KUMPEL, NOELLE

Whether people hunt for food or income, and through choice or necessity, has important implications for both conservation and development policy, but hunter incentives are often not well-understood. 1607 household interviews, 72 hunter interviews and an offtake survey were conducted in the village of Sendje, continental Equatorial Guinea over a period of 15 months. Relatively little bushmeat was bought or consumed by rural households as its high cost meant it was too valuable to consume; households sold nearly all marketable bushmeat and used the profit to buy cheaper frozen alternatives. Hunting was the second highest-earning livelihood in the village behind waged jobs, but per capita median monthly income from hunting was less than half that of a job. Although the odd hunter earned a high monthly income, most preferred the security of a regular wage, and nearly all disliked hunting. Most men fell back on hunting as an income source in the absence of alternative livelihood opportunities. Whilst increasing the availability of alternatives at the urban level would decrease demand for bushmeat, without provision of alternative rural income-generating opportunities, low opportunity costs mean that hunting will continue and hunting households will simply get poorer. Policies therefore need to tackle both supply and demand simultaneously to be effective.

"PLEASING THE EYE": CHANGING AESTHETIC VALUES OF WILDLIFE AMONG MAASAI COMMUNITIES OF THE AMBOSELI ECOSYSTEM, KENYA, AND CONSERVATION IMPLICATIONS
ROQUE DE PINHO, JOANA

According to Maasai aesthetics, maximal visual impact created by contrasting colours represents beauty. This notion of "beautiful colours" is the basis for perceptions of beauty in beadwork and cattle. As part of an ethnographic study of local attitudes towards wildlife in the Amboseli ecosystem, Kenya, I examine the aesthetic dimension in Maasai-wildlife interactions, and explore whether perceptions of beauty are diversifying under the influence of socioeconomic changes. I demonstrate that the wild animals that "please the eye" resemble livestock species and/or have contrasting colours. However, the distinction between "good" and "beautiful" is not clear-cut. Thus, harmless animals tended to be considered beautiful, and the dangerous ones, that caused economic losses, were "ugly". I show that these notions are shifting under the influence of education, and conservation discourse, which emphasise wildlife's economic value. For younger people and those living near protected areas, animals perceived as attracting tourists and money are considered beautiful, even though they are the ones that conflict the most with people's lives. This would confirm that community-conservation fosters positive attitudes towards wildlife. However, expected wildlife-based economic benefits have not materialized. With unfulfilled expectations and rising human-wildlife conflicts, a shift towards economically-driven aesthetic values might end up promoting negative attitudes towards wildlife.

CONSERVATION FUTURES: THE ROLE OF SCENARIO PLANNING IN CONSERVATION ORGANIZATIONS

REDFORD, KENT, Colleen McCann, Stephen Aldrich, Jim Newcomb

The conservation community has not thought much about the future—being preoccupied with the present—or how best to prepare for uncertain but plausible outcomes. When the future is considered it is often as a linear extension of the present and usually within a three to five year timeframe. The business community has pioneered a very different way of thinking about the future using scenario planning—a method for helping groups socially deconstruct the present in order to formally reconstruct highly plausible futures that are especially relevant for their shared purposes. These multiple future scenarios test assumptions about the way the world works by identifying predetermined elements, driving forces, critical uncertainties and major actors. They can then be used to empower conservation organizations to both better prepare for, respond to, and determine, the unfolding future. We describe the development of scenario planning by the Wildlife Conservation Society, an international conservation NGO, and Bio-era, a bio-economic advisory firm, and propose ways in which this methodology can be more broadly useful to the conservation community.

RECOVERY OF A HIGHLY THREATENED BROWN BEAR POPULATION IN PAKISTAN

ALI NAWAZ, MUHAMMAD, Jon Swenson, Vaqar Zakaria

The Himalayan brown bear has been exterminated in most of its former distribution range in Pakistan. It presently occurs very sparsely, in small populations, the Deosai Plateau supporting the largest isolate. The Deosai was declared as a National Park in 1994 to give protection to the declining brown bear population and other wildlife. We carried out census of the population annually from 1993 through 2006, in order to gauge success of the park in terms of population recovery. The small population in Deosai, estimated to be about 20 individuals in 1993, is growing and 43 bears were recorded during the recent census. The genetic method based on fecal samples also estimated the comparable numbers, 40-50 bears. The finite rate of increase was estimated at 5%. The observed growth rate was product of both reproduction and immigration. Reproductive parameters of the population were lowest ever reported for the brown bear; means for age at reproduction, litter interval and litter size were 8.4, 5.7, 1.33 respectively. Poor habitat quality, low nutritious food, high seasonality and extreme weather conditions in Himalaya are contributing to the poor growth rate. The population growth is most vulnerable to harvesting, therefore control on human caused mortalities is very critical for survival of the population.

PREVENTION OF INVASIVE SPECIES EXPANSION IN LARGE RUGGED LANDSCAPES USING AN INNOVATIVE ECOLOGICALLY DESIGNED AND GEOGRAPHICALLY EFFICIENT APPROACH

TALSMA, ARTHUR, Michael Atchison

Invasive weeds have been rated as the number one threat to native grasslands and shrub steppe plant communities in some western landscapes. Traditionally, land managers spend most of their time fighting weeds with expensive herbicides and biocontrols on large noxious weed invasions. We have designed an innovative cooperative leading edge approach to weed control and prevention. We define (EDGE) as Ecologically Designed and Geographically Efficient strategies to manage weed invasions in large rugged landscapes. We couple Digital Aerial Sketch Mapping (DASM) surveys and Strategic Weed Action Teams (SWAT) with ranchers and land managers to effectively detect and eradicate weeds that are invading relatively weed free areas. The Nature Conservancy has demonstrated the capacity to increase landowner

participation and prevent weed invasions in large landscapes using these cost effective early detection and rapid response strategies.

THE EFFECTIVENESS OF CAR ENERGY LABELS IN OXFORD: THE JOURNEY SO FAR NGWODO, FIDELIA

This research examines the effectiveness of the UK voluntary car labelling scheme in influencing the behaviour of car dealers and customers towards buying and selling of higher energy efficient cars using some theories with interlinking factors such as awareness, social pressure and organisational structure as general framework. Qualitative analysis with triangulation is used. In general, the research results appear to be consistent with stated theories. However, they are not in support of some items stated in Beckers Health Belief theory. In contrast to this theory, the research shows that perceived susceptibility to risk of climate change, awareness of the scheme, its associated incentives and disincentives did not translate into the action of displaying the accurate car energy label in showrooms by some car dealers. In addition, it did not make dealers to inform customers voluntarily without being asked by them about the label in relation to desired cars to be purchased. A majority of consumers surveyed appear to be ignorant of the car labelling scheme. In comparison with some earlier research, the current method of using car showrooms as sole official centres for the presentation of the labelling scheme to the public is judged to be poor and ineffective in influencing behaviours of the public towards buying and selling of more energy efficient cars. Stiffer penalties, incentives, more environmental education, training and campaigns are needed.

MONITORING CONSERVATION ACHIEVEMENTS AND PREDICTING FUTURE RESOURCE NEEDS FOR PROTECTING ENDANGERED CAPE HABITATS VON HASE, AMREA, Donovan Kirkwood

As part of a conservation assessment for the critically endangered Cape Lowlands in the Cape Floristic Region, CFR, South Africa, planners and the implementing agency developed a spatial five-year plan to guide priority action by a conservation stewardship program. No cost projections were made. Following three years of implementation, we evaluated achievements (contracts signed by private landowners) by the stewardship program and related these to the five-year conservation goals and to resources spent by the implementing agency. We used this to obtain approximate future resource requirements for protecting other endangered ecosystems in the CFR through stewardship measures. We estimate alone the conservation of priority habitat in the 5-year Cape Lowlands plan to take around 35 person years (@ 200 days p.y.) and R12m to establish legal contracts, followed by about R8m p.y. to service the contracts. So far, only a fraction of the original conservation goal for protecting Cape Lowland areas has been achieved. In conclusion, we want to emphasize the promising yet highly resource-intensive nature of habitat protection through conservation stewardship measures and we recommend that all conservation plans are accompanied by detailed projections of resource needs for implementation. Further, monitoring implementation programs is essential for evaluating conservation success.

CAN INTERNATIONAL STRATEGIC ALLIANCES HALT AGRICULTURAL EXPANSION IN THE BRAZILIAN AMAZON? WALKER, NATHALIE, Daniela Montalto

Agricultural expansion is a leading cause of deforestation in the Brazilian Amazon and has been fuelled by a growing demand for soybeans from Europe. A handful of companies control the export of soy and its spatial distribution as they have financed roads and built ports in the Amazon. We analyzed the pattern of expansion of soybean farms and found increasing forest conversion for soy, many farms contravening the Brazilian Forest Code and we documented social and environmental problems. We traced the chain of custody of soy from these farms to soy traders, who sell to animal feed manufacturers in Europe that supply farms producing meat sold by multinational meat companies and restaurant chains. When presented with the evidence of the origin of the soy used to produce their meat, a number of companies agreed to alter their procurement policies. By working with these companies and coalitions of NGOs in Brazil and Europe, pressure was brought on the soybean traders and in July 2006, the major Brazilian soy traders and exporters agreed to a two year moratorium on purchasing soy grown on newly deforested land in the Amazon. They also agreed to develop strategies to facilitate compliance with the Brazilian Forest Code and to implement a monitoring system for farms. This has offered opportunities to put in place longer lasting measures and demonstrates how globalization, which has been a driver of deforestation, can be used to limit the expansion of agribusiness in the Amazon.

CONSERVEONLINE: A PLATFORM FOR COMMUNITY COLLABORATION AND ON-LINE PUBLISHING ADAMS, JONATHAN

Access to timely, relevant information often determines whether a conservation project succeeds or fails, yet conservation information and knowledge is difficult to find and often unavailable to scientists and project managers. Information resources must be made more readily available to people engaged in conservation,

particularly in developing countries, where the cost of obtaining information is high and the need for conservation action is often most urgent. Beyond accessing documents and publications, there is a need to enable conservation managers, scientists, and decision makers to more effectively interact, form networks, and collaborate. The mission of ConserveOnline, a free online resource developed by The Nature Conservancy, is to connect conservation practitioners to each other and to the information they need to achieve their conservation goals by providing tools for collaboration and dissemination of information. ConserveOnline is a neutral forum for shared problem solving and the free and open exchange of ideas, and is freely available to anyone engaged in conservation. ConserveOnline is now being substantially revised to focus on enhancing collaboration among widely dispersed conservation practitioners by enabling users to easily create common workspaces to facilitate collaboration around a common problem. ConserveOnline will also facilitate the publishing of conservation knowledge and practices in a variety of formats, in particular XML driven on-line, open access publishing.

CAMPUS-BASED WATERSHED RESTORATION BUILDS CONSERVATION LITERACY ACROSS THE CURRICULUM

Walter, Cynthia, Caryl Fish, JOHN MICHAEL ATHERTON, Dean Nelson

Adaptive management of a campus watershed brings conservation education into the real world. Multidisciplinary summer research teams of faculty and students design assessment protocols, collect data, run statistical analyses, and select management options using ethical and scientific criteria, collaborating with government and NGO experts. Such intensive research and the close proximity of the site allow participants to monitor watershed changes throughout the year. For example, invertebrates repopulated a dead stream after constructed wetlands intercepted 700 kg. iron/day from abandoned coal mine drainage. Individuals have personal, physical contact with biota that benefit from pollution abatement; thus abstract rationales for restoration, e.g., atonement, biotic recovery, become a daily reality. Participants use cognitive, kinesthetic, and social ways of knowing to integrate conservation thinking across the curriculum as we analyze water quality data in statistics and chemistry, biodiversity in ecology, wetland legislation in political science, land use conflicts in ethics, and nature writing in literature. This project provides a well-studied site visited annually by over 2000 school children and their teachers. Local schoolyard conservation projects replicate our template and expand conservation literacy. Watersheds are ubiquitous and their management integrates multiple disciplines; therefore, universities worldwide are potential sites for academically robust, on-campus watershed conservation projects.

APPLYING THE IUCN RED LIST OF THREATENED SPECIES: RECENT PROGRESS AND REMAINING CHALLENGES

BROOKS, THOMAS, Jonathan Baillie, Stuart Butchart, Abigail Entwistle, Paul Matiku, Jon Paul Rodriguez

The IUCN Red List of Threatened Species evaluates the status of >40,000 species, finding >16,000 threatened. In 2004, the third IUCN World Conservation Congress (the biodiversity conservation forum for governments and NGOs), passed resolution "RESWCC3.013: The uses of the IUCN Red List of Threatened Species". This flagged the importance of the Red List and called its appropriate use in four policy arenas. In the first category of use, national legislation, we find a trend of increasing influence on national red lists from the IUCN Red List and its regional guidelines. The second category concerns international conventions. Here, Red List Indices have been adopted for the Convention on Biological Diversity 2010 Target, with specific progress in implementing a sampled indicator, and in expanding taxonomic coverage. However, incorporation into other conventions has been mixed. In third category, conservation planning, much progress has been made in developing methodology for identifying key biodiversity areas. Also, sites of potential imminent species extinctions have been identified by the Alliance for Zero Extinction, and the EDGE approach developed for prioritizing among species. Guidance from IUCN remains an urgent need regarding the final category, on the implications of Red Listing for scientific research on threatened species. Overall, despite significant advances, more effort is needed to ensure that the value of the Red List for practical conservation is maximized.

HOW THE COMMUNITY ON AN INHABITED FIJIAN ISLAND ERADICATED PACIFIC RATS TO PROTECT AN ENDANGERED GROUND FROG

MORLEY, CRAIG, Joape Kuruyawa, Rob Chappell

Community involvement is crucial in any conservation programme and the people of Viwa Island, Fiji, relished the idea of eradicating rats to help restore their island. They were actively involved in the planning, implementation, and goals of the project. Now this may sound normal for any conservation project but the logistics and difficulties of eradicating rats off an inhabited island are immense compared to an uninhabited island. However, having the community do the work had many advantages, such as, learning new skills, increased conservation awareness, and they took ownership of the project and outcomes. Furthermore, they now understand what will be involved in the next phase of the project which is to eradicate cane toads (*Bufo marinus*). The key success in this project was the involvement of everyone, from the young children to the village elders. However, not everything went smoothly and a great deal was learnt about managing future rat

eradication programmes in the Pacific. Based on our data and experience we suggest rats can be eradicated off other inhabited islands provided the community is trained and given the responsibility to undertake the task themselves.

PROMOTING SUSTAINABLE LIVELIHOODS ALONG THE WESTERN SERENGETI BY FOSTERING POSITIVE RELATIONSHIPS BETWEEN COMMUNITIES AND WILDLIFE

HARRIS, BRIAN, Peter Goodman, Barbara Schachenmann, Claire Lewis, Ed Sayer

The Grumeti Reserves complex comprising the Grumeti and Ikorongo Game Reserves, the Sasakwa concession area and the Issenye, Nyakitono and Ikoma Open Areas is situated along the western boundary of the Serengeti National Park. When the Grumeti Fund in conjunction with the Wildlife Division of Tanzania embarked upon the project of securing the integrity of this concession, it was faced with the onerous task of simultaneously curbing the rampant poaching problem in the area and of replacing a local economy heavily reliant on the illegal bush meat trade, with alternative sustainable livelihoods. Over the last four years considerable research has gone into identifying the socio-economic factors driving this trade and fashioning community development programmes around identified needs. As a result significant investments by the Fund have been made into the direct provision of employment in the project, local education, the supply of drinking water and the creation of sustainable jobs through small business development in communities along its boundaries. The small business initiatives all have inextricable links to the wildlife resource in the form of guaranteed markets. Through this initial investment, it is demonstrated that the current land use provides greater benefits and more sustainable livelihoods to neighbouring communities than those of the past based largely on the illegal bush meat trade.

COMMUNITY RIGHTS AND EMPOWERMENT OR COOPERATIVE GOVERNANCE? THE NEED FOR PRAGMATIC TRADE-OFFS FABRICIUS, CHRISTO

Adaptive co-management is a process of collaborative learning, knowledge sharing and joint action between many actors working at different levels. The outcomes are improved decision making and increased awareness of threats and opportunities, leading to improved management of ecosystem services. Adaptive co-management involves local communities, policy makers, non-government organizations, international donors and policy makers, academics, and the business community. I assessed the process and outcomes involved in adaptive co-management in several South African and international case studies involving communities and other actors. Local communities do manage ecosystems, but that they face significant formal management capacity problems compared to other stakeholders. More distant stakeholders again lack detailed information about local ecosystem services and processes. Focusing exclusively on communities' rights, empowerment and autonomy therefore seldom solves stakeholder capacity problems because stakeholder empowerment and know-how is an end product of adaptive co-management rather than a departure point. Thus serious trade-offs need to be made in terms of communities' autonomy, their rights to self-determination, their intellectual property rights and their right to 'do things their own way', for adaptive co-management to work. Adaptive co-management is most effective when the focus is on learning and cooperative governance rather than on rights alone.

IS CONSERVATION WITH THE PRIVATE SECTOR BETTER THAN CONSERVATION WITH NGOS? ÜLGEN, HÜMA

An Environmental Investment Programme (EIP) as a department of an oil pipeline company in Turkey was created to benefit biodiversity within the biogeographical units it affects. Since 2004, together with its NGO partners, the programme successfully completed six conservation projects, and is currently carrying out seven more. Experience during this time has shown that in a country still wary of NGOs, the Private Sector can do much to help open the doors that are often closed to NGOs. The suspicion that exists in people working in the public sector against the third sector is replaced by respect. It seems most likely that this is because the private sector is both an understood entity and represents money and political power. The success of the EIP conservation projects is the product of a fortunate combination of some key factors such as the political and financial power the Company in Turkey, the dedication of the Company to provide real benefits to biodiversity, the constantly increasing trust it is able to provide to both its NGO partners and the government, and a competitive project selection and amelioration policy to generate the most conservation return for the money spent. The programme thus provides a model for an effective NGO-Public-Private partnership, with each partner filling the others' gaps to achieve the best results for conservation. So is private sector better than NGOs for conservation? No, but when in harmony, the total is more than the sum of its parts.

ASSESSING AND REDUCING THE IMPACT OF U.S. CONSUMERS ON WILDLIFE TRADE IN REGIONS OF HIGH CONSERVATION PRIORITY: CONGO BASIN, AMAZON, AND MEKONG
WITHERS, TAMARA, Caroline Humphrey, Tamar Norkin, Heidi Ruffler

Unsustainable wildlife trade is an overlooked threat to regions of high biodiversity. Despite oversight from international agreements, most wildlife trade is unmonitored and unsustainable. Regulation and education have addressed wildlife trade traditionally; however, NGO-private sector collaborations can also improve wildlife trade sustainability. TRAFFIC, a joint program of IUCN & WWF that focuses on wildlife trade monitoring, requested a study of U.S. wildlife trade data between 2001 and 2005 from the Congo Basin, Mekong & Amazon. The study sought to identify industries impacting wildlife populations due to U.S. consumption and develop recommendations for working *with* industry to minimize the trade impact. During the study period, there were 270 million wildlife items imported to the U.S., representing 5 industries: pet, leather, food, ornamental, and biomedical. Trade commodity analyses conducted on 14 taxa across industries revealed 3 barriers to sustainable trade: poor sourcing of wildlife items, lack of transparency and accountability throughout the supply chain, and limited information about wild populations and the impact of wild collection. Based on these findings, we developed recommendations for NGO-private sector partnerships to encourage sustainable trade. The main recommendation- a supply chain approach- engages all stakeholders, from harvesters, importers/exporters and processors to final vendors, in addressing sourcing, transparency and the need for further research.

SOUTH AFRICAN RED LISTING: PARTNERSHIPS AND INNOVATION PRODUCE SOLUTIONS
FODEN, WENDY, Domitilla Raimondo

Driven by the need for better biodiversity data to support rapidly advancing monitoring and spatial planning strategies, South Africa is becoming a global leader in Red Listing. Programs for birds, reptiles, plants, arachnids, butterflies, frogs and marine organisms assess species extinction risk and, using the IUCN's Red Listing Categories and Criteria (2001), identify those with high probability of extinction. The IUCN's information-intensive system poses particular challenges for mega-diverse and developing countries. In South Africa, the traditional reliance on biologists' knowledge and data is supplemented with the innovative involvement of the public and industry. Partnerships with amateur biological organisations enable large-scale atlases; trained public volunteer groups independently survey and conserve their local areas; amateur photographers email photos to online "virtual museums"; public members of all ages and experience participate in field surveys; professional biological survey data, typically from EIA's, are centralized in a national database. Centralised support, standardization and coordination of programs by SANBI facilitates the cross-collection and exchange of data between programs. We present key lessons learned from South African Red Listing partnerships and programs and conclude that while integrating such information poses challenges, rewards include an ongoing source of inexpensive data and rapidly increasing public involvement in conservation.

SCIENTISTS, MANAGERS AND MANDATES: COMMUNICATING TO IMPROVE CONSERVATION
ALONG ROAD, RAIL, RIVER AND POWERLINE SERVITUDES
Esler, Karen J, SUZANNE J MILTON

Linear natural and anthropogenic corridors along ground transport routes or servitudes are potentially valuable conservation areas in landscapes where agricultural and urban development is intensifying. However, managers of such corridors in South Africa have mandates that are unrelated to ecological conservation. They need to maintain transport safety, supply of power and water efficiently from source to consumer, and provide employment for unskilled workers. For this reason corridors of natural vegetation along roads, railways and rivers or in powerline servitudes are usually managed to maintain short and homogeneous vegetation such as lawn grass. In natural shrublands this is achieved by clearing the natural vegetation mechanically or with herbicides, thereby nullifying the value of the corridors for biodiversity conservation. In order to understand the mandates of managers and to consider ways in which mandates could be met in more conservation friendly ways, we workshopped problems and solutions among scientists, managers and interest groups from a variety of government and non-government organizations. The outcomes included enhanced awareness of management and conservation issues and a discussion forum for reaching compromises.

NEST AVAILABILITY FOR THE HYACINTH MACAW IN THE PANTANAL, BRAZIL
SANTOS, ANTONIO Jr, John Hay

Sterculia apetala has been indicated as a key species for the conservation of *Anodorhynchus hyacinthinus* (hyacinth macaw) since 94% of its nests are made in this tree species. Due to the intense conversion of the forest type where this tree occurs to pasture we began an evaluation of the status of the *S. apetala* populations regarding their suitability for serving as nest trees and possibility of long-term maintenance in this region. A logistic model of the relation between tree diameter (DBH) and presence of nests indicated a minimum diameter of 50 cm DBH with almost all individuals having a DBH of greater than 100 cm containing

nests. A study of population structure of *S. apetala* conducted at three sites in the Pantanal showed a strong decline of individuals in size classes greater than 50 cm DBH and extremely few individuals with diameter greater than 110 DBH. As conservation priorities the following steps should be taken: 1) the reduction of cutting of forest areas to reduce the risk of local extinction of large individuals of *S. apetala* and 2) the development of governmental programs to combat deforestation in the region and the initiation of programs of regeneration of *S. apetala*.

MANAGING THE RECOVERY OF A CRITICALLY ENDANGERED MEGAHERBIVORE IN A COMPLEX TRANSBOUNDARY SETTING: BLACK RHINO IN THE SERENGETI-MARA ECOSYSTEM THIRGOOD, SIMON, Matt Walpole

Species recovery plans emphasize biological processes – both ecological and genetic – particularly in the context of small, fragmented populations. There are often complex interactions between ecological considerations and the wider socio-political context in which species conservation is conducted. Using the example of black rhino in the Serengeti-Mara Ecosystem of Tanzania and Kenya we examine the implications of sharing management responsibilities amongst multiple institutional actors within and across national boundaries. These institutional dynamics influence the extent to which ecological aspects of metapopulation management can be prioritized and also interact with security considerations which are particularly important for high value species such as rhino. Despite efforts to coordinate the principal stakeholders, collaborative management of rhino in the ecosystem has progressed slowly. We draw parallels with successful and unsuccessful attempts to develop collaborative inter-agency and transboundary species recovery plans elsewhere in Africa, North America and Europe. We conclude that successful metapopulation management in complex transboundary settings requires: (1) effective coordination mechanisms actively facilitated at an appropriate scale; (2) buy-in at all levels from local to national institutions; and (3) trust and transparency in both dialogue and information sharing and cooperation to achieve shared visions.

CONSERVATION RELIANT SPECIES: OUR NEW RELATIONSHIP WITH NATURE SCOTT, MICHAEL J., Dale D. Goble, Aaron Haines

With passage of endangered species regulations in the United States, Australia, Canada and elsewhere came an expectation that species at risk would be identified management actions implemented on their behalf, the species would increase in numbers and distribution to a point of recovery it would be de-listed and fall under existing regulatory actions no longer in need of the species specific protections afforded by Endangered species laws. Recovered species like the peregrine falcon, gray whale and Aleutian Canada goose, meet this expectation but 54% of the 1311 species listed under the US ESA do not. We characterized these species as conservation reliant. That is continuous human intervention in the form of predator control, nest parasite control, prescribed burns or other species specific management actions will be required to sustain these species at numbers above those considered at risk. Examples of conservation reliant species that have been or are proposed for delisting and those that might be de-listed will be discussed. We will describe Recovery Management Agreements a biologically and legally defensible tool between the government and a second party, public or private, that allows for species “adoption” to facilitate removing a species from the endangered species list. Mans relationship with nature has changed, at least a subset of species are dependent upon our continuous intervention for their existence, often at population sizes and distributions that are b

MONITORING FOR THE 2010 TARGET: A PRACTICAL EXAMPLE FROM KENYA'S IMPORTANT BIRD AREAS MWANGI, KIRAGU, Leon Bennun, Paul Matiku, Ronald Mulwa

The global 2010 target to reduce the rate of biodiversity loss has attracted much attention, yet effective large-scale biodiversity monitoring remains a major challenge. This is especially so in developing countries, which are often rich in biodiversity but poor in capacity and resources, and where individual monitoring schemes face issues of sustainability and replicability. BirdLife International's Important Bird Areas (IBAs) monitoring framework is designed to tackle these problems. The scheme is simple, robust and grounded in national and local institutions, but produces scaleable results that can be compiled into national or regional indices. Information from the field, collected mainly by site management authorities and local conservation groups, is assessed for each IBA and simple scores assigned for indicators of site condition (state), threat (pressure) and conservation intervention (response). In Kenya, a pilot project (funded by the Darwin Initiative) has successfully tested this approach, producing national IBA status reports in 2005 and 2006. The final scoring system was applied retrospectively to the data in these reports and to the national IBA inventory published in 1999, providing three sets of state, pressure and response scores across the country's 60 most important sites for biodiversity conservation. Over the period 1999-2005, overall interventions have strengthened substantially and the intensity of threats diminished slightly, but trends in site condition, reflecting biodiversity value, remain downward. Although changes in state are expected to lag

behind changes in response, these results suggest Kenya is not yet on track to meet the 2010 target at national level.

LIMITATIONS OF ALTERNATIVE INCOME ACTIVITIES AS A CONSERVATION TOOL

Andor, Eva, AGNES KISS

Support to local communities for “alternative income activities” is a very common biodiversity conservation strategy, particularly in lower income countries. However, people are more likely to add the new income sources to existing ones rather than substituting them, unless they are limited by factors such as time or labor constraints. Current residents may also abandon very demanding, risky or otherwise unpopular economic activities if given better options, but more disadvantaged individuals or new immigrants will probably replace them unless there is a substantial labor shortage or strong legal or societal obstacles. This paper reviews the recent literature to test the hypothesis that the income substitution strategy will only achieve conservation objectives when such limiting conditions are present. It also examines the effectiveness of contractual agreements as an alternative mechanism for linking economic development support with conservation outcomes in the absence of these types of inherent limitations. The results of the analysis help to identify situations where support for “alternative income activities” can be a sound conservation strategy, and those where it is not.

NEW FLEXIBLE TOOLS FOR MEASURING CONSERVATION SUCCESS

Kapos, Valerie, Andrea Manica, Rosalind Aveling, Philip Bubb, Peter Carey, Abigail Entwistle, John Hopkins, Teresa Mulliken, Roger Safford, Alison Stattersfield, MATTHEW WALPOLE, Andrew Balmford

Evaluating the success of conservation efforts and identifying those approaches that are most effective are major challenges facing conservationists, policy-makers and donors alike. The Cambridge Conservation Forum - a consortium of 28 global to local organisations - has spent three years developing a conceptual framework and a practical scorecard for evaluating all major categories of conservation activity. These tools are now available for wider use. Applying them to sample projects from 10 conservation organizations has shown that (a) standard questions about the links between activity and conservation impact can help project implementers to identify the likely impacts of their actions, even for projects still in progress and for activities such as capacity building or policy-related work where biological impacts are not commonly measured; and (b) while few organizations are good at openly declaring whole projects to be complete failures, or indeed sharing widely their failures, examining projects by their component interventions can help to identify more and less successful approaches. We introduce a new electronic version of these tools to facilitate their wider use and propose a simple scoring system that can be used to synthesize experience from a diverse range of activities and projects and identify semi-quantitatively some important predictors of conservation success.