

Carnivore Communications

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1. Seasonal variation in scent marking by river otters.

Session: Ecology and Conservation of Mammals

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Nearctic river otters (*Lontra canadensis*), like many carnivores, are difficult to study because of their nocturnal habits and low population density. Therefore, most monitoring efforts have focused on indirect detection methods, such as sign surveys. Sign surveys are an efficient means of documenting presence or absence because river otters scent mark (i.e., deposit scat, urine and/or glandular secretions) at conspicuous terrestrial locations called latrine sites. We monitored eight latrine sites in Pennsylvania and Maryland with remote video and still cameras from August 2004 through August 2005. We recorded 2,698 latrine nights resulting in 0.185 otter detections per latrine night. River otters were detected 500 times representing 327 independent visits. River otters visited latrine sites at night 4 times more often than during the day, and 5 times more often than during crepuscular periods. Time of visit did not vary by season, group size, or study area. However, the number of latrine site visits, and group sizes comprising those visits, varied by month. The greatest frequency of visits occurred in April 2005, while average group size was greatest in November 2004. Number of scent marks also varied by month with peaks observed in September 2004 and March 2005. Scat was the most common scent mark. Anal sac secretions were only detected during spring. This study verifies that river otter scent marking varies seasonally: both in quantity and in the relative frequency of anal sac secretions. We discuss possible causes for the observed variation and implications for monitoring river otters.

2. Moss or a rolling stone? Home range in a “migratory” carnivore: Serengeti cheetah.

Session: Ecology and Conservation of Mammals

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Wildlife management usually requires an understanding of animal movement behavior, yet home range studies often omit tests for a true home range. In addition, minimum sample sizes (number of locations) for home range estimation are often based on statistical properties of estimators alone, ignoring behavioral considerations. Even the simple concept of an asymptotic home range has been questioned in Multiscaled Home Range (MHR) models. Cheetah (*Acinonyx jubatus*) show great plasticity in movement behavior and thus provide a good model for exploring home range theory. The Serengeti population is considered migratory. We challenged this assumption using 25 years of data for 240 females from the Serengeti Plains. We tested for migration using MRPP and Schoener's Index, and tested for true home ranges using site fidelity, statistical core ranges and asymptote analyses. 85% of females shifted range between the wet and dry seasons. They exhibited circannual movements, with statistically dependent locations at intervals <2 months and >9 months, and maximum displacements at 6-month intervals. However, they also showed site fidelity within a year with 73% having more concentrated and less linear movements than expected at random. All females exhibited core areas (40 - 81% volume contours) using kernel density estimation (KDE). MCP asymptote analyses supported the MHR concept, while KDE indicated home range asymptotes at 70 locations. We conclude that

females in this population are not migratory, but exhibit true home ranges. We recommend that the home range concept be tested in all home range analyses, and that asymptote analyses use KDE and not MCP. We posit that the MHR may be an artifact of MCP methods.

3. Moving in Social circles: Philopatry and interaction in Serengeti cheetahs.

Session: Ecology and Conservation of Mammals

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The social interaction within a population can affect resource dispersion, home range placement and potential inter-specific agonistic behavior. When managing populations within protected areas it is also important to understand dispersal behavior where it may expose individuals to external risks. For cheetah (*Acinonyx jubatus*) of the Serengeti Plains, little is known about dispersal behavior. This population also provides an opportunity to examine social interaction under predictable geographic resource constraints. To explore these aspects of sociality we used data for 240 female and 315 male cheetah from over 60 matriline between 1969 and 1994. We tested for dispersal using MRPP, and examined static interaction using MRPP, simple overlap metrics, and Spearman's Rank Order Correlation Coefficient (rs). 17% of females and all males shifted between juvenile and adult ranges, with most males present as only juveniles or adults. Using Kernel Density Estimation (KDE), fewer unrelated than related pairs overlapped in lifetime and core ranges. Degree of overlap also differed significantly between unrelated and closely related pairs. The proportion of related pairs that overlapped remained constant over different temporal scales, but increased at the monthly scale for unrelated pairs. Overlap in unrelated pairs decreased during the wet season and increased during the dry season. 70% of closely related and only 27% of unrelated pairs showed attraction, while no related pairs and 16% of unrelated pairs showed avoidance. We conclude that degree of relatedness and seasonal resource distribution influence area requirements, health and hunting success of females in this population. We recommend that future research focus on the movement of dispersing males and potential metapopulation dynamics.

4. Landscape scale wolverine distribution and habitat use in interior Alaska: Identification of key habitat parameters.

Session: Habitat Relationships of Mammals

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We evaluated landscape scale level wolverine distribution and habitat use in January and February in a 180,000 km² area in eastern interior Alaska. The study area was divided into 180 hexagons that measured 1,000 km², approximating the home range size of a resident adult male. We used a Piper Supercub to fly transects approximating 32 km through each hexagon. We established the use of a hexagon by wolverine, wolves (*Canis lupus*), ungulates, other furbearers, human activity by observing tracks in the snow. We used GIS to determine dominant landcover types, elevation and terrain ruggedness within each hexagon. We determined the probability of wolverine occupancy in each hexagon by using a removal design. A multiple logistic regression was employed to model the presence/absence of wolverines and investigate the effects of wildlife species and habitat on wolverine presence. The results showed that wolverine presence was negatively correlated to wolves, snowmachines and the presence of human activity and use and positively correlated to marten (*Martes americana*), caribou (*Rangifer tarandus*) and rough terrain. The model with lowest AIC (Akaike's Information Criterion) score (144.03) indicated wolves, snowmachine tracks, marten and rough terrain were the most important predictors of wolverine presence. Correlations among the covariates made it difficult to define a best model. The identification of influential factors of wolverine presence provided by this study will help guide the management of this species into the future.

5. Grizzly bear selection of roads in the eastern slopes of west-central Alberta.

Session: Habitat Relationships of Mammals

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Given persistent and growing human encroachment into grizzly bear habitats, it is imperative that we strive for a mechanistic understanding of bear behavior to justify and direct conservation efforts, particularly in high-mortality areas such as near roads. In the Rocky Mountain foothills of Alberta, Canada, 90% of grizzly bear mortalities occur near roads, yet bears continue to use these high-risk areas. We examined the hypothesis that bears were not necessarily attracted to roads, but that roads were placed in habitats that bears preferred. Our objectives were therefore to (1) identify areas that were similar to roads but did not yet contain human disturbance and (2) quantify grizzly bear seasonal response to roads and these “road-like” habitats. Between 1999 and 2004, 30 grizzly bears with home ranges in areas of road development were fitted with GPS radiocollars, and selection was analyzed for roads and road-like habitats. We found that roadsides act as an attractant to bears, particularly in the spring, because they were correlated with high-quality grizzly bear habitats and contained early herbaceous vegetation necessary for weight gain immediately after den emergence. Of the 30 grizzly bears surveyed, 63 percent (19) were closer to roads than random, and 40 percent (12) selected road-like habitats. Unexpectedly, we also found that grizzly bears consistently chose areas with higher road-like habitat values in the fall, while moving further from roads themselves. We conclude that roads were constructed in preferred grizzly bear habitats, and the tradeoff between mortality risk and high-quality forage near roads must be addressed to prevent these areas from acting as attractive sinks.

6. Landscape analysis of a recolonizing black bear population in the Trans-Pecos region of Texas.

Session: Habitat Relationships of Mammals

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Black bears (*Ursus americanus*) were once widespread across Texas, but their numbers were reduced in the early 1900's. A small number of individual bears from northern Mexico have recolonized the Trans-Pecos area of Texas in recent years. Increased sightings could be an indication the population in Texas is beginning its road to recovery and that expansion of this population will continue into the future assuming there is suitable habitat. We utilized black bear sightings from 1904 to 2003 to map the current distribution of black bears with a 2.2 km buffer around each sighting. We used logistic regression using these bear sightings and an equal number of random points with 2.2 km buffers to model the probability of occurrence of black bears in the Trans-Pecos region using the following layers: landuse/landcover, elevation, aspect, slope, vegetation diversity, distance to water sources, distance to roads, water density, and road density. The influence of each variable on bear presence was investigated by a one-way analysis of variance and then we mapped the predicted habitat from the regression using ArcGIS. Preliminary results indicate that bear presence is positively associated with water density, rock landcover, and urban landuse, and negatively associated with elevation, road density, distance to water, distance to roads, aspect, cropland, and grassland. All habitat variables were significantly different between bear sighting buffers and random point buffers (all $p < 0.001$). The model using these variables predicted bear presence 97.4% of the time ($X^2 = 26.05$, $p < 0.001$). These results indicate that sighting data can be useful in predicting the expansion of the black bear population in the Trans-Pecos of Texas. More importantly the model can identify critical areas where black bears may expand, which will enable management to mitigate the potential impacts black bear may have on the ranches in this region.

7. Effects of habitat fragmentation and landscape context on medium-sized mammalian predators in northeastern national parks.

Session: Habitat Relationships of Mammals

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Effects of habitat fragmentation on wildlife have been well-documented, but for medium-sized mammalian predators, these effects are difficult to evaluate and not well understood because many of these species are cryptic and elusive, making them difficult to sample. We used remote cameras, track plates, and hair traps to collect presence/absence data on several species in 8 National Park Service sites throughout the northeastern United States. We collected data on environmental variables at multiple spatial scales and modeled the response of 10 species using site occupancy models that incorporate the probability of detection. Detection probabilities varied across time and space, and all were <1 . We calculated cumulative detection probabilities for each species and found that sampling periods between 18 and 174 days were required to confirm the presence of target species with a 95% probability of capture. Using site occupancy models to account for variation in detection, we determined that landscape scale variables like the amount of development, fragmentation, and distance to the nearest occupied building were among the most important in describing the probability of occupancy. At the local scale, habitat variables such as canopy closure, coarse woody debris, and habitat edge were more important to the target species than the proportion of non-native vegetation or vegetation diversity. Overall, models that included variables from multiple scales increased the accuracy of occupancy estimates, and no single spatial scale was consistently better than others. Fragmented landscapes surrounding small protected areas like NPS sites in the northeast can influence species presence and patterns of distribution. This work suggests that detection is an important parameter to incorporate when sampling populations because detectability varies over time and space, and non-detection of a species does not always imply absence.

8. Does home range spatial structure resist resource and population changes? Experimental tests of coyote spatial patterns.

Session: Habitat Relationships of Mammals

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Theory predicts that food resources affect both home range spacing patterns and behavior. Even though coyotes (*Canis latrans*) are noted for being highly adaptive, coyote home ranges are stable between generations. Two key questions then are: what drives spatial stability and what environmental factors would cause changes in space use patterns in coyotes? The objective of this study was to determine the influence of a change in food availability and dispersion on coyote space use and diet during home range establishment. The study was conducted on a ~3,500 ha section of the 22,258 ha McFadden Enterprises Ranch in south Texas. We added a clumped, high quality food source ad libitum to randomly selected home ranges to measure the influence of food dispersion and abundance on home range patterns and trespassing rates in a coyote population that was subjected to intensive removals beforehand. During home range establishment, we found no difference in home range overlap ($P = 0.41$, $t = 2.78$, $df = 4$, $n = 6$) or core areas ($P = 0.79$, $t = 4.30$, $df = 4$, $n = 6$) of treated versus controls coyotes, nor were there differences between treatment (control vs. treated) or time period (experiment vs. post-experiment). But, there was a significant difference in the interaction of treatment and time period between the distance treated coyotes were located from their experimentally-placed food during the treatment and post-treatment periods ($P < 0.02$, $F = 8.83$, $df =$

1,8, n = 897). The observed patterns of coyote space use and diet are likely reflecting optimal foraging patterns and show some support for the resource dispersion hypothesis (RDH). This study emphasizes the usefulness of experimental approaches to test theoretical predictions of the role of resource dispersion in space use patterns.

9. Occupancy and detection of coyotes in urban and rural areas in western Georgia.

Session: Habitat Relationships of Mammals

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Over the past fifty years, coyotes (*Canis latrans*) have expanded their range and established themselves as dominant carnivores throughout the southeastern U.S. in both rural/forested areas and urban/suburban areas. However, since coyotes are relatively new to the Southeast, little research has been conducted on them in habitats in this region. Though we know that coyotes have moved into urban/suburban areas, it is not known if they are using them in the same way as rural/forested areas. Rural/forested areas and urban/suburban areas differ in habitat quality, human development, management approaches, and food resources. Our first objective in this project was to determine if land use was constant between these two area types or if it was dependent on season, development or other factors. Our second objective was to determine if coyotes were more easily detected in certain areas or during different seasons. In an attempt to address these objectives, digital motion sensor cameras and scent stations were positioned throughout three counties in western Georgia from October 2004 through February 2006. For analysis purposes, years were divided into four biological seasons (dispersal, breeding, gestation and pup rearing) and a closed photo-trapping session occurred at each site during each season. Robust occupancy design models in Program PRESENCE were used to analyze camera photo-capture data. Occupancy and detectability rates were compared across sites, human development levels, seasons, and temperature. Our models show occupancy varying by human development levels with site occupancy being higher in urban areas. Extinction and colonization rates between seasons also appear to be influenced by human development. However our highest ranked models show that season has the strongest effect on the detectability of coyotes with higher detection during dispersal and gestation seasons. In addition, implications of occupancy patterns and management practices affected by detection will be discussed.

10. Dispersal and extra-territorial movements of swift foxes in northwest Texas

Session: Habitat Relationships of Mammals

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Dispersal plays an important role in the population dynamics of many carnivores, yet little information exists about the dispersal and movement patterns of swift foxes (*Vulpes velox*). We radiocollared and monitored 68 swift foxes for dispersal at 2 study sites in northwest Texas from January 2002 to April 2004. Dispersal distance for juveniles (13.1 ± 0.3 km), adults (10.4 ± 0.7 km) and transients (25.4 ± 9.1 km) did not differ by age class ($P = 0.64$) or sex ($P = 0.24$), but differed by study site ($P = 0.04$). Mean dispersal distance from private ranches (PR) was greater than from public grasslands (NG). Peak dispersal occurred during October-November (13 individuals) and January-February (7 individuals). Dispersal direction was influenced by land use practices (i.e., toward rangelands and away from anthropogenic features). Direction of dispersal among foxes that occupied the NG was random ($n = 16$; $P = 0.08$), whereas foxes from PR dispersed in a northwesterly direction ($n = 18$; $P = 0.001$) away from a town and croplands. Three resident adult foxes had extra-territorial movements. Distances of these movements ranged from 0.2 km to 11.4 km. Distance of extra-territorial movements did not differ by

sex ($P = 0.93$) or duration ($P = 0.28$). Knowledge of movement distances and patterns is important for conservation and protection swift foxes and their habitats.

11. Brown bears in our midst: Alaskan brown bear in habitat refugia of Elmendorf Air Force Base and Fort Richardson Army Post, and on salmon streams in city parks of Anchorage, Alaska.

Session: Ecology and Conservation of Mammals

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Elmendorf Air Force Base, Ft. Richardson Army Post, and Chugach State Park abut Anchorage, Alaska, which is the largest metropolitan area in the state. All four jurisdictions contain productive anadromous streams frequented by brown bears (*Ursus arctos*). The potential for human - bear encounters is considered high as bears can be found close to areas of human activity, and bear and human use overlap in time and location. Movement data were collected on 9 brown bears captured on these lands in 2005 and outfitted with spread spectrum GPS collars. Brown bear travel corridors through military, state, and city lands were identified and correlated to the effect(s) of large-scale fencing projects and other development. Brown bears frequented undeveloped and developed areas, often in close (<10m) proximity to areas with significant levels of human activity, including military training, suburban subdivisions, recreational jogging/biking trails, and city roads. Two thousand locations from 3 adult bears (1 lone male, 1 lone female, 1 female with 3 cubs of the year) were recorded within one Anchorage city park (Bicentennial Park). Thirty-eight percent of those locations were within 100 meters or less of urban fishery streams, and 20% were within 100m or less of maintained park trails. Stable isotope ($\delta^{13}C$; $\delta^{15}N$; $\delta^{34}S$) values from bear hair samples collected along streams in the study area were used to determine diet. Increased development on military and city lands may constrain bear movements, however urban fisheries provide a critical resource for maintaining the local brown bear population. These sport fisheries provide very popular recreation activities, and enhancing salmon numbers or salmon spawning habitat will likely increase the presence of brown bear in urban areas as well as the potential for interactions with humans.

12. Spatial and temporal patterns in human-bear interactions and human-caused mortality of grizzly bears in the southwest Yukon, Canada.

Session: Ecology and Conservation of Mammals

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In North America the extirpation of grizzly bear populations is the result of direct human-caused mortality. In 1989 the Yukon Government began a program to reduce human-bear interactions and associated mortality. Landfills in the Kluane Region were closed or electric fencing was erected around the site to act as a deterrent for bears to enter the area. Parks Canada began a program to reduce human-bear conflicts in Kluane National Park by introducing bear-proof food canisters for backpackers and placing human-use restrictions in problem areas. We examined how these management actions have changed the frequency and distribution of grizzly bear problem occurrences and mortality in the Kluane Region in the southwest Yukon, Canada. We used break point regression to examine temporal trends, and discrete choice modeling and a spatial clustering algorithm to examine the spatial characteristics of human-grizzly bear interactions and human-caused mortality. We developed predictive models for occurrences and mortalities. We found a substantial lag between time of management interventions and reduction in mortalities. Total non-hunt mortality increased slowly to 1998 then decreased rapidly and was positively associated with the amount of backcountry visitation. The trend in hunting related mortalities decreased until 1993, and then increased. Human-

bear interactions and bear mortalities were close to linear features and in areas with high human infrastructure density, but mortalities were more likely than occurrences to happen in areas with high human use and high bear use. The locations of human-caused bear mortality appears to be a function of how bears use their habitat, including how they respond to changes in food quality and biomass, human-related habitat changes, bear tolerance of humans and human tolerance of bears. If reduction of bear mortality is a goal, managers should restrict development of permanent dwellings or other infrastructure in high-use bear habitats.

13. Puma habitat use and spatial ecology in an urbanizing landscape.

Session: Ecology and Conservation of Mammals

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As California's wild landscapes are developed, the habitats of large and wide-ranging species become fragmented, undermining ecosystem integrity. Knowledge of megafauna habitat needs and responses to landscape change is needed to ensure long-term viability and sustain ecological functioning. In support of a California Department of Fish and Game conservation modeling effort, we deployed GPS tracking collars on 18 pumas (*Puma concolor*) in the western Sierra Nevada during 2002-2005. Collared pumas included males and females, adults and juveniles, and occupied both urban interface and interior habitats. We sought to identify features affecting puma habitat utility, barriers to or corridors for movement, and the spatial characteristics of the population. Data collected from collared individuals was analyzed using ArcGIS 9.1. We calculated puma home ranges and seasonal range use, habitat utility distributions, travel parameters (speed, extent, habitat, and paths), and dispersal characteristics (distance, direction, and duration). We then used correlation and path analysis to identify the potential impacts of a variety of landscape features on these attributes, including: road density and class, property parcel sizes, land use and ownership, habitat and vegetation types, riparian areas, major river canyons, deer abundance, aspect, slope, time of day and season, and puma sex and age classes. Results indicated home range and landscape level constraints on puma habitat use in urbanizing settings. We defined ranked zones of puma habitat suitability and created a conceptual model of spatial dynamics for the western Sierra puma population.

14. Ecological investigations of grizzly bears in western Canada using DNA from snagged hairs, 1995 to 2005.

Session: Ecology and Conservation of Mammals

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The use of DNA has expanded the range and scale of ecological questions that can be investigated much like radio telemetry did 40 years ago. Over the past decade we have used genetic sampling to explore a suite of ecological questions of grizzly bears (*Ursus arctos*) in western Canada, many of which were impractical a decade ago. In 1995, the first operational-scale sampling project using DNA from bear hair collected with barbed wire hair traps was tested. The success of this experiment led to large scale sampling (1,650 to 9,866 km² grids) in 26 areas covering a combined 102,532 km² where genetic IDs of >1200 grizzly bears were recorded. Estimating density was the primary goal in most areas, and resulted in estimates ranging from 5.6 to 44.1 bears/1000 km² (\bar{x} = 30.1). Estimating population trend, distribution, and presence in areas where grizzly bears are rare, as well as population fragmentation in a heavily settled area, were also explored. When the spatially diverse samples were

combined with human and landscape features, we were able to quantify factors that influence grizzly bear distribution, population fragmentation and competition with black bears (*U. americanus*) and to map variation in bear densities across the landscape. The hair samples also enabled the estimation of sex-specific dispersal distances and patterns, regional movements, and patterns of genetic diversity. General diets from the analysis of stable-carbon (d13C) and nitrogen (d15N) isotopes in the hair complemented the DNA-based analyses. We discuss what we have learned using DNA to improve sampling efficiency and study designs that may enable greater inference. The information obtained from DNA-based surveys has improved our understanding of several aspects of grizzly bear ecology, particularly at the broad scale, furthering our ability to manage and conserve populations across a diverse landscape in western Canada.

15. Stable isotope evidence that salmon are important to brown bears in southwestern Alaska.

Session: Ecology and Conservation of Mammals

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Brown bear (*Ursus arctos*) population size is known to correlate with the availability of high-quality food resources. We report on a ten-year study (1993 - 2003) of brown bear ecology in southwestern Alaska during which, in 1998, salmon escapement dropped sharply. The study area was above treeline and at the fringe of salmon availability. We characterized diets by conducting stable-isotope analysis (d13C, d15N, and d34S) on bear hair and putative diet items. The range in d13C of forage items was insufficient to aid in resolving brown bear diets and was excluded from stable isotope-based diet estimates. In contrast, d34S provided excellent discrimination among food sources and spanned a broad range (-4 to 18 per mil, V-CDT) in bear hair. Over the entire study period, diet composition estimates based on d15N and d34S suggest that salmon accounted for the highest proportion of bear diets (40.5%), followed by berries (30.4%), mammals (13.6%), green vegetation (7.8%), and freshwater fish (7.7%). Average salmon contribution to bear diets dropped from 49% to 30% following the decline in salmon escapement. Our data suggest that salmon are a major food resource for brown bears in southwestern Alaska. Wildlife managers should consider salmon as a critical resource when drafting brown bear management plans.

16. Relative contributions of habitat complexity and prey physical condition to predation by cougars and recolonizing wolves

Session: Ecology and Conservation of Mammals

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Numerous studies have documented how prey may use antipredator strategies to reduce the risk of predation from a single predator. However, when a recolonizing predator enters an already complex predator-prey system, specific antipredator behaviors may conflict and avoidance of one predator may enhance vulnerability to another. We studied the patterns of prey selection by recolonizing wolves (*Canis lupus*) and cougars (*Puma concolor*) in response to prey habitat shifts in the northern Madison Range, Montana. Elk (*Cervus elaphus*) were the primary prey for wolves, and mule deer (*Odocoileus hemionus*) were the primary prey for cougars, but elk made up an increasingly greater proportion of cougar kills annually. While both predators preyed disproportionately on bull elk, wolves were most likely to prey on bulls in poor physical condition. Although we found that the predators partitioned hunting habitats, structural complexity at wolf kill sites increased over time, whereas complexity of cougar kill sites remained static. We concluded that habitat shifts in prey were attempts by formerly

naïve prey to lessen predation risk from wolves; nevertheless, shifting to more structurally complex habitats might have made prey more vulnerable to cougars. Following a change in predator exposure, habitat shifts may represent a compromise to minimize overall risk.

17. Ecological relations between coyotes and reintroduced elk in southeastern Kentucky.

Session: Ecology and Conservation of Mammals

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The coyote (*Canis latrans*) has rapidly colonized the eastern United States during the 20th century despite attempts to eradicate it from much of its original range. In contrast, elk (*Cervus elaphus*) have been deliberately reintroduced to 5 states east of the Mississippi River during the same period. As a result, a unique predator-prey dynamic between coyote and elk has been developed that historically occurred only in the western U.S. Little is known about how these species interact in this highly productive region. We used radio-telemetry and diet analysis to characterize ecological relations between coyotes and reintroduced elk in southeastern Kentucky. Our objectives were to: 1) determine whether coyotes would shift diets after elk were introduced, and 2) assess whether predation by coyotes might limit population growth of reintroduced elk. To address the first question, we analyzed coyote scats collected before and after elk were released in the Daniel Boone National Forest. To address the second question, we captured, radio-collared, and monitored 93 elk calves over a 4 year period to determine survival and causes of mortality. We found post-elk release differences in coyote diet ($X^2 = 10.75$, $df = 1$). The percent of cervids in the diet of coyotes increased from 24.7% to 40.4% post-elk release, largely as a result of the scavenging of 15 elk that died from capture myopathy. Coyotes infrequently consumed elk after this period, but continued to consume white-tailed deer during deer hunting and fawning seasons. Ten of 93 (10.8%) radio-collared elk calves died within their first year, and 3 of 10 (30%) of these deaths were attributed to coyote predation. Our findings indicate that coyote predation is not a significant cause of elk mortality and will likely not limit population growth of reintroduced herds in the eastern U.S.

18. Temporal changes in habitat potential for Canada lynx in the Upper Peninsula of Michigan.

Session: Ecology and Conservation of Mammals

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In the ruling to list Canada lynx (*Lynx canadensis*) as a federally threatened species, the US Fish and Wildlife Service identified the Great Lakes region as one of the geographic units defining the Distinct Population Segment of the species in the contiguous United States. While there is no current evidence of a resident population in the Upper Peninsula (UP) of Michigan, trapping records over the past century suggest the area was periodically invaded by lynx during population eruptions in Canada. The dynamic of these movements prior to European settlement and degree to which populations may have persisted is unknown. Our objectives were to quantify past and present forest conditions in the UP (~42,610 km²) for lynx habitat potential, using a spatially explicit, landscape-level habitat model. The model required multiple layers of spatial data (e.g., classified and unclassified Landsat satellite imagery, soil surveys, ecoregions) compiled in a GIS to create ecological land units defining areas with similar vegetation composition and structure that could describe three lynx habitat components (foraging, denning, and interspersions). USFS Forest Inventory and Analysis plots were used to provide detailed stand attribute information relating to snowshoe hare habitat quality, as part of the foraging component. The historical range of variability in presettlement forest conditions was simulated with the landscape age-class demographics simulator (LADS) utilizing maps generated by General Land

Office survey records from the 1800s and estimated historic fire rotations for various biophysical units within the UP. Outputs from the habitat model indicate that the western UP contains the greatest extent of potential habitat for lynx, and that post-settlement conversion of forested areas into agricultural and other human developments has decreased habitat quality and connectivity most severely in the eastern UP. Our results can aid the development of management policies concerning lynx conservation in the region.

19. Population monitoring and ecology of bobcats in Iowa.

Session: Ecology and Conservation of Mammals

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Distribution and abundance of bobcats (*Lynx rufus*) has increased throughout the agricultural Midwest in the past few decades, but data on life history traits and feasible population monitoring techniques to support management of this species is still lacking. In response to the recent growth of bobcats in Iowa, we initiated a radio-telemetry project in south-central Iowa to estimate vital rates, habitat relationships and investigate population monitoring techniques applicable to bobcats in Iowa. We describe spatial use, dispersal, habitat selection, and survival rates of 60 radio-marked bobcats. Adult male bobcat home range sizes were substantially larger than adult female home ranges sizes, with males using an average of 42 mi² and 33 mi² during summer and winter, respectively. Adult females used an average of 9 mi² and 14 mi² during summer and winter, respectively. Bobcats selected forested habitats almost twice as frequently as grassland. The major mortality source was roadkills, with incidental trapping the second most prevalent mortality source. We estimated annual survival rates of males and females at 87% respectively. Juvenile male and female bobcats dispersed an average of 80 and 12 straight-line miles, respectively. Currently, we are evaluating 3 techniques applicable to statewide assessment of population trends. A postcard survey to the general public has produced over 500 sightings since 2003. A bowhunter survey in fall of 2004 reported 124 bobcat sightings, with bobcats observed/1000 hours ranging 9.4 in SW Iowa to none in NE Iowa. We also tested a bridge track survey within radio-tagged bobcat home ranges. We found bobcat tracks at 25% of the 63 bridges surveyed. The Iowa Department of Natural Resources is currently proposing a bobcat harvest season for Fall of 2006. Information from this study will be an essential component of effective bobcat population management in Iowa if a season is implemented.

20. Geographic distribution and broad-scale habitat associations of the wolverine in the contiguous United States: An historical analysis.

Session: Ecology and Conservation of Mammals

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The conservation of wolverine (*Gulo gulo*) at the southern extent of its range in North America requires reliable understandings of historical and current distribution patterns and broad-scale habitat associations. We compiled wolverine occurrence records from the contiguous U.S. and spatially referenced all verifiable and documented records that had temporal precision <10 yr and spatial precision <36 mi² (93.2 km²). We located 820 wolverine records from 24 states dating from 1801 to 2005, and spatially referenced 729 records dating from 1827 to 2005. Historical (<1960) records are located primarily in the western mountains and the Great Lakes region; we found little evidence of wolverine occurrence in the northeastern U.S. Our results and ancillary genetic studies show that the historical distribution of wolverine in the Pacific states was disjunct, not continuous, as previously believed. Our results provide strong evidence that wolverine range in the contiguous U.S. contracted substantially during the 20th century. Current (1995-2005) wolverine distribution is limited to north-central Washington, northern and central Idaho, western Montana, and northwestern Wyoming. Causal factors for the extirpation of wolverine from the southernmost portions of its range are unknown, but

are probably related to high levels of human-caused mortality and low or nonexistent immigration rates. We investigated hypotheses that wolverine may be associated with attributes of subarctic or alpine vegetation, very cold temperatures, or deep and persistent snow cover by overlaying historical wolverine locations on Kuchler's potential natural vegetation types, Holdridge's climatic life zones, and the probability gradient for snow cover persisting through the end of the wolverine denning period (April 15-May 14) based on the EASE-Grid Weekly Snow Cover dataset. We found a strong association with alpine habitat conditions in the western mountains. However, the only habitat layer that fully accounted for historical distribution patterns was persistent snow cover throughout the wolverine denning period.

21. Survival and cause-specific elk calf mortality following wolf restoration to Yellowstone National Park: Bears remain top neonate predators.

Session: Population Dynamics of Mammals

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Wolves (*Canis lupus*) were restored to Yellowstone National Park (YNP) during 1995-1996. Annual trend counts of northern Yellowstone elk (*Cervus elaphus*) have declined by approximately 50% from 19,045 just prior to wolf restoration (1994) to 9,545, 10 yr post-wolf restoration (2005). The mean of calf:cow ratios during 1990-2001 was 29:100, while during 2002-2005 it dropped to 13:100. During May 2003, we initiated a 3-year study of mortality in northern Yellowstone elk calves to determine the basis for the decline in calf recruitment. The primary objectives of the study were to: 1) estimate calf survival rates; 2) estimate the relative causes and timing of calf deaths; and 3) evaluate factors that may predispose calves to death. Calves <6-days old (n=151; 83 females:68 males) were captured and fit with radio-transmitters. Sixty-nine percent (n=104) died within the first year of life. Grizzly and black bears (*Ursus arctos* and *U. americanus*, respectively) accounted for the majority of deaths and killed younger calves than other predators on average. Calf survival was modeled using Known Fates in Program MARK with individual covariates. Calf survival was lowest during weeks 1-2 following capture, much higher thereafter, and varied significantly across calving areas. Prior to wolf restoration a similar study was conducted in YNP from 1987-1990 providing some measure of comparison with our results. Our results indicate some compensatory mortality is likely occurring in that overall summer predation has increased (94%; 2003-2004) while winter malnutrition has decreased (0%; 2003-2004) compared to 1987-1990 (72% and 58%, respectively; Singer et al. 1997). Our results suggest that changes in bear abundance and the varying spatial survival of elk calves across Yellowstone's northern range should be considered when predicting northern Yellowstone elk calf recruitment rates.

22. A habitat-based population viability analysis for ocelots in the United States.

Session: Population Dynamics of Mammals

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Strategies are needed to recover the ocelot *Leopardus pardalis* from the endangered species list. Recently, a population viability analysis (PVA) was developed which concluded that combinations of different recovery strategies were needed to effectively reduce ocelot extinction probability in the United States (U.S.), with habitat protection and restoration identified as the most effective recovery scenario. We expanded this PVA model by incorporating landscape data to develop a more realistic habitat-based PVA for ocelots in southern Texas. We used RAMAS/gis software to conduct a habitat-based PVA by linking landscape data with a demographic metapopulation model. The primary goal of this study was to provide a model for evaluating ocelot recovery strategies in the U.S. Each model scenario was simulated 1,000 times over 50 years and we defined extinction as 1 individual remaining.

The RAMAS/gis model identified 11 possible ocelot habitat patches (i.e., subpopulations) occurring in southern Texas. In addition, the habitat-based PVA model concluded that combinations of different recovery strategies were needed to effectively reduce ocelot extinction probability in the U.S., with reducing road mortality the single most effective strategy. Short-term recovery strategies should include reducing ocelot road mortality, and translocation of ocelots into the U.S. from northern Mexico. Long-term recovery strategies should include the restoration of habitat between and around existing ocelot habitat patches and the establishment of a dispersal corridor between ocelot breeding populations.

23. Wolverine demography: The importance of adult females for conservation of the Scandinavian wolverine population.

Session: Population Dynamics of Mammals

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The wolverine (*Gulo gulo*) is one of the northern hemisphere's least known carnivores. In Scandinavia the wolverine is classified as endangered, and its main prey is semi-domesticated reindeer. Thus, wolverines live in conflict with reindeer husbandry, which is deeply tied to the Sámi culture of Scandinavia. Therefore, managers are faced by the challenge to compromise between sustainability of an indigenous culture and conservation of wolverines. Knowledge of wolverine ecology in general and demography in particular is essential for a sound management of wolverines in Scandinavia. I analyzed demography and behaviour of radio-collared wolverines in northern Sweden. Wolverine females started producing offspring no earlier than at 3 years of age, the proportion of adult females reproducing was 0.53 (n=102), and average birth rate was 0.74 young per female. Reproduction incurred costs on female wolverines that affected reproduction the subsequent year. Experimental food-supplementation of females in early winter enhanced reproductive rates, suggesting that reproduction is limited by winter food availability. The low productivity of females implies that wolverines have a low capacity to compensate for increased mortality. Poaching was the most important cause of adult mortality and an important limiting factor for population growth. Intraspecific predation was the main cause of juvenile mortality. Elasticity analysis showed that survival of adult females is the single most important determinant of the growth of wolverine populations. Furthermore, I show that adult females are strictly territorial and dispersal of young females is determined by territory availability. Hence, the importance of adult female survival has both demographic and behavioural components. This study emphasizes the importance for managers to consider especially adult female survival when developing and implementing conservation policies and harvest regulations.

24. Response of moose to experimental removal of bears and public wolf control efforts in western interior Alaska.

Session: Population Dynamics of Mammals

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During 2001-2005 we annually radiocollared and monitored 50-81 moose calves, 12-41 yearling moose, and 22-64 adult moose to document causes and timing of moose (*Alces alces gigas*) mortality in western interior Alaska along the Kuskokwim River. Immediately prior to and during early calving in 2003 and 2004, we removed 115 black bears (*Ursus americanus*) and 10 grizzly bears (*Ursus arctos*) from a 1350-km² portion of the study area in an attempt to reduce bear predation on calves. In addition, public wolf control efforts in the study area began during February 2004 and have continued to the present, and have resulted in the taking of 31 wolves. Prior to removal of bears and public wolf control, annual survival rates for moose calves were 33% and 27% for the 2001 and 2002 cohorts respectively. Following removal of bears and public wolf control, annual survival rates for moose

calves were 52% and 40% for the 2003 and 2004 cohorts respectively. Yearling moose survival rates varied between 74% and 94% during 2001-2005, with the highest year coinciding with department bear removal and public wolf control efforts. Similarly, adult moose survival rates varied between 86% and 100% during 2001-2005, with the highest year coinciding with department bear removal and public wolf control efforts.

25. Sampling grizzly bears using rub trees.

Session: Population Dynamics of Mammals

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Hair deposited when bears rub on a variety of objects can be used in conjunction with microsatellite genotyping in estimating population size, distribution, and, potentially, monitoring population trend. We collected bear hair from naturally occurring bear rubs found along trails in an area occupied by both grizzly bears (*Ursus arctos*) and black bears (*U. americanus*) in and around Glacier National Park, Montana, USA. No attractant was used to attract bears to rubs. Concurrent with the sampling at rub objects, we collected hair at barbed wire hair snag stations. Snag stations were off-trail and baited with a scent lure. We collected 10,453 hair samples from 1,016 bear rubs during May-October 1998-2000. A higher proportion of grizzly bears than black bears were sampled at rubs than at snag stations. The ratio of grizzly bear to black bear hair samples averaged 67:33 at rub trees compared to 32:68 at hair snags in the same area. The number of hair samples genotyped to individual males averaged 12.6 (range 1-79) compared to an average of 3.9 (1-19) for individual females. Among individual grizzly bears, males were 1.4 times more likely to leave hair at rubs than females, however the proportion of females detected increased during summer and fall. Rub tree sampling detected 66% of the grizzly bears identified through rub and snag sampling and 28% of the bears were detected only at rubs. We found bear rubs wherever we knew bears occurred: on national park, multiple use, ranch, and industrial forest lands. Potential uses of rub data to estimate population size include using it in combination with snag data as marks and recaptures in a Lincoln-Petersen model or using a joint dataset in the Pledger closed models. Bear rubs present an excellent opportunity to sample a large number of bears across large and varied landscapes.

26. Effects on population estimates from using food to lure bears to DNA hair traps and then sub-sampling.

Session: Population Dynamics of Mammals

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Bear managers and researchers across the country are captivated by the potential of non-invasive DNA sampling to produce population estimates, not just indices. Some type of food, in addition to scent, is regularly used to lure bears to DNA hair traps. Due to prohibitive lab costs, researchers are often forced to analyze only a subset of samples. We tested sub-sampling approaches for estimating population size of black bears (*Ursus americanus*) and investigated whether using food as a lure alters recapture rates. Two sets of 12 barbed wire corrals were alternated in a grid pattern in Hyde County, North Carolina. The lure was raspberry or BBQ at scent corrals and peanut butter scent with five ounces of peanut butter at food corrals. We analyzed all 1,240 hair samples collected during this 13 week study and identified 144 different bears (70 females, 74 males) visiting corrals a total of 500 times. During the first 4 week manipulation, 31 different bears visited food only corrals, while 49 different bears visited scent only corrals. During the second 4 week period, scent was added to food corrals and 82 bears visited, while 61 bears visited scent only corrals. For the last 5 weeks, all corrals were scented with peanut butter; 51 bears visited food and scent corrals, while 40 bears visited scent only corrals. To monitor repeat visits by bears within a sampling week, seven bears were collared with GPS collars programmed to record locations every 5 minutes. Corrals with food and scent averaged 2

more weeks with at least one hair sample than corrals with just scent. Females returned to corrals at a greater rate than males. Use of food lures and sub-sampling can lead to erroneously low population estimates and may actually be an index of minimum population size, not a population estimate.

27. Effects of a harvest ban on a migratory wolf population in Algonquin Park, Ontario

Session: Population Dynamics of Mammals

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Algonquin Park is the largest protected area for wolves in Ontario. However, many wolves from Algonquin were killed by people while following migratory deer out of the Park during the 1980s and 90s. A moratorium on wolf harvesting in the 39 townships surrounding the Park was implemented in November 2001. During 2002-06 we radio-tagged 189 wolves, including 76 pups, to assess the effects of the harvest ban on wolf population dynamics. During early winters 2002-05 median pack size was 4.5, 4.5, 5, 4.75 in western Algonquin, and 4.5, 4.5, and 5 during 2003-05 in Eastern Algonquin, respectively. Overall pack sizes observed during 2002-05 appear similar to those observed during 1990-96, but larger than observed during the late 1990s. Similarly, wolf densities have remained relatively stable following the ban (2.5-3 wolves/ 100 km²). Some packs declined in size from one winter to the next despite high adult survival and confirmed presence of pups during the previous summer. Annual dispersal rates of yearling and adult wolves rose from ~10% the first year following the ban to ~25% during the next three years. Twenty-four radio-collared yearling and adult wolves have died during the study period with the deaths of 18 of those animals attributable to natural causes (e.g. intra-specific strife, malnutrition, mange). This is in stark contrast to the 1990s when ~2/3 of wolf mortality was attributable to humans. During the first year following the ban yearling and adult survival was >92% but this rate declined to <80% during subsequent years owing to an increase in natural mortality. That relatively high survival is apparently being offset by high dispersal with little overall change in wolf density suggests wolf densities in the Park may presently be self-regulated at a level suitable for the present abundance of prey.

28. Grizzly bear population density in Glacier National Park, Montana.

Session: Population Dynamics of Mammals

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Population size in Glacier National Park, Montana, (GNP) was last estimated in 1971 using sightings of unmarked bears. Trend has not been monitored. We estimated the size and distribution of the grizzly bear (*Ursus arctos*) population in the greater GNP area in 1998 and 2000 using hair sampling in conjunction with microsatellite analysis to identify individual bears. The study area encompassed 8,362 km² in and around GNP in northwestern Montana, USA. GNP comprises 49% of area and is managed primarily as wilderness. The study area consists of National Park, National and State Forest, Blackfeet Indian reservation, and private lands. We employed two methods concurrently to collect bear hair. We distributed approximately 625 baited hair snag stations each year on an 8x8 km grid to systematically sample the study area during 5 14-day sample sessions. Hair snags were moved to a new location within cells after each session to decrease the likelihood of a behavioral response to snag sites. The second sampling method collected hair at 2-4 week intervals from over 1,000 unbaited bear rub trees along trails. Collectively, 10,816 samples were collected from hair snags and 8,964 samples were collected from rub surveys. Bear rub and hair snag sampling datasets were analyzed independently and jointly using closed mixture models in program MARK and traditional Lincoln-Peterson estimators. We present the results of these models and discuss implications of multi-year datasets and multiple sampling methods. Grizzly bear density was highest within GNP and lower outside the park where the majority of mortality occurred. We compare the density of grizzly bears in

GNP with other populations and discuss potential explanations. This study provides baseline information important for managing one of the few remaining populations in the contiguous United States.

29. Population dynamics and management of Kodiak bears

Session: Population Dynamics of Mammals

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Kodiak Island, Alaska supports a healthy and productive population of brown bears (*Ursus arctos middendorffi*). These bears live in habitats that have been relatively unaltered by humans, but they encounter humans regularly spring through fall. They are also viewed as an important economic resource for bear hunters and bear viewers. From 1982 - 2003 we investigated bears on 4 separate study areas on Kodiak Island, capturing and marking 403, and collecting 15,539 relocations from 261 radio-collared bears. Coincident with the collection of radio telemetry data, we gathered information on habitat use, productivity, survival, population density, and harvest. The study areas ranged from steep mountainous terrain in the northern areas to rolling hills and tundra in the south, and each offered different resources for bears. Bears in the central area had access to 1,482 kg/bear/yr of salmon (*Oncorhynchus* spp), while those in the southwest area had access to 13,976 kg/bear/yr. We found that in spite of the short distances between study areas and a lack of formidable topographic barriers, most female bears remained within their respective study areas, and male movements were less than anticipated. Denning behaviors varied significantly by sex, by reproductive status, and by area. Home ranges and utilization distributions also varied significantly by area and sex. In spite of these differences, we noted comparable densities of bears within each area (mean = 214 bears/1,000 km²). These findings reveal the adaptability of brown bears to a wide range of conditions, and emphasize the dangers of extrapolating estimations of critical habitat for bears based on limited spatial or temporal investigations. Data derived from this investigation are also being applied in the development of a population model that can be used to refine harvest guidelines for bears on Kodiak Island.

30. Relating habitat and harvest methodology to harvest structure of black bears in Wisconsin.

Session: Population Dynamics of Mammals

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Sex and age composition of harvested individuals provides the foundation for estimating trends in populations of hunted species. Factors other than actual population size or sex-age structure may influence the composition of hunter harvest. In black bears (*Ursus americanus*), food availability, and harvest method have both been related to variation in hunter success and harvest composition and may bias population estimates based on harvest data. Spatial and temporal differences in food availability and harvest methodology likely account for regional variation in hunter success and different vulnerabilities of certain age and sex classes to harvest. In Wisconsin, the range of black bears spans varied habitat types and a spectrum of resource availability. Wisconsin's bear hunting regulations in the northern part of the state include an alternating framework wherein hound hunters and non-hound hunters hunt first during alternate years. We modeled a 6-year record of Wisconsin black bear harvest data using land cover (quantified at the county level) and harvest method framework to compare the effects of habitat and harvest method on harvest sex and age composition. The percentage of females harvested was positively related to the percentage cover by broad-leaved deciduous tree species indicating that county level differences in the prevalence of specific habitat types influence sex structure of harvest. With other variables held constant, mean age of females harvested increased by 0.8 years in regions where dog hunting was allowed. A 0.3 year decrease in mean age of harvested males was attributable to hound hunters hunting first in regions with first hunting opportunities alternating between hound and non-hound hunters. These findings suggest that regional differences in

habitat and the framework of hunting seasons in Wisconsin may result in a harvest composition that is biased with respect to the bear population structure and that monitoring programs may need to adjust accordingly.

31. Modeling fur harvests, trapper behavior, and landscape change in the Rocky Mountain foothills of Alberta.

Session: Population Dynamics of Mammals

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American marten (*Martes americana*) are of both economic and ecological importance throughout the mature, mesic forests in which they occur in North America. Declines of this mustelid have been attributed primarily to overtrapping and habitat loss. Although harvests today are managed on a registered trapline system in Canada, few studies have examined the cumulative effects of human disturbance on marten harvests. The rate of human disturbance and population growth in Alberta exceeds any other province, highlighting the importance of documenting the effects of industrial development on sensitive wildlife. Using thirty years of fur harvest records, interviews with trappers, and GIS maps of industrial activity (mainly energy and forestry) in the foothills of Alberta, we investigated the relationship between furbearer harvest dynamics and landscape change. The relationship between trappers and habitats is important to understanding how fluctuating furbearer harvests might be linked to population trends. Using an information-theoretic approach, we identified variables that affect marten harvests and trapper behavior. Major differences existed between active and inactive traplines. Active traplines had significantly less road and quad-trail access and oil- or gas-well density, a greater proportion of closed conifer, and were larger than inactive traplines, indicating that development was an important factor influencing trapper effort. Further, the probability of a trapline being active was explained most by trapline size and conifer habitat. Industrial activity, vegetation type, and trapper effort explained a large proportion of the variation in average marten harvest among traplines ($R^2=0.8$). Controlling for trapper effort, the density of marten harvested maintained a strong positive association with proportion of conifer habitats. Therefore, habitat is clearly a major driver in influencing trapper effort and marten harvests through time. We can use this information to link existing fur records, effort, and habitat variables to monitor trapping and furbearers in a rapidly changing multi-use landscape.

32. The bobcat as an icon for integrating research, education, and habitat conservation on Kiawah Island, South Carolina.

Session: Human Dimensions, Conservation Education, and Conservation Policy

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Resort development on Kiawah Island (3,200 ha), South Carolina since the 1970s has significantly increased property values, yet many residents wish to maintain wildlife habitat suitability. This presentation describes a community response to the integration of research, education, and habitat conservation for one wildlife species in the wildland-urban interface. We began conducting bobcat (*Lynx rufus*) research on the island in 2000 to document behavioral responses to development. Island-wide scent station indices revealed a fairly stable population of about 30 bobcats (1.4 bobcats/km²). During 2004-2005, we monitored 16 radio-collared bobcats (8 males and 8 females) to determine reproduction, survival, home range size, habitat use, dispersal, and daily and seasonal movement patterns. Using data collected from these bobcats, we are conducting a GIS-based analysis of bobcat locations using Euclidean distance and habitat suitability indices to determine the most important habitats for protection from development. Based on our results to date, secondary dune wax myrtle (*Myrica cerifera*) thickets and marsh edge (salt marsh/upland interface) were the most important habitat types for bobcats on Kiawah Island. A non-profit organization, the Kiawah Conservancy, has

used the results of our research to help educate residents about wildlife ecology and backyard habitat, to raise funds for habitat conservation, and to prioritize the protection of individual building lots on the island. They annually sponsor a social event (the “Bobcat Ball”) where residents make tax-deductible donations and island maps depicting bobcat telemetry locations are auctioned-off to benefit habitat protection goals. The Conservancy has recently purchased over \$3.5 million of land on the island for wildlife conservation. Use of our research results to educate residents and help foster their interest in wildlife ecology has made the bobcat an icon for habitat conservation on Kiawah Island.

33. Human-black bear conflict in Eastern Kentucky: Management efforts and obstacles.

Session: Human Dimensions, Conservation Education, and Conservation Policy

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The black bear (*Ursus americanus*) was extirpated from Kentucky more than 100 years ago but is now recolonizing the Commonwealth. Preliminary results from DNA analysis indicate that colonizing black bears may be coming into Kentucky primarily from West Virginia. Their return presents both challenges and opportunities. Though much of eastern Kentucky appears to be suitable bear habitat, settlement patterns are such that little land exists without human habitation, making human-bear interaction inevitable. Over the last three years we have used formal and informal interviews, participant observation, and nuisance and media reports, to chronicle and evaluate efforts made by the Kentucky Department of Fish and Wildlife Resources, civic organizations, local citizens, and a joint black bear task force to address human-bear conflict. We found a widespread belief among residents that 1) observable bears will increase tourism and bring much-needed revenue to this economically depressed region, and 2) that the return of the bears is part of the restoration of an area that has suffered severe environmental degradation. However, the desire to see bears has in many cases exacerbated nuisance problems. Complaints about nuisance animals have risen steadily as bears have returned to Kentucky. Since 2004, we have received four confirmed and five unconfirmed reports of bears killed illegally because of nuisance activity. This is problematic because removing adult bears could disrupt local demographics in this small population. Local socio-economic and cultural conditions, as well as a lack of municipal support, restrict the range of management techniques that can be employed. For example, although many people interviewed said they would use bear-proof garbage cans if provided, they are unable to purchase them themselves because of economic constraints. Educational programs that provide positive reinforcement of bear-compatible human behavior, coupled with proactive local leadership, may be a more effective means of addressing the problem.

34. Estimating wolf functional response in a multi-prey system using GPS collars.

Session: Population Dynamics of Mammals

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Advancements in describing wolf (*Canis lupus*) functional response to prey populations hinge on accurate estimates of wolf predation rates across a range of prey densities. Past approaches to estimating wolf kill-rates in North America have relied primarily on intensive aerial searches; these techniques are hampered by requirements for ideal snow conditions, favorable flying weather, sparse forest cover, and a limited ability to detect kills of smaller prey species (i.e. deer). In addition, the substantial expenses typically associated with intensive aerial work often limits the number of wolf packs that can be successfully monitored; relatively small sample sizes make accurate assessments of wolf functional response in a multi-prey system difficult. We used a space-time cluster scan technique originating from the epidemiology field to scan wolf GPS collar datasets from 4 packs in west-central Alberta for clusters of wolf locations, and searched a sample of these clusters for prey remains in the field. The scan technique was successful in locating >90% of all wolf kills, which included deer, elk, moose, and feral horses. We developed a logistic regression model based on wolf movement

characteristics and landscape variables at clusters to predict the probability of a cluster being a kill, and subsequently extended the model to classify kills according to species. These models were applied to 25 wolf GPS datasets from 15 wolf packs during 2003-2006 to describe the functional response of wolves in a multi-prey system.

35. Habitat selection and fractal dimension of movements by raccoons in Illinois.

Session: Ecology and Conservation of Mammals

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An important facet of predator ecology is habitat use and the movements of predators through their environments. Compositional analysis and fractal dimension of movement pathways can be useful tools for quantifying predator movements and habitat use; thus, we undertook a two-year telemetry study in a grassland preserve in Illinois to investigate raccoon (*Procyon lotor*) movements and habitat use in an area managed for imperiled grassland birds. During the avian nesting season, raccoon movement pathways had significantly lower fractal dimension, indicating more linear movements and less searching behavior than fall/winter pathways ($U=64.00$, $p=0.027$). Movement distances and rates did not differ between the sexes, nor did they differ on a seasonal basis. Seasonal habitat use differed at two scales of investigation: (1) home range composition differed from that within the study area, and (2) individuals selected particular seasonal habitats within their home ranges. We found that raccoons generally avoided grasslands during the avian nesting season, usually moving quickly and directly across grasslands to reach richer food patches (e.g. wetlands and riparian strips). Fractal dimension of movement pathways during the spring and summer indicated that raccoons did not exhibit nest searching behavior in grassland habitats; however, pathways became more convoluted in winter when raccoons searched for limited food, particularly waste corn, in residential areas and crop fields.

36. Promiscuity and multiple paternity in raccoons.

Session: Ecology and Conservation of Mammals

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Observing mating behaviors in wild populations is difficult because of the relative infrequency of copulations, nocturnal habits of many species, and possible observer effects on behavior. However, the development of genetic techniques has enabled the outcome of reproductive activities to be examined by sampling young and potential parents. Parentage studies are now commonplace in the avian literature, but the mammalian literature lags behind in comparison, with a heavy bias towards small mammals and primates. Our objective was to examine paternity in a population of wild raccoons (*Procyon lotor*) in southern Illinois using 11 highly polymorphic microsatellite markers. We followed 31 radiocollared females back to 60 different den trees early in the cub-rearing season (Apr-May) during 2004-05. Den sites were visited at night while females were foraging to obtain tissue samples for genetic analysis from 11 litters. Samples from 2 additional litters were obtained from pregnant females involved in fatal vehicle collisions. We identified potential fathers as adult males that were likely to spatially overlap female use areas based on trap locations and female home ranges. We determined genotypes for 188 individuals (41 ad F, 23 juv F, 57 ad M, 26 juv M, and 41 cubs). Most litters (mean: 3.2 ± 0.4 young/litter) had >1 sire, as indicated by >2 paternal alleles at each locus. These results indicate that females mate with multiple males during estrous. Although mating behaviors might vary at other population densities, in this dense raccoon population (1 raccoon/0.61 ha), the mating system is best described as promiscuous, rather than polygynous.

Recovering the black-footed ferret in Colorado and Utah

Session: Ecology and Conservation of Mammals

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Recovering the black-footed ferret (*Mustela nigripes*) is a difficult challenge for resource managers. Reintroduction in Colorado and Utah occurs in a series of adjacent white-tailed prairie dog (*Cynomys leucurus*) complexes that span portions of northeastern Utah and northwestern Colorado; these efforts are considered jointly because the habitat is contiguous and the partnership leverages available resources. To date, 452 ferrets have been released in Colorado and Utah including young-of-the-year and adults reared at breeding facilities throughout North America. Considering both states jointly, annual releases have ranged from 106 individuals in 2001 to 39 in 2005. Intensive monitoring, including spotlighting, radiotelemetry, and use of detection dogs has been implemented annually. Reproduction in the wild has been confirmed in Utah annually since 2001 totaling a minimum of 20 individuals; 2005 marked the first confirmed wild produced litter in Colorado with at least 1 individual surviving at the time of survey. The minimum end-of-year population estimate in 2005 considering both states jointly was 42 individuals. Black-footed ferret recovery in Colorado and Utah may be emerging as a successful facet of an expanding national (and perhaps international) effort in endangered species conservation. We provide a comprehensive update of ferret recovery and monitoring in Colorado and Utah. We overview contributions specific to the Colorado and Utah effort including: (1) successful interstate multi-agency collaboration; (2) advancement of recovery on one of only two white-tailed prairie dog sites (the other being Shirley Basin, Wyoming); and (3) ongoing biomedical, plague-related, and telemetry research. Last, we consider the future of black-footed ferret recovery in Colorado, Utah, and elsewhere in terms of habitat, disease, and monitoring issues, measures of success in wildlife reintroduction, and research needs.

38. Alaskan polar bears: Dietary biomagnification of organochlorine contaminants.

Session: Wildlife Diseases and Toxicology

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Studies of organochlorine (OC) contamination in the adipose tissues of polar bears (*Ursus maritimus*) report a wide range in the burdens of highly recalcitrant compounds which have not been explained fully by location, age, sex, condition, or reproductive status of the bear. Dietary pathways expose polar bears to a variety of contaminant profiles and concentrations, ranging from the relatively contaminant free tissues of the bowhead whale (*Balaena mysticetus*) representing a low trophic level, to the highly contaminated tissues of the higher trophic level ringed seal (*Phoca hispida*). We used stable isotopes $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ to help determine the trophic status of 43 free ranging polar bears sampled along Alaska's Beaufort Sea coast and assayed their adipose tissue for persistent organic pollutants. $\delta^{15}\text{N}$ values ranged from 18.2‰ to 20.7‰ with a mean value of 19.4‰ (SD=0.95). Two-element three-source mixing models indicate that lower trophic level prey such as scavenged bowhead whale carcasses may have composed as much as 26% of the diet in winter, 2003. In both sexes we found positive relationships between contaminant burdens and trophic level ($\delta^{15}\text{N}$) in models incorporating age, %lipid, and $\delta^{13}\text{C}$: PCB153 (males: $F=13.43$, $p<0.0001$, $r^2=0.668$, females: $F=18.31$, $p<0.0001$, $r^2=0.849$), PCB180 (males: $F=10.69$, $p<0.0002$, $r^2=0.6159$, females: $F=8.22$, $p<0.0021$, $r^2=0.6378$). $\delta^{15}\text{N}$ was important in explaining variation in OC concentrations between individuals, indicating structural differences in food webs and biomagnification of OCs among individual polar bears related to their sex, age, and the apparent use of lower trophic level prey.

39. Pathogens associated with Pacific fishers in northwestern California: Implications for trapping and translocations

Session: Wildlife Diseases and Toxicology

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Fisher, *Martes pennanti*, populations from Washington, Oregon, and California were recently designated by the USFWS to be a distinct population segment (DPS) meriting listing under the Endangered Species Act. Disease was noted as a potential issue in this DPS, and this study provides information on exposures of a population in northwestern California that appears to have declined during recent years. Of the first 31 fishers sampled during Winter, 2005, one (3%) had been exposed previously to canine distemper virus, 13 (41.9%) had been exposed to a feline parvovirus-like virus, and 30 (96.8%) had been exposed to *Anaplasma phagocytophilum*, the cause of granulocytic anaplasmosis. Although little is known about diseases of fishers, both viruses cause immunosuppression and mortality of susceptible mustelids, and both can be transmitted via exposure to fecal contamination. In addition, anaplasmosis causes debilitating immunosuppression in susceptible species; the seroprevalence of fishers for exposure to *A. phagocytophilum* is unprecedented for areas other than Hoopa. While these data are preliminary, and will be updated for the meeting with data from samples collected through summer, 2006, they illustrate the potential importance of (1) disinfecting traps and handling equipment between captures to minimize risks of spreading viruses throughout a population, and (2) consideration of disease issues prior to translocation of wildlife that could succumb to diseases cycling at a release site or into areas with existing communities that might be adversely affected by disease.

40. Optimal allocation of resources in a hierarchical sampling design for the middle Georgia black bear population.

Session: Biometrics in Wildlife Management

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An important goal with estimating demographic parameters in a sample population is to use an optimal sampling design, which we define as the design that maximizes the ratio of accuracy to cost. The sampling design is influenced by the spatial and behavioral ecology of the study species, the amount of resources available, and the desired accuracy for the parameter of interest. We present an algorithm for designing an optimal hierarchical study through a mixture of simulated and field data from 2 sampling sessions (Summer- Fall 2004,2005) in our combined model designed to estimate black bear (*Ursus americanus*) density in Middle Georgia. Our hierarchical sampling design includes non-invasive techniques, such as DNA hair snares and digital cameras, placed in a trapping web design, with replicated trapping webs located throughout the study area. Bears with telemetry collars are also monitored for presence in the webs. We found a trade-off between increasing the number of sample observations (i.e. number of hair snares/cameras per web, number of webs, and trapping occasions), which increases accuracy of density estimates, versus the costs (e.g. money, time) required to obtain those estimates. An optimal sampling design under this scenario also incorporates a laboratory component with DNA from hair samples. The optimal number of markers for genetic analysis is based on the heterozygosity in a population, variability of markers, and associated genetic error to achieve a certain level of accuracy.

41. Using aerial line transect sampling to estimate bear density.

Session: Biometrics in Wildlife Management

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Managing bear populations can be very expensive and difficult over large geographic areas. Our objective was to develop a cost-effective method to estimate bear population density over the large geographic regions of Alaska that are used to set game regulations. Aerial line transect sampling is used to obtain these estimates. The methodology uses contour transects in mountainous terrain and straight transects in relatively flat terrain to obtain bear sighting distances. GPS technology and software is used to obtain the location of the flown transect and all observed bear locations and this information forms the basis of the distance calculations. Advanced line transect models are used to obtain density estimates. We use a partial likelihood model with a specialized gamma-shaped detection function for each observer. This parameterization allows for non-shouldered detection apexes which often occur with aerially collected data. Data from the pilot and backseat observer are modeled separately to obtain an estimate of the maximum detection probability associated with each detection curve. Covariates such as group size, percent cover, bear activity, and search distance can be used as potential covariates to improve model precision. Utilizing this methodology, we obtained a brown bear density estimate for a 12,559 km² game management unit on the Alaska Peninsula. In the spring of 2001, we flew 370-aerial transects, for a total length of 7,581 km, and observed 253 bear groups. This data set was used to obtain an estimated density of 171.3 brown bears/1000 km² (se = 20.43). We conclude that this is a very cost effective method for monitoring bear population status, especially in areas with high densities.

42. Status of the black bear in the Northwestern Lower Peninsula of Michigan: A non-invasive mark-recapture population estimate study.

Session: Indigenous Peoples Wildlife and Ecosystem Management

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The use of hair-snares and microsatellite genetic markers in mark-recapture population estimates has become increasingly common in studying large mammals. In black bear (*Ursus americanus*) studies, hair-snares are advantageous over traditional methods because complications and dangers associated with direct personal contact of the bears are avoided. Open- and closed-population models may offer differing estimates of population size. Open-population models often require less effort than closed-population models because they cover a smaller area. While closed-population models are useful in estimating population size over an all encompassing area (state level), open-population models estimate a still large, but more precise area. Hair-snares were used to non-invasively collect hair samples from black bears (May-July 2005) in order to estimate population size. Sample collection took place in 9 counties in the Northwestern Lower Peninsula of Michigan where hair-snare units (n=265) were distributed in a grid-like fashion. DNA was extracted from hair follicles and amplified at 7 microsatellite loci using PCR. Data was analyzed using the open-population models in program MARK and yield a population size of 48 individuals (95% C.I. 17-95). In previous population estimates including the entire Northern Lower Peninsula, closed-population models estimated population size of 1,882 bears (95% C.I. 1,389-2,551). Our study area encompassed approximately 33% of the closed population study area but only 3% of the total bears. Our results indicate that black bears are not equally distributed throughout the Northern Lower Peninsula of Michigan. This discrepancy may be attributed to urban development and lack of usable habitat. Closed-population models may not accurately describe the distribution of bears across their entire sampling area.

43. Proactive management of gray wolves in the Great Lakes region.

Session: Indigenous Peoples Wildlife and Ecosystem Management

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Wolf-caused depredation results in substantial economic loss to individual farmers, and it can lead to greater public animosity towards wolves (i.e., reduction in social tolerance) and the agencies that manage depredations. Current public opinion favors the use of non-lethal and other control measures over lethal control of wolves if possible. Further, Michigan and Wisconsin farmers have exhibited some interest in using non-lethal management tools. During 2003-2006, we examined several non-lethal tools for application by agencies and farmers in proactive wolf management. We also surveyed farmers in the northern Great Lakes Region relative to their interest in participating in wolf management programs, including active management on their lands. In general, farmers had low to moderate interest in non-lethal management tools, despite the vast majority (>85%) having not received any educational materials on such tools. We present some of our results from experimental trials, surveys, and discuss our current efforts at monitoring a recovering wolf population in the northern Lower Peninsula of Michigan. This latter work includes active engagement of the farming community in the hopes of implementing farmer-based management tools before the wolf population expands.

44. Combining data from animal movements, DNA based identification, and stable isotope values of diet to more completely identify important habitat: A test case with Alaska brown bears

Session: Physiology for Populations

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Raw location data of an animal's movements can be used to identify home range and travel routes, but do not provide information regarding other important natural history attributes, such as nutritional status or the extent of genetic relatedness across a species' range. Thus, nutritional or physiological parameters are often overlooked or underutilized when identifying critical habitat. Determining natal dispersion and inferring relatedness through location data alone is a costly, laborious and tentative process. DNA-based techniques can provide these data with greater certainty and in a much shorter time frame. Diet can only be imperfectly estimated incidental observations of prey capture, and dietary inferences derived from scat analysis are strongly affected by the differential digestibilities of food items. Instead of scat analysis, stable isotopes can be used to determine diet and to approximate intake. We report here data collected on animal movements, genetic relationships, and dietary habits of two geographically distinct groups of adult female brown bear (*Ursus arctos*) in Alaska. Home ranges were determined from location data collected by GPS radio collars. Genetic relatedness was calculated from DNA collected from hair and blood samples. Diet was determined from stable isotope (C/N/S) analysis of blood and hair samples. We discuss how these three types of information can be used to derive a fuller understanding of a target animal's habitat requirements.

45. Survival and population size of polar bears in western Hudson Bay in relation to earlier sea ice breakup.

Session: Global Climate Change and Wildlife in North America

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We estimated demographic parameters for polar bears (*Ursus maritimus*) in western Hudson Bay, Canada, from capture-recapture data collected 1984-2004, and handling data for polar bears that entered the community of Churchill, Manitoba, located adjacent to the study area. The size of the Western Hudson Bay polar bear population declined from 1194 (95% CI = 1020, 1368) in 1987, to 935 (95% CI = 794, 1076) in 2004. Total apparent survival of prime-adult polar bears (age 5-19 yr) was stable over the course of the study for both females (0.929; 95% CI = 0.914, 0.942) and males (0.893; 95% CI = 0.875, 0.908). Survival of juvenile, subadult, and senescent-adult polar bears was correlated with the timing of sea ice breakup, which was variable between years and occurred approximately two weeks earlier in 2004 than at the beginning of the study in 1984. We propose that this correlation provides evidence for a causal association between earlier sea ice breakup (due to climatic warming) and decreased polar bear survival. It may also explain why Churchill, like other communities along the western coast of Hudson Bay, has experienced an increase in the number of human-polar bear interactions in recent years. Earlier sea ice breakup may have resulted in a larger number of nutritionally-stressed polar bears, which are encroaching upon human habitations in search of supplemental food. Because western Hudson Bay is near the southern limit of the polar bear's range, our findings may foreshadow how more northerly polar bear populations will respond to the continued warming that is projected for many parts of the Arctic.

46. Polar bears, canaries, and declining sea ice-wildlife managers or wildlife historians.

Session: Global Climate Change and Wildlife in North America

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Research efforts of the past few decades have given wildlife professionals the tools necessary to address past and present polar bear management challenges. Now climate changes appear to threaten the sea ice itself-the floating platform upon which polar bears depend for nearly all of their life history needs. As a universal symbol of the Arctic, polar bears have been heralded as the “canary in the coal mine” of global climate change, and recent reports suggest their Arctic ice habitat may be gone in 100 years. Some even have suggested there is nothing we can do to prevent disappearance of the summer sea ice. Is there any point, then, in continuing to study polar bears? Are we doomed to become simply polar bear historians? As the apex predator in the Arctic, polar bears reflect the status of the ecosystem supporting them and are one of the best harbingers of things to come. Also, we know that polar bears somehow survived the Holocene hypsithermal-a period between 5 and 10 thousand years ago when temperatures were substantially warmer than they are now. These facts alone suggest there is reason to continue to study polar bears. Because current predictions of increasing temperature are based upon a relatively short time line there is uncertainty about what the future may bring. And, with resolve, we can manage the extent to which humans are contributing to predicted climate trajectories. By knowing how they respond to diminishing ice-spatially and demographically, we will have the best chance of predicting where polar bears may continue to survive in a diminished ice environment and of adapting management strategies to reconcile the needs of bears with their altered habitat. This will maximize our opportunities to assure the long-term survival of polar bears throughout whatever the future brings.

47. Contrasting patterns of recolonization by two mustelid species from a landscape genetics perspective.

Session: Applications of Landscape Genetics to Wildlife Management

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Furbearer species including fishers (*Martes pennanti*) and American martens (*M. americana*) experienced severe declines throughout the United States in the late 1800s to early 1900s, and were extirpated in many areas. Reintroductions of both species into Michigan and subsequent dispersal from known release locales have provided a means to evaluate reintroduction strategies. Data also provide opportunities to investigate population spatial genetic structure and movement patterns

relative to landscapes onto which founders were recently released (~5-30 generations BP). Our objective was to provide evidence for the relative importance of landscape features to spatial genetic relationships at population and individual scales following recolonization of these two mustelids. Evidence for co-location of genetically related individuals was also evaluated. We used microsatellite loci for fishers (N = 555) and martens (N = 576) legally harvested from 2000-2004. Fishers were analyzed as geographically contiguous subpopulations and martens were analyzed individually. Genetic population structure relative to reintroduction history was determined using Bayesian-based clustering methods. We used Mantel tests and one- and two-dimensional spatial autocorrelation methods to provide evidence for the presence of, and the distance and ordination of effective gene flow. To further investigate observed spatial genetic patterns, we modeled landscape features of known importance to each mustelid and to their preferred prey using least-cost surface analysis. For fishers, evidence of significant spatial autocorrelation in allele frequency was documented over ~70 km and consistently in a SW-NE orientation. Martens formed three genetically distinct and spatially contiguous populations extending from three independent release representing different ancestral source populations. Spatial genetic analyses revealed differences in distance and direction over which gene flow occurred (range of significant positive autocorrelation of 30-120 km). Results show how different ecological characteristics of two codistributed species shape spatial genetic relationships following concurrent reintroduction into the same landscape.

48. Spatial analysis of black bear gene flow on the Kenai Peninsula, Alaska.

Session: Applications of Landscape Genetics to Wildlife Management

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The definition of population genetic structure is a central concern of population genetics as well as wildlife management. Information regarding population subdivision and connectivity is particularly important for guiding wildlife management in an increasingly fragmented landscape. In this study we elucidate spatial patterns in the population genetic structure of black bears (*Ursus americanus*) on the Kenai Peninsula, Alaska, merging techniques from population genetics and spatial statistics. Bayesian assignment tests revealed 3 genetically distinct clusters, the mainland, the upper Kenai and the lower Kenai. Individuals were mapped in a GIS along with population genetic data including the proportion of ancestry (Q) ascribed to each of the population clusters and status as a resident or migrant in the location of capture. Physical and anthropogenic landscape features were also layered in the GIS. Moran's I statistic was used to describe autocorrelation in values of genetic ancestry. Local Indicators of Spatial Association (LISA) statistics were used to assess local spatial patterns in genetic variation. By measuring the change in autocorrelation across increasing distances, we defined the extent of the genetic neighborhood of each population cluster. Local patterns in the genetic variation indicated areas of sharp change between population clusters, areas of high gene flow among different clusters and corridors that maintained connectivity within clusters. Patterns of genetic variation and genetic neighborhood size were then correlated with landscape variables giving an indication of features facilitating or forming barriers to black bear gene flow on the Kenai.

49. Habitat specialization in a generalist species, the coyote, diversifies populations in a heterogeneous landscape.

Session: Applications of Landscape Genetics to Wildlife Management

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Individuals of many species have been found to disperse preferentially into habitat similar to that in which they were born. Theoretically, such behaviour can lead to discrete habitat-specific population subdivisions even where no physical dispersal barriers or habitat gaps occur. If so, populations are expected to be most structured in heterogeneous (but not necessarily fragmented) landscapes. Previous

studies of coyotes (*Canis latrans*) from a small region of California have supported this hypothesis qualitatively. However, the evolutionary significance of such habitat-specific subdivisions ultimately depends on their extent and magnitude relative to other population diversifying factors (e.g., geographic distance). Here, we address these questions using landscape genetics analyses of multiple types of molecular marker and >2,000 coyotes from a broad region of southwestern North America. Consistent with predictions of the natal habitat-biased dispersal hypothesis, we found a close correspondence between population genetic structure and habitat subdivisions throughout the California Floristic Province, a large region of high landscape heterogeneity, and virtual panmixia over an even larger region of desert and prairie, characterized by comparably low landscape heterogeneity. Overall genetic diversity was similar in the two ecoregions. Conversely, site-specific genetic diversity was lower within subregions of the former than latter ecoregion, as expected from genetic drift. The magnitude of habitat-specific genetic subdivisions (i.e., genetic distance) in the California Floristic Province was higher, on average, than that due to geographic distance. Habitat-specific structure can enhance a species' adaptive potential by increasing the range of epistatic gene combinations facilitated by drift and through maintenance of functional genetic polymorphism via local selection. Therefore, these findings suggest the California Floristic Province may constitute an evolutionarily important portion of the range for coyotes and, possibly, other, sympatric species exhibiting habitat-specific population structure.

50. Non-invasive genetic typing in the study of badger ecology: Past research and future directions.

Session: Noninvasive genotyping: Recent advances and future directions

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Over the past three decades, the Eurasian badger (*Meles meles*) has been the focus of a variety of research projects on, among others, its social organisation, spatial ecology and population dynamics. An important proportion of this research was initiated in response to the species' potential role in the transmission of bovine tuberculosis and other management problems. However, even collection of the most basic information, like population size, has always been a difficult exercise as live-trapping is highly labour intensive and time consuming, as well as impracticable over much of the badger's geographical range owing to low capture success. Here, we will summarise our work aimed at developing an efficient monitoring method based on non-invasive genotyping. Because badgers use communal latrine site in moderate- to high-density populations, our initial interest focussed on faeces as a source of DNA. However, a number of drawbacks made the technique impractical as an effective and widely applicable management technique. The problems were solved by using remotely plucked hair samples as DNA source, obtained using barbed-wire traps suspended above badger paths. The method proved to be applicable at different population densities, and was not prohibitively expensive. Reliable genetic profiles were obtained using single-hair DNA extracts. A very important advantage of our method is that it was possible to obtain genetic profiles from a high proportion of the animals present. Using examples from our field site in Luxembourg, we will illustrate how the method can also be used to answer questions beyond abundance estimates.

51. Fecal DNA genotyping: A tool to manage the endangered red wolf population.

Session: Noninvasive genotyping: Recent advances and future directions

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Introgressive hybridization with coyotes (*Canis latrans*) is a major threat to the recovery of the endangered red wolf (*Canis rufus*). In 2000 the United States Fish and Wildlife Service adopted an adaptive management plan, the primary mandate of which was to control hybridization within the red wolf experimental population area. In 2000 the red wolf program began exploring the feasibility of

using non-invasive sampling of fecal material (scat) to locate hybrid and coyote individuals. Initially, mitochondrial DNA sequencing of collected scats was used to identify hybrids but this method missed hybrids with red wolf mothers. In 2003 a genetic test was developed which used 18 locus microsatellite genotypes to increase the resolution of hybrid detection. As a result, the shift was made to fecal DNA microsatellite genotyping and different sampling methods were evaluated. Explorations into the application of fecal DNA genotyping with different scat sampling strategies determined an opportunistic spot-check scat sampling strategy was logistically feasible and detected new individuals. The red wolf program has continued to use this strategy to collect scat samples within areas of uncertainty with great success. Eight locus genotypes have been generated for 28 of 46 scat samples collected since January 2004. Fourteen individuals were identified, eight red wolves and six coyotes. Identification of the coyotes allowed managers to focus trapping efforts and resulted in the capture and removal of three coyotes. In addition to hybrid detection, fecal DNA genotyping is also being explored as a way to answer questions about space use. Radio-telemetry locations and fecal samples were collected for three red wolf packs. Fifty-six fecal genotypes and 86 radio-telemetry locations were obtained for all packs. A comparison of minimum convex polygons generated from radio-telemetry and scat locations determined that scat locations could provide a useful alternative approach for assessing space use.

52. The response of coyote social groups to food shortage and patchiness.

Session: Noninvasive genotyping: Recent advances and future directions

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We examined the response of coyote (*Canis latrans*) social groups to a 10-fold decline in the abundance of their primary prey, snowshoe hares, and a simultaneous increase in the spatial patchiness of prey. We used a novel technique to study these elusive carnivores during a three-year period in the Alaska Range. Fecal genotyping was combined with conventional scat analysis and radiotelemetry to determine the resource use, genetics, and fate of 37 coyotes belonging to nine social groups. Based on optimal foraging theory, we predicted that food shortage would increase the niche widths of social groups, thus increasing pairwise diet overlap. However, we also predicted that increased spatial patchiness would cause diets to diverge, thus decreasing overlap. Consistent with these predictions, the diet breadth of all social groups widened during the hare decline, but pairwise diet overlap did not change. Food shortage and patchiness may therefore have opposing effects on intraspecific diet similarity. Most coyotes died or dispersed during the hare decline, and coyotes were more likely to persist if they had higher hare densities in their territories, relatively high vole consumption, and relatively low consumption of wolf-killed carrion. Patchiness in prey abundance may interact with characteristics such as risk-taking behavior to determine which predators survive periods of food scarcity. However, heritability of diet choice was low, thus limiting the potential for evolutionary change despite the strong effect of diet on survival.

53. Salivary DNA evidence convicts breeding male coyotes of killing sheep.

Session: Noninvasive genotyping: Recent advances and future directions

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Resolving conflicts between predators and livestock producers depends on obtaining reliable information about the predators that kill livestock. We used salivary DNA obtained from attack

wounds on domestic sheep carcasses to identify the species of predator responsible for the kill, as well as the sex and individual identity of coyotes (*Canis latrans*) that killed sheep. Coyotes killed 36 of 37 depredated sheep. Breeding pairs whose territories overlapped sheep grazing areas were the primary predators on domestic sheep, and only breeding pairs killed multiple sheep. Breeding males, acting alone or with their mate, were involved in 21 of 25 kills. Breeding females participated in 13 kills, but only 1 breeding female killed sheep on her own. Transient females did not kill sheep, and both kills by transient males occurred in territories with a breeding vacancy. Our results suggest that predator control should be targeted at breeding male coyotes. Salivary DNA is a potentially powerful means of both investigating predation patterns and evaluating the effectiveness of control at targeting individuals that kill livestock.

54. The application of resource selection functions in polar bear research and management

Session: Marine Mammals in Alaska: Biology, Conservation and Management

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Resource selection functions (RSF) provide a powerful tool for understanding wildlife habitat associations and explaining wildlife distributions. Knowledge of the status and distribution of polar bear populations is necessary for managers to effectively address issues regarding hunting, industrial expansion, contaminants, international treaties, and sea ice degradation from climate change. While telemetry data can describe the general distribution and discreteness of polar bear populations, RSFs help to explain why polar bears occur where they do, allowing predictions of likely population status and distribution based on sea ice composition. RSFs may be employed in a number of research and management endeavors directed towards polar bears. Applying RSFs to near-real time satellite imagery will aid in the design of aerial surveys and mark-recapture research to increase the effectiveness of polar bear field research. A polar bear RSF can help managers to assess the potential impacts of human cause perturbations, such as industrial expansion and oil spills, by an understanding of the sea ice characteristics surrounding the perturbation and the expected response of polar bears to those characteristics. Sea ice degradation due to climate warming will have the largest future impact on polar bears and their prey. RSFs employing long-term forecasting of likely sea ice scenarios will allow predictions of polar bear distribution resulting from climate change and will be a first step in assessing impacts on the population. If Arctic sea ice continues on a trend toward thinner ice and a longer ice minima season, RSFs will assist in an adaptive management strategy for harvest recommendations and the management of human populations to accommodate a changing polar bear population. In a warming Arctic, RSFs will be necessary to identify high Arctic refugia where persistent sea ice would allow the continued survival of a remnant population of polar bears.

55. Managing the adverse impacts of the biting dog louse on wolves in Alaska.

Session: Disease Impacts on Wildlife Management and Conservation Efforts

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The biting dog louse (*Trichodectes canis*) was first identified in Alaska on a coyote (*Canis latrans*) and wolves (*C. lupus*) on the Kenai Peninsula during the winter of 1981-82. Wildlife managers attempted to eliminate lice on wild canids by administering ivermectin injections during live-capture and with ivermectin-treated baits. This effort was unsuccessful because of the difficulty in treating all exposed individuals. In 1998, trappers reported wolves and coyotes with lice in the Mat-Su Valley (south-central Alaska). Treatment attempts were similarly unsuccessful. The spread of lice to Interior wolves is a concern because of unknown effects on wolf population health and the loss of economic value to hunters and trappers resulting from poor pelt quality. Poor hair quality in wolves could potentially affect predator-prey relationships through changes in wolf production or survival. Sporadic reports of

poor hair quality in some wolves occurred for several years near Fairbanks but the presence of lice was not confirmed until March 2004. Lice infection in Interior wolves appear distinctive from infections described from the Kenai Peninsula. A strong odor, marked skin irritation and severe sebum production accompanied by secondary yeast and bacterial infections are commonly reported in wolves from the Kenai Peninsula and mainland areas south of the Alaska Range. Those signs have not been apparent in Interior wolves. The density of lice per pelt is also lower and pelt damage less severe in Interior wolves. Lice have also been detected on wolves from additional regions of Alaska as more pelts were examined by the digestion technique. Eradication has proven unfeasible and research is now focused on alternative louse management techniques and adverse effects on wolf health and survival. Additional research is needed to define the genetic, immune function, and environmental conditions that predispose wolves to severe, symptomatic lice infections.

56. The impact of sylvatic plague on black-footed ferret recovery.

Session: Disease Impacts on Wildlife Management and Conservation Efforts

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The black-footed ferret (*Mustela nigripes*) is one of the most highly endangered mammals in North America. Once thought to be extinct, a captive breeding and recovery program was established for ferrets in 1987. Although the breeding program has been highly successful and ferret populations (about 500 animals) have been established in several western states, the recovery effort is seriously threatened by sylvatic plague, caused by the bacterium *Yersinia pestis*. Plague was introduced into U.S. seaports in the early 1900's via commensal rodents and quickly spread into native rodent populations, including prairie dogs (*Cynomys* species). Mortality in plague-infected prairie dog colonies often reaches 95-99%, and the disease frequently results in local extinctions and population reductions followed by partial recovery. Plague in prairie dog towns significantly impacts black-footed ferret survival by destroying their primary prey base. In addition, the black-footed ferret is susceptible to the disease, suffering high mortality rates upon plague infection in captivity and in the laboratory. In 2005, a plague outbreak killed numerous black-tailed prairie dogs (*Cynomys ludovicianus*) in South Dakota about 30 miles south of Conata Basin, where the largest population of black-footed ferrets (about 250) resides. Efforts were made to halt the spread of the disease by dusting more than 300,000 individual prairie dog burrows in Conata Basin with pesticides to kill fleas, but pesticide application is a labor intensive and costly solution and difficult to sustain for a long period of time. Some ferrets were also vaccinated against plague to prevent infection, but protection from the disease won't prevent the loss of their prey base. A plague vaccine for prairie dogs that can be delivered via oral baits has been shown to be efficacious in laboratory experiments and may provide a better method of managing the disease for both prairie dogs and ferrets.

57. The big picture: What can be done about the various forms of pollution effecting sea otters and their ecosystem?

Session: Disease Impacts on Wildlife Management and Conservation Efforts

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The southern sea otter population in California suffers from high adult mortality, approximately 50% of which is due to infectious diseases, parasites and intoxications. There has been little population growth in 10-12 years. Current evidence indicates that oocysts of two protozoal parasites that cause significant fatalities in sea otters are associated with fresh water inputs. Other bacterial and protozoal pathogens may come from sewage or farm run off. Chemical contaminants which may make sea otters more susceptible to disease appear to originate from terrestrial sources and are likely dispersed by run off from various sources. Nutrient pollution also appears to promote harmful algal blooms that result in sea otter deaths. All of these ocean inputs can be seen as forms of non-point source pollution that are difficult to intercept and regulate. Pending State legislation could assist us in better understanding

and eventually reducing various forms of non-point source pollution that harm sea otters, other marine species, and jeopardize human health. Changes in animal management practices in coastal areas and better use of existing State and Federal laws, regulation and permitting processes could also help. Several agricultural “best management practices” have been shown to reduce nutrient, sediment, pathogen and contaminant runoff, but are voluntary and thus not widely applied. The aging and inadequate infrastructure in coastal cities must be repaired and upgraded and in areas of “special ecological concern” storm water runoff must be dealt with more effectively. Artificial marshes or reclaimed wetlands may improve sewage treatment and reduce storm water flushing. A new series of marine protected areas for California are being set aside to assure both fisheries recovery and to protect all marine life forms. In the big picture dealing with the larger issues in more comprehensive ways may be more cost effective than dealing individually each non-point pollutant.

58. Predator-prey studies through the years.

Session: Predator-Prey Ecology: Large Mammals in Terrestrial and Marine Systems

L. David Mech, U.S. Geological Survey, Jamestown, ND, USA. Contact e-mail: david_mech@usgs.gov

This will be an invited keynote address to introduce the symposium on Predator-Prey Ecology. Predator-prey studies have been ongoing over many decades, in the lab, in the field, and in the minds and computers of theoreticians. The research has yielded many interesting results, new concepts, and many controversies. One of the most contentious issues is the question of predation effects on prey population. If there is any generalization that can be made at the present stage of predator-prey research, it is that it is difficult or impossible to form a generalization that applies well to the full breadth of predator-prey interactions

59. Polar bear habitat preferences and prey availability in a changing sea ice environment.

Session: Predator-Prey Ecology: Large Mammals in Terrestrial and Marine Systems

George M. Durner, Steven C. Amstrup, USGS, Alaska Science Center, Anchorage, AK, USA. Contact e-mail: george_durner@usgs.gov

In the Beaufort Sea, polar bears (*Ursus maritimus*), ringed seals (*Phoca hispida*), and bearded seals (*Erignathus barbatus*), inhabit a seasonably dynamic environment that has experienced climate induced changes. During most seasons polar bears prefer mixed ice habitats near ice edges in shallow waters over the continental shelf. In past decades, this habitat use pattern was maintained during summer because of persistent near shore ice. The summer distribution of polar bears, however, has changed in recent years because of extensive ice melt that forces most polar bears to summer in deep water ice habitat > 200 km from the mainland coast while a smaller segment of the population is forced to use shoreline habitat. At question are prey resources available to polar bears while they occupy these extreme habitats. Winter and spring distribution of ringed seals reflects the general distribution of polar bears. During summer, while some ringed seals may track the ice edge as it retreats north, others may have an open water life style and thus would be unavailable to polar bears. Bearded seals, due to their benthic feeding habits, are not available to polar bears during recent summers. Hence, prey resources may be diminished for polar bears during summer. A changing sea ice environment may affect reproduction of both predator and prey. Many pregnant polar bears in Alaska den on the active sea ice, the thinning of which brings into question whether winter ice has the temporal stability necessary for successful den tenure. Seals depend on sea ice for birth and hence are also susceptible to changes in the composition of sea ice. Effective research of polar bear and seal habitat relationships must overcome difficulties of working with animals that occur at low densities, in an environment hostile to humans, and identify appropriate temporal and spatial scales.

60. Wolf community ecology: A Yellowstone case study.

Session: Predator-Prey Ecology: Large Mammals in Terrestrial and Marine Systems

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Wolf ecosystem effects have not been well studied because the controversy that typically surrounds wolves has focused studies on population dynamics and predator-prey ecology. Yellowstone National Park presents an ideal opportunity to examine pre- and post-wolf ecosystem effects because data are available on wildlife populations and vegetation since the late 1800s. Wolf ecosystem effects have taken two forms: a terrestrial trophic cascade and effects on community ecology. After being suppressed for nearly a century, willows have released approximately 2-3 years post wolf reintroduction. This occurred despite elk being artificially controlled to 25% of their current population prior to wolf reintroduction. Elk behavior has changed affecting their use of woody plant habitats, but despite this no similar release has been recorded for aspen and cottonwoods trees. Differences between shrubs and tree growth are likely reasons for the difference. It is hypothesized that a combination of numerical and behavioral responses are triggering willow regrowth. Effects on songbirds and beavers are discussed. Twelve species have been documented to scavenge wolf kills. This may be especially important to grizzly bears who are dominant to wolves at wolf kills and use them when fall foods such as whitebark pine nuts are absent. Wolf kills also create nutrient surges in the local area of the kill. Interference competition has been documented between wolves and cougars and wolves and coyotes. In short, wolves may be having significant effects on Yellowstone ecosystem structure and function.

61. Sea otters as predators and prey: The causes and consequences of trophic cascades.

Session: Predator-Prey Ecology: Large Mammals in Terrestrial and Marine Systems

James Estes, University of California, Santa Cruz and USGS, CA, USA. Contact e-mail: jestes@ucsc.edu

The trophic interaction among sea otters, sea urchins, and kelp is one of the earliest and best known examples of a trophic cascade. The ability to see and understand the interaction dynamics that drive this particular cascade resulted from a large-scale ecosystem perturbation—the near extinction and subsequent recovery of sea otters in the Pacific maritime fur trade. Throughout much of the coastal northeast Pacific Ocean, otter-dominated ecosystems are characterized by kelp forests whereas otter-free systems are characterized by deforested sea urchin barrens. When sea otters are either added to the otter-free systems or removed from the otter-dominated systems, the transitional dynamics between kelp forests and sea urchin barrens occurs as a strongly punctuated phase shift. In the first part of this overview presentation, I will explain the mechanisms underlying these nonlinear transitional dynamics and describe how the two phase states (kelp forests vs. sea urchin barrens) influence other species and ecosystem processes. In the second part of the talk, I will describe and discuss the unexpected recent collapse of the sea otter-kelp forest ecosystem in southwest Alaska. I will end by listing the general insights and conclusions that have emerged from almost 40 years of work on the interaction dynamics between sea otters and kelp forests and discussing the potential relevance of these insights to other large predator-prey ecosystems.

62. Dynamics of the large mammal predator-prey web in northern British Columbia.

Session: Predator-Prey Ecology: Large Mammals in Terrestrial and Marine Systems

Katherine L. Parker, Michael P. Gillingham, University of Northern British Columbia, Prince George, BC, Canada. Contact e-mail: parker@unbc.ca

The Muskwa-Kechika Management Area in northern British Columbia supports one of the largest intact predator-prey systems in North America. Our goal was to quantify interactions among the focal species (grizzly bears, wolves, woodland caribou, Stone's sheep, moose, and elk). We defined the spatial and temporal patterns associated with predator and prey use of a relatively non-impacted landscape. Our collaborative studies combined field-based research with global positioning satellite

(GPS) locations to quantify animal movements and distributions; remote-sensing images of vegetation associations with indices of biomass and quality; use and resource selection models; stable isotope assessments of predator food habits; and the trade-offs between forage and predation risk for ungulates. Even with seasonal variability in life history and selection strategies among and within species, there were commonalities related to food resources and energetic demands. Our findings can inform land management decisions and conservation area designs to help minimize impacts associated with increased access to the area.

63. Twenty-plus years of population and habitat studies that support predator control to increase moose harvest in rural interior Alaska.

Session: Predator-Prey Ecology: Large Mammals in Terrestrial and Marine Systems

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Data data show that moose in interior Alaska live at relatively low densities because of high, largely additive predation from black and grizzly bears and wolves (and a lack of alternate large prey). Sustainable harvests of moose are limited to 4-15 moose/1000 km² despite habitat that is adequate to support higher moose densities (indicated by twinning rates, bodyweights, diet, and browse characteristics). In contrast, after wolves were strongly controlled (56-79% reduction, 1976-1982) in 13,044 km² near Fairbanks, moose: (1) increased 5-fold and continue to increase, (2) now live at >5-fold higher density and sustain >5-fold higher harvest density than respective rural Interior averages, (3) have supported >7% of the statewide reported moose harvest since 1995 in <1% of the state, and (4) support higher wolf densities than rural areas but with several times more moose per wolf. Habitat is relatively poor in this 13,044 km² (lowest twinning rates, lowest bodyweights, highest browse removal rates and prevalence of brooming, and reduced diet quality), yet calf survival is the highest among 6 calf mortality studies in the Interior because predation is relatively low. In most rural systems, grizzly and/or black bears limited moose by killing large proportions of moose calves; calf survival increased significantly following translocation or diversionary feeding of bears. Wolves were significant secondary predators in most rural systems; case histories indicate that only prolonged wolf control elevated moose harvest. No data support the theory that, following significant predator control, sensitive nutritional feedback keeps moose density low. Rather, near Fairbanks, nutritional feedback began 10 years after the initiation of strong predator control (1976-1982) but has not yet halted population growth. Results of this wolf control offer 2 current challenges garnering support: (1) from fire-fighting agencies to rejuvenate habitat, and (2) support for and administering substantial harvests of moose cows and calves.

64. Wolves, bears and killer whales: contrasting problems and approaches to modeling large mammalian predators in marine and terrestrial ecosystems.

Session: Predator-Prey Ecology: Large Mammals in Terrestrial and Marine Systems

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The ecological and management problems associated with wolves and their ungulate prey in North America are perhaps the most conspicuous and controversial of predator-prey studies in the wildlife literature. While there have been exciting developments in the way wolf-ungulate data are fit to models in recent years, we've generally failed to address important shortcomings in the underlying theoretical framework: models rooted in Lotka-Volterra style functional and numeric responses are often unstable in the parameter space indicated by field studies of wolves and ungulates. From a modeling standpoint, we've also ignored the demonstrated importance of bear predation in many northern ecosystems. Addressing the reasons for this, I explore some modifications that allow for more realistic assumptions that are still within the framework of classical functional and numeric response curves. Heuristic simulations are used to examine the potential importance of class-specific vulnerability and the addition of brown bears to terrestrial wolf-moose models. In contrast to the rich

literature on wolf-ungulate models, models of predation by mammal-specialist killer whales have little application to the potential dynamics of this system. Only static models of dietary proportions and expected consumption rates have been used to evaluate possible short-term impacts of killer whales on prey populations, but dynamic predator-prey models will be needed to address larger, sometimes controversial questions. Simple dynamic models with multiple prey species and species-specific vulnerability were applied to these mammal-specialist killer whales interacting with other marine mammal populations in the North Pacific. The lower intrinsic growth rates of both predators and prey lead to more stable model behavior on a longer time scale when compared to wolf-ungulate models, while small predator stocks suggest that demographic stochasticity will be an important factor in their dynamics.

65. Wisconsin wolf depredation compensation program: 1985-2005.

Session: Multi-dimensional evaluation of wildlife compensation schemes

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Abstract: The Wisconsin Department of Natural Resources (WDNR) is responsible for gray wolf (*Canis lupus*) management in the state of Wisconsin. An important part of wolf management is dealing with human-wolf interactions; especially depredation to domestic animals. As the wolf population has grown depredations on livestock, hunting dogs and pets have increased dramatically. The WDNR wolf damage reimbursement program paid 232 claims between 1985 and 2005, totaling \$ 469,431. During this same time the wolf population increased from 15 to 425. During 1985-1995 there were 18 wolf depredation claims paid (average 1.6 /year), the number of wolves varied from 15 to 83 (average 37); depredation payments averaged \$1,505/year (\$41.00 per wolf in the population). From 1996-2000 there were 60 wolf depredation claims paid (average 12.0/year), the wolf population varied from 99 to 248 (average 176); payments averaged \$27,204/year (\$ 148.00 per wolf). From 2001-2005 there were 154 cases of wolf depredation (average 30.8 /year) the wolf population varied from 257 to 425 (average 343); payments averaged \$63,371/year (\$183.00 per wolf). The WI program is unique because it pays for “missing” livestock and hunting hounds. From 1985 to 2005 reimbursement for hounds killed by wolves accounted for 35% of all payments, calves 32%, farm raised deer 18%, cows 5%, horses 4%, pet dogs 2%, veterinary bills 2%, sheep 1%, and poultry 1%. Some social scientists estimate the success of depredation payment programs by asking questions about the preferred wolf population size or about the likelihood people would illegally shoot a wolf. I assess the success of the WI program on what people are actually doing not on what people say they would do. Survival data from radio-collared wolves between 1979 and 2005 shows that the percent of illegal human caused mortality is decreasing despite the increase in the number of wolf-human conflicts.

66. Evaluating the importance of compensation payments for wolf recovery in Wisconsin

Session: Multi-dimensional evaluation of wildlife compensation schemes

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Analysis of 537 mailback surveys of residents of human-wolf conflict zones in WI suggests that compensation payments do not improve individual citizens' tolerance for wolves. Yet during personal interviews, livestock producers and hunters stress that compensation is essential to wolf recovery. These seemingly contradictory results highlight the challenges of measuring the impact of compensation programs. Compensation may not change individual attitudes toward wolves, but it can improve wolves' political viability at a broader level. Results of a second survey in WI (n = 1,545) reveal general public opinion on compensation. The majority of respondents favored compensation for livestock losses provided there was evidence of wolf culpability and the livestock producer was following best management practices. Fewer respondents supported compensation for hunting dogs killed by wolves on public land. As wolf numbers and conflicts increase, managers face serious

dilemmas regarding funding compensation. Livestock producers and hunters have successfully lobbied for increases in compensation, even as wolves are removed from the ESA. But the individuals who have voluntarily paid for compensation thus far (mainly city dwellers) have markedly different views on managing wolves than do livestock producers and bear hunters, particularly with regard to lethal control and public hunts. Will these contributors continue to pay for compensation programs even though 'problem wolves' are being shot? Or should wolves be reclassified as a game species such that the burden of funding compensation shifts to hunters themselves? The WI case reveals the promises and pitfalls of compensation, including the difficulty of reducing or eliminating compensation payments once a species has recovered.

67. Conserving snow leopards in Asia through community-based incentive programs.

Session: Multi-dimensional evaluation of wildlife compensation schemes

Thomas MCCARTHY¹, Charudutt MISHRA², Jennifer SNELL-RULLMAN¹, ¹Snow Leopard Trust, Seattle, WA, USA; ²Snow Leopard Trust, Mysore, India. Contact e-mail: tmccarthy@snowleopard.org

Livestock depredation by snow leopards *Uncia uncia* causes substantial financial loss to indigenous herders and resultant retaliatory persecution is a primary threat to this endangered carnivore throughout its range in South and Central Asia. Livestock, which outnumber wild ungulate prey in much of the region, make up as much as 50% of the snow leopard's diet. The Snow Leopard Trust has employed several community-based conservation programs across the region, using economic incentives to reduce retribution killing of the cats. In northern India we initiated a community-based conflict resolution program that involves establishment of small livestock-free wildlife reserves on village land to promote wild ungulate populations, and a livestock insurance program that promotes better herding practices and off-sets economic losses due to depredation. The insurance program off-sets up to 100 % of the losses, while prohibiting meat/carcass collection and persecution of wildlife. Starting with a single site in Spiti in 2002, as a village-run insurance model, the program is currently benefiting over 116 herder families in five villages (66 % participation). The program has recently been expanded to Ladakh where four villages are participating. This model has not resulted in increased livestock herd size, which would be counter-productive. It has, however, significantly improved peoples' tolerance towards wild carnivores and has diminished the persecution of wildlife. We compare these results with those of community-based incentive models from two distinctly different parts of the region; Mongolia and Pakistan. In these countries the Snow Leopard Trust uses small handicraft development and livestock vaccination/husbandry programs to reduce retribution killing of snow leopards and alter human attitudes. We demonstrate that it is essential for each program to be grounded in science while having a strong understanding of local conditions, human desires and existing community capabilities in order to design and implement successful incentive-based predator conservation programs.

68. Large carnivore depredation and compensation schemes in Sweden and Norway - different schemes and different effects.

Session: Multi-dimensional evaluation of wildlife compensation schemes

Henrik Andrén, Grimsö Wildlife Research Station, Riddarhyttan, Sweden. Contact e-mail: henrik.andren@nvb.slu.se

The parliaments in both Sweden and Norway have accepted maintaining viable populations of the four species of large carnivores (wolf, wolverine, brown bear and Eurasian lynx). Both countries have stated that predator-killed livestock (primarily sheep and semi-domesticated reindeer) should be fully compensated. However, Norway and Sweden represents the two ends of a spectrum in relation to sheep depredation. In Norway 2 million sheep graze on open ranges in mountain and forested habitats. Whereas, in Sweden 450 000 sheep are almost all kept within fenced pastures on farmsteads. This results in tremendous differences in depredation rates on sheep by large carnivores and consequently large differences in compensation costs, both total costs and cost per predator. The compensation costs

for losses of semi-domesticated reindeer to large carnivores are about the same in both countries. However, the compensation schemes differ. In Norway the compensation is based on the number of reindeer killed by large carnivores, whereas in Sweden it is based on the number of carnivores within the area. This Swedish compensation system gives an incentive for better protection of the reindeer. If the losses decrease due to better protection, but the number of large carnivores remains the same, the compensation remains the same. However, both Eurasian lynx and wolverine depend on reindeer for their survival. To conclude, sheep and carnivores can only co-exist if effective mitigation measures are used and are required for payment of compensation. The reindeer and large carnivore conflict can probably be solved if there are defined population goals for the large carnivores and defined acceptable losses of reindeer to large carnivores.

69. Incentive strategies for carnivore conservation in the western United States.

Session: Multi-dimensional evaluation of wildlife compensation schemes

Nina FASCIONE, Defenders of Wildlife, Washington, DC, USA. Contact e-mail: nfascione@defenders.org

Restoration of large, wide-ranging carnivores is often controversial and wrought with emotion due to occasional human-carnivore conflicts. Conservation measures in the United States to assist grizzly bear (*Ursus arctos*) and gray wolf (*Canis lupus*) populations have been no exception. To facilitate good will towards predators and thus aid in their recovery, Defenders of Wildlife established two programs that incorporate market-based incentives for carnivore restoration. The Bailey Wildlife Foundation Wolf and Grizzly Compensation Trusts were established in 1987 and 1997, respectively, to reimburse ranchers for livestock lost to predation by these species. The goals of these programs are to spread the cost and responsibility for maintaining healthy carnivore populations, rather than have the burden fall on individual ranchers, and to establish an economic mechanism to correct for a market failure associated with providing a public good. To date, the programs have paid out more than \$600,000 and have helped facilitate the growth of wolf and grizzly populations. This talk will compare and contrast management of compensation programs for two different carnivore species in the northern Rockies, and examine the logistical and administrative challenges of these programs under changing federal and state regulatory protections. Regardless of the obstacles, we believe these programs have gone a long way toward building tolerance for predators throughout the United States.

70. Investing in a Sustainable Future: an economics-based approach to human-wildlife conflict resolution in pastoralist East Africa.

Session: Multi-dimensional evaluation of wildlife compensation schemes

Tom Hill, Ol Donyo Wuas Trust, Anchorage, AK, USA. Contact e-mail: tom320@aol.com

Mbirikani Group Ranch (MGR) is a 300,000-acre semi-arid grazing land and wilderness habitat in southeastern Kenya owned communally by 9,000 Maasai pastoralists. In late 2001 resident members of MGR and their Maasai neighbors began killing lions at a far higher rate than previously - twenty-two in eighteen months on MGR alone -- using spears and a new, far more lethal weapon, poison. In response, Ol Donyo Wuas Trust (ODWT) launched the Mbirikani Predator Compensation Fund. PCF provides significant benefits: compensation equal to full replacement value for all species of domestic livestock killed by all major carnivores, not just lions. It also contains harsh penalties: fines of cattle or their cash equivalent and possible arrest and jail terms for killing lions; cash fines and reduced amounts of compensation for lesser offenses; and, most critically, the invalidation of otherwise valid compensation claims for entire local communities for failure to enforce agreed-upon self-regulation (i.e., failure to prevent the killing of lions). Since PCF was introduced in April, 2003 lion killing on neighboring group ranches (by spearing and poisoning) has continued at or near pre-PCF levels while on MGR lion killing has diminished substantially; only three lions killed, none by poisoning, in three years. Given the average annual population of livestock on MGR, PCF costs approx. \$.50/head of livestock per year to operate. Data collected during the history of PCF on the cost of carnivore depredation -- when combined with all other costs of living with wildlife -- provides clear evidence

the Maasai of the Amboseli-Tsavo ecosystem are paying an unacceptable economic price for tolerance toward any and all wildlife. Yet the success of PCF suggests a hopeful way forward, very possibly a breakthrough, for conservationists - using an economics-based approach -- to not only protect lions but also to help conserve and sustain long term the Amboseli-Tsavo ecosystem itself before it collapses.

71. Conservation of American martens across an archipelago: Will one strategy work?

Session: Landscape-Level Science and Conservation in the Tongass

Rodney W. Flynn¹, Thomas V. Schumacher¹, Merav Ben-David², ¹Alaska Department of Fish and Game, Douglas, AK, USA; ²University of Wyoming, Laramie, WY, USA. Contact e-mail: rod_flynn@fishgame.state.ak.us

The management plan for the Tongass National Forest (TNF) allocated a forest-wide system of old-growth reserves to support viable populations of indicator species including American martens (*Martes americana*). This conservation strategy (CS) assumed that marten abundance and ecological relationships were similar across a vast landscape of islands and fragmented mainland coast and single strategy could be applied. In order to function as a metapopulation, the CS assumed that a large OGR would provide sufficient habitat for a minimum of 25 female martens during periods of low prey availability. We tested this assumption by estimating marten densities during autumn (2001 -2003) at 8 sites throughout Southeast Alaska and projected the number of females to a 16,200 ha OGR. Furthermore, we examined the relationships among marten densities with the variable abundances of small mammals and ensured that these were important components of their diets with stable isotopes. We found that marten densities varied greatly across Southeast Alaska and depended on the abundance of long-tailed voles (*Microtus longicaudus*) in sites of similar habitat composition. Although our estimates were relatively imprecise, 80% confidence limits included 25 females at only 3 sites, suggesting that large OGRs near the minimum size and habitat composition requirements would not support 25 females. Martens switched to feed on salmon once vole numbers fell below a capture rate of about 2 per 100 TN, even in areas with higher prey diversity. Keen's mice (*Peromyscus keeni*), which were largely associated with fragmented habitats, did not constitute an important alternative prey. Conservation on the TNF should emphasize the management of martens by individual populations which would incorporate the unique combination of available foods, habitats, and land area. In populations with poor food availability, OGRs may need to be larger or more of the matrix managed as marten habitat.

72. Brown bear use of riparian zones on Chichagof Island, southeast Alaska.

Session: Landscape-Level Science and Conservation in the Tongass

Stephen B. Lewis, Rodney W. Flynn, LaVern R. Beier, Grey Pendleton, Alaska Department of Fish and Game, Douglas, AK, USA. Contact e-mail: steve_lewis@fishgame.state.ak.us

In the revised Tongass Land Management Plan (TLMP), brown bears (*Ursus arctos*) were one of the wildlife species used to design the Plan's conservation strategy. As part of a wildlife conservation strategy, the TLMP allocated a system of reserves of various sizes and spacing along with specific standards and guidelines (S&Gs) for the management of wildlife habitats. For example, riparian management S&Gs must consider the needs of riparian-associated wildlife species, especially brown bears. During that revision, expert panels had expressed concern about the long-term population viability of brown bears unless adequate riparian vegetation was maintained, especially in areas with spawning salmon (*Oncorhynchus* spp.). Riparian zones are important habitats for brown bears where they occur in Southeast Alaska. During late summer, bears concentrate in riparian areas to utilize vast runs of spawning salmon. In addition to feeding on salmon, brown bears use daybeds, loafing sites, and forage on berries and skunk cabbage (*Lysichiton americanum*) within or adjacent the riparian zone. Thus, vegetative cover along streams is probably important to bears, so interactions with other bears can be avoided. We set out to study the spatial relationships, resource selection, and population numbers of brown bears during the salmon-spawning period in relation to riparian management. We used GPS collared 38 brown bears to understand use of specific resources during this important time

of year. We used non-invasive sampling of bear hair to generate a DNA-based population estimate of our study streams, identifying 59 and 53 individual bears using 5-km reaches of our study streams. In addition, we used the hair to examine bear diet during the hair growth period (i.e., mid- to late-summer) and to estimate the amount of salmon in the diet to learn about the amount of time bears spent on streams.

73. The coyote: an urban carnivore

(title put by cc.org since there was none)

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

Stanley D. Gehrt, Ohio State University, Columbus, OH, USA. Contact e-mail: gehrt.1@osu.edu

Urban landscapes continue to increase across much of the world, which presents challenges for the management and conservation of carnivores. Coyotes (*Canis latrans*) have become more common in many metropolitan areas across North America, and they are arguably the most feared carnivore in these cities. I report on a long-term study of coyotes in the Chicago area in which we have radiocollared 175 individuals, and compare these results to previous research in western cities, to describe how the coyote adjusts to urban life, and what this means for urban management. Coyotes located in urban areas become more nocturnal, and have smaller home ranges (and possibly higher densities) than coyotes in rural areas. Urban coyotes, like their rural counterparts, maintain an organized, territorial social system that also includes solitary transients that span most areas of the urban landscape. Coyotes are able to exploit varying levels of urbanized landscapes by continuing to use patches of undeveloped habitat and feeding on a variety of prey. Some coyotes become habituated through feeding by people, but most urban coyotes do not typically seek anthropogenic food. Most conflicts involve pet predation by coyotes. Much like coyote management in rural areas, coyote conflicts are largely a political issue in the cities. Given that coyotes often coexist with people in urban areas, successful management plans in urban areas should include public education for prevention through limiting wildlife feeding, and focus removal on specific individuals that have become habituated rather than general population control.

74. The kit fox: an urban carnivore

(title put by cc.org since there was none)

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA, USA. Contact e-mail: bcypher@esrp.csustan.edu

San Joaquin kit foxes (*Vulpes macrotis mutica*) occur in central California and are Federally Endangered and California Threatened. This taxon has declined significantly primarily due to profound habitat loss associated with agricultural, industrial, and urban development. Interestingly, kit foxes occur in several urban areas in the San Joaquin Valley. An estimated 200-400 kit foxes reside in the city of Bakersfield (human population ca. 300,000). This kit fox population appears to be demographically robust and exhibits high survival and reproductive rates. In addition to the innate adaptability common among many canids, various other factors contribute to the success of kit foxes in urban environments. The foxes are small in size (about the size of a house cat), and are able to slip through small gaps (ca. 10 cm) in order to access fenced areas and elude people and domestic animals. They can establish den sites in a variety of open space including vacant lots, parks, powerline and railroad corridors, storm water drainage basins, and long the banks of dirt-lined canals. Kit foxes utilize a diversity of foods including rodents, birds, insects, refuse, and pet food. The foxes also do not constitute a nuisance; they do not damage property, make noise, attack people or domestic animals, transmit disease. They also are primarily active nocturnally and are somewhat secretive. Nominal conservation efforts in urban environments could significantly benefit kit foxes as well as contribute to range-wide recovery efforts.

75. Uneasy neighbors: On the relationships between urbanization, people, and carnivores.

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

Stanley D. Gehrt, Ohio State University, Columbus, OH, USA. Contact e-mail: gehrt.1@osu.edu

From our earliest existence, we have been in conflict with carnivores. Indeed, carnivores elicit strong emotions in most people, and the most extreme conflicts that wildlife can inflict on humans come from carnivores. Thus, carnivores have tended to decline in human-dominated landscapes, especially urban areas. However, not all carnivores respond to urbanization the same way. Here, I briefly describe the unique ecological attributes of urban ecosystems as we currently understand them, and then introduce the focus group of this symposium, the carnivores. It is increasingly important to understand how wildlife species, including carnivores, are affected by urbanization because more land in North America is currently being converted for urban purposes than any other land use. Urbanization is also a major land consumer in other countries around the world. Large metropolitan areas have their own unique ecological characteristics, in which urbanization alters hydrology, erosion/compaction, productivity, and biodiversity. For example, recent research has shown that the ‘heat island effect’ may affect local climate patterns up to 10 km beyond the metropolitan area. In urban areas, however, cultural and political factors are important components of the urban system, and I argue are at least as important as ecological factors when considering urban carnivores. Across North America, carnivore species exhibit a tremendous range in average weight, from 35g to over 600 kg. Members of the Carnivora also vary in the extent of their carnivory, social systems, and range of movements. How these animals differ in their response to urbanization, their relationship to humans, and the implications for conservation and conflict, will be discussed in the following presentations. As the human population continues to increase, with concomitant increases in land consumption, it is likely the complex relationships we have with carnivores will continue to magnify in urban landscapes.

76. Factors facilitating the successful colonization of urban environments by San Joaquin kit foxes.

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA, USA. Contact e-mail: bcypher@esrp.csustan.edu

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77. Life history comparisons of sympatric urban and rural foxes in central Illinois.

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

Todd E. Gosselink¹, Timothy R. Van Deelen², Richard E. Warner³, ¹Chariton Research Station, Chariton, IA, USA; ²University of Wisconsin - Madison, Madison, WI, USA; ³University of Illinois - Champaign-Urbana, Urbana, IL, USA. Contact e-mail: todd.gosselink@dnr.state.ia.us

Spatial heterogeneity in agriculture-urban landscapes may impact wildlife demography. We studied 334 radio marked red foxes (*Vulpes vulpes*) from 90 family groups in urban and rural areas of central Illinois to study life history traits. Urban pups and adults weighed more (mean = 0.25 kg) than their rural counterparts. Survivorship rates were nearly identical for urban and rural foxes, but yearly variation in survival differed greatly due to periodic sarcoptic mange outbreaks in urban areas, the major source of mortality in all urban age classes. Mange was nearly obsolete in rural areas with coyote predation as the major source of mortality for rural juveniles, followed closely by vehicle collisions, the major source of rural adult mortality. Behavior and social organization differed between foxes in urban and rural areas. Spatial separation of rural family members was greater than urban family members during summer, and urban family members were located together more often than their rural counterparts. Juvenile dispersal of rural foxes (mean = 10 Nov.) started before that of urban juveniles (mean = 14 Dec.) and < 50 % dispersed, while 75% of rural juveniles dispersed. During the winter, rural fox home ranges were nearly 4x's larger than urban fox home ranges. Our research suggests that urban landscapes may alter fox behavior and social organization due to different mortality sources and greater food and cover resources. In lieu of disease, urban areas may provide refugia from predation pressure from the surrounding rural habitats.

78. Coincidence of range utilization patterns in urban red foxes: Are subordinate animals likely to impose a cost?

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

Stephen Harris, Philip J. Baker, Graziella Iossa, Carl D. Soulsbury, University of Bristol, Bristol, United Kingdom. Contact e-mail: S.Harris@bristol.ac.uk

Species such as the red fox (*Vulpes vulpes*) and Eurasian badger (*Meles meles*) are thought to represent an early stage in the evolution of group living in carnivores since individuals exhibit little or no cooperative behaviour. One key assumption underpinning hypotheses for the mechanisms promoting group formation in these species is that subordinate individuals impose little or no cost to dominant animals. However, subordinates could potentially impose a range of costs, including increased risk of disease transmission and competition for food. Yet this has rarely been examined. Urban fox populations represent an ideal model to examine such issues, as fox densities can be very high and, in Britain, the major component of the diet of red foxes is food supplied by resident householders. Consequently, it is possible to accurately determine the location and availability of the key food sources on a nightly basis simply by asking householders whether they put food out and how much they supplied. Furthermore, the major property of these food sources is that they are rapidly depleted. As a result, subordinate animals can remove significant numbers of foraging patches each night, thereby reducing the amount of food available to dominant animals and imposing a potential cost. In this paper, we compare the degree to which the range utilization patterns of dominant and subordinate foxes coincide within group territories to begin to examine whether this assumption of no cost is valid or not.

79. The urban raccoon: Conservation and conflict for a highly successful species.

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

Suzie Prange¹, Stanley D. Gehrt², ¹Max McGraw Wildlife Foundation, Dundee, IL, USA; ²Ohio State University, Columbus, OH, USA. Contact e-mail: sprange@mcgrawwildlife.org

In North America, the raccoon (*Procyon lotor*) is the most common urban carnivore in terms of distribution and density. Raccoons are habitat and dietary generalists, and this flexibility is the basis for their success in urbanized landscapes. Raccoons readily utilize garbage as food and man-made structures as den sites. Anthropogenic supplementation of resources reduces mortality, increases

recruitment, and consequently elevates raccoon densities. Raccoons exploit urban landscapes with such efficiency that their numerical response is typically greater than that of any other “urban adapted” carnivore. Their success causes problems, including increased predation, increased threat of disease, and structural damage to homes and buildings. Increased predation, particularly of ground nesting species, can lead to altered community structure and possibly loss of species. Raccoons are known reservoirs of numerous diseases and parasites, many of which are zoonotic, the most notable being raccoon rabies. Costs associated with rabies control have increased in direct relation to the spread of the raccoon rabies epizootic, and efficiency of control efforts is diminished in urban environments. Raccoons are often the most commonly reported nuisance species by urban residents. Proactive measures such as capping chimneys, reinforcing areas of possible ingress, and removing food sources could alleviate many nuisance problems. Proactive measures, however, are seldom taken. Whereas the control of nuisance raccoons was largely under the jurisdiction of state or county animal control agencies, the magnitude of the problem now necessitates the use of privately owned nuisance wildlife companies. Euthanasia by animal control personnel only partly replaces harvest typical in rural areas. Furthermore, the relocation of nuisance raccoons, whether sanctioned or not, frequently occurs, perpetuates nuisance problems, and facilitates the spread of diseases or parasites. The raccoon is arguably the most important urban carnivore in North America when economics and difficulty of control efforts are considered.

80. Bobcats in urban areas: A quiet success story?

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

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Some carnivore species survive and even thrive in urban landscapes, often opportunistic omnivores such as raccoons, skunks, foxes, and coyotes. These species also have flexible social systems that include groups larger than the individual or greater intraspecific tolerance. Felid species, on the other hand, are strongly territorial and strictly carnivorous, potentially inhibiting their success in urban areas. However, among Felids, bobcats (*Lynx rufus*) are broad in their habitat associations, occupying areas from desert to swamplands, and their food habits, feeding on prey from birds to lagomorphs to deer. When prey is present in sufficient abundance, bobcats are being spotted in urban areas from Florida to Arizona to California. Although there are still very few studies of urban bobcats, valuable insights have been gleaned from projects in northern and southern California. Bobcats may not acclimate to urbanization as readily as some species, but they can be found up to the edges of, and even within, developed areas. The willingness to enter developed areas may vary between landscapes, with increasing fragmentation perhaps requiring greater flexibility in landscape use. There is evidence of differences in landscape use between the sexes in bobcats, a species that exhibits distinct morphological, ecological, and behavioral sexual dimorphism. The strength of intraspecific territoriality may also be relaxed in urban areas, where the amount and accessibility of habitat is restricted. To date, the incidence of bobcat-human conflicts has remained low, another factor which promotes coexistence with people. Despite evidence of flexibility and acclimation in the face of urbanization, bobcats also face threats from development including road mortality, disease, and toxins. Larger roads may also reduce dispersal and even gene flow in developed landscapes. Although they may never be as ubiquitous urban residents as carnivores such as raccoons, bobcats may prove to be surprisingly successful in many urbanizing areas.

81. Coyotes and people: conflict and coexistence in the city.

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

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Urban landscapes continue to increase across much of the world, which presents challenges for the management and conservation of carnivores. Coyotes (*Canis latrans*) have become more common in

many metropolitan areas across North America, and they are arguably the most feared carnivore in these cities. I report on a long-term study of coyotes in the Chicago area in which we have radiocollared 175 individuals, and compare these results to previous research in western cities, to describe how the coyote adjusts to urban life, and what this means for urban management. Coyotes located in urban areas become more nocturnal, and have smaller home ranges (and possibly higher densities) than coyotes in rural areas. Urban coyotes, like their rural counterparts, maintain an organized, territorial social system that also includes solitary transients that span most areas of the urban landscape. Coyotes are able to exploit varying levels of urbanized landscapes by continuing to use patches of undeveloped habitat and feeding on a variety of prey. Some coyotes become habituated through feeding by people, but most urban coyotes do not typically seek anthropogenic food. Most conflicts involve pet predation by coyotes. Much like coyote management in rural areas, coyote conflicts are largely a political issue in the cities. Given that coyotes often coexist with people in urban areas, successful management plans in urban areas should include public education for prevention through limiting wildlife feeding, and focus removal on specific individuals that have become habituated rather than general population control.

82. Mountain lions in fragmented, urban landscapes: Experiences from southern California.

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

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Urbanization results in the widespread loss and fragmentation of natural habitat and can have substantial effects on wildlife, particularly for wide-ranging species such as carnivores. The largest carnivores, such as mountain lions (*Puma concolor*), represent the most difficult challenge for wildlife conservation in fragmented urban areas because they have the greatest spatial needs and may also come into conflict with humans. Although there is increasing interest in the relationship between mountain lions and human development, to date few studies have focused on pumas in urban areas. We review results from two southern California projects, one in the Santa Ana Mountains in the early 1990s and current work in the Santa Monica Mountains National Recreation Area, a national park next to Los Angeles. Roads and development have affected lion movements as lions have learned to reach isolated fragments of habitat and to use underpasses to cross freeways and secondary roads. Mountain lions apparently do find and utilize narrow habitat corridors, including passageways across major roads. The barrier effects of development can also lead to long-term population isolation and gene flow reduction, a significant conservation concern. Although mountain lions may frequent areas near development and human activity, interactions are extremely rare and mountain lions continue to hunt native prey (primarily mule deer, *Odocoileus hemionus*). Recently, two mountain lions in the Santa Monica Mountains area died from anticoagulant poisoning that they may have acquired by preying on coyotes. In general, the persistence of mountain lions in urban fragmented areas will depend on reducing human-caused mortality sources and ensuring that sufficient habitat and connectivity remain. Our results suggest that people can live and recreate near lions along the urban interface, but that a human willingness to promote conservation and coexistence will be necessary for long-term mountain lion survival.

83. Predation by domestic cats in Bristol, UK: Is it important?

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

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The domestic cat is the most abundant carnivore in Britain, with an estimated population of 9 million individuals. The majority of these are free-ranging pets and, in urban areas, cat density may exceed 200 individuals km⁻², potentially giving rise to hyper-predation effects. Furthermore, urban areas are increasingly being recognised as important habitats for populations of birds, including some species

that are declining nationally e.g. the house sparrow *Passer domesticus* and starling *Sturnus vulgaris*. Consequently, although individual pet cats may kill only a few individuals annually, the total effect of cat predation could be a significant factor affecting prey dynamics in urban areas. However, the realised effect of cat predation is dependent on the degree to which it is additive to other forms of mortality. For example, if cats are taking individuals that are likely to die from other causes, then their impact is likely to be minimal: prey fitness may be related to factors such as genetic heterozygosity, symmetry (as a measure of developmental stability), and physical condition. In this paper we will present the results of our research on (i) the magnitude of predation by domestic cats in areas within the City of Bristol, UK and (ii) the degree to which the characteristics of preyed animals differ from random samples within the prey population as a whole.

84. Community ecology of urban carnivores.

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

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Mammalian carnivores are ecologically pivotal organisms that differ considerably in their responses to urban fragmentation, with some species markedly sensitive to urbanization and other species enhanced by it. We review the community ecology of urban carnivores, focusing on interactions among carnivore species and among carnivores and their prey. Most empirical and theoretical studies of predator-prey relationships have emphasized the direct effects between predators and prey. From a top-down perspective, predators are expected to have a direct and negative impact on prey, and from a bottom-up perspective, prey are expected to have a direct and positive impact on predators. Indirect predation effects, however, can have important and often unexpected influences on community structure. For example, apex carnivores are particularly vulnerable to local extinction in urbanizing landscapes due to large ranges, low population densities, and direct persecution by humans. The decline and disappearance of dominant carnivores in urban areas can result in the ecological release of native and introduced mesopredators, whose activity was previously restricted through resource and interference competition, intraguild killing, and direct predation by larger predators. Increased predation by some urban mesopredators, such as domestic cats, may have dramatic impacts on birds and other prey species. Indeed, such “mesopredator release” has been implicated in the decline and extinction of prey populations urban and other systems.

85. Resolving conflicts with urban carnivores: Methods, strategies and concerns.

Session: Urban Carnivores: Ecology, Behavior, Conflict, and Conservation

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Conflicts with carnivores have existed throughout human history. For most of that time these undoubtedly focused on our trying to avoid becoming prey items, but quite recently we seem to have turned the tables and gained ascendancy over even the largest and fiercest of our former foes, exercising with ruthless efficiency our ability to drive many populations to near extinction. The extermination of wolves, bears and mountain lions from much of North America was a deliberate and socially sanctioned undertaking that began in the late 1800’s and continued until recent times. Aimed primarily at satisfying demands of livestock producers, eradication campaigns took place largely on open range, far from the towns and cities where it seemed human presence alone limited that of most wildlife. Some time within the last hundred years a tentative exploration and later colonization of urban habitats by small carnivore species began, followed in very recent times by further influx of larger forms, including coyotes, bears and even mountain lions. The urban populace, which also gained demographic and political dominance over the rural during that time, was almost certainly responsible for the attitudinal shifts that led to greater acceptance of carnivores and, in numerous cases, organized efforts to restore and maintain populations at viable levels. Now, with direct contacts

between carnivores and urbanites increasing, a highly dynamic period of adjustment and accommodation is occurring, the consequences of which are not exactly clear. This talk examines the contemporary nature of human-carnivore conflicts in urbanizing areas, the approaches and strategies employed to control these, and the possible future in which urban carnivore management will take place.

86. When science, policy and politics don't mix: The case of the missing lynx.

Session: Conducting Wildlife Science in the Public Eye

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National Interagency Canada Lynx (*Lynx Canadensis*) Survey participants were embroiled in a major controversy when several participating agency biologists were accused of attempting to bias the study by violating the project protocol. The chronology and viewpoints surrounding the controversy are described, including perspectives of field biologists, research scientists, media, state and federal natural resource agencies, elected officials, investigative agencies, and nongovernmental organizations (including TWS). The “Case of the Missing Lynx” illustrates the realities, perceptions, and potential conflicts surrounding science, policy, and politics of wildlife issues. The case shows that actions of a few individuals may impact an entire profession. The case also highlights the volatile nature of public and political perceptions of threatened and endangered species issues. Given the tensions involving rare species and limitations on public lands, this situation could have happened anywhere, to anyone working on such projects. Open and honest channels of communication between professionals, agencies, Congress, and the public are essential for professionals to remain credible and to maintain the public’s trust in science and management decisions. This case exemplifies the importance of upholding standards of professional conduct, following protocols, and seeking resolution of concerns through appropriate channels. Observations and recommendations are offered to help prevent similar problems in the future and to ensure that wildlife biologists are prepared to carry out their projects effectively while maintaining credibility and public confidence in their work.

87. Mountain lion management: A tale of two models.

Session: Conducting Wildlife Science in the Public Eye

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Mountain lion (*Puma concolor*) management in North America over the last 100 years has exhibited extreme shifts in public policy, population level responses, evolution of scientific study techniques and public value judgments applied to the species. Science-based investigations over the last 40 years have provided important insight into the life history of this charismatic large carnivore. However, knowledge gained through field research across mountain lion range has been inconsistently applied to conservation efforts and management policies. In this paper I present observations related to the role of science in public policy and management programs related to mountain lions based on over 30 years of professional experience working in California and Idaho. Specific examples are drawn from contrasting the history and current status of management programs in these states. The paper summarizes the 2 models as: Value driven public policy with limited management flexibility in CA; and Adaptive management based on goals and objectives in ID. Observations are provided on the role of science in managing mountain lions under these sets of public policy and human demographic conditions in western North America. My goal is to share experience and observations related to the socio-political challenges of applying science to wildlife conservation and management in the public policy arena.

88. Brown (grizzly) bear management in Alaska: Perspectives of four retired Alaska Fish and Game Department biologists.

Session: Conducting Wildlife Science in the Public Eye

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Management of grizzly(brown) bears (*Ursus arctos*) and other large carnivores in Alaska has undergone marked changes over the last 25 years. In this paper, we focus on the changes in brown/grizzly bear management over this period from the perspectives of biologists who formerly worked on bears as researchers and managers for the Alaska Department of Fish and Game. Trends in hunting regulations and bear management since the late 1970s raise concerns over the conservation and management of Alaskan grizzly bears over the long term. This concern results from the perceptions by some politicians, managers and hunter groups that bears are undesirable predators and competitors for ungulate game species (primarily moose and caribou). These perceptions are increasingly being translated into regulations designed to reduce bear abundance over progressively larger portions of the state especially on state-owned and BLM lands. In this paper we document statewide trends in the geographic extent of liberalized hunting seasons, increased bag limits, elimination of tag fees for resident bear hunters, issuance of “control permits” allowing additional kills by permittees, legalized baiting of grizzly bears, legalization of the sale of bear parts and the impacts of these changes on harvests. Legal mandates from the Alaska legislature and from members of the Alaska Board of Game give Alaskan game managers little flexibility to reverse these trends. At the same time regulations are being liberalized, funds to assess trends in bear numbers are declining. We recommend new approaches toward bear management in Alaska that we hope will avoid repeating some of the mistakes in bear management that occurred in the lower 48 states during the last century. With enlightened proactive conservation efforts and preventative management, Alaska can remain a stronghold for the grizzly in North America and a model for bear conservation throughout the world.

89. Lethal control of wolves to increase ungulate densities in Alaska.

Session: Conducting Wildlife Science in the Public Eye

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Lethal control of wolves (*Canis lupus*) designed to increase ungulate densities has occurred intermittently in Alaska, USA, for the past three decades. Controversy over control methods, including aerial shooting, accompanied these programs. From 1976 to 1983 1,300 wolves were taken by a combination of helicopter shooting and private trapping. Adverse public reaction largely restricted wolf control from 1984 to 2003. In 1997 a National Research Council review suggested numerous biological standards to guide control programs. Control proponents sponsored legislation in the 1990s that mandated intensive management of depleted populations of ungulates for consumptive use by humans. Population and harvest objectives were based on historical highs that are now likely unattainable and almost certainly are unsustainable. Control programs have recently been approved in 5 areas of interior Alaska that total about 50,000 square miles. Several hundred wolves have been shot by private pilots during the past 3 winters. Recommended standards and guidelines for justifying, implementing, monitoring, and evaluating control are not being applied. Conservation concerns include sustainability of ungulate populations, protection of ungulate habitat integrity, and population viability of predators.

90. Redefining Florida panther habitat: Reconciling wishful thinking with the evidence.

Session: Conducting Wildlife Science in the Public Eye

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As the previous presentations made clear, wildlife controversy is not restricted to a particular taxon or geographic area. Herbivorous birds and carnivorous canids seem equally capable of eliciting both ire

and sympathy from the public. Criticisms of past analyses of Florida panther (*Puma concolor*) habitat, and the desire by some national nongovernmental organizations to use this endangered population as the hedge against development in south Florida have created a new view of panther habitat use that is very different than previously believed. This change included strategic attacks on at least one biologist closely identified with previous interpretations of panther habitat relations, ostensibly because of the absence of nighttime telemetry data. Largely lead by media interest and efforts by NGOs to prevent urban sprawl in southwestern Florida, the panther is now promoted (using only daytime telemetry data) as a habitat generalist in the review of development permit applications. In the rush to claim the panther as something other than a forest specialist, proponents of the new view of panther habitat must shoulder the burden of claiming that which cannot be proven. This has the potential of promoting accelerated loss of habitat rather than protecting it. In such situations, professional biologists must not succumb to the same tactics employed by advocacy groups, but rather pursue more rigorous interpretations of existing data. The short term downside may be maladaptive policies, but the long term upside is the development of a more accurate interpretation of the ecological factors necessary to drive appropriate conservation policy.

91. Decomposing lynx-hare population and habitat dynamics across a latitudinal gradient: another kick at the cat.

Session: Canada lynx-habitat relationships in the contiguous United States

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The population and habitat ecology of Canada lynx and their main prey, snowshoe hares, is well understood for the northern boreal forest where lynx and hare populations are cyclic. Yet, many uncertainties remain regarding the ecology of southern lynx and hare populations where their cyclic numerical trends are uncertain and where lynx are listed as threatened under the Endangered Species Act. In this paper we will review basic lynx-hare ecology in the northern range and highlight the complex nature of these dynamics and the spatio-temporal factors affecting abundance and habitat requirements. Next, we will examine the issue of lynx-hare relationships in the southern range by examining what is known and what needs to be known for proper conservation and management; this analysis will stress the need to debunk myths and dogma that have gone unchallenged in the literature. Specifically, we will address; i) whether southern lynx-hare population dynamics are cyclic, ii) the importance of hares versus alternate prey in the diet of southern lynx, iii) the potential role of competing carnivores in limiting southern lynx numbers, iv) lynx and hare habitat needs, including old growth forest, and v) the demography and viability of both species in fragmented landscapes of the southern range. We will conclude by providing specific research priorities that are needed for effective conservation and management of southern lynx and hare populations.

92. Canada lynx conservation in a continental context: regional contrasts in North America.

Session: Canada lynx-habitat relationships in the contiguous United States

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Due to their association with boreal forest, Canada lynx are widespread and abundant in northern North America, but patchily distributed in the southern periphery. In most of Canada, where lynx retain 95% of their current range and are considered abundant and widespread, lynx are managed primarily as furbearers and receive relatively low levels of monitoring attention. In the lower 48 United States, by contrast, they are listed as threatened under the federal Endangered Species Act, and are considered species at risk and subjected to trapping prohibitions and receive relatively high levels of monitoring attention in most states. A few Canadian jurisdictions, notably Nova Scotia and New Brunswick, also fall into this southern periphery. Where lynx populations are confined to the southern extensions of boreal-like forest habitat that exist primarily in large upland plateaus and at higher

elevations, habitat quality is naturally lower. This situation is compounded by higher resource extraction and human settlement pressures and a changing climate. Conservation issues for this northern species at the southern edge of its range limits include low overall availability of suitable habitat, tenuousness of genetic connectivity within patchy suitable habitats, and hybridization with bobcat cousins. In this paper I highlight two transboundary regions -- the Great Lakes and the Northern Appalachians -- where the dichotomies in lynx status and management play out at smaller scales. These case studies illustrate both the overall challenges of ensuring for lynx conservation and the benefits of coordinated conservation and management planning.

93. Temporal and spatial variation in snowshoe hare densities in eastern North America: Relationships to lynx and forest management.

Session: Canada lynx-habitat relationships in the contiguous United States

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The snowshoe hare (*Lepus americanus*) is a keystone species in northern forests and is the primary prey of the federally threatened Canada lynx (*Lynx canadensis*). Hares have been well-studied, are cyclic, and exhibit 5- to 25-fold changes in density with a periodicity of approximately 10 years in the boreal forest. Little is known, however, about population- and habitat-level ecology of hares in the mixed coniferous-deciduous Acadian forest, which coincides with the southeastern distribution of lynx and hares. We quantified temporal changes in hare densities to evaluate the effects of forest management activities on hares at the stand scale, and to model the effects of stand and sub-stand scale vegetation on hare densities in northern Maine. During 1995-2005, densities of hares were high (approximately 2 hares/ha) and remained temporally stable (range = 1.63-2.43 hares/ha) within preferred stands, supporting previous assertions that hares may not cycle in the southeastern portion of their range. Hare densities were lowest (< 0.3/ha) in mature selectively harvested (3-4 years previously) stands and in mature deciduous, coniferous, and mixedwood stands. Intermediate densities (0.5 - 1.0/ha) were observed in insect-killed mature stands, in longer-established partial harvests, and in precommercially thinned clearcuts. High (>1.6/ha) hare densities were observed in stands that had been clearcut 15-30 years previously and subsequently herbicided. Modeling using an information-theoretic approach suggested that understory stem cover (+) and canopy closure (-) were most closely associated with within-stand scale density of hares. At larger scales encompassing the home ranges of several hares, densities were most closely related to conifer stem density (+), basal area that had been removed via harvesting (+), and log density (-). Population ecology and habitat relationships of hares in the Acadian forest may differ from the boreal forest and Rocky Mountain regions because of differences in climate, forest structure, and biotic communities.

94. Hierarchical resource selection of lynx in northwestern Montana.

Session: Canada lynx-habitat relationships in the contiguous United States

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From 1998-2006 we studied lynx (*Lynx canadensis*) ecology throughout northwestern Montana. We present analyses of second-order selection (selection of home ranges within the broader landscape), third-order selection (selection of habitat features within home ranges), and fourth-order selection (selection of kill-sites within use areas) of lynx using a variety of technologies and methods. We have captured 119 lynx since 1998, and used a minimum convex polygon of all locations collected from VHF, Argos, and GPS technologies to define the available landscape. We used logistic regression in a GIS framework to compare 59 used home ranges to a Monte Carlo simulation of 1,000 available home

ranges within the available landscape. We studied lynx selection within home ranges using intensive vegetation sampling and GIS analyses along 582 km of winter backtracks and 1,260 summer VHF locations. Lastly, we assessed selection of winter kill-sites by comparing habitat features at 79 kill sites located along backtracks to a paired set of plot sites randomly located along the same lynx backtrack. In selecting home ranges, lynx showed strong preference for mild slopes within an elevation band of 1435-1935 m and the denser Spruce-Fir forests associated with this zone. Selection within the home range revealed strong correlations to hare densities, deep snow, and high horizontal cover, with even higher horizontal cover at kill sites.

95. Habitat fragmentation and its potential influence on the persistence of lynx populations in Washington state.

Session: Canada lynx-habitat relationships in the contiguous United States

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Lynx (*Lynx canadensis*) are found in the northern counties of Washington State. Since the 1980's population persistence and reproduction have been documented only in Okanogan County along the east slope of the Cascade Range. Telemetry studies of lynx in that area (Meadows study area, MSA) have shown that lynx primarily occupy habitats above 1,463 m where Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and lodgepole pine (*Pinus contorta*) are dominant. We snowtracked lynx 104 km within the 200 km² MSA, which was dominated by the above overstory species, and 155 km within the adjacent 211 km² Black Pine Basin study area (BPBSA), which included only 45% Engelmann spruce/subalpine fir forest types. Results of snowtracking in the BPBSA showed that lynx selected for Engelmann spruce/subalpine fir forest types and canopy cover of 11-39%, and selected against forest openings, recent burns, Douglas-fir (*Pseudotsuga menziesii*)/Ponderosa pine (*Pinus ponderosa*), canopy cover <10%, understory cover <10%, and slope > 30°. Currently, the high-elevation habitats where lynx historically occurred in Washington are intersected and fragmented by landscape features and forest conditions that are avoided by lynx. During the past 2 decades, natural fires have burned 42 km² of the MSA and 15.5 km² of the BPBSA, as well as 420 km² adjacent to both study areas. Insect outbreaks have also fragmented lynx habitat and created conditions for large stand-replacing fires that may remove additional habitat in the coming decades. Lack of evidence of lynx in neighboring areas suggests that fragmented landscape conditions may have impeded recolonization into portions of northeastern Washington where lynx were extirpated by the 1970's. Because of the uncertain future status of lynx in Washington, translocations of lynx to these portions of their former range, where forest conditions appear adequate to support lynx, may be necessary to ensure their persistence in Washington.

96. Lynx-habitat relationships in an intensively managed, commercial forest landscape in Maine.

Session: Canada lynx-habitat relationships in the contiguous United States

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The listing of Canada lynx (*Lynx canadensis*) as a federally threatened species in 14 States requires region-specific information on the status and requirements of lynx to ensure conservation plans are adequate throughout lynx range. At the time of listing, there was limited information on the status of lynx in the northeastern U.S. A 10-year telemetry study of a lynx population in northern Maine was

initiated in 1999 to address this knowledge gap. We investigated lynx habitat needs relative to hare densities and lynx fitness in an intensively managed forest in northern Maine. Past insect outbreaks and resulting forest harvest activities led to younger forest; 45% of our study area was in the sapling stage. We radiocollared 43 lynx (22F:21M) in northern Maine between 1999 and 2004; 19 lynx were residents (10F:9M). Selection of habitat by resident lynx was assessed at multiple spatial scales using the Euclidean distance approach. We identified 7 stand-level habitat classes based on covertype and stand age from landowner forest inventory data. At all spatial scales, lynx preferred regenerating sapling stands that were coniferous or mixed coniferous/deciduous forest; these stand types supported the highest hare densities (1.65-2.42 hares/ha). High lynx productivity (2.83 kittens/litter; on average 91% adult females giving birth each year), recruitment (71%), and density (15.5 lynx/100km²) provide additional evidence of the quality of these habitats. Within core areas, lynx also preferred mature softwood stands (>40 years old). Clear cutting of large tracts of spruce/fir forest in northern Maine following the spruce budworm epizootic provided ideal habitat conditions for lynx. In recent years, following the passage of the Maine Forest Practices Act, there has been a shift to partial harvest techniques, where most mature conifer-dominated stands are harvested using shelterwood techniques. Additional information is needed to determine if shelterwood-managed forests will support lynx at current levels.

97. Biology of Canada lynx in Minnesota.

Session: Canada lynx-habitat relationships in the contiguous United States

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Canada lynx (*Lynx canadensis*) management in Minnesota is challenging because lynx are at the southern edge of their range. Lynx were present through much of the 20th century but may have been only occasionally present in the early 1990's. Sightings reports increased after federal listing as a threatened species, coincidentally with increased lynx harvest in Ontario. To date 33 lynx have been radiocollared in a telemetry study begun in 2003 as a cooperative project including the Superior National Forest, Minnesota Dept. of Natural Resources, U.S. Fish and Wildlife Service, U.S. Forest Service, and the Biological Resources Division of U.S.G.S. GPS collars have been deployed on 14 animals with 19 animals wearing VHF collars. Females have weighed 8 to 11 kg while males have weighed 11 to 14 kg. Over 12,000 GPS locations identify habitats used by males and females, supplemented by more than 750 locations on lynx with VHF collars. 95% kernel home ranges of females are from 13 to 21 km² while 95% kernel home ranges of males are from 86 to over 350 km². Long-distance movements by several males have been documented with GPS collars. At least 22 kittens have been born in 7 litters from 4 mothers. Adult females have remained in localized areas while raising kittens. At least 1 kitten born in Minnesota has survived for 24 months indicating conditions are suitable for successful reproduction in Minnesota. To date 16 of 33 animals have died during almost 16,000 radiocollar days. Mortality causes have included car kills, illegal shooting, incidental catch in traps, harvest in Ontario, and mortality that was not human caused. Persistence of this population will be addressed through long-term monitoring and genetic analyses. Project results will allow management and recovery efforts for Canada lynx to be based on region-specific demographic and habitat use data.

98. Demography and movement patterns of lynx reintroduced to Colorado.

Session: Canada lynx-habitat relationships in the contiguous United States

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In an effort to establish a viable population of lynx (*Lynx canadensis*) in Colorado, the Colorado Division of Wildlife (CDOW) initiated a reintroduction in 1997. From 1999-2006 218 radio-collared lynx were released in southwestern Colorado. We documented survival, movement patterns,

reproduction, and habitat-use through aerial ($n = 7421$) and satellite ($n = 14,788$) tracking. Most lynx remained near the release area in southwestern Colorado. Reproductive females had the smallest 90% adaptive kernel annual home ranges (mean = 75.2 km², SE = 15.9 km²), followed by attending males (mean = 102.5 km², SE = 39.7 km²) and non-reproductive animals (mean = 653.8 km², SE = 145.4 km²). Human-caused deaths by gunshot and vehicle collision were the highest sources of mortality for reintroduced lynx. Reproduction was first documented in 2003 and again in 2004 and 2005 totaling 105 kittens known to have been born from 37 litters. From snow-tracking, the primary winter prey species ($n = 426$) were snowshoe hare (*Lepus americanus*) annual mean = 75.1% (SE = 5.17,) and red squirrel (*Tamiasciurus hudsonicus*) mean = 15.3% (SE = 3.09); other mammals and birds formed a minor part of the winter diet. Mature Engelmann spruce (*Picea engelmannii*)-subalpine fir (*Abies lasiocarpa*) forest stands with 42-65% canopy cover and 15-20% conifer understory cover were the most commonly used areas in southwestern Colorado. Little difference in aspect (slight preference for north-facing slopes), slope (mean = 15.7°) or elevation (mean = 3173 m) were detected for long beds, travel and kill sites ($n = 1841$). Den sites ($n = 35$) however, were located at higher elevations (mean = 3347 m) on steeper (mean = 29°) and more commonly north-facing slopes with a dense understory of coarse woody debris. We have documented high initial post-release and long-term survival, site fidelity and reproduction. What is yet to be demonstrated is whether Colorado can support sufficient recruitment to offset annual mortality for a viable lynx population. Monitoring continues in an effort to document such viability.

99. Over-winter movements of arctic foxes on Alaska's North Slope using satellite telemetry.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Using satellite telemetry, we investigated movements, especially winter movements, of arctic foxes (*Alopex lagopus*) collared in a developed area (Prudhoe Bay Oil Field) and an undeveloped area (National Petroleum Reserve-Alaska). The main focus of the study was to determine whether foxes in a developed area remain there through the winter because of the availability of anthropogenic foods that are unavailable in an undeveloped area where foxes are expected to roam more widely in search of food. A total of 37 foxes were collared from 2004-2005; 17 from NPR-A and 20 from Prudhoe Bay. Movements of animals from Prudhoe Bay were restricted to the oilfield, while movements of greater than 150km from capture site were common for most animals collared in NPR-A, with some animals traveling in excess of 800km. We also documented the use of sea ice by three foxes collared in NPR-A, but did not see similar use of sea ice by foxes from Prudhoe Bay.

100. Geographic variation in size and growth of skulls from Alaskan brown bears.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Quantifying phenotypic growth and body size patterns is critical for illuminating regional differences in the life history strategies of an organism. For large mammal species like brown bears (*Ursus arctos*), small sample sizes have bedeviled comparisons. This study seeks to remedy this problem, utilizing the skull measurements of over 12,000 known aged brown bears taken from 1969 through 2004 from six distinct populations in Alaska: Kodiak Island (KO), the Alaska Peninsula (AP), the Kenai Peninsula (KP), interior Alaska (IN), the North Slope (NS), and Southeast Alaska (SE). I fit growth curves to measurements of skull length, width, and their sum. There is large variation in the size and growth patterns of skulls across these populations. The asymptotic skull size (a measure of

the maximum size attained by a population) for male and female bears is much larger on KO, AP, and KP than in SE, IN, and NS. Sexual dimorphism is highest in KO and KP bears. The estimated growth rate constant is highest in KP and IN bears for both sexes. These and other results are discussed. Intraspecific allometry in skull growth likely compares to differences in life history parameters influenced by nutrition and somatic growth.

101. River otters of Oregon: Using genetics to identify population structure.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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The North American river otter (*Lontra canadensis*), is a resident of wetlands and has experienced a tremendous amount of habitat destruction, pollution, and over-harvesting, resulting in its extirpation from most of its range. Little is understood regarding the past, present, or future of the otter in Oregon and how this resource should be managed from a genetics standpoint. The primary focus of this work was to identify population structure and relationships through the use of microsatellite DNA from individual tissue samples of otters in Oregon. After extracting DNA from samples throughout the state, 6 microsatellite loci were amplified by PCR and the allele sizes were estimated using an automated fragment analyzer. Evidence from the model-based clustering method in STRUCTURE2.1 indicates that a single population is likely. Further analysis with an assignment test using DOH has shown an 8-12% dispersal rate between the Eastern and Western sides of the state and a 15-17% immigration rate from areas surrounding Oregon. Even though potential geographic barriers to gene flow exist (e.g. mountains, arid regions, etc.), this analysis suggests that the otters of Oregon may experience high enough dispersal to constitute a single management unit. The average observed heterozygosity (Hobs) was found to be 0.52, similar to previous studies of otters in the Eastern U.S. Additionally, the number of alleles per locus ranged from 4 to 9 and the average mean ratio, M, was found to be greater than 0.7. Due to this moderately high retention of alleles and heterozygosity, it is reasonable to assume that the otters have not experienced a severe bottleneck in the recent past.

102. Survival and cause-specific mortality of gray foxes in southwestern Georgia.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Survival estimates are an important factor in understanding a species' life history and longevity. However, few estimates are available for gray foxes (*Urocyon cinereoargenteus*), and those available indicate low annual survival rates. Therefore, from December 2002 -February 2006 we used radio telemetry to estimate survival of a population of gray foxes (n=32) in southwestern Georgia. Trapping has traditionally been cited as the major source of gray fox mortality, but with decreases in fur prices and trapping effort, current rates and causes of mortality are unclear. Mean annual survival was 0.61 ± 0.10 . Survival differed by season ($P=0.046$), with least survival in summer (0.83 ± 0.12) and greatest survival in winter (0.93 ± 0.08). Fourteen carcasses were recovered, and cause of death was established for 10. Most deaths (9) were due to anthropogenic factors, with 6 foxes dying from vehicle collisions, 2 killed by trappers, and 1 dying from canine hepatitis. This disease had not previously been documented in gray foxes but is known to exist in domestic animals and captive wild canids. The only fox that died of known natural causes was killed by an unknown predator. Current anthropogenic

factors may be compensatory to historic trapping levels because, while annual survival may be low, fox populations appear to be stable.

103. Bobcat spatial distribution and habitat use after an experimental population reduction.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Few controlled, field experiments have been conducted on bobcat behavior or ecology. Understanding behavioral characteristics associated with territoriality, interactions with conspecifics, and habitat availability may lend insight into less understood life history traits of the bobcat, which may help us better manage the species. We investigated bobcat (*Lynx rufus*) spatial distribution and habitat use relative to an experimental population reduction in southwestern Georgia. During 1 January - 14 February 2005, we removed about 50% of the bobcat population on a 7,041-ha removal area, whereas no removals occurred on an adjacent 3,521-ha control area. We monitored 21 radio-collared bobcats during pre- and post removal time periods, and observed that male bobcats in the removal area shifted ($F_{1,3}=138.08$, $P=0.0013$) their home ranges more relative to baseline (i.e., shift post-removal reported as a percentage of shift pre-removal) than males within the control area. Dispersion (reported as a percentage of pre-removal dispersion) of radio locations for female bobcats that had been exposed to the removal of a potentially interacting male increased significantly less ($F_{1,14}=6.78$, $P=0.0209$) than females within the control area. Likewise, females in the removal area that had been exposed to both a potentially interacting male and female increased less ($F_{1,14}=8.27$, $P=0.0122$) than females in the control area. Male bobcats likely shifted their home ranges to increase breeding opportunities. The difference in dispersion of female radio locations may be the result of a decrease in intraspecific competition or possibly the result of a decreased need for scent markings along territorial boundaries. Neither habitat selection nor actual habitat use differed as a function of the population reduction, suggesting that density-dependent habitat selection was not occurring.

104. Evidence of coyote-dog hybridization found in an urbanized ecosystem.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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The coyote (*Canis latrans*) is a relative newcomer to the Cleveland metropolitan area, and consequently, not much is known about the population structure of coyotes locally. The green spaces of the greater Cleveland area are urbanized and fragmented, and much of the habitat suitable for coyotes is found in parks that are surrounded by urban and suburban developments. The presence of coyotes near urban developments is a new concern for the public, and consequently, there is a demand for information about the size of the population, how widely individuals disperse, and if any hybridization is occurring with domestic dogs. In order to answer those and other questions relating to the population dynamics of local coyotes, we chose to evaluate the genetic diversity present in the mitochondrial DNA control region (D-loop). A survey employing non-invasive genetic sampling techniques was conducted in the greater Cleveland area, yielding 74 scat samples, of which 58 were successfully amplified and sequenced. Among those samples, along with two tissue samples taken from coyotes captured by local animal control officers, 35 unique haplotypes were obtained. Two of those haplotypes were more similar to haplotypes of dog than to coyote. Discovery of a dog mitochondrial DNA haplotype from a coyote scat sample suggested the possibility that hybridization

has occurred; specifically, a female feral dog may have mated with a male coyote. To confirm the discovery of coyote-dog hybridization, a biparentally-inherited nuclear marker was needed. We used a small region of an MHC gene to determine if the nuclear DNA present in the samples was contributed by coyote, dog, or both species.

105. Brown bear population density estimation using double-observer aerial transect surveys: Southwest Alaska survey estimates and lessons learned.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Our objective was to estimate brown bear (*Ursus arctos*) population density for a 21,178 km² study area in southwest Alaska. Estimates were obtained using an aerial line transect method specifically developed for this wildlife application and that allows for peak detection to be both off the transect line and < 100%. Being the first team of investigators to employ this method without direct participation of the developers, we discuss the method's training, logistical, data support, and data analysis requirements and costs. Data collection involved five small airplanes and two-person crews flying surveys in a window of 10 days in each of two years to detect sufficient bear groups to estimate detection functions. The survey detected 197 bear groups (330 bears) in 969 aerial transects averaging 24.8 km in length and with an effective search width of 750 m. We estimated a population density of 37.6 bears/1000 km² for the survey region, with a 95% bootstrap confidence interval of 30.3 to 43.8 bears/1000 km². This estimate roughly corroborates more subjective estimates by other investigators.

106. A non-invasive genetic estimate of abundance for black bear in the Greater Glacier Ecosystem

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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The Greater Glacier Bear DNA project was initiated in 1998 with the primary purpose of assessing brown bear (*Ursus arctos*) and black bear (*Ursus americanus*) abundance and distribution within the Greater Glacier Ecosystem (GGE), Montana. Demographic assessments for *U. arctos* have already been presented; here, we present an initial abundance estimate for *U. americanus*. During the summers of 1998, 1999 and 2000, hair samples were collected using 1259 hair snags (623 in 2000) and 1058 rub trees (12283 rub survey 'events') across the 8200 km² study area. Species identification using mitochondrial DNA analysis detected 3949 black bears, and we have generated 5-locus microsatellite genotypes for 1212 samples collected in 2000 - 272 collected from known rub trees along Glacier Park's trail system and 940 collected as part of a comprehensive program of hair snagging. From these samples, we identified 413 unique genotypes. Based on these data, our estimates of *U. americanus* abundance within the GGE range from 733 (Jackknife estimator in program CAPTURE, 95% confidence interval 664 to 815) to 727 (Lincoln-Peterson, 95% confidence interval 601-855). We are currently finalizing this dataset, including obtaining sex identification for samples carrying each unique genotype. We will discuss these results, implications for the ecology and management of *U. americanus* within the GGE, as well as some preliminary spatial analysis of the data.

107. Status of the black bear in the Northwestern Lower Peninsula of Michigan: A non-invasive mark-recapture population estimate study.

Session: Indigenous Peoples Wildlife and Ecosystem Management

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The use of hair-snares and microsatellite genetic markers in mark-recapture population estimates has become increasingly common in studying large mammals. In black bear (*Ursus americanus*) studies, hair-snares are advantageous over traditional methods because complications and dangers associated with direct personal contact of the bears are avoided. Open- and closed-population models may offer differing estimates of population size. Open-population models often require less effort than closed-population models because they cover a smaller area. While closed-population models are useful in estimating population size over an all encompassing area (state level), open-population models estimate a still large, but more precise area. Hair-snares were used to non-invasively collect hair samples from black bears (May-July 2005) in order to estimate population size. Sample collection took place in 9 counties in the Northwestern Lower Peninsula of Michigan where hair-snare units (n=265) were distributed in a grid-like fashion. DNA was extracted from hair follicles and amplified at 7 microsatellite loci using PCR. Data was analyzed using the open-population models in program MARK and yield a population size of 48 individuals (95% C.I. 17-95). In previous population estimates including the entire Northern Lower Peninsula, closed-population models estimated population size of 1,882 bears (95% C.I. 1,389-2,551). Our study area encompassed approximately 33% of the closed population study area but only 3% of the total bears. Our results indicate that black bears are not equally distributed throughout the Northern Lower Peninsula of Michigan. This discrepancy may be attributed to urban development and lack of usable habitat. Closed-population models may not accurately describe the distribution of bears across their entire sampling area.

108. Use of electric fences in a high brown bear density area at McNeil River, Alaska.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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McNeil River State Game Sanctuary is located on the Alaska Peninsula and is renowned for world class bear viewing. Large concentrations of brown bears (*Ursus arctos*) gather in the McNeil River area every summer to feed on food provided by the rich coastal environment. We documented the effectiveness of electric fences to exclude bears from telemetry data logger stations established at two sites in the Sanctuary. Electric fences were not 100% effective at excluding bears but overall worked well in minimizing bear disturbance of these sites. Recommendations are given for others seeking to use exclusionary electric fences in high bear density areas.

109. Stable isotope and mercury profiles in polar bears from northern Alaska

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Mercury (Hg) is both a naturally occurring and anthropogenic element that bioaccumulates and biomagnifies in apex predators, such as polar bear (*Ursus maritimus*) and their prey. Increasing observational and chemical data potentially indicates that polar bears have a diverse source of prey to

hunt and scavenge (variety of pinnipeds and cetaceans). The magnitude of this “variation” and its impact on polar bears is still in early debate. This emerging issue requires clarification with respect to exposure to contaminants. Blood and hair samples from captured polar bears offer the opportunity to assess spatial, temporal, and feeding ecology related variations in exposure to Hg. Samples available from captures in 2005 (n=62) were analyzed for Hg content as well as stable isotopes of C and N to examine correlations between trophic level and Hg bioaccumulation with respect to other biological variables (i.e. age, sex). Isotopic signatures from the blood of polar bears showed a positive relationship between d15N and d13C (Pearson’s=0.43, p=0.0005, n=62). Blood d13C also differed between adult and sub-adults (Pearson’s=0.31, p=0.016, n=60), and was depleted in polar bears captured near Barter Island (mean=-19.01, SE +/- 0.10, n=15) as compared to animals captured at Endicott and Barrow (combined mean=-18.74, SE +/- 0.09, n=46). Trophic level, as indicated by d15N, did not differ significantly between females (mean=19.52, n=33) and males (mean=19.43, n=28). Stable isotope signatures of polar bears offer preliminary insight into factors that may affect contaminant exposure in wildlife populations. Hg content in blood will be presented to shed light on these interactions.

110. Using the arctic fox model to assess interactions between health status, contaminants and stable isotope C and N fractionation.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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The arctic fox (*Alopex lagopus*) is a small carnivore of the Arctic that exploits both terrestrial and marine environments for food, similar to humans and polar bears (*Ursus maritimus*). The bioavailability of essential and nonessential elements and stable isotopes of carbon and nitrogen (d13C and d15N) in certain subsistence food items such as moose (*Alces alces*; lower trophic source) and spotted seal (*Phoca largha*; higher trophic source) liver, kidney and muscle were determined. These food items are well known to have concentrations of Cd and Hg (including the organic form) that are of concern to consumers of these animal tissues. The present study is aimed at characterizing the arctic fox as a model for laboratory studies to address health status, immune function and histopathology related to contaminants and infectious agents in the arctic Alaska human and wildlife food web. Ten arctic fox were held in captivity at the University of Alaska Fairbanks (IACUC 05-15). They were randomly placed on 2 terrestrial based diets and 1 marine based diet while one animal remained on a commercial reference diet. Two animals did not complete the study due to lethargy and weight loss. These two animals are currently being reviewed as diagnostic cases. Necropsies and histologic evaluation were performed on all individuals. Hematology and clinical chemistry were used to monitor the foxes during the study and to address husbandry needs for future studies. Our goal is to better understand the interaction of elements, contaminants (e.g., organochlorines) with stable isotopes of C and N in arctic foxes to determine if this animal model will assist in polar bear and human studies related to these elements in the apparently healthy traditional subsistence diet of Native Alaskans.

111. Feeding ecology and contaminant exposure in wildlife: Using arctic fox to model the interactions between stable isotopes and mercury.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Mercury (Hg) can enter the environment by anthropogenic sources (e.g., burning of fossil fuels) and be transported through air and water. High concentrations of Hg (especially methyl mercury) in wildlife have been associated with neurological damage, immune suppression, and impaired fetal development. Captive arctic fox (*Alopex lagopus*) were used to determine bioavailability and pathways of contaminants and nutrients in terrestrial and marine food webs. We compared interactions between stable isotope signatures ($\delta^{15}\text{N}$, $\delta^{13}\text{C}$) and Hg in arctic fox to measures collected from polar bear (*Ursus maritimus*) and spotted seal (*Phoca largha*) from Alaska and bottlenose dolphin (*Tursiops truncatus*) from Florida. Arctic fox consuming terrestrial (moose) diets retained a low trophic signature in blood ($\delta^{15}\text{N} = 6.7\text{‰}$; $\delta^{13}\text{C} = -19.3\text{‰}$), that was enriched in $\delta^{15}\text{N}$ compared to herbivores. Blood from arctic fox consuming marine (spotted seal) diets was enriched ($\delta^{15}\text{N} = 13.8\text{‰}$; $\delta^{13}\text{C} = -18.2\text{‰}$) over arctic fox on terrestrial diets, but did not plateau within 5 weeks, and was depleted compared to polar bear and spotted seal. The $\delta^{15}\text{N}$ in blood of dolphins indicated that they feed at a higher trophic level than AK terrestrial species, but at a lower trophic level than polar bear and spotted seal. A forward stepwise regression indicated that increases in blood total Hg in dolphins were linearly related to the interaction of $\delta^{15}\text{N}$ and age (GLM, $F=86.1$, $P<0.001$, $R^2=0.854$). Differences in isotopic signatures of arctic fox on terrestrial versus marine diets suggest that this model can be used to investigate pathways of contaminants through food webs. Increases of Hg in dolphins with trophic level and age suggest that the route of contaminant exposure is dietary. Similar interactions between Hg and feeding ecology in arctic fox, polar bear and spotted seal are presented to better understand the incorporation of dietary Hg into tissues.

112. Monitoring long-term stress in grizzly bears using protein microarray technology

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Grizzly bears (*Ursus arctos*) are regarded as a keystone species of upland and montane ecosystems in western Canada. There is concern that rapid human-caused change in these ecosystems is detrimentally affecting the survival of some grizzly bear populations. Of particular concern is the increased access into grizzly bear habitat as a result of resource extraction activities (mining, oil and gas, and forestry), municipal development, and recreation. We hypothesize that these human activities are causing long-term stress in grizzly bears. Although short-term stress can be beneficial to animals in coping with immediate stressors such as predator avoidance, long-term stress can have negative effects on an individual's health status, including immune function, reproduction and growth. Our primary research objective is to evaluate effects of landscape change on the health of bears. As one component of our research initiative, we are developing a proteomics technique to detect long-term stress in grizzly bear populations in Alberta.. Specifically, an antibody-based protein microarray is being developed that will detect increased or decreased expression of a suite of stress-activated proteins. We are collecting skin and muscle samples from grizzly bears, determining stress protein patterns in these samples, and integrating these results with other health data, such as measures of growth, and immune and reproductive functions to provide an overall health index. After corroboration using field data, this proteomic technique will provide an essential tool for early warning of ecosystem change negatively affecting the health of grizzly bear populations. Further, as this technique is based on evolutionary conserved stress proteins, the microarray may potentially be used to evaluate long-term stress in other wildlife species of concern.

113. Parasites of Mesocarnivores in the Arcata.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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The objective of this study was to identify and map mesocarnivore parasite distribution in the Arcata area. Three study sites were used in the Arcata area from September to November 2005. These were the Marsh, Bottoms, and Streets. Floatation tests were used to measure parasite egg counts. The types of parasites found were then divided into four different classes: *Ascaris*, *Trichuris*, *Taenia*, and unidentifiable Nematoda. Nematoda, found in Raccoons and Foxes, accounted for the greatest number of occurrences at each of the study sites. The highest egg counts were found in *Trichuris* at 1400 eggs per gram located in the Street study site. The distribution of *Trichuris* was found mostly in the Streets and Bottoms, while *Ascaris* was found in the Marsh and Bottoms. Overall low egg counts show that most of the mesocarnivores in these areas do not experience heavy parasite loads.

114. Use of hide digestion for the detection and density determination of biting dog louse infestations in Alaskan wolves.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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The biting dog louse, *Trichodectes canis* was first detected in Alaska infecting coyotes and wolves on the Kenai Peninsula in 1981. In 1998, coyotes and wolves in the Mat-Su Valley had lice. Gross examination of wolves from elsewhere failed to detect lice infestations. In 2004, lice were seen (by histopathology) from wolves trapped north of the Alaska Range for the first time. In this study, two techniques were evaluated for detecting occult (not grossly detectable) lice infestations, histopathology and hide digestion. Intact pelts from 1 coyote and 17 wolves were subdivided into 10x10cm sections. Sections were digested with a 5% potassium hydroxide/detergent solution and passed through a 180 micron sieve. Adult lice, larval instars and eggs were enumerated under a dissecting microscope. Spatial distribution of lice was evaluated by examining all sections from four entire half hides. On fourteen hides, three survey sections were examined, dorsally between the shoulders, low back, and groin. Eight wolves were positive on histopathology but only one of those was negative on three survey sections by digestion. On one wolf, six sections were digested and examined yet only a single louse was detected. On the most heavily infected wolf, the densities of adults and instars were approximately equal (4.2 and 4.1 lice/cm²) while eggs were lower (2.6 eggs/cm²). The calculated density of all stages combined was 10.9 lice/cm². Based on the 1/2 hide, the total burden of lice on this wolf was 80,010! With the 2 techniques employed, 12 wolves from Interior areas previously thought to be louse-free were identified with *Trichodectes canis* infestations. Histopathology and digestion were both able to detect lice when they were not detected grossly. However, hide digestion was extremely sensitive and less expensive than histopathology albeit time consuming.

115. Recent efforts to assess Beaufort Sea polar bear health.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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A study of free ranging populations of polar bears in northern Alaska has been initiated to establish clinical (health) baseline data in order to monitor potential change in health status, using multiple hematologic endpoints and infectious agents exposure measures. Plasma protein, hematocrit, total leukocyte and leukocyte differential counts measured fall within one standard deviation of values reported for captive polar bears (International Species Database). Hematocrit, total leukocyte as well as neutrophil, monocyte, and lymphocyte counts were significantly greater (7%, 33%, 40%, 22%, and 16% respectively; $p < 0.05$) in males as compared to females. A 7.7% increase in neutrophils ($p = 0.012$) and 17.6% decrease in lymphocytes ($p < 0.001$) were observed with increasing age. A relatively high prevalence of serum antibodies to four morbilliviral species [canine distemper (CDV), dolphin morbillivirus (DMV), phocine distemper (PDV), and porpoise morbillivirus (PMV)] were also identified. This group of viruses can cause significant disease and mortality in populations of some marine mammals as well as interfere with differentiation and specialization of lymphocytes in vitro. Serological data indicate 48% of animals tested ($n=64$) in 2005 were positive for antibodies to CDV, DMV, PDV, and/or PMV via differential serum neutralization. Antibodies to *Toxoplasma gondii* were found in 13%, with titers as high as 1:2048. Relationships between antibody titers and hematological parameters were examined, revealing a 7% decrease in total leukocytes ($p = 0.004$), an 8% decrease in neutrophils ($p = 0.033$), a 10% decrease in monocytes ($p = 0.03$), and a 23% decrease in eosinophils ($p = 0.014$) with increasing CDV titer. In addition, eosinophils and monocytes increased 22% ($p = 0.016$) and 11% ($p = 0.03$), respectively with increasing *Toxoplasma gondii* titer. Functional assays (e.g. blastogenesis) and further sample collection (Spring 2006) will assist in evaluating the biological significance of these observed changes.

116. Gray fox research to support oral rabies vaccination programs in Texas.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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A study examining the ecology of the gray fox to assist oral rabies vaccination (ORV) programs in Texas was initiated in 2005 by National Wildlife Research Center scientists in cooperation with Texas Wildlife Services and Texas Department of State Health Services. A major objective of this study is to document the movements and the potential of long-distance movements of gray fox at three study sites using VHF and GPS collars. One of these study sites is associated with a recent ORV zone break which occurred near Kerrville, TX. To date, we have documented one male gray fox which has moved over 13 km in straight-line distance and other long-distance movements were also noted. An additional objective of this project involves a landscape-genetics approach to assist gray fox ORV strategies in Texas. Specific objectives include: 1) identification of landscape features influencing dispersal and gene flow, 2) estimation of dispersal rates, and 3) examination of sex bias in dispersal. This study will be of great complimentary value to the telemetry study described above. To date, in cooperation with the aforementioned collaborators, we have collected over 300 DNA samples from gray fox and are presently genotyping these individuals. A third major objective, which compliments both genetic and telemetry studies, is the development of GIS habitat layers. These layers are presently being built and will be used to compliment the genetic analyses.

117. Brucella Species Testing in Polar Bears

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Brucellosis usually occurs globally in a variety of terrestrial and marine wildlife. Brucellosis has a low mortality rate, but causes abortions, infertility, bursitis, arthritis, orchitis, and osteomyelitis in domestic and wildlife species. It is highly contagious and transmitted to other wildlife through exposure to reproductive discharges after abortions or close contact with other infected individuals. There are six known species of the genus *Brucella*: *B. abortus*, *B. melitensis*, *B. suis* (biovar 1,2,3,4), *B. ovis*, *B. canis*, and *B. neotomae*, although only *B. abortus*, *B. melitensis*, and *B. suis* biovar 4 are problematic in the United States. In 1994, *Brucella* spp. was first discovered to exist in marine mammals when it was found in a captive bottlenose dolphin (*Tursiops truncatus*) in California. Since then, *Brucella* spp. or its' antibodies have been found in a variety of marine mammals, including polar bears (*Ursus maritimus*), ringed seals (*Phoca hispida*), harbor porpoises, (*Phocoena phocoena*), Atlantic walrus (*Odobenus rosmarus rosmarus*), and minke whales (*Balaenoptera acutorostrata*), many of which are prey for polar bears. We present serological data for *Brucella* spp. in polar bear in Alaska. Considering polar bears are predators of both terrestrial and marine mammals, we assess the species of *Brucella* that polar bears may be exposed to (terrestrial vs. marine varieties). Serum is analyzed for *Brucella* spp. using the Standard Plate Test (SPT) and the buffered *Brucella* antigen (BBA) card test. Those that result positive for the presence of antibody to *Brucella* spp. are further assessed by the Western Blot analysis for species specific varieties of *Brucella*.

118. Evaluating the use of cementum annuli to identify the age at first reproduction in sea otters.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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One of the most plastic life history parameters is age at first reproduction (AFR), which typically increases when resources are limited, and decreases when resources are abundant or predation increases. Thus AFR may be used to evaluate potential causes of population change. However determining AFR outside of mark-recapture studies is difficult, as it requires corpora lutea and corpora albicantia counts from reproductive tracts of aged individuals. In some mammals, the first reproductive event coincides with reduced annuli width; suggesting that teeth may indicate maturity. Given the long term and widespread declines of marine predators in Western Alaska, and the availability of paired teeth and reproductive tracts collected by native hunters, we decided to evaluate the use of cementum annuli for the determination of maturity and by extension AFR in sea otters (*Enhydra lutris*). To do so we measured the annuli width at three sites on each of two premolar slide sections for otters from across Alaska, compared standardized measurements by site and section using a repeated measures two-way ANOVA, and found no significant variation due to either factor ($p > 0.05$ in all cases). To identify the otter as immature or mature a threshold value was determined by examining the distribution of annuli widths. Maturity results from changes in annuli measurements were then compared to maturity established from reproductive tract analysis. Maturity was correctly identified in 86% of otters ($n=51$). These age-specific maturity assignments were used to calculate an average AFR from teeth and reproductive tract analysis. The average AFR was not significantly different between the two methods (modified T-test, $p > 0.05$). However, power analyses suggested larger sample sizes are required to detect differences of < 1 year between techniques. At this time the use of annuli measurements appears to be a promising indicator of maturity and by extension AFR for sea otters.

119. Effects of weather on habitat preferences and resource sharing in striped skunk.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Abstract: Understanding habitat preferences, seasonal home range fluctuations, and resource sharing of striped skunks (*Mephitis mephitis*) are key components to reducing rabies transmission within suburban areas. Weather variables can greatly impact skunk movements and cause temporary migration patterns from preferred habitat into alternative habitat offering greater protection from the elements. We outfitted one hundred skunks from the Houston, Harris County, Texas metropolitan area with telemetry collars and monitored skunk movements between March 2004 and June 2006. Movement data indicated a strong feeding and denning preference for short grass areas throughout most of the year, however, habitat usage changed as temperatures approached or dropped below 7 C. During colder temperatures, skunks migrated into more remote, brushy areas, exhibited increased utilization of commercial structures, and spent additional time in dens, often sheltered the entire night. Additionally, data points indicate that skunks also increased time allocation proximate to residential dwellings during colder temperatures, increasing the likelihood of resource sharing with domestic pets and other commensal mammals, such as opossums and raccoons. In areas where rabies is endemic in the skunk populations, resource sharing can increase the possibility of disease transmission to people, domestic pets, and other wildlife.

120. Quantifying spatiotemporal overlap of Alaskan brown bears and people.

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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The competing interests of people viewing salmon-feeding brown bears and people and brown bears (*Ursus arctos*) fishing for salmon at the same location can create conflicts and difficult management decisions. One location where such conflicts are occurring is Wolverine Creek and Cove, 130 km southeast of Anchorage, Alaska on the west-side of Cook Inlet. The area encompasses approximately 0.14 ha and generates over \$3,000,000 in income during June and July as over 9000 anglers and bear viewers catch sockeye salmon (*Oncorhynchus nerka*) and watch salmon-feeding brown bears. This study's objectives were to determine human and bear use of the area by conducting 24-hour observations in real time using a handheld computer from a 4.5 m tall tower anchored in Wolverine Cove. Observations took place between June 18 and July 31, 2002, and between June 11 and July 25, 2003. While people are confined to the Cove, bears use both the Creek and Cove. Bears spent 25% of the total time that they were observed in the first 12 m of the Cove, made 71% of their fish capture attempts, and acquired 38% of their total fish captures in that area. However, the bears were not along in that first 12 m as 23% of all boat activity and 30% of all fish caught by people also occurred in that same area. Although a minimum of 16 brown bears visit the area, most day-time bear viewing depends on a single, highly-habituated adult female, her dependent offspring and a few subadults. Efforts to create an experimental boat exclusion zone 10 m into the Cove to decrease spatial overlap between bears and people and potentially increase day-time bear use and bear viewing opportunities have been unsuccessful.

121. A comparison of randomized and fixed survey points for presence/absence surveys of river otter (*Lontra canadensis*).

Session: Ecology and Conservation of Herptiles; Population Dynamics of Mammals; Biometrics in Wildlife Management; New Technologies; Wildlife Damage Management; Wildlife Diseases and Toxicology; and Oil, Gas, Mining and Wildlife Conservation

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Randomization of survey sites is generally preferred over using predetermined fixed sites for most sampling designs. Randomization presents an unbiased approach to sample site selection that often leads to improved interpretation and inference of results. Unfortunately, a completely randomized approach to sample site selection often leads to serious logistical complications and may simply not be possible in many situations. Sign surveys are a common method for determining the presence and distribution of river otters (*Lontra Canadensis*). However, to date no studies have been conducted to determine the relative efficacy of survey point selection for sign surveys of river otters. We compare the results of a two year presence/absence sign survey for river otter on a Missouri Ozark watershed where both predetermined bridge sites and randomized reaches of stream were used to select survey points. The logistical and statistical considerations of both approaches are explored.

122. Understanding the role of physiology in reintroduction success: Stress and reproduction in reintroduced Canada lynx.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Despite the increasing importance of reintroductions in conservation, their success rates are generally poor. One of the most significant threats to reintroduction success is a phenomenon known as the “reintroduction effect” (RE), in which survival and/or reproductive success are inhibited during the initial stages of a reintroduction effort. The RE is very poorly understood, and poses a significant challenge for conservation biologists. Here we examine the neuroendocrine basis of the RE using reintroduced Canada lynx (*Lynx canadensis*) as a model system. In 1999, the state of Colorado initiated a large-scale effort to restore populations of Canada lynx. During the first several years of this effort, there was no successful reproduction. Using the technique of fecal hormone analysis, we monitored the expression of reproductive hormones (androgens, estrogens, and progestins) and adrenal/“stress” hormones (GCs) for known lynx throughout the reintroduction process. Compared to captive and naturally-occurring populations of lynx, reintroduced individuals exhibit significantly elevated expression of GCs and suppressed expression of reproductive hormones while in holding pens prior to release. We are currently measuring the time course of hormone profiles post-release; these data will be presented.

123. Determining the impact of relocation on nuisance Florida black bears.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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The relocation of nuisance animals has been used for decades in North America as a method to reduce human-wildlife conflicts. Despite the widespread use of relocation as a management practice few guidelines have emerged and questions remain concerning the efficacy of the technique. The bear density in the Ocala National Forest Region (ONFR), in central Florida, is the highest in Florida, with dense and rapidly growing communities along the forest boundary where human-bear interactions and bear relocations are frequent. The purpose of this study is to investigate the impact of relocation on

nuisance Florida black bears (*Ursus americanus floridanus*) in the ONFR, and to examine the efficacy of relocation as a management tool as practiced by the Florida Fish and Wildlife Conservation Commission (FWC). Our objectives are to quantify the effects of relocation on survivorship, movement, home-range establishment, and continued nuisance activities, and to determine relocation “success” based on these factors. Data will be compared from two studies on resident bears in the ONFR. Forty-three bears were relocated into ONFR between 25 May 2004 and 31 December 2005 and were uniquely tagged, tattooed, and fitted with radio-collars before release at one of three approved locations. Twenty-four are currently collared and will be monitored until 31 December 2006, the collar drops off, or the bear dies. Preliminary data suggest that the mortality rate may be lower than anticipated; two bears are confirmed dead, one bear is presumed dead. Fifteen bears returned to capture area traveling 24-80 kilometers from release site. Nineteen bears continued nuisance activities and five were recaptured for these activities. Eight bears currently reside within, or are immediately adjacent to, human-communities with no documentation of further nuisance activities. The results of this study will provide state managers information needed to assess the value of relocation as a management tool.

124. Sexual segregation in brown bears on salmon streams in Southeast Alaska: Evidence from GPS data

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Salmon spawning streams in Southeast Alaska provide an abundant food source during the late summer. Numerous brown bears (*Ursus arctos*) are attracted to the streams to forage on the spawning salmon. We deployed GPS collars on adult brown bears during the late summer on northeast Chichagof Island to determine fine-grained movements and spatial use. We hypothesized that females would travel farther away and spend less time on the streams to avoid conflict with males. Furthermore, we wanted to determine whether forested buffers increased the relative use of riparian habitats by females. During summer 2002 and 2003, we captured and collared 38 adult brown bears (11 males and 27 females) along 2 salmon-spawning streams with different riparian management histories. The GPS collars were programmed to collect a location every 20 minutes to provide frequent relocations. We found that female brown bears spent significantly less time on the salmon-spawning streams and traveled substantially farther away, often on a daily basis. On the stream with less forested riparian habitat, female bears spent significantly less time and traveled farther away compared with females on the more intact watershed. Our data suggests strong sexual segregation of brown bears along salmon spawning stream and that riparian systems with more intact forested buffers will result in greater use by female brown bears.

125. The role of sexual dimorphism, reproductive strategy, and human activities in affecting resource use by brown bears.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Despite significant sexual dimorphism and differing reproductive strategies in carnivores, sexual segregation studies are rare, and its implications are often overlooked when managing wild populations. Potential nutritional constraints imposed by sexual dimorphism and differing reproductive strategies between the sexes have important implications, particularly when combined with differential effects of human activities on sex and age classes. Therefore, this study examined the effects of sexual dimorphism, reproductive strategies, and human activities (bear-viewing and hunting) on resource use by different sex and age classes of brown bears (*Ursus arctos*). Sexual segregation of habitat use and effects of experimental bear-viewing were quantified at a single site in south-central

Alaska by capturing, collaring, and observing brown bears at a salt marsh and salmon stream. In addition, the effects of salmon capture rate, availability of alternative salmon runs, harvest pressure, and numbers of annual visitors on sex and age class use were examined from data collected or previously published from 13 other sites. Bear-viewing sites on salmon streams where salmon capture rates were low (< 4 salmon/hour) resulted in low use by adult males ($< 10\%$ of all bears), except for sites with falls. However, maximum male use of viewing areas also depended on the availability of alternative salmon streams and harvest pressure. Use of habitats by females with dependent young was significantly related to the prevalence of adult males at the site. Thus, both sexual dimorphism and differing reproductive strategies led to sexual segregation in habitat use by bears. Because carnivores often exhibit both sexual dimorphism and infanticide, selection for sexual segregation is likely to be high. In these cases, the nutritional demands of large adult males balanced with responses to human activity drives dynamic temporal and spatial distributions of individuals in the population.

126. Genetic bottleneck analysis in reintroduced populations of American martens in Michigan.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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The American marten, *Martes americana*, was extirpated from the Northern Lower Peninsula (NLP) of Michigan by 1911, largely due to human exploitation and poor resource management practices. More conservative resource management practices allowed the Michigan Department of Natural Resources to reintroduce a total of 85 marten in two regions of the NLP from 1985 - 1986. Currently, little research has been performed on the NLP populations and it is thought that they have experienced a bottleneck as a result of their reintroduction, creating both short and long-term concerns. Reintroduced populations face a number of demographic and genetic problems due to their smaller effective population sizes, increased isolation due to reintroduction to a fragmented habitat, and the tendency to exhibit reduced genetic variation compared to their source population. For this study, 24 NLP marten were live-trapped and genetic samples were obtained for genetic analysis. DNA was extracted from each sample and analyzed at 8 microsatellite loci to genotype individuals. Genotypes were utilized to test for a population bottleneck using the programs Bottleneck and M-ratio. Preliminary results show no evidence of a bottleneck in either NLP marten population, but a significant loss in allelic diversity compared to the source population. These findings have management implications for the NLP marten populations, as managers may be able to minimize further loss of allelic diversity and heterozygosity to sustain the populations long-term.

127. Use of a non-invasive genetic survey to determine marten distribution in Wisconsin.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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American marten (*Martes americana*) are rare in Wisconsin. Before decisions can be made about future recovery efforts a solid understanding of the distribution of martens is required. Recent advances in non-invasive survey techniques and in the field of molecular ecology have enabled the use of molecular markers as “genetic tags” to identify species and/or individual animals. The objective of this project was to determine the distribution of American marten on the Chequamegon-Nicolet National Forest, Wisconsin. A total of 220 snares were placed on eleven transects through previously identified potential marten habitat. Snares were checked every 2 weeks for three snaring periods. Hairs snared in the glue pads were sent to the Molecular Ecology Laboratory at Michigan State University for identification using genetic techniques. Of the 213 submitted samples, 21 samples were identified

as marten from 15 individuals. Martens were detected on 4 of the 11 survey routes. Two of these routes passed through original marten reintroduction sites and have had martens present for years. Two other detections were on transects removed from release sites. One transect traversed a marten research area in which 6 resident animals were present with established home ranges. Of these 6 animals, 2 (33%) were detected. Thus a lack of marten detections did not mean that martens were not present. This hair snare survey was the first large-scale project attempting to describe marten distribution in Wisconsin. It confirmed that most martens remain within a few miles of the original release sites and that only limited dispersal has occurred. Survey effort and costs will be discussed.

128. Florida black bear movements relative to U.S. 98 in northwestern Florida.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Roadkill is the primary mortality factor that the Florida Fish and Wildlife Conservation Commission has documented for the Florida black bear (*Ursus americanus floridanus*) statewide since 1976. Six black bears were killed from December 2001-March 2002 on a section of U.S. 98 within southeastern Jefferson County, Florida. The objective was to assess the movements and abundance of the Aucilla black bear population relative to this section of U.S.98 by: 1) Generating an estimate for the black bear population in the Aucilla area using genetic analyses of hair samples, 2) Assessing the effect of roadkill on the Aucilla black bear population, and 3) Assessing specific road crossing locations and rates correlated with various parameters. The results indicate a moderately high rate of genetic drift during a period of relative genetic isolation. Habitat differences, intersecting roads, and seasons have an effect on black bear crossing rates, however; none of the tested variables had an effect on black bear roadkill. There was an increased occurrence of black bear crossings at intersecting roads and there was no correlation between black bear crossings and roadkill. Recommendations are to address elevated crossing and roadkill activity concurrently for all seasons. These include specific wildlife crossings, habitat manipulations, signage and visual stimuli, and road improvements for segments of U.S.98, U.S.19, and S.R.59. These measures would facilitate the apparent black bear movement within the Aucilla area and toward coastal resources and may significantly decrease bear mortality, increase driver safety, and benefit multiple species while ensuring connectivity to conservation lands for this expanding population of genetically distinct black bears. Results from this study concur with several findings and recommendations from previous research and provide information for managers and planners to assess road characteristics on road projects in an effort to minimize road impacts on the Florida black bear.

129. Effects of GPS collar sampling frequency on collar efficiency, estimated movement distance, and home range size of wolves

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Global Positioning System (GPS) technology has greatly advanced our abilities to investigate animal ecology at fine spatial and temporal scales. However, most research regarding animal movements using GPS has involved sampling frequencies far less than the technical capabilities of modern transmitters, and on animals that exhibit relatively sedentary movement patterns. There is also a need to assess GPS collar longevity and efficiency within the confines of field research using variable fix intervals. We measured wolf (*Canis lupus*) movement distance and territory size using variable sampling frequency to compare estimates across variable GPS fix schedules. Estimates of movement distance decreased exponentially with decreasing sampling frequency, thus, intense sampling frequencies (e.g., 10 min per location) are required for accurate measures of animal movements. Territory size estimates using 95% minimum convex polygons also decreased with decreasing

sampling frequency, but with a more gradual slope. Adaptive kernels resulted in nearly equal territory size estimates across all sampling frequencies. Collar longevity increased with increasing fix intervals but collar efficiency (e.g. total no. fixes recorded during life of a single battery pack) was highest at intermediate fix intervals. Relative to estimating movements, less intense sampling frequencies are necessary for accurate measures of home range size, especially when using adaptive kernel methods. We conclude that GPS transmitters are effective tools for fine-scale assessment of wolf movement patterns, and suggest that researchers should be mindful of trade-offs between sampling frequency, collar efficiency, and collar longevity, when designing GPS-based wildlife research.

130. Status and distribution of American marten in New York State.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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In New York State, American martens (*Martes americana*) occur primarily within Adirondack Park, represent the southernmost population in the northeast, and are geographically isolated from all other marten populations in the U.S. and Canada. Since 1978, after a 42-year closure on marten trapping ended, we have been collecting biological and harvest data on trapped martens. Currently, our GIS database includes approximately 2,000 marten locations from 1975-2005, representing harvest records (n = 1,600), results of live-trapping efforts (n = 110), and marten sightings (n = 270). A preliminary analysis of these data indicate that martens occupy an area of approximately 6,100 mi² in northern New York, whereas the majority of the trapping harvest occurs within 2,500 mi² of the central Adirondacks. While these data have provided considerable insight into marten range and distribution, they have also allowed us to identify data gaps. In particular, we lack harvest information from the western Adirondacks and robust data on marten occurrence and distribution in the northern and eastern Adirondacks where the marten trapping season is closed. To address these data gaps, we have initiated a long-term study to document marten distribution using photographic bait station and snow-tracking survey techniques. I will present preliminary results of these surveys and highlight current research on martens in the Adirondacks.

131. The interaction between wolverines and Eurasian lynx and their effect on reindeer in Sweden.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Eurasian lynx (*Lynx lynx*) and wolverine (*Gulo Gulo*) coexist with semi-domesticated reindeer in the Swedish mountain area and reindeer is the main prey for both species. Reindeer herding is deeply tied to the Sámi culture of Scandinavia and, at least locally, reindeer husbandry suffers from heavy predation by both predators. Therefore, Swedish managers have to compromise between sustainability of an indigenous culture and conservation of predators. The current compensation scheme for predator damage is based on the number of predators present within a reindeer herding district. This scheme is believed to increase acceptance of predators and thereby facilitate the conservation. However, current experience with the compensation system points out the need for a more solid scientific base for the compensation system. The aim of this study was to describe the interaction between lynx and wolverines and to estimate their combined depredation on reindeer. Sympatric wolverines and lynx were equipped with GPS-collars to monitor movements of both species in general and lynx predation rate and wolverine use of lynx kills in particular. Lynx kill rates were estimated from clusters of GPS-locations, confirmed by ground visits. We found a great overlap in home ranges between wolverine and lynx. However, lynx spent more time at lower elevations in valleys while wolverines spend more time above the tree line. Lynx kill rate was estimated to 3-5 reindeer per month depending on sex and reproductive status. Wolverines were observed to frequently visit lynx kills often within 4 days after the lynx left. Our study confirms that wolverines frequently scavenge lynx-killed reindeer. Therefore,

we hypothesize that the presence of lynx might influence both wolverine demography and wolverine predation rate on reindeer. This need to be further investigated and considered by managers in the future management of wolverine and lynx in reindeer herding areas.

132. Harvest management and sustained yield of Alaska's brown bears.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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We evaluated brown bear (*Ursus arctos*) harvest patterns and management across Alaska from 1976-2003. The historic range of brown bears remains occupied in Alaska with densities varying from ~10 to >600 brown bears (all ages)/1,000 km². Brown bears are hunted across Alaska with the exception of some national parks, viewing and residential areas. During this period >32,000 brown bears were harvested (mean annual harvest 1999-2003 = 1,560) and the highest harvest takes place in coastal areas where densities typically exceed 300 bears/1,000 km². Harvest has been focused on male brown bears for many decades and females with cubs and unaccompanied cubs cannot be harvested. Protecting the adult female segment of the brown bear population has proven an excellent sustained yield management tool. For example, 73% and 66% of the bears harvested from Admiralty, Baranof, and Chichagof islands (ABC islands) and Kodiak Island respectively, have been males. Harvest goals vary across Alaska. On the ABC islands the harvest goal is up to 4% of the total estimated population, or no more than a 1.5% harvest of females based on total population size. In contrast, the harvest goal may be ~10% for some highly productive interior populations, even though interior brown bears occur at much lower densities. Kodiak Island's bear harvest is managed at a fine scale whereas harvest is managed more coarsely across much of the state. In one interior Alaska area, management has recently focused on reducing brown bear numbers up to 60% to increase ungulate populations. Research suggests brown bears can kill a high percentage of neonatal moose (*Alces alces*) calves in areas where wolves (*Canis lupus*) are also being reduced through a control program. These intensive management programs that involve ungulates, wolves and bears will remain under high public scrutiny.

133. Habitat use and selection by bobcats in the fragmented landscape of south-central Iowa.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Since the mid-1900's bobcats (*Lynx rufus*) have been rare throughout the cornbelt, but within the last 10 years sightings and incidental trapping of bobcats in Iowa have increased. Our research explores the ecological mechanisms that are enabling this carnivore to expand in an agriculturally dominated landscape, with fragmented forests and grasslands. In cooperation with the Iowa DNR, we have radio-collared 44 bobcats across 9 different counties in south-central Iowa. To date, we have collected over 10,000 ground and aerial locations. Home range size of males (56.36 ± 7.06 km²) is consistently larger than that of females (20.16 ± 2.18 km²; $P < 0.01$). Females used smaller home ranges during April-September when they were with kittens (15.64 ± 2.25 km²), as compared to October-March (26.30 ± 4.03 km²; $P = 0.04$), although home ranges of males did not differ between seasons ($P = 0.85$). Compositional analysis shows that habitat selection is occurring at both the landscape and local scale ($P < 0.01$). Standardized habitat selection ratios illustrate that bobcats are selecting forest cover twice as often as any other habitat class, including grassland and CRP. These results suggests that bobcats are maintaining home ranges in areas of the landscape with a large proportion of forest, and that within home ranges bobcats utilize forest patches more than other types of habitat patches. We have developed models of home range size based on variables such as patch density, edge density,

mean forest patch size, distance between forest patches to predict the densities of bobcats on the landscape. Our results will enable managers to understand the species space and habitat requirements in Iowa.

134. Integrating and evaluating livestock guarding dogs for reducing wolf-human conflicts on Michigan farms.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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As wolf (*Canis lupus*) populations continue to recover, the chance for wolf-human conflicts also increases. Using an experimental design, we test livestock guarding dogs as a non-lethal management tool for preventing wolf depredations on cattle. Furthermore, we include farmers as an important stakeholder in managing depredations. In March 2005, 6 working cattle farms in the Upper Peninsula of Michigan were each given 2 Great Pyrenees pups. Funds for food and dog care costs are provided to farmers during the study. Following guidelines we have given them and with our supervision, farmers are responsible for the care and training of their dogs. Proper training was accomplished by raising pups with the livestock they will be guarding in order to establish a bond between dog and livestock. Pups were raised in pens with calves until 7 months of age and then incorporated into the adult cattle herd. Nine cattle farms, 6 treatment and 3 control, are being monitored for predator activity using sand tracking swaths, data loggers and farmer observation. 2005 predator monitoring began in June and was completed in August. Dogs were integrated into the pasture after monitoring was completed. Treatment farms incurred 6 wolf and 8 coyote visitations. Control farms incurred 0 wolf and 4 coyote visitations. 2006 predator monitoring will begin in June and will be completed in August. Visitations on treatment farms in 2005 will be compared to visitations in 2006. Additionally, the difference in visitations between treatment and control farms in 2005 will be compared to the difference in visitations in 2006. Success will be determined by the dogs' ability to deter wolf use of livestock areas and of farmers' perceived effectiveness of the dogs. This research will provide baseline data for a non-lethal management tool that could reduce conflict between wolves and agriculture while benefiting both.

135. Denning ecology of grizzly bears in the oilfield region of Alaska's North Slope.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Grizzly bears (*Ursus arctos*) in the oilfield region are at low density and northern extreme of their North American range. Early investigators suggested that scarcity of denning habitat limited the population and forced bears to move to the Brooks Range to den. The Arctic Coastal Plain in this region is relatively flat arctic tundra. However, well-drained microsites along riparian areas and geomorphic features associated with permafrost landscape offer potential den sites. During a long-term study of grizzly bears in the region, characteristics of 160 dens of 47 radio-marked bears were investigated between 1991-2003. Habitat attributes, entrance and exit dates, proximity to permanent human infrastructure, and error in detecting the true location of the den from aerial radio-tracking were investigated. Results confirmed that grizzly bears denned throughout the region, including <1 km from the Beaufort Sea coast. Some food-conditioned bears denned within the active oilfields. Sites in well-drained substrates associated with riparian areas (terraces and stream banks), relict Pleistocene sand dunes, and geomorphic features associated with permafrost landscapes, were used for dens. Pingos--conical ice-cored mounds developing from thawed lakes-- appeared to be highly selected. Sixty per cent of dens in all geomorphic types, and 70% of those in pingos (where all aspects are available) faced between 181-270 degrees N. These aspects collected large snow drifts, important for insulation to bears at this latitude. Timing of den entrance, mid-September to late October, also coincided with the period of major snow deposition. Permanent oilfield infrastructure and activity appeared to

influence choice of den location. Tradition may also influence site selection for some bears. Location error of up to 490m suggests that further investigation into methods to detect den locations is warranted for industry compliance with land use stipulations to avoid dens.

136. Survival and habitat use by juvenile American marten in northeastern Wisconsin.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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The American marten (*Martes americana*) was extirpated from Wisconsin, USA in the early 1900s from deforestation and unregulated trapping. From 1975-1990, marten reintroductions occurred in two protected core areas in northern Wisconsin. Early monitoring indicated that reintroductions were successful, with marten populations expanding within the core areas. However, more recent surveys indicate that marten populations remain restricted to the original release sites and may be declining. As a result, American marten continue to be the only state-endangered mammal in Wisconsin. Reasons for the lack of population expansion are currently unknown, but hypotheses include high mortality and limited dispersal potential. We present results of an ongoing study (2004-2006) investigating (1) cause-specific mortality rates and survival of marten, and (2) biologically important habitat variables utilized by marten within their home ranges within and adjacent to the Chequamegon-Nicolet National Forest core area in northeastern Wisconsin. Captured marten ($n = 34$) were fitted with mortality-sensitive radio transmitters and tracked daily (1 October to 15 January) or bi-weekly (16 January to 30 September) to monitor survival and determine location. To date, we have observed 2 natural mortalities, and censored 7 individuals. Annual survival rate for 2004-05 was 0.87, with a 95% confidence interval from 0.67 to 1.0. Survival rate for 2005-06 was 0.94 with a 95% confidence interval from 0.84 to 1.0. Average 95% fixed kernel home range in 2004-05 ($n = 13$) was 3.1 km². Male home ranges ($n = 8$) were significantly larger ($p < 0.001$) than females ($n = 5$). Site-level biotic and abiotic habitat variables were measured at visual locations ($n = 15$) and random locations ($n = 15$) within each marten home range and resource selection was estimated using discriminant function analysis.

137. Habitat use by reintroduced American marten in hardwood dominated forest.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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American marten (*Martes americana*) are often considered old growth forest specialists. Although marten have been found in hardwood stands in both Maine and British Columbia, this predator is most commonly found in late successional conifer dominated forests, which provide the habitat characteristics necessary for marten survival. After being extirpated due to logging and unregulated trapping in the early 1900's, American marten were reintroduced to Michigan's Northern Lower Peninsula. Reintroductions occurred in the Manistee National Forest and Pigeon River Country State Forest in 1985 and 1986 respectively. In addition to conifer stands, both forests have large areas which are dominated by hardwood species. During this study, American marten were live trapped and radio collared. Radio telemetry points were used to create minimum convex polygon home-ranges. Within these home-ranges, a concentrated use adaptive kernel was created to identify each animal's area of focused use. Micro-habitat characteristics were then measured in a variable shaped (according to kernel shape) 15 point grid within each marten's adaptive kernel. Fifteen point kernels were then overlaid outside of known marten home-ranges to assess random habitat characteristics. Habitat characteristics collected within known marten home-ranges were compared to habitat characteristics

gathered outside of marten home-ranges. These data do not support the idea that conifer dominated forest stands are necessary for the survival of American marten. Tree and vegetation species were not a good indicator of a habitats ability to support marten populations, although concentrated marten use mainly occurred in hardwood stands. Coarse woody debris, tree diameter, and vegetative cover were all significantly different between areas used by marten and random data sites. These forest characteristics are part of the overall forest structure, which is important in maintaining marten fitness. American marten need complex structure to provide avenues of prey capture, predator avoidance and escape, and resting sites.

138. Home-range dynamics and habitat selection of American marten in Michigan's northern lower peninsula.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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The American marten (*Martes americana*) was reintroduced to the Northern Lower Peninsula (NLP) of Michigan following a 75 year absence as a result of habitat destruction and over harvest. Reintroduction efforts took place in 1985 - 1986 at 2 geographically isolated locations: the Pigeon River Country State Forest (PRSF) and the Manistee National Forest (MNF). To our knowledge, there has been no previous ecological study focusing on home-range dynamics and habitat selection of the NLP marten populations since their reintroduction. Our current research focuses on intra and inter-sexual differences in home-range size between the 2 reintroduction sites, and habitat selection at a landscape scale. Martens were trapped and affixed with a VHF radio collar during the winters of 2005-2006. Eight martens were radio tracked in the PRSF (5 males, 3 females) and 6 martens were radio tracked in the MNF (5 males, 1 female). Results indicate male martens having larger home ranges than females ($F = 16.8$, d.f. = 1, $P = 0.01$), and home ranges in the PRSF were found to be larger than home ranges in the MNF ($F = 14.3$, d.f. = 1, $P = 0.01$). We were unable to calculate statistical analyses of female home ranges between sites due to small female sample size in the MNF. Using compositional analysis we were able to determine that marten home ranges were primarily comprised of upland deciduous and coniferous forests when compared to the overall study landscape ($p < 0.001$). These data provide important information for martens in the southern extent of their geographic range and in a region where populations were reintroduced.

139. Brown bear use of a coastal salt marsh in Lake Clark National Park & Preserve, Alaska.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Along the western shore of Cook Inlet, Alaska, brown bears (*Ursus arctos*) congregate in spring and early summer on small pockets of salt marsh habitat to feed on nutrient-rich sedges (*Carex* spp.), grasses (*Poa* spp.), and forbs (*Triglochin* spp.). These critical habitats provide humans with predictable bear viewing opportunities and consequently the bear viewing tourist industry has rapidly expanded in this region. The southeast boundary of Lake Clark National Park & Preserve encompasses 200 km of Cook Inlet coastline which includes 52 km² of salt marsh habitat. Park managers need quantitative information on bear use of salt marshes in order to manage human use of these areas. Scan and focal-animal sampling from elevated platforms was used to estimate bear temporal, spatial, and seasonal use patterns and activity budgets in salt marsh study areas from late May through mid August 2001-03. Sampling occurred during 6 hour time blocks between 0500 and 2300 hours. In addition to feeding, bears used salt marshes for nursing young, resting, and courtship and mating. All cohort types except sows with cubs-of-the-year were present by late May. Sows with cubs-of-the-year were first observed using the salt marsh in mid June.

140. Comparing two techniques that determine habitat use of carnivores.

Session: Ecology, Conservation, and Habitat Relationships of Mammals

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Radio-telemetry is an expensive and time-consuming technique for collecting wildlife habitat data. Using scent stations may provide a more time-efficient and less-costly alternative. However, there are few data to compare these two techniques. Therefore, we compared bobcat (*Lynx rufus*) habitat use as determined from radio-telemetry locations versus scent station visitations on the 11,735-ha Joseph W. Jones Ecological Research Center at Ichauway in Baker County, southwestern Georgia. Our data included habitat associated with 1,468 radio-telemetry locations from 23 bobcats which we compared to habitat surrounding 49 scent stations that had been visited by bobcats ($n = 227$ stations sampled) during a 3-day sampling session. We compared the proportions of each habitat used as derived from radio-telemetry locations to the proportions of habitats within buffers surrounding scent stations visited by bobcats. We then determined habitat preferences using the two techniques by comparing each technique's estimate of habitat use to proportion of habitats available on the study area. Habitat preferences determined using telemetry locations did not differ from those determined using scent station visitation rates. Our results suggest that scent station visitations may be a suitable technique for measuring habitat selection. Future work should evaluate efficiency of scent stations for quantifying habitat selection in other species. Additional comparisons of bobcat habitat selection should be conducted on other study sites to determine if our results can be extended to other areas.

141. A genetic baseline of wolves in interior Alaska parks: Examining genetic relationships among wolves of Yukon-Charley Rivers National Preserve, Denali National Park and Preserve and Gates of the Arctic National Park and Preserve.

Session: ANILCA: Conservation Biology Masterpiece or Road to Endless Compromise?

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A baseline of genetic variation and relatedness was established for 158 members of the wild wolf (*Canis lupus*) populations of Yukon-Charley Rivers National Preserve (YUCH, $N=102$), Denali National Park and Preserve (DENA, $N=52$) and Gates of the Arctic National Park and Preserve (GAAR, $N=12$), Alaska. This enabled the assessment of the "natural and healthy" status of these wolf populations in accordance with Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA 1980) and the Government Performance and Reporting Act (GPRA 1993) goal IB01. Wolves are specifically listed as "species to be managed for conservation" in the enabling legislation of these national areas. NPS Management Policies (2001) specifies protection of the "full range of genetic types in National Parks." Analyses of genetic variation, inbreeding, evolutionary dispersal and relatedness within and among packs and populations were used to characterize native genetic types. All samples were genotyped across 13 microsatellite loci and 72 samples (YUCH, $N=63$; DENA, $N=9$) were bi-directionally sequenced at the mitochondrial-DNA control region. Results for all loci and populations revealed insignificant inbreeding, substantial allelic diversity and heterozygosity levels comparable to those expected for interbreeding populations. Perpetuation of common haplotypes and mutual genotypes at various loci indicate mating persists among all 3 populations. Significant genetic differentiation based on F_{ST} analyses signals genetic sub-structuring of populations into discrete packs. The population tree (Reynolds coancestry coefficient) indicates YUCH and DENA are closely related, however, detection of unique haplotypes signifies some genetic differentiation and isolation among wolf populations. Analyses of parent/offspring relatedness in these populations revealed unexpected, sly extra-pack matings of non-dominant wolves among packs and intra-pack matings of non-dominant wolves within packs, demonstrating that alpha individuals are not

the only parents within packs. Violations of Hardy-Weinberg equilibrium were attributed to non-random mating expected in wolf-pack hierarchical, breeding structure.

142. Bear research and adaptive management in Glacier Bay National Park and Preserve.

Session: ANILCA: Conservation Biology Masterpiece or Road to Endless Compromise?

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Glacial retreat over the past 200 years in Glacier Bay, Alaska has created lush upland meadows along the shoreline that are desirable to both humans and bears (*Ursus arctos* and *Ursus americanus*). Bear-human conflicts have increased over the past 30 years as the number of backcountry campers has increased. In response to these conflicts, including a human fatality, two large areas of shoreline have been closed to camping since the 1980's. In the 1990's, park managers began collaboration with USGS bear researchers to identify key research needed to determine bear habitat characteristics and activity patterns in Glacier Bay and ultimately to minimize bear-human conflict. Two research projects have subsequently been conducted including a risk assessment of campsites in Glacier Bay, and an assessment of bear habitat and activity in areas of management concern, which included the areas closed to camping. As bear research commenced, park managers made changes to educational content and safety trainings based on preliminary findings from the field. Consequently, the number of bear-human conflicts decreased. Research is now completed and the park is incorporating findings into new management policies and a bear management plan.