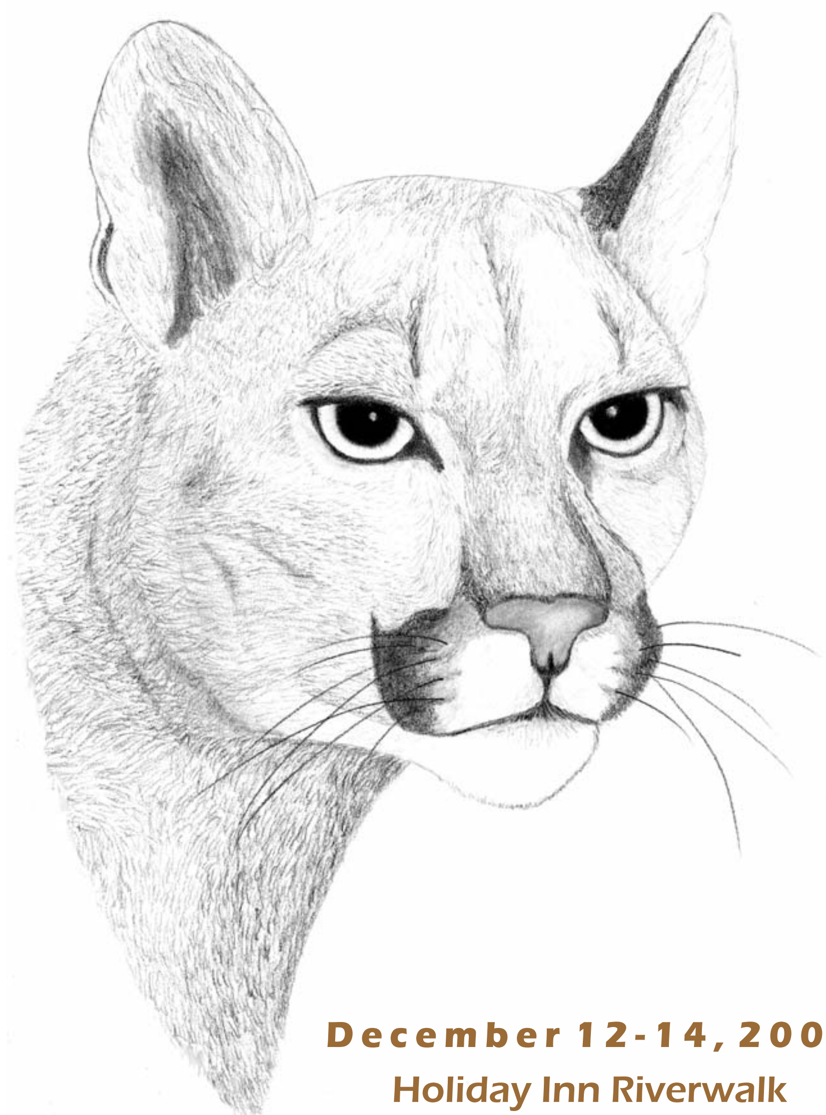
PROCEEDINGS OF THE

sixth Mountain Lion workshop



December 12-14, 2000

Holiday Inn Riverwalk
San Antonio, Texas

sixth Mountain Lion workshop

December 12-14, 2000 • Holiday Inn Riverwalk • San Antonio, Texas

Recommended Citation Formats:

Entire volume:

Harveson, L. A., P. M. Harveson, and R. W. Adams. eds. 2003. Proceedings of the Sixth Mountain Lion Workshop. Austin, Texas.

For individual papers:

Fecske, D. M., J. A. Jenks, and F. G. Lindzey. 2003. Characteristics of mountain lion mortalities in the Black Hills, South Dakota. Pages 31-36 *in* L. A. Harveson, P. M. Harveson, and R. W. Adams, eds. Proceedings of the Sixth Mountain Lion Workshop. Austin, Texas.

Cover artwork by Patricia M. Harveson
Inside artwork contributed by Texas Parks and Wildlife Department

TABLE OF CONTENTS

MEMORIAL

Michael Gratson

1952-2000

The Proceedings of the Sixth Mountain Lion Workshop is dedicated to Michael Gratson. Dr. Gratson died in a helicopter crash while monitoring mountain lion transects just days after presenting 2 papers at the Sixth Mountain Lion Workshop in San Antonio. Michael was an accomplished biologist with Idaho Game and Fish and was active in their elk, grouse, and mountain lion programs.

S C H E D U L E

Monday, 11 December 2000

1:00 pm - 5:00 pm **Registration**

Tuesday, 12 December 2000

7:30 am - 5: 00 pm	Registration
7:30 am - 8:30 am	Breakfast Buffet (Free to Registrants)
Noon - 5:00 pm	Poster Session

Session 1: Welcoming Address, Plenary Paper, and Discussion Forum, 9:00-12:00
Moderator: Dede Armentraut, Director, Mountain Lion Foundation of Texas

9:00 am	Welcoming Comments, Robert Cook, Chief Operating Officer, Texas Parks and Wildlife Department
	Welcoming Comments, Clark Adams, President, Texas Chapter of The Wildlife Society
	Program and Proceedings Business Affairs, Louis A. Harveson, Chair, Department of Natural Resource Management, Sul Ross State University
9:15 am	Plenary Paper: **Puma: A parochial View Back by a Modern Van Winkle.** Harley Shaw
9:45 am	Plenary Paper: **Historical Biogeography of Wild Cats and Their Environment in Texas**, Michael E. Tewes
10:15 am - Noon	Discussion Forum: **Challenges in Mountain Lion Conservation and Management**, Tom Logan, Kevin Hansen, Melissa Grigione, and Others
Noon -2:00 pm	**LUNCH**

Tuesday, 12 December 2000

Session 2: Mountain Lion Status Reports, 2:00-4:30
Moderator: Paul Robertson, Texas Parks and Wildlife Department

2:00 pm - 2:15 pm	**Are exotic pumas breeding in Britain?**, Hooper, Street-Perrott, and Cooper
2:15 pm - 2:30 pm	**Lions and tigers and cows: jaguar densities in Sonoran cattle country**, Gonzalez, Pina, and McRae
2:30 pm - 2:45 pm	**Managing the captive mountain lion populations in North American zoos**, Schireman
2:45 pm - 3:00 pm	**Field evidence of cougars in Eastern North America**, Bolgiano, Lester, and Maehr
3:00 pm - 3:15 pm	**Status of the puma in the Mexican Chihuahuan Desert**, Hernandez and Laundre
3:15 pm - 3:30 pm	**A survey of recent accounts of mountain lion in Arkansas**, Clark, White, Bowers, Lucio, and Heidt
3:30 pm - 3:45 pm	**BREAK**
3:45 pm - 4:00 pm	**Texas mountain lion status report**, Robertson and Altman
4:00 pm - 4:15 pm	**Status report on mountain lions in Nebraska**, Bischof and Morrison
4:15 pm - 4:30 pm	**Florida Panther genetic restoration: a status report**, Land, Bass, Jansen, McBride, and Shindle
4:30 pm	**BREAK**
6:30 pm 8:00 pm	**Social and Banquet. Keynote Address by Kevin Hansen**

Wednesday, 13 December 2000

7:30 am - 5: 00 pm Registration

7:30 am - 8:30 am Breakfast Buffet (Free to Registrants)

9:00 am - 5:00 pm Poster Session

Session 3: **Mountain Lion Interactions with Prey I, 9:00-10:30**
Moderator: Terry Blankenship, Welder Wildlife Foundation

9:00 am - 9:15 am **Mountain lion predation on elk calves in North-Central Idaho**, Gratson and Zager

9:15 am - 9:30 am **Prey selection of female mountain lions in Northeast Oregon**, Nowak and Witmer

9:30 am - 9:45 am **Habitat composition of successful kill sites for lions in Southeastern Idaho and Northwestern Utah**, Laundre and Hernandez

9:45 am - 10:00 am **Habitat factors affecting hunting success of cougars and wolves in Northwestern Montana**, Kunkel, Pletscher, and Ruth

10:00 am - 10:15 am **Mountain lion predation on cattle in Sierra San Pedro Martir, Baja California, Mexico**, Avila-Villegas, Martinez-Gallardo, Bueno-Cabrera, and Alaniz-Garcia

10:15 am - 10:30 am **A case of mountain lion limiting and elk population: the Green River watershed, Washington**, Vales and Spencer

10:30 am - 10:45 am **BREAK**

Session 4: **Monitoring Programs for Mountain Lions, 10:45-11:45**
Moderator: Michael Tewes, Caesar Kleberg Wildlife Research Institute

10:45 am - 11:00 am **An evaluation of accuracy and efficacy of cougar population estimators**, Choate, Wolfe, and Belovsky

11:00 am - 11:15 am **Long term population trends of mountain lions in southeastern Idaho and Northwestern Utah**, Laundre and Hernandez

11:15 am - 11:30 am **Mountain lion population estimation using aerial sampling of tracks in snow**, Gratson, Zager, Garton, and Bomar

11:30 am - 11:45 am **What is revealed in a mountain lion heel: using heel shape to ascertain identity**, Grigione and Burman

11:45 am - 1:30 pm **LUNCH**

Wednesday, 13 December 2000

Session 5: Mountain Lion Interactions with Prey II, 1:30-3:00
Moderator: Louis Harveson, Department of Natural Resource Management

1:30 pm - 1:45 pm	**Mountain lion use of open, edge, and forest habitat: evidence for optimal foraging?**, Holmes and Laundre
1:45 pm - 2:00 pm	**Prey items of mountain lions in a forestry system in Brazil**, Mazzolli
2:00 pm - 2:15 pm	**Predation rates of female mountain lions in Northeast Oregon**, Nowak and Witmer
2:15 pm - 2:30 pm	**Mountain lion predation on endangered woodland caribou, mule deer, and white-tailed deer**, Katnik, Almack, Clarke, Robinson, and Wielgus
2:30 pm - 2:45 pm	**Using GPS collars to estimate mountain lion predation rates and selection of large prey**, Anderson and Lindzey
2:45 pm - 3:00 pm	**A test of optimal foraging: mountain lions and mule deer**, Blum and Laundre
3:00 pm - 3:15 pm	BREAK

Session 6: Human Dimensions and Mountain Lion Management, 3:15-5:00
Moderator: Clark Adams, Department of Wildlife and Fisheries Sciences

3:15 pm - 3:30 pm	**Changing dynamics of puma attacks on humans**, Fitzhugh
3:30 pm - 3:45 pm	**Mountain lion-human interactions in Yosemite National Park**, Chow
3:45 pm - 4:00 pm	**Regulating hunting of mountain lions: metapopulation approach**, Laundre, Hernandez, and Clark
4:00 pm - 4:15 pm	**Criteria used to implement public safety cougar removals with the use of dogs**, Martorello and Pierce
4:15 pm - 4:30 pm	**Investigating cougar attacks on humans: the British Columbia approach**, Corbett
4:30 pm - 4:45 pm	**An evaluation of cougar management strategies in Utah**, Wolfe, Bates, and Choate
4:45 pm - 5:00 pm	**A spatial evaluation of cougar-human encounters in U.S. National Parks: the cases of Glacier and Big Bend National Parks**, Tiefenbacher, Butler, and Shuey
5:00 pm	BREAK

Thursday, 14 December 2000

7:30 am - Noon	Registration
7:30 am - 8:30 am	Breakfast Buffet (Free to Registrants)

Session 7: **Ecology of Mountain Lions I, 9:00-10:30**
Moderator: David Shindle, Florida Fish and Wildlife Conservation Commission

9:00 am - 9:15 am	**Use of dispersal distance to assess the long term conservation of mountain lions**, Laundre
9:15 am - 9:30 am	**Dispersal characteristics of juvenile mountain lions in Southwest Oregon**, Robertson, Jones, and Jackson
9:30 am - 9:45 am	**Home ranges and movements of cougars in a non-hunted population in western Washington**, Spencer, Allen, Sheeler-Gordon, Anderson, and Dixon
9:45 am - 10:00 am	**Mountain lion home range use in a fragmented landscape**, Koloski and Lindzey
10:00 am - 10:15 am	**Ecology of the mountain lion on Big Bend Ranch State Park in the Trans-Pecos Region of Texas**, Pittman, Guzman, and McKinney
10:15 am - 10:30 am	**Density and resilience of mountain lions in a forestry system of Brazil**, Mazzolli
10:30 am - 10:45 am	**BREAK**

Session 8: **Ecology of Mountain Lions II, 10:45-Noon**
Moderator: Rich Beausoleau, New Mexico Game and Fish Department

10:45 am - 11:00 am	**Florida panthers in a wetland ecosystem**, Jansen
11:00 am - 11:15 am	**Recovery of the Florida Panther: Accomplishments and future needs**, Land, Kasbohm and Jennings
11:15 am - 11:30 am	**Ecology and management of the "European mountain lion" (Lynx lynx)**, Linnell, Odden, and Andersen
11:30 am - 11:45 am	**The effects of predator control on mountain lions in Texas**, McBride
11:45 am - Noon	**Cougars and desert bighorn sheep in the FRA Cristobal Range: Scale, geography, and seasonality**, Wright, Kunkel, Hornocker, and Quigley
Noon - 1:30 pm	**LUNCH**

Thursday, 14 December 2000

Session 9: **Genetics, Diseases, and Modeling of Mountain Lions, 1:30-3:15**
Moderator: Dede Armentraut, Director, Mountain Lion Foundation of Texas

1:30 pm - 1:45 pm	**A phylogenetic study of pumas (Puma concolor) using mitochondrial DNA markers and microsatellites**, Culver, Johnson, Pecon-Slattery, and O'Brien
1:45 pm - 2:00 pm	**Estimating sex reporting bias in mountain lions using DNA analyses**, Anderson and Lindzey
2:00 pm - 2:15 pm	**Relationship between dispersal and gene flow among populations of mountain lions (Puma concolor) in fragmented habitat**, Loxterman, Laundre, and Ptacek
2:15 pm - 2:30 pm	**Viral diseases and cougar demography**, Biek, Anderson, Ruth, Murphy, Johnson, Gillin, and Poss
2:30 pm - 2:45 pm	**The application of a Richards curve growth model to cougars in the Northern Great Basin**, Laundre and Hernandez
2:45 pm - 3:00 pm	**Energetics of free roaming mountain lions in the Great Basin**, Laundre and Hernandez
3:00 pm - 3:15 pm	**Aging cougars in the field from birth to death**, Laundre and Hernandez
3:15	**Closing Comments, Ideas for Next Workshop**

RESEARCH AND STATUS REPORTS

STATUS REPORT ON MOUNTAIN LIONS IN ARIZONA

JOHN PHELPS, Arizona Game and Fish, 2221 W. Greenway Road, Phoenix, Arizona 85203

Abstract: The following data are provided as a summary of mountain lion harvest trends and techniques employed in Arizona from 1951-1999.

Table 1. Summary of mountain lion harvest, Arizona Game & Fish Department [1]

Year	Tags Issued	Sport[2]	Depredation[3]	Other[4]	Total Harvest
1951	-	-	181	0	181
1952	-	-	198	0	198
1953	-	-	200	0	200
1954	-	-	201	0	201
1955	-	-	230	0	230
1956	-	-	189	0	189
1957	-	-	266	0	266
1958	-	-	264	0	264
1959	-	-	243	0	243
1960	-	-	215	0	215
1961	-	-	242	0	242
1962	-	-	231	0	231
1963	-	-	197	0	197
1964	-	-	267	0	267
1965	-	-	286	0	286
1966	-	-	257	0	257
1967	-	-	257	0	257
1968	-	-	226	0	226
1969	-	-	217	0	217
1970	-	-	278	0	278
1971	3835	172	0	0	172
1972	4214	120	48	0	168
1973	4917	190	15	0	205
1974	4896	172	22	0	194
1975	5460	219	19	1	239
1976	6261	238	14	0	252
1977	7498	248	4	0	252
1978	7964	229	12	0	241
1979	7938	283	7	0	290
1980	7799	204	2	0	206
1981	7871	191	9	1	201
1982	8069	316	8	1	325
1983	7004	221	7	1	229
1984	6876	184	9	0	193
1985	7523	246	19	7	272
1986	7936	191	25	0	216

Table 1. (continued).

Year	Tags Issued	Sport[2]	Depredation[3]	Other[4]	Total Harvest
1987	8304	205	31	5	241
1988	8495	183	24	1	208
1989	3656	130	65	1	196
1990	3046	188	40	1	229
1991	3038	179	25	1	205
1992	3177	201	28	5	234
1993	3407	188	38	12	238
1994	4156	215	35	6	256
1995	4859	234	31	1	266
1996	5552	225	38	2	265
1997	5657	267	47	3	317
1998	6590	289	52	1	342
1999	6885	246	47	2	295

[1]Data from Indian Reservations are included through 1987 and excluded thereafter.
[2]Estimated from a mail questionnaire from 1971-1987 and from mandatory check-outs from 1988-present.
[3]As reported by Arizona Livestock Sanitary Board through June 30, 1970, and reported stock-killers since 1971.
[4]Includes known kills other than sport or depredation (e.g., highway mortality, capture mortality, and illegal take).

Table 2. Mountain lion harvest information, Arizona Game & Fish Department.

1951 to 1999*

Variable	Mean	Minimum	Maximum	Std. Dev	Std. Error
Total Harvest	236.6	168	341	39.5	5.6

1971 to 1999*

Variable	Mean	Minimum	Maximum	Std. Dev	Std. Error
Tags Issued	5961.5	3038	8495	1838.8	341.5
Sport Harvest	212.9	120	316	43.9	8.2
Depredation	24.9	0	65	17.0	3.2
Total Harvest	239.5	168	341	44.2	8.2

Table 2. (continued).

1989 to 1999*

Variable	Mean	Minimum	Maximum	Std. Dev	Std. Error
Tags Issued	4547.5	3038	6885	1436.4	433.1
Sport Harvest	214.7	130	289	44.5	13.4
Depredation	40.5	25	65	11.6	3.5
Total Harvest	258.4	196	341	45.1	13.6

*	1951-1970	All harvest data was obtained from bounty records.
	1971-1999	Depredation harvest data obtained from mandatory reporting.
	1971-1988	Purchase of a mountain lion tag required ($1.00).
	1971-1988	Sport harvest data obtained from mail surveys.
	1989-1999	Purchase of a mountain lion tag required ($11.00).
	1989-1999	Sport harvest data obtained from mandatory checkout.

Table 3. Arizona mountain lion harvest data by method, 1995-2000.

	1995			1996			1997			1998			1999			2000		
Method	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**	**M**	**F**	**U**
Calling Only	8	2	0	12	4	0	10	2	0	13	6	1	16	5	0	12	5	0
Dogs/Calling				0	1	0												
Dogs Only	50	97	3	45	86	0	84	98	0	74	117	1	66	93	1	58	51	1
Dogs/Stalking												0	1	0				
Glassing Only	4	0	0	1	2	0	4	0	0	1	2	0	4	0	0	0	1	0
Hunt Deer	10	5	1	5	4	0	8	3	0	15	4	0	11	4	0	8	1	0
Hunt Elk				1	0	0				1	0	0	0	2	0	1	0	0
Hunt Javelina	3	0	0	1	0	0	1	0	0	1	0	0				1	0	0
Other	12	8	1	10	6	0	6	3	0	9	2	0	8	3	0	7	0	0
Other Game				1	0	0	1	0	0				1	1	0			
Stalking/ Glassing	1	0	0	1	1	0	1	0	0				0	1	0	2	1	0
Still Hunting							0	1	0				1	0	0	2	1	0
Stalking Only	11	5	0	17	7	0	11	19	0	15	15	1	8	12	0	6	2	0
Stand Hunting							1	1	0									
Trapping							1	0	0									
Unknown	4	9	0	12	8	0	6	7	1	7	4	0	5	4	0	3	1	1
TOTAL	**103**	**126**	**5**	**106**	**119**	**0**	**134**	**134**	**1**	**136**	**136**	**3**	**121**	**125**	**1**	**100**	**63**	**2**
TOTAL		**234**			**225**			**269**			**275**			**247**			**165**	
Illegal Kill										0	1	0	1	1	0			
Not Sport Kill	0	0	1	1	1	0	0	0	3									
GRAND TOTAL	**103**	**126**	**6**	**107**	**120**	**0**	**134**	**134**	**4**	**136**	**137**	**3**	**122**	**126**	**1**	**100**	**63**	**2**
GRAND TOTAL		**235**			**227**			**272**			**276**			**249**			**165**	

(as of 11/19/2000)

STATUS REPORT ON MOUNTAIN LIONS IN NEBRASKA

RICHARD BISCHOF, Nebraska Game and Parks Commission, 2200 North 33rd St. Lincoln, NE 68503

BRUCE MORRISON, Nebraska Game and Parks Commission, 2200 North 33rd St. Lincoln, NE 68503

Abstract: From 1991 to 2000, 8 confirmed observations of mountain lions were made in the state of Nebraska. Several hundred additional, unconfirmed reports were submitted throughout the state. This status report evaluates confirmed and unconfirmed observations with respect to distribution, type of observation, and response.

Available records suggest that the mountain lion (*Puma concolor*) once occurred throughout Nebraska, but was probably never abundant (Jones 1962, 1964). The species was likely associated with the rough country in the Pine Ridge in northwest Nebraska, and occasionally ranged south and eastward along the larger streams (Jones 1949). Mountain lions were extirpated in Nebraska by the end of the 19th century. Regardless of this, reports of mountain lion sightings occurred almost annually throughout the second half of the 20th century. In 1991 the first confirmed mountain lion for nearly 100 years was observed in Sioux County and subsequently shot by a hunter. To this point, mountain lions were not protected by state law, mainly because of the low chances of an encounter in the state. The controversial shooting in 1991 and the possibility that more mountain lions might be found in the state made the consideration of a status change necessary. In 1995 the mountain lion was designated as a game species by the Nebraska legislature. Since no hunting season has been established, the species is protected year-round.

The objective of this report is to provide a compilation and evaluation of recent mountain lion reports in Nebraska. It also attempts to correlate sighting locations and tolerance for mountain lions with other factors such as human population density.

OBSERVATIONS

From 1990 to 2000 hundreds of mountain lion reports have been submitted to the Nebraska Game and Parks Commission (NGPC). Reports have been submitted in various formats from personal phone and email communications to formal data sheets, and thus vary greatly in accuracy and detail. Eighty-eight of these reports provided sufficiently accurate spatial and temporal information and were entered into an ACCESS database and subsequently mapped using ArcView GIS software. The reports submitted include visual observations, observations of signs (such as tracks, foraging remains), as well as mortalities (i.e. dead mountain lions).

Reports were often incomplete, so most parameters (e.g. gender, age, behavior) are only available for a small subset of the entire report collection. The geographic location information varies greatly in its accuracy as well. While some observers recorded legal land description up to section quarter, others only indicated the approximate distance and direction to certain landmarks such as towns, etc.

Of the 88 reports entered into the database, 72 were visual observations, 11 were observations of signs, 4 were mortalities, and 1 was an acoustic observation. In 9 cases, reports were submitted of observations of more than 1 mountain lion (2-3).

MORTALITIES

Five mountain lion mortalities were reported between 1991 and 2000 (See Figure 1). All specimens were examined by veterinarians. Four were males and 1 was a female. All animals were adults and in fair to excellent body condition. Three animals died as a result of wounds caused by firearms, and 1 may have been killed by a train. None of the animals that were shot could be associated with depredation complaints, however 1 animal was shot within the Harrison city limits and another was treed near a farm house and shot by the farm owner. The most recent specimen was shot by law enforcement officials within the city limits of St. Paul, Nebraska on November 20, 2000.

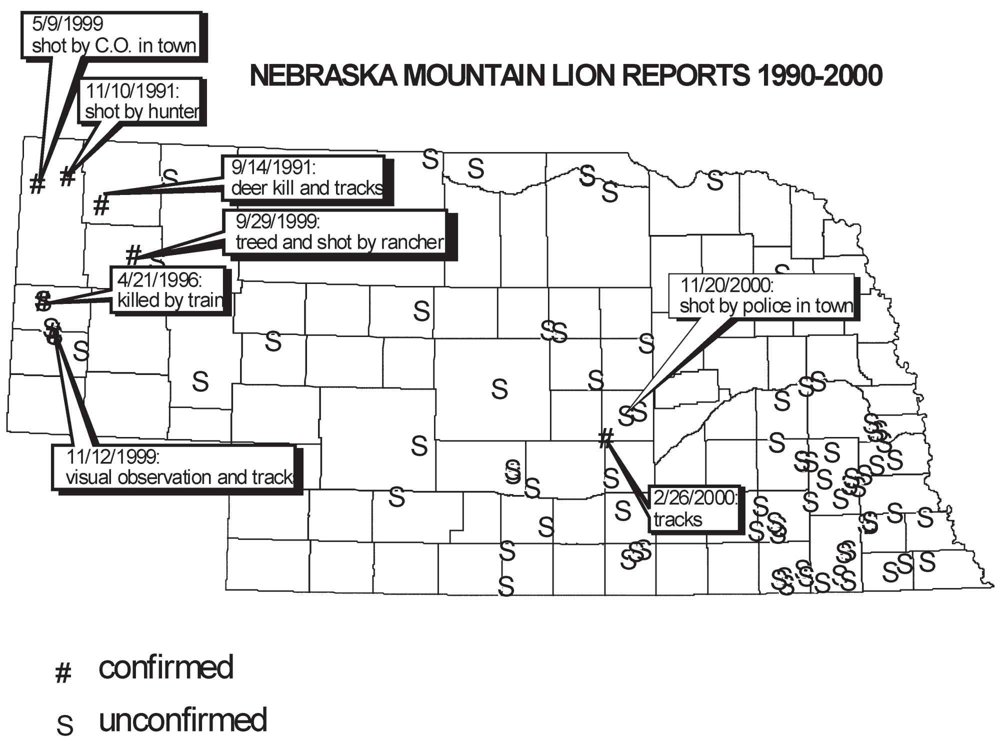


Figure 1: Distribution of Nebraska mountain lion observation reports that were included in the analysis.

SOURCES

Based on the geographic pattern of the confirmed mountain lion reports and the mountain lion population status in neighboring states, it is reasonable to believe that least some of the animals encountered in Nebraska originated either in Colorado, Wyoming and/or the Black Hills of South Dakota (Benedict et al. 2000). Another source may be animals that escaped or have been released from captivity.

DEPREDATION

Of all reports entered into the database, 14 were associated with depredation complaints. Cattle, hog, goat, horse, dog, and cat were the domestic species suspected of being injured or killed by mountain lions. Cattle (mostly calves) were most commonly reported as being preyed upon by mountain lion. Article 37-557 (Laws of the State of Nebraska pertaining to the Game and Parks

Commission) provides legal opportunity to destroy mountain lions causing agricultural depredation. None of the confirmed sightings was linked with depredation occurrences.

RESPONSES

The responses of NGPC staff to reports ranged from shooting a mountain lion to site investigations to no response at all. In 1997 a Mountain Lion Action Plan was composed by the NGPC in an effort to standardize report investigation, evaluation, and response.

In 55 of 88 cases the reporter spoke directly with an NGPC employee or was contacted by an NGPC employee after submitting a report. In >20 of 88 cases NGPC employees inspected the observation site.

CONCLUSION

The majority of confirmed mountain lion observation reports come from the panhandle area in close proximity to Colorado, Wyoming or South Dakota, all states with extant mountain lion populations. On the other hand, the majority of reports that could not be confirmed coincide with areas of high human population density. Two factors may be responsible for this clustering of unconfirmed reports in areas with denser human population. First, the more people live in an area the greater the number of possible observations and thus reports. Second, an initial report that becomes public (regardless of whether it is confirmed or not) can cause biases in future observers, thus potentially causing a chain reaction of additional "observations". This illustrates the importance of appropriate responses to the public, even if reports are unconfirmed.

Considering the recent confirmed sightings of mountain lions and the large number of deer in the state, it is likely that additional mountain lions will be encountered in Nebraska. It is doubtful that a population will establish itself in areas where human population density and associated habitat disturbance is high. Encounters, however, in those areas are not impossible considering the large distances that individual animals, especially young males, can travel. In addition, it is possible that some animals were released or escaped from captivity. A frequently updated management plan will continue to provide protocols for handling a variety of situations from a biological, emergency, and public relations point of view.

LITERATURE CITED

Benedict, R. A., H. H. Genoways., and P.W. Freeman. 2000. Shifting distributional patterns of mammals in Nebraska. Transactions of the Nebraska Academy of Sciences. 26:55-84.

Jones, J. K., Jr. 1962. Early records of some mammals from Nebraska. Bulletin of the University of Nebraska State Museum. 4:88-99.

Jones, J. K., Jr. 1949. The occurrence of the mountain lion in Nebraska. Journal of Mammalogy. 30:313.

Jones, J. K., Jr. 1964. Distribution and taxonomy of mammals of Nebraska. University of Kansas Publications. Museum of Natural History. 36:299-302.

Linnell, J. D. C., J. Odden, M. E. Smith, R. Aanes, and J. E. Swenson. 1999. Large carnivores that kill livestock: do "problem individuals" really exist? Wildlife Society Bulletin. 27:698-705.

Logan, K. A., and L. L. Irwin. 1985. Mountain lion habitats in the Bighorn Mountains, Wyoming. Wildlife Society Bulletin. 13:257-262.

Lindzey, F. 1987. *In* Novak, M., J.A. Baker, M.E. Obbard., and B. Malloch. Wild Furbearer Management and Conservation in North America. p657-668

STATUS OF THE MOUNTAIN LION IN NEW MEXICO, 1971-2000

RICHARD A. BEAUSOLEIL, New Mexico Department of Game and Fish, 408 Galisteo, Santa Fe, New Mexico 87504 USA

Abstract: The mountain lion (Puma concolor) is an important species in New Mexico. A long-range plan for mountain lion management in New Mexico was developed in 1997. New Mexico currently conducts 2 mountain lion control programs. There were 156 (58F, 98M) mountain lion pelts tagged from 63 game management units during the 1999-2000 hunt season. Hunter survey cards, implemented since the 1984-85 hunt season, have provided New Mexico Game and Fish (NMDGF) with information to aid in managing cougar populations. Currently, NMDGF is designing a population study to estimate the statewide mountain lion population using a DNA technique. The NMDGF received $100,960 in revenue from mountain lion hunting license sales during the 1999-2000 license year.

MANAGEMENT HISTORY

The mountain lion (*Puma concolor*) became a protected species in New Mexico in 1971. Since then, New Mexico Department of Game and Fish (NMDGF) has assumed management authority and established regulations on hunting seasons, bag limits, and depredation resolution. In 1971 the State Game Commission (Commission) passed a regulation protecting spotted kittens and female lions with young from harvest. Also in 1971, NMDGF initiated a 4-month hunting season in the southwestern quarter of the state with a bag limit of 1 mountain lion. In subsequent years hunting areas expanded and the hunting season was gradually extended. Between 1979 and 1983 the bag limit was increased to 2 lions and the season was 11 months throughout most of the state. In 1979 the Commission initiated mandatory pelt tagging by NMDGF personnel. In 1983 the agricultural industry, concerned with livestock depredation, introduced a bill to New Mexico's House of Representatives to eliminate the mountain lion's protected status. The bill was tabled but more information was requested. In response, NMDGF produced a detailed report of mountain lions in New Mexico (Evans 1983). Based on recommendations from this report the 1984 hunting season was reduced to 3 months in most areas of the state. From 1985-1999 the season was extended to 4 months and the bag limit reduced to 1. In 1999, after NMDGF made presentations to the Commission and the public, the mountain lion harvest structure was revised to implement a harvest quota system. In this system New Mexico would be divided into 10 mountain lion management zones (Fig. 1). Each zone would be open to mountain lion hunting from 01 October to 31 March, or until the total number of kills (as determined by mandatory check-in for successful hunters) reached the harvest quota for that zone. A harvest quota hotline is available for hunters to obtain the status of a particular zone, and for NMDGF officers to report pelt tag information. Harvest objectives within each zone were based upon mountain lion distribution, habitat, and desires expressed by the pubic and the Commission to maintain, increase, or decrease mountain lion populations within various parts of New Mexico. The yearly harvest goal for the 2000-01 and 2001-02 hunting seasons was set at 176 mountain lions (Table 1). A long-range plan for mountain lion management in New Mexico was developed in 1997 (NMDGF 1997). The projects listed in this plan addressed the major issues that were identified through 18 public meetings held throughout the state. In addition to listing a series of tasks and strategies to achieve each task, this plan describes the schedule, personnel, and budget required for implementing actions. The plan will be revised in 2001. Beginning with the 2000-01 season, NMDGF will collect a tooth from all lions killed in the state for more accurate aging of kills.

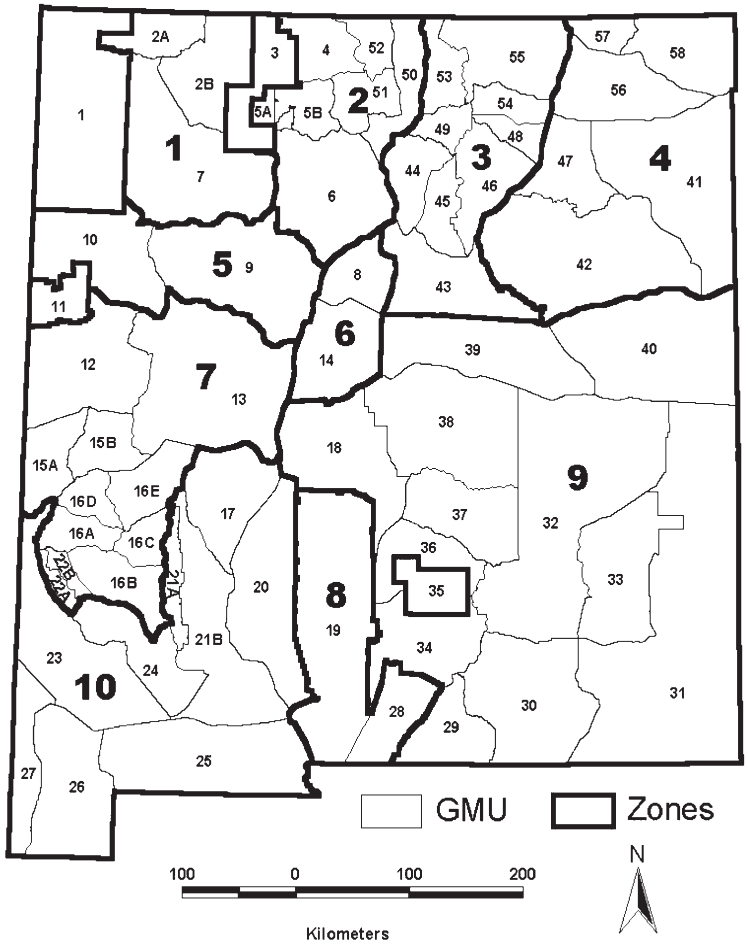


Fig. 1. Current cougar management zones (Zones) and game management units (GMU) in New Mexico, New Mexico Department of Game and Fish, 2000.

Table 1. Details of New Mexico's mountain lion harvest quota including zone, zone area description, game management units in each zone, and allowable lion harvest for the 2000-01 and 2001-02 hunting seasons, New Mexico Department of Game and Fish.

Zone	General Description of Area in Zone	Game Management Unit Numbers in Zone	# Lion Kills Allowed
I	San Juan Mountains	2,7	11
II	Jemez Mountains	4 6,50-52	34
III	Sangre De Cristo Mountains	43-46,48,49,53-55	18
IV	High Northeast Plains	41,42,47,56-58	12
V	West Central Mountains	9,10	3
VI	Sandia & Manzano Mountains	8,14	6
VII	Gila Mountains	12,13,15,16,22	18
VIII	Military Reservations	19,28	3
IX	Southeast	18,29-34,36-40	18
X	Southwest Deserts	17,20,21,23-27	53
		Total	**176**

HARVEST

There were 156 (58F, 98M) mountain lion pelts tagged from 63 game management units during the 1999-2000 hunt season (Table 2). This harvest represents a 1% increase over the 1998-99 hunting season. The 5-year (1995-96 through 1999-2000) average mountain lion harvest in New Mexico is 155 mountain lions (57F, 98M); the 10-year average harvest (1990-91 through 1999-2000) is 138 (51F, 87M).

Mountain lion hunting license sales have increased in New Mexico. Sales began to escalate during the 1990-91 hunting season and increased 62% (482 to 781) from the previous year (Table 2). Since that time, numbers have fluctuated but continued in an upward trend. In the past 5 years hunting permit sales have increased 102% (842 to 1702).

Table 2. Mountain lion hunting licenses issued and sex of harvest in New Mexico, 1981-2000, New Mexico Department of Game and Fish.

Hunt Year	Licenses Issued	Male Harvest	Female Harvest	Unknown Sex	Total Harvest
1981-82	360	78	44	3	125
1982-83	481	55	44	1	101
1983-84	661	67	65	0	132
1984-85	443	47	32	0	79
1985-86	472	56	48	0	104
1986-87	437	55	46	0	101
1987-88	456	43	35	0	78
1988-89	450	56	35	0	91
1989-90	482	70	42	0	112
1990-91	781	72	36	0	108
1991-92	765	77	42	0	119
1992-93	826	68	37	0	105
1993-94	926	75	52	0	127
1994-95	1145	87	61	2	150
1995-96	842	74	45	0	119
1996-97	980	114	62	1	177
1997-98	974	108	58	2	168
1998-99	1485	95	58	0	153
1999-00	1702	98	58	0	156

HUNTER SURVEY CARDS

Hunter survey cards, implemented since the 1984-85 hunt season, have provided NMDGF with information to aid in managing cougar populations. Although less reliable for determining harvest trends than actual pelt tag data, surveys provide valuable hunter and harvest statistics such as hunter effort, method of take, and whether aids such as guides and dogs were used. Furthermore, surveys allow this information to be obtained from hunters who do not make a kill. According to the 1999-2000 survey, hunters spent an average of 8 days hunting lions, 57% of successful hunters utilized guides and hounds, 32% hunted with hounds only, and 10% hunted without aid. In the past 5 hunt seasons, the average survey return rate was 37%; in the past 10 hunt seasons, the average return rate was 38% (Table 3). In an effort to increase the return rate, NMDGF is considering making changes to the mail-in survey. Providing the survey with the hunting license at time of purchase would eliminate mailing costs, increase sample size by eliminating mailing address errors (due to illegibility), and may provide more accurate information if the time between the hunt and survey response is reduced. Another possibility is to send several surveys throughout the season. Although more costly, this may increase survey response rate and data accuracy by reducing the time between the hunt and survey return.

Table 3. Mountain lion hunter surveys mailed, number returned, and return rate in New Mexico, 1984-2000, New Mexico Department of Game and Fish

Year	# Surveys Mailed	# Surveys Returned	Return rate
1984-85	386	139	36%
1985-86	403	235	51%
1986-87	437	120	27%
1987-88	456	108	24%
1988-89	450	N/A[a]	N/A[a]
1989-90	482	120	25%
1990-91	781	388	50%
1991-92	765	318	41%
1992-93	826	333	40%
1993-94	735	281	38%
1994-95	1145	368	32%
1995-96	842	302	43%
1996-97	895	297	33%
1997-98	974	269	28%
1998-99	1346	537	40%
1999-00	1601	646	40%

[a]Data are not available

DEPREDATION

It is the policy of NMDGF to resolve depredation and to minimize property damage, conflict, and threat to human safety by mountain lions. The legal definition of depredation in New Mexico is "property damage by protected wildlife on privately owned or leasehold interest land, where the damage value exceeds applicable income earned on that site from the wildlife species causing damage." When a depredation complaint is received, a NMDGF investigator and the complainant visit the complaint site within 24 hours, or as soon as the complainant is available. The on-site investigation is to identify the complaint type as a depredation, conflict, or human safety problem and to verify if any human actions are contributing to the problem. If a depredation situation exists, a permit authorizing a kill is issued to the investigator or directly to the landowner. Permits issued have a specific start and end date and all kills are reported immediately. When the permit expires, the investigating officer submits a detailed narrative of the incident and outcome to the depredation coordinator. In the previous 5 years, NMDGF has issued an average of 31 permits per year, the highest being 45 permits in 1999 (Table 4).

Table 4. Number of mountain lion depredation permits issued and lions killed in New Mexico, 1981-1999, New Mexico Department of Game and Fish.

Year	# Depredation Permits Issued	# Male Lions Killed	# Female Lions Killed	# Unknown Sex Killed	Total # Lions Killed
1981	13	0	0	0	0
1982	22	0	0	0	0
1983	11	3	4	0	7
1984	6	0	0	0	0
1985	5	0	0	0	0
1986	14	4	1	2	7
1987	15	3	2	2	7
1988	7	0	1	0	1
1989	17	2	3	1	6
1990	24	1	3	0	4
1991	31	7	3	0	10
1992	32	3	5	0	8
1993	23	4	5	0	9
1994	16	5	4	0	9
1995	27	3	2	0	5
1996	26	6	4	0	10
1997	29	6	3	0	9
1998	28	3	2	0	5
1999	45	5	14	1	20

MOUNTAIN LION CONTROL PROGRAMS

New Mexico currently conducts 2 mountain lion control programs. The first program was passed by the Commission in January 1985 in response to the increasing number of livestock being killed by lions in game management unit 30 (Fig. 1). This Order instructed NMDGF to remove lions on ranches that had more than 4 verified depredations in a 4-year period. Each year, NMDGF could remove up to 14 lions from all ranches combined. In 1986 the Order was revised and the number of verified depredations required for lion removal was increased to 6 within a 3-year period; the maximum number of lions that could be removed yearly remained at 14. This program still operates according to those parameters. Fourteen lions were killed in 1999 (Table 5).

Table 5. Preventative lion control permits issued and number of mountain lions killed in Unit 30, New Mexico, 1985-1999, New Mexico Department of Game and Fish.

Year	# Preventative Permits Issued in Unit 30	# Males Killed in Unit 30	# Females Killed in Unit 30	# Unknown Sex Killed in Unit 30	Total # Lions Killed in Unit 30
1985	16	9	4	0	13
1986	18	4	9	0	13
1987	17	9	5	0	14
1988	14	6	8	0	14
1989	19	2	4	0	6
1990	11	4	3	0	7
1991	14	8	6	0	14
1992	14	6	8	0	14
1993	12	6	2	4	12
1994	11	9	2	0	11
1995	8	6	2	0	8
1996	11	5	5	1	11
1997	11	6	2	2	10
1998	12	8	2	2	12
1999	14	5	7	2	14

The second lion control program was initiated in response to declining Rocky Mountain and desert bighorn sheep populations. Currently, 5 wild populations of Rocky Mountain bighorns totaling 600 sheep and 7 wild populations of desert bighorns totaling 200 sheep occupy New Mexico (W. C. Dunn, personal communication). Of 50 radiocollared bighorn mortalities between 1995 and early 2000, 37 (74%) were killed by cougars (Dunn 2000). In 1997, the Commission passed a regulation that instructed NMDGF to kill any lion that was known to have killed a bighorn sheep. Eight lions were killed that year but lion predation remained high. In 1999, the Commission passed another regulation allowing the removal of up to 34 lions per year, for 5 years, in 4 bighorn sheep ranges. This number is included in the harvest quota but allows for removal after the sport-hunting season if the unit quota was not met during the season. Four houndsmen were contracted in 1999 to remove lions, but to date no lions have been removed under this program.

RESEARCH

The first study of mountain lions in New Mexico began in 1934 (Hibben 1937), documenting life history attributes in the northern and western portion of the state. From 1971 until 1980, NMDGF conducted research in southwestern New Mexico, investigating food habits and movement ecology and using radio telemetry (Donaldson 1975, Johnson 1982). The National Park Service funded a research study in southeastern New Mexico between 1982 and 1985, within Carlsbad Caverns and Guadalupe Mountains National Parks (Smith et al. 1986). This study focused on population dynamics and provided basic ecological information of mountain lions in that region. From 1983-1985, NMDGF performed a study to determine the extent of illegal commercialization of mountain lions (Anonymous 1985). Most recently, NMDGF contracted Hornocker Wildlife Institute to conduct an intensive study of mountain lion ecology (Logan et al. 1996). This 10-year study examined population dynamics, social organization, interactions between mountain lions and mule deer and desert bighorn sheep, and mountain lion translocation as a management tool (much of this information was presented at the Fifth Mountain Lion Workshop).

In 1996, the Geography Department at New Mexico State University was contracted to delineate mountain lion ranges and expected densities throughout New Mexico by analyzing characteristics of actual mountain lion locations that were obtained during the study conducted by Logan et al. (1996). The result was a predictive GIS model of cougar habitat in New Mexico (Campbell 1998).

Currently, NMDGF is designing a population study to estimate the statewide mountain lion population using a DNA technique. This evolving technique for population monitoring is based on microsatellite analysis (Paetkau ans Strobeck 1994). Essentially, DNA can be used as marks to identify individuals in the capture and recapture segments of the study. These data can then be incorporated into capture-recapture population models to generate a population estimate.

ECONOMIC IMPACTS

The NMDGF received $100,960 in revenue from mountain lion hunting license sales during the 1999-2000 license year. Currently, the cost for a license to hunt lions in New Mexico is $30 for residents and $200 for non-residents. These fees have remained constant since the 1996-97 season when the resident license fee rose from $10 to $30. Non-residents accounted for 17% of the total revenue from lion hunting license sales in 1999-2000 and an undetermined amount of income to local economies in the form of accommodations, hunting supplies, and outfitting services. Guides and outfitters play a significant role in mountain lion hunting. For the 1995-96 through 1999-2000 hunt seasons, an average of 56% of hunters that harvested a lion employed guides or outfitters. Although the fees charged by guides and outfitters vary, the revenue from these services almost certainly exceeds the total revenue generated from lion license sales.

Mountain lions can have negative economic impacts on some livestock operations. Lions occasionally prey on domestic sheep or other livestock. Although the number of these depredation incidents in New Mexico is relatively small (10 in 1999), there may be significant economic impacts to individual ranchers that suffer from chronic lion depredation losses.

LITERATURE CITED

Anonymous. 1985. Statewide investigations of commercialization of captive mountain lions. Final Report, Pittman-Robertson Project W-126-R. New Mexico Department of Game and Fish, Santa Fe, New Mexico USA.

Campbell,, R.J. 1998. A predictive model of cougar habitat, San Andres Mountains, New Mexico. Thesis. New Mexico State University, Las Cruces, New Mexico USA.

Donaldson, B. 1975. Mountain lion research. Final Report, Pittman Robertson Project W-93-17, Work plan 15, Job 1. New Mexico Department of Game and Fish, Santa Fe, New Mexico USA.

Dunn, W.C. 2000. Cougar predation on bighorn sheep in New Mexico. A case study for the Western Association of Fish and Wildlife Agencies. New Mexico Department of Game and Fish, Santa Fe, New Mexico USA.

Evans, W. 1983. The cougar in New Mexico: biology, status, depredation of livestock, and management recommendations. Response to House Memorial 42. New Mexico Department of Game and Fish, Santa Fe, New Mexico USA.

Hibben, F.C. 1937. A preliminary study of the mountain lion (Felis oregonenis spp.). University of New Mexico Bulletin, Biological Series 5(3) 5-59.

Johnson, J. 1982. Mountain lion research. Final Report, Pittman Robertson Project W-124-R-4, Job 1. New Mexico Department of Game and Fish, Santa Fe, New Mexico USA.

Logan, K.A., L.L. Sweanor, T.K. Ruth, and M.G. Hornocker. 1996. Cougars of the San Andres Mountains, New Mexico. Federal Aid in Wildlife Restoration, Project W-128-R, for New Mexico Department of Game and Fish, Santa Fe, New Mexico USA.

New Mexico Department of Game and Fish. 1997. Long range plan for the management of cougar in New Mexico. Federal Aid in Wildlife Restoration Grant W-93-R39, Project 1, Job 5. New Mexico Department of Game and Fish, Santa Fe, New Mexico USA.

Paetkau, D., and C. Strobek. Microsattelite analysis of genetic variation in black bear populations. Molecular Ecology 3:489-495.

Smith, T.E., R.R. Duke, M.J. Kutilek, and H.T. Harvey. 1986. Mountain lions (Felis concolor) in the vicinity of Carlsbad Caverns, New Mexico and Guadalupe Mountains National Park, Texas. Harvey and Stanley Associates Incorporated, Alvisa, Texas USA.

STATUS REPORT OF MOUNTAIN LIONS IN SOUTH DAKOTA

DOROTHY M. FECSKE, Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings, SD 57007, USA

JONATHAN A. JENKS, Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings, SD 57007, USA

Abstract: *Mountain lions historically occurred in South Dakota but were nearly extirpated in the 1900s due to bounties placed on this animal from 1899 to 1966. Since receiving legal protection in 1978, the population has reestablished in the Black Hills, SD, to the point that South Dakota Department of Game, Fish, and Parks (SDGF&P) is seeking to determine research and monitoring needs and establish a mountain lion population goal. In 1998, a 5-year research project was begun by the Department of Wildlife and Fisheries Sciences at South Dakota State University in cooperation with SDGF&P, to determine distribution, estimate the current population size, and evaluate potential surveys for monitoring population trends of mountain lions in the Black Hills. A habitat-relation model was constructed to identify potential mountain lion habitat in the Black Hills. Eleven mountain lions (6 males, 5 females) were radio-collared between January 1999 and April 2000. Mean home range size for 3 male mountain lions was 798.6 km^2 and for 3 females, 158.9 km^2. A scent station survey was conducted during summer 2000 in habitat most likely to be used by mountain lions, but the survey was not effective at documenting lion presence.*

INTRODUCTION

In the late 1800's, mountain lions (*Puma concolor*) occurred throughout South Dakota and were considered numerous in the Black Hills (Turner 1974, Packet and Hackman 1995). However, in the early 1900's the population declined from bounties placed on this animal from 1889 to 1966 (SDGF&P 1998a). For example, from 1906 through 1930 there were no lions taken, and in 1931, only one mountain lion was killed in the Black Hills (Young and Goldman 1946). After 1931, few unverified reports of mountain lions occurred in the Black Hills and in 1978, the species was classified as state threatened. It is believed that transient mountain lions originating from established populations in the Bighorn Mountains and throughout Wyoming recolonized the Black Hills (Berg et al. 1983). Not only are mountain lions reoccupying their former range in the Black Hills, but lions also are occasionally sighted in the Missouri River Breaks Region in the center of the state. In 1997, South Dakota Department of Game, Fish, and Parks (SDGF&P) estimated 15 to 25 mountain lions resided in the Black Hills with an additional 15-25 on the western South Dakota prairie (SDGF&P 1998b); estimates were based on antidotal information and most were unverified.

In 1985, SDGF&P began recording sightings of mountain lions in the Black Hills. They observed an overall increase in numbers of reported sightings from 1995 to 1999. Greater numbers of sightings in the last several years likely indicate continued population expansion in the Black Hills. In addition, numbers of sightings are not randomly distributed in the Black Hills. When numbers of reported sightings were adjusted for county population size, more reports were obtained from the southern counties (Custer and Fall River counties) than the northern counties (Lawrence and Pennington counties). In addition, although sample sizes are small (n=12), higher incidences of mountain lion deaths (since 1996) occurred in the southern two counties (58%), than in the counties of the northern Black Hills (42%). Results of these independent data sets indicate that the southern Black Hills may have better mountain lion habitat and higher lion densities than the northern Black Hills.

South Dakota is facing similar concerns of human safety and protection of property from individual 'problem' mountain lions to that of other western states. Although there have been no documented mountain lion attacks on pets or humans in the Black Hills, there have been 2 confirmed reports of deer killed by mountain lions in Rapid City; the first was an adult male mule deer (*Odocoileus hemionus*), and the second, a fawn mule deer (T. Benzon, SDGF&P, Rapid City, SD, pers. commun.). Due to their controversial nature, the SDGF&P drafted an action plan to manage for mountain lion/ human/ property interactions (SDGF&P 1998b). The mountain lion action plan describes current state law regarding management of this state-threatened predator, and lists both short and long-term management objectives for the species. The first long-term objective of the plan is to determine research and monitoring needs and establish a mountain lion population goal for various areas in South Dakota. In 1998, a 5-year research project was begun by the Department of Wildlife and Fisheries Sciences at South Dakota State University in cooperation with SDGF&P to determine distribution, estimate the current population size, and evaluate potential surveys for monitoring population trends of mountain lions in the Black Hills, South Dakota. In addition, in 1999 the SDGF&P Commission was given authority by the Governor of South Dakota to change the status of the mountain lion from threatened to a game species to control numbers if necessary.

PROGRESS

To date, the University has developed a draft habitat-relation model for mountain lions to determine potential distribution in the Black Hills. The model incorporated habitat requirements [e.g., steep slopes (associated with rocky and rugged topography), proximity to drainages, and proximity to primary prey (winter and summer range of deer, *Odocoileus virgianus*] of the species based on peer-reviewed literature into a geographical information system, to ultimately rank habitat in the Black Hills according to its suitability to mountain lions. The model will be tested for its ability to predict lion presence using locations of radio-collared study animals and other mountain lion sign. A total of 11 mountain lions (6 males, 5 females) have been captured and radio-collared. Weekly locations, using aerial-telemetry techniques, are being obtained to gather information on home-range size and how individuals space themselves relative to each other. Preliminary cumulative average home-range size [Minimum Convex Polygon (100%)] of 3 adult male mountain lions is 796.8 km^2 and for that of 3 adult females, 158.9 km^2. In addition, we are recording locations of mountain lions (from snow tracks) that have not been radio-collared to include in estimating lion density and distribution for the region.

We conducted a scent-station survey during summer 2000 in cooperation with the Wildlife and Fisheries Department at University of North Dakota. First, we tested various scent lures for their effectiveness at attracting mountain lions on 4 captive cougars (1 adult male, 1 adult female lion, and 2 juvenile males; Bramble Park Zoo, Watertown, SD; South Dakota State University, Brookings, SD). Then, we used the habitat relation model to aid in determining high-quality mountain lion habitat to aid in placement of 12 scent-stations. We also placed scent stations in portions of annual home ranges of 4 radio-collared cats. Although 2 scent lures (skunk essence and Powder River cat call) seemed to elicit desired responses in captive cats (based on detection rates, and time spent and behaviors exhibited at the lures) scent stations were not effective at attracting wild mountain lions in the Black Hills.

The SDGF&P is continuing its efforts of recording sightings of mountain lions throughout the Black Hills to monitor population trends. In addition, we are examining other methods to determine population size and monitor trends [e.g., Transect-Intercept Probability Sampling, (VanSickle and Lindzey 1991), track surveys (Smallwood and Fitzhugh 1995), etc.].

Acknowledgments. This study is supported by Federal Aid to Wildlife Restoration Funds, Project W-75-R through the South Dakota Department of Game, Fish and Parks (Study Number 7594). We thank the Bramble Park Zoo and South Dakota State University for allowing us to conduct research on captive mountain lions, and South Dakota GAP Analysis Project Coordinator V. J. Smith for help in the construction of the mountain lion habitat-relation model. We thank F. G. Lindzey, C.R., Jr. Anderson, and D. Wroe for providing training on successfully capturing and radio-collaring mountain lions. We also thank houndsman D. Morgan, S. Seneczko, DVM, SDGF&P personnel S. Griffin and B. Waite, and all the volunteers who helped capture our study animals. Sincere thanks to D. Morgan for mapping snow-tracks of uncollared mountain lions. Thanks to Laird Flying Service and South Dakota Civil Air Patrol for help locating radio-collared mountain lions using aerial-telemetry techniques. We thank SDGF&P personnel T. Benzon, and S. Griffin for reviewing this manuscript.

LITERATURE CITED

Berg, R. L., L. L. McDonald, and M. D. Strickland. 1983. Distribution of mountain lions in Wyoming as determined by mail questionnaire. Wildlife Society Bulletin 11:265-270.

Paquet, P., and A. Hackman. 1995. Large carnivore conservation in the Rocky Mountains: a long-term strategy for maintaining free-ranging and self-sustaining population of carnivores. World Wildlife Fund, Toronto, Canada. 52 pp.

South Dakota Department of Game, Fish, and Parks. 1998*a*. Action plan for managing mountain lion/human/property interactions in western South Dakota. South Dakota Division of Wildlife, Pierre, South Dakota. 6 pp.

South Dakota Department of Game, Fish, and Parks. 1998*b*. Yes, a few mountain lions live in South Dakota. South Dakota Division of Wildlife, Pierre, South Dakota. Pamphlet.

Turner, R. W. 1974. Mammals of the Black Hills of South Dakota and Wyoming. Misc. Publ. No. 60, University of Kansas Publications, Museum of Natural History. 178 pp.

VanSickle, W. D., and F. G. Lindzey. 1991. Evaluation of a cougar population estimator based on probability sampling. Journal of Wildlife Management 55:738-743.

Young, S. P., and E. A. Goldman. 1946. The puma: mysterious American cat. Dover Publications, Inc., New York. 358 pp.

CHARACTERISTICS OF MOUNTAIN LION MORTALITIES IN THE BLACK HILLS, SOUTH DAKOTA

DOROTHY M. FECSKE, Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings, SD 57007, USA

JONATHAN A. JENKS, Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings, SD 57007, USA

FREDRICK G. LINDZEY, USGS Biological Resources Division, Wyoming Cooperative Fish and Wildlife Research Unit, University Station, Laramie, WY 82071, USA

Abstract: Mountain lions (Puma concolor) are a state threatened species in South Dakota, and few sightings were documented from the early 1900's until recently. In 1985, the South Dakota Department of Game, Fish and Parks (SDGF&P) began compiling and verifying sightings of mountain lions in the Black Hills. Since then, sightings have increased but little is known of population characteristics for this species. We documented deaths of mountain lions in the Black Hills from 1996 to 2000. Mountain lion carcasses were obtained from SDGF&P, transported to South Dakota State University, necropsied and cause of death determined. Carcasses were sexed and aged based on tooth wear. Nutritional condition was assessed based on kidney fat (ranked as high, medium, or low), and foods consumed documented from identification of intestinal tract contents or evidence on the carcass. A total of 12 mountain lion deaths were documented between 1996 and 2000. Mountain lions were killed by vehicle collisions (3), shootings (5), died from capture-related or trap injuries, or injuries inflicted by another mountain lion. One mountain lion sought refuge in a cave during a fire and was asphyxiated. Sex ratio of the dead lions was 50:50 and age ranged from 4 months to 9 years (n=12). Of the 9 mountain lions we assessed, 6 had high levels of kidney fat suggesting they were in relatively good nutritional condition. Eight of the 12 mountain lions showed evidence of porcupine (Erethizon dorsatum) consumption.

INTRODUCTION

Historically, mountain lions occurred throughout South Dakota (Paquet and Hackman 1995), and in the late 1800's were relatively common (Turner 1974). Mountain lions were found in the plains and Badlands region of the state and were numerous in the Black Hills (Young and Goldman 1946). In the early 1900's, the population dramatically declined from bounties placed on the animal in 1889 (SDGF&P 1998). One mountain lion was killed in the Black Hills in 1931, but in the 25 years prior to this occasion, no other reports of mountain lions were recorded in the state (Young and Goldman 1946). Nevertheless, the species remained listed as a state pest until 1966, and in 1972, its status was changed to state threatened. Transient mountain lions, likely from Wyoming, recolonized the Black Hills (Berg et al. 1983). Since its protection, lion sightings have increased, especially the last few years (19, in 1995; 40, in 1996; and 56, in 1997). However, many are unverified and no information exists on population characteristics of this species in South Dakota. As part of a study to determine distribution and estimate population size of mountain lions in the Black Hills, we documented mortalities of mountain lions from 1996 to 2000.

STUDY AREA

The Black Hills is an 18,050 km^2, isolated mountain range located in western South Dakota and northeastern Wyoming (Petersen 1984). Elevations range from 973 to 2,202 m (Orr 1959, Turner 1974), with forests occurring at elevations between 1,200 and 2,100 m (Hoffman and Alexander 1987). Ponderosa pine (*Pinus ponderosa*) forest alliances occupy 84% of the forested landscape within the Black Hills (Rumble and Anderson 1996). The remaining forests are composed of white-spruce (*Picea glauca*) forest alliances in high-elevation, cool, moist sites, and burr oak (*Quercus macrocarpa*) forest alliances, in low elevation, warm, dry sites. The mountain range has semi-arid continental and mountain climate types. Generally, precipitation in the northern Black Hills is higher and temperatures are cooler than in the southern Black Hills (Hoffman and Alexander 1987). Average annual precipitation ranges from 45 to 66 cm (Orr 1959); mean annual temperature is 7.5°C. Forests are managed by the United States Department of Agriculture Black Hills National Forest primarily for timber production, livestock grazing, and recreation

METHODS

Carcasses of mountain lions killed in the Black Hills were transported to South Dakota State University for necropsy. We determined place of death through interviews with SDGF&P employees. Proximity of death was coded as northern, central or southern Black Hills. During our initial examination of the carcass, we determined sex and estimated age of animals. Age was estimated based on presence of a subcanine ridge, wear on incisors and canines, coloration (white or yellowed) of the teeth, and fur coloration (i.e., presence of spots on the body or barring on the limbs) (Anderson and Lindzey 2000). Average age of mortalities was estimated using the midpoint of the range in age estimate for each carcass. Carcasses were then necropsied and, if unknown, cause of death was established. Nutritional condition of animals was evaluated by ranking kidney fat as high, moderate, or low. Foods consumed were assessed based on a cursory examination of digesta in the stomach and gastrointestinal tract or evidence on the carcass of interactions with potential prey (e.g., porcupine quills).

RESULTS

Twelve mountain lion mortalities were documented over the 4-year period, 1996-2000. Sex ratio of mortalities was 50:50. Age of mortalities ranged from 4-5 months to 8-9 years and averaged 3.3 years. Causes of mortality were categorized as: shooting, vehicle collision, intraspecific interaction, fire, and accidental (unintentional trapping in a bobcat snare, and capture-related) (Table 1). Of mortalities, 5 (41.7%) were due to shooting with 3 (25.0%) resulting from vehicle collisions. Other causes of mortalities (1 trapping, 1 capture-related, 1 intraspecific interaction, and 1 fire) were equally represented at 8.3% of the total. Eight (66.7%) of the mortalities occurred in the southern Black Hills region. Two (16.7%) mortalities occurred in the central Black Hills, and 2 (16.7%), in the northern region. Of the 9 specimens assessed, 6 (66.7%) had high kidney-fat levels, indicating the animals were in good nutritional health at the time of their death. Preliminary results of foods consumed were obtained for 8 lions. Of these, 6 (75.0%) showed evidence of consumption or interactions with porcupines. Other foods documented during cursory examination included vegetation ($n = 2$) and small mammals (i.e., *Peromyscus* spp.) ($n = 1$).

Table 1. Characteristics of mountain lion mortalities in the Black Hills, South Dakota (1996-2000).

Sex	Age	Fat	Food	Mortality	Location	Proximity
M	8.5-9.5	L	PP	Shooting	Custer	South
M	2.5-3.5	L	None	Vehicle	Spearfish	North
F	1.5-2.5	H	PP	Accidental	Pactola Lake	Central
M	4-5 months	M	NE	Vehicle	Hill City	South
F	3.5-4.5	NE	NE	Shooting	Pringle	South
F	3.5-4.5	H	PP	Accidental	Custer	South
M	1.5-2.5	H	PP	Vehicle	Black Hawk	North
F	1.5-2.5	H	PP	Shooting	Deerfield Lake	Central
M	3.5-4.5	NE	NE	Shooting	Hot Springs	South
M	2.5-3.5	H	PP	Interaction	Custer	South
F	3.5-4.5	H	None	Fire	Jewel Cave	South
F	1.5-2.5	NE	NE	Shooting	Hot Springs	South

[1] Fat reserves were ranked as high (H), medium (M), or low (L) based on kidney fat

[2] Food categories: PP= porcupine, NE=not evaluated, None=GI tract empty

[3] Proximity refers to region of the Black Hills.

DISCUSSION

We documented both human-caused and natural mortality of mountain lions in the Black Hills. Although mountain lions are protected, 83.3% of the deaths we encountered were human-caused. Legal and illegal shootings represented the majority of the mortalities, followed by vehicle collisions. Our findings are similar to those of protected mountain lion populations in Colorado, Arizona, and British Columbia, where humans also were the primary cause of mountain lion deaths (Logan and Sweanor 2000). South Dakota law provides that citizens can obtain a permit (issued by the Secretary of SDGF&P) to kill individual, problem mountain lions that persistently kill livestock, pose a threat to the public's health, safety or welfare, or damage property. In addition, any person can legally kill a mountain lion in an emergency situation involving an immediate threat to human life (SDGF&P 1998).

Three male mountain lions were killed from collisions with vehicles. Two relatively young male cats were killed on Interstate 90, a high-speed highway (104-120 km/h) that occurs on the northern and eastern periphery of the Black Hills. These animals may have been in the process of dispersing, which can occur anywhere from 10 to 33 months (Sweanor et al. 1999), or were forced to use suboptimal lion habitat to avoid aggressive encounters with older males (Logan et al. 1996). Based on preliminary findings of radio-collared animals, it is possible that male territories are limited in the Black Hills. Moreover, the kitten in our sample was killed on U.S. Route 16, where at least 3 adult cats (2 radio-collared adult males and 1 uncollared female with two kittens) have been documented to cross on more than one occasion all within a 0.8 km stretch of road. In 1997, on the same stretch of road, an adult mountain lion was hit by a car but not killed. Specific locations on high-speed highways could act as population sinks for cats with home ranges fragmented by such roads. In populations in California and Florida, where animals exist in severely fragmented habitat, vehicle collisions are the predominant cause of death to lions (Logan and Sweanor 2000). This information has important long-term management implications for mountain lions. Managers could identify locations where lions are known to cross high-speed highways and construct wildlife underpasses. Wildlife culverts were constructed in Florida in 1994 to decrease mountain lion/vehicle collisions. The culverts were used by mountain lions and other species as well (i.e., black bears (*Ursus americanus*), bobcats (*Lynx rufus*), raccoons (*Procyon lotor*), deer (*Odocoileus virginianus*), etc.) (Foster and Humphrey 1995).

In unhunted mountain lion populations, intraspecific killing may be the major natural cause of death of these territorial carnivores. In New Mexico, 44.0% of kitten deaths resulted from infanticide and cannibalism, and intraspecific aggressive encounters resulted in 100% of deaths of subadults and 52.0% of adults, respectively. All killing was done by male mountain lions (Logan et al. 1996). Intraspecific aggression also was the predominant cause of death to mountain lions in Florida (Maehr 1997) and California (Beier et al. 1993). We documented an intraspecific aggressive encounter between 2 radio-collared male mountain lions in the Black Hills (66 kg, 4 to 5-year-old and 54 kg, 2.5-year-old), which resulted in the death of the younger cat. Other reported natural causes of death include deaths from other carnivores (Boyd and Neale 1992), injuries sustained during pursuit of prey (Ross et al. 1995), starvation, accidents (Lindzey 1987), and from parasites and disease (Dixon 1982). To our knowledge there have been no reports of mountain lions killed during natural disturbances such as fire. We documented the death of a radio-collared, adult female mountain lion from a recent fire in the Black Hills. The death probably occurred because most of her 12,950 ha home range was contained within a region of the 33,795 ha fire. The lion's death likely occurred on the second day of the fire when 19,650 ha burned, trapping her in the draw where she died.

Results of 9 mountain lions evaluated for body fat reserves indicated the population of lions in the Black Hills is in good overall nutritional health. Six animals had high fat reserves and of the 2 animals that had low reserves, 1 was a young potentially dispersing male, and 1, and old male cat, which was partially blind. Gross examination of 7 carcasses revealed evidence of consumption of porcupines in all age classes represented indicating this species may be an important food item for lions in this region. Further analysis of foods consumed by mountain lions in the Black Hills is forthcoming. The fact that 66.7% of the cats died in the southern Black Hills supports findings of reported mountain lion sightings by SDGFP. For example, when reported sightings were corrected for county population size, more reports were obtained in the southern counties suggesting mountain lion densities may be higher in this region of the Black Hills.

Acknowledgments: We wish to acknowledge our sources of support and funding: South Dakota State University and Federal Aid to Wildlife Restoration administered through the South Dakota Department of Game, Fish, and Parks. Thanks to SDGF&P personnel S. L. Griffin, B. Waite T. Benzon, M. Kintigh, and for field help and support, and South Dakota State University graduate students J. R. Gerads, L. E. Schmitz, C. N. Jacques, V. J. Smith, and technician C. Kopplin for help with necropsies. Sincere thanks to houndsman D. Morgan, and S. Seneczko, DVM, for their continual dedication to this project. We thank SDGF&P personnel T. Benzon, and S. Griffin for reviewing this manuscript.

LITERATURE CITED

Anderson, C. R., Jr., and F. G. Lindzey. 2000. A guide to estimating mountain lion age classes. Wyo. Coop. Fish and Wildl. Res. Unit, Laramie. 2 pp.

Beier, P. and R. H. Barrett. 1993. The cougar in the Santa Ana Mountain Range, California. Final Report. Orange County Cooperative Mountain Lion Study, CA.

Berg, R. L., L. L. McDonald, and M. D. Strickland. 1983. Distribution of mountain lions in Wyoming as determined by mail questionnaire. Wildlife Society Bulletin 11:265-270.

Boyd, I. K. and G. K. Neale. An adult cougar, Felis concolor, killed by gray wolves, Canis lupus, in Glacier National Park, Montana. Canadian Field Naturalist 106:524-525.

Dixon, K. 1982. Mountain lion. Pages 711-727 *In* J. A. Chapman, and G. A. Feldhamer, eds., Wild mammals of North America. Johns Hopkins University Press, Baltimore, Maryland 1147 pp

Foster, M. L., and S. R. Humphrey. 1995. Use of highway underpasses by Florida panthers and other wildlife. Wildlife Society Bulletin 23:95-100.

Hemker, T. P., F. G. Lindzey, and B. Ackerman. 1984. Population characteristics and movement patterns of cougars in southern Utah. Journal of Wildlife Management 48:1275-1284.

Lindzey, F. G. 1987. Mountain lion. Pages 657-668 *In* M. J. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, eds., Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources, Toronto Canada. 1150 pp.

Logan, K. A.. L. L. Sweanor, and M. G. Hornocker. 1996. Cougar population dynamics. Pages 22-113 *In* K. A. Logan, L. L. Sweanor, T. K. Ruth, and M. G. Hornocker, eds., Cougars of the San Andres Mountains, New Mexico. Final Report, Federal Aid to Wildlife Restorations Project W-128-R. New Mexico Department of Game and Fish. Santa Fe.

Logan, K. A. and L. L. Sweanor. 2000. Puma. PP 347-377 *In* S. Demaris, and P. R. Krausman, eds., Ecology and management of large mammals in North America. Prentice-Hall, Inc. New Jersey 778 pp.

Maehr, D. S. 1997. The Florida panther: life and death of a vanishing carnivore. Island Press, Washington, DC 320 pp.

Paquet, P. and A. Hackman. 1995. Large carnivore conservation in the Rocky Mountains: a long-term strategy for maintaining free-ranging and self-sustaining population of carnivores. World Wildlife Fund, Toronto, Canada. 52 pp.

Ross, P. I., M. G. Jalkotzy, and P. Y. Daoust. 1995. Fatal trauma sustained by cougars, *Felis concolor*, while attacking prey in Southern Alberta. Canadian Field Naturalist 109:261-263.

South Dakota Department of Game, Fish, and Parks. 1998. Action plan for managing mountain lion/human/property interactions in western South Dakota. South Dakota Division of Wildlife, Pierre, South Dakota 6 pp.

Sweanor, L. L., Kenneth, A. Logan, and M. G. Hornocker. 1999. Cougar dispersal patterns, metapopulation dynamics, and conservation. Conservation Biology 14:798-808.

Turner, R. W. 1974. Mammals of the Black Hills of South Dakota and Wyoming. Misc. Publ. No. 60, University of Kansas Publications, Museum of Natural History. 178 pp.

Young, S . P. and E. A. Goldman 1946. The puma: mysterious American cat. Dover Publications, Inc., New York. 358 pp.

WYOMING MOUNTAIN LION STATUS REPORT – 2001

DANIEL D. BJORNLIE, Trophy Game Biologist, 260 Buena Vista, Lander, WY 82520

DAVID S. MOODY, Trophy Game Section Coordinator, 260 Buena Vista, Lander, WY 82520

Abstract: Mountain lions (Puma concolor) are distributed widely throughout Wyoming in all types of habitats. The status of the mountain lion in Wyoming has changed considerably since the nineteenth century. Wyoming is currently divided into 28 mountain lion hunt areas with a quota system. Wyoming statutes allow any mountain lion damaging private property to be killed by the owner, employee, or lessee of the property. Information collected from harvested mountain lions is presently the primary source of data used to monitor lion populations in Wyoming.

DISTRIBUTION AND ABUNDANCE

Mountain lions (*Puma concolor*) are distributed widely throughout Wyoming in all types of habitats. Densities, however, are not uniform, with the highest densities thought to be in the Bighorn, Owl Creek, and Laramie mountain ranges (Wyoming Game & Fish Department 1997). Logan and Irwin (1985) found that habitat use by mountain lions in the Bighorn Mountains was varied and included virtually all habitat types. However, mixed conifer and curlleaf mountain mahogany were preferred and sagebrush-grass was generally avoided. Lions also preferred rugged terrain in all seasons (Logan and Irwin 1985) and the timber/prairie interface in winter (Chuck Anderson, pers. comm.). Presently, there are no estimates of how many mountain lions inhabit Wyoming. However, responses from houndsman surveys distributed since 1996 and increasing hunter harvest indicate populations are stable or increasing throughout the state.

MANAGEMENT

The status of the mountain lion in Wyoming has changed considerably since the nineteenth century. In 1882, the Wyoming Territorial government enacted legislation placing a bounty on mountain lions and other predators (Wyoming Game & Fish Department 1997). This allowed lion hunting the entire year without bag limit. In 1973, the mountain lion was reclassified as a trophy game animal. Since then, seasons have been created, management units and hunt areas delineated, and quotas established to better control the number and sex of lions harvested.

The Wyoming Game & Fish Department (WGFD) prepared a draft management plan for mountain lions in 1997. That plan has not been finalized to date. Currently the WGFD uses age and sex ratio data from harvested lions as the primary means of assessing population status and establishing seasons and quotas for mountain lions. Wyoming is currently divided into 28 mountain lion hunt areas. These hunt areas are grouped into 5 Mountain Lion Management Units (MLMU) based on geographic boundaries. Each hunt area has a maximum annual mortality quota that varies from 2 to 34, with one area also having a maximum female mortality quota. If either quota is filled, the hunting season in that hunt area is closed. Harvest counts begin at the start of each season and include all legal and illegal hunting mortalities. Total and female mortality quotas are reevaluated each year after the seasons close by the Trophy Game Section and regional biologists, game wardens, and supervisors. The annual harvest report, conflict records, and perceived lion abundance are utilized to determine whether quotas need to be changed.

The individual bag limit for lions is 1 lion per hunter per calendar year, except for 2 units in north central and central Wyoming, where 1 additional lion may be taken each calendar year. Hunters are responsible for inquiring about the status of harvest quotas prior to hunting, and pelts and skulls from harvested lions must be inspected by a Game and Fish official within 3 days of harvest. The season extends from September 1 to March 31 for all hunt areas except for 4 units in and around the Bighorn Mountains, which have year-round seasons. Because of their secretive nature, lions are rarely harvested without the aid of dogs. From 1990 through 1999, 89% of all lions legally harvested were taken with dogs.

NUISANCE AND DAMAGE ACTIVITY

Wyoming statutes allow any mountain lion damaging private property to be killed by the owner, employee, or lessee of the property. Damage generally occurs in areas where domestic livestock are seasonally permitted to graze. Lions will kill most species of livestock, although cattle and sheep are the most common in depredation records. While lions will kill adult and young sheep, most cattle taken are calves (Lindzey 1987). In Wyoming and other northern Rocky Mountain states, most cattle give birth in areas where lions are not prevalent. Livestock owners in Wyoming are reimbursed for confirmed lion-related losses. An average of 2.5 nuisance lions were removed annually in Wyoming from 1990 to 1999, with a low of 0 in 1995 and a high of 6 in 1999. There are no limits on the number of nuisance lions that can be removed, and removed lions do not count toward annual mortality quotas.

POPULATION MONITORING

Information collected from harvested mountain lions is presently the primary source of data used to monitor lion populations in Wyoming. The mandatory check system for successful hunters makes it possible for Game and Fish to collect data for sex and age of the harvested lion. Two teeth are collected for aging, and hair and tissue samples are collected for DNA analysis. The location of kill, sex, number of days hunted, and method of take are also recorded.

Although harvest data is the primary source of lion population demography data, other techniques are being investigated. Current research conducted by C.R. Anderson at the Wyoming Cooperative Fish and Wildlife Research Unit at the University of Wyoming is investigating the effects of intense harvest on mountain lion population demographics, as well as overall mountain lion management and population genetics. Snow track aerial surveys are also being conducted to attempt to obtain more accurate lion population estimates.

HARVEST SUMMARY

Mountain lion harvest has averaged 115 per year for the last 10 years (1990-99). However, there has been a steady increase in harvest over this time (Figure 1), with an average of 156 lions per year for the past 5 years (1995-99). Yearly harvest numbers ranged from 51 in 1991 to 208 in 1999. In this same time period, 89% of all legal lion harvest has utilized dogs. Hunter days (1 hunter for 1 day = 1 hunter day) have also increased dramatically over the past 10 years (Figure 2), ranging from 120 in 1991 to 743 in 1999. However, with the exception of a peak in 1993, hunter days per lion harvested remained relatively constant over this time period (Figure 2). Of the 615 successful hunters who responded to the question of whether they were selective when hunting, 470 (76%) said they were not. This is reflected in the fact that the overall percentage of males harvested in the past 10 years is only slightly higher than that of females (58% males:42% females). The annual percentages ranged from 50% males:50% females in 1990 to 68% males:32% females in 1993.

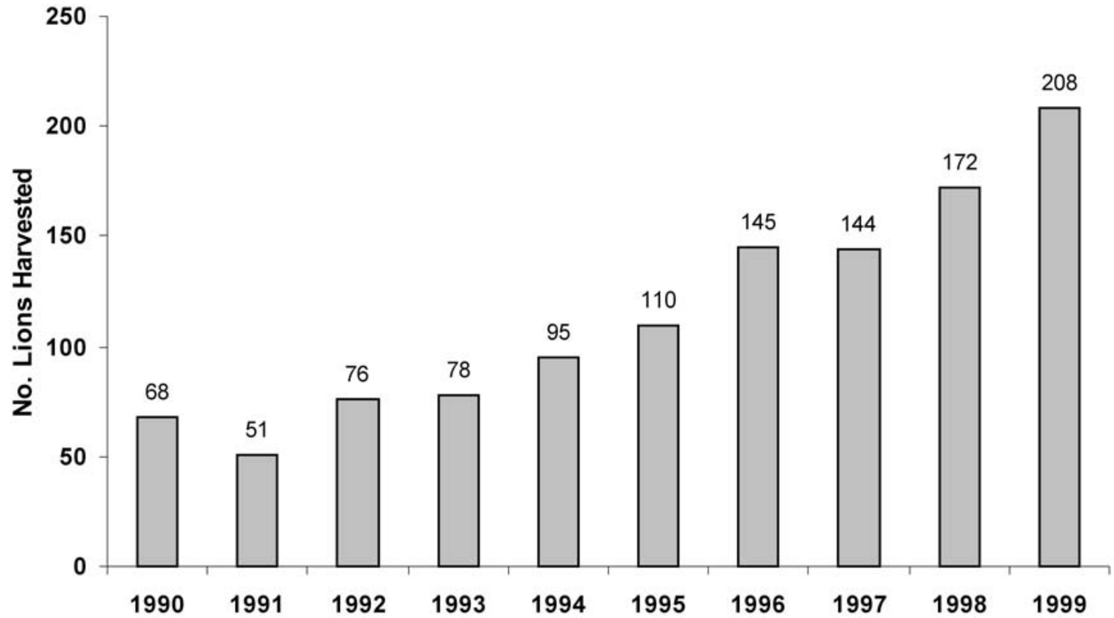


Figure 1. The total number of mountain lions harvested in Wyoming from 1990 to 1999.

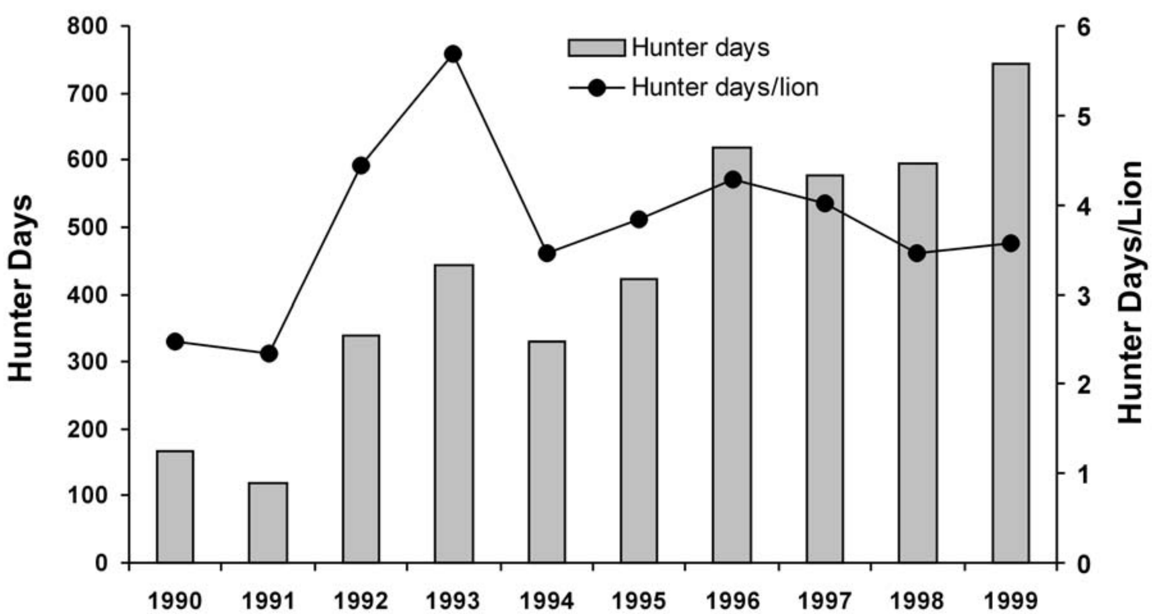


Figure 2. The number of mountain lion hunter days and the number of hunter days per lion harvested in Wyoming from 1990 to 1999.

PUBLIC ATTITUDES

In 1995, the Game and Fish contracted with the Survey Research Center at the University of Wyoming to determine attitudes and knowledge of Wyoming residents on mountain lions and mountain lion management (Gasson and Moody 1995). Of the approximately 500 respondents, over 71% believed lions were a benefit to Wyoming. Attitudes toward mountain lion hunting were generally supportive, with 49.6% agreeing or strongly agreeing that mountain lion hunting should continue and 29.3% disagreeing or strongly disagreeing. The remaining respondents were either neutral or did not answer. However, most (57%) disagreed or strongly disagreed that hunting lions with dogs should continue as a legal method of take. Only 25.3% of respondents agreed or strongly agreed. The remaining respondents were neutral or had no answer. A large majority (80.7%) agreed or strongly agreed that mountain lion hunting seasons should be modified to avoid killing or running females with kittens. Only 8% disagreed or strongly disagreed. Respondents were also opposed to a pursuit season, with 71.1% disagreeing or strongly disagreeing to running lions with dogs but not killing them.

CONCLUSIONS

Both the number of mountain lions harvested and the number of hunter days have increased steadily over past 10 years. Recent responses from houndsman surveys and increasing hunter harvest indicate that the number of mountain lions in Wyoming is at least steady and may be increasing in most areas of the state. Future research may shed more light on the population status and the effects of hunting on lions in Wyoming. Although more than half of Wyoming residents surveyed do not agree with the use of dogs in lion hunting, the vast majority of lions harvested in Wyoming are taken with the aid of dogs. In the future, this divergence could generate a call for changes in mountain lion management policies in Wyoming.

LITERATURE CITED

Gasson W. and D. Moody. 1995. Attitudes of Wyoming residents on mountain lion management. Planning rep. #40, Wyoming Game & Fish Dept., Cheyenne. 7 pp.

Lindzey, F.G. 1987. Mountain Lion. Pages 657-668 *in* M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch, eds. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources and Ontario Trappers Association, Toronto, Canada. 1150 pp.

Logan, K.A. and L.L. Irwin. 1985. Mountain lion habitats in the Bighorn Mountains, Wyoming. Wildlife Society Bulletin 13:257-262.

Wyoming Game & Fish Department. 1997. Mountain Lion Management Plan. Wyoming Game & Fish Dept. 30 pp.

FIELD EVIDENCE OF COUGARS IN EASTERN NORTH AMERICA

CHRIS BOLGIANO, James Madison University, Harrisonburg, VA 22807; Eastern Cougar Foundation, Fulks Run, VA 22830

TODD LESTER, Eastern Cougar Foundation, P.O. Box 91, North Spring, WV 24869

DONALD W. LINZEY, Dept. of Biology, Wytheville Community College, Wytheville, VA 24382

DAVID S. MAEHR, Dept. of Forestry, University of Kentucky, Lexington, KY 40546-0073

Abstract: Confirmed physical field evidence of cougars living wild in several regions of eastern North America is beginning to accumulate. Related issues of legal status, habitat management, and social acceptance are also emerging. We document twelve instances in which various items of field evidence have been confirmed by biologists: three cases involving live animals, a dead body or body part; four cases of scats; three cases of tracks; and two videos. The geographic range of these incidents is New Brunswick, Canada to Missouri, and the date range is 1976 to 2000. Each case entails consideration of significant details, including the history of cougars in the local area, the circumstances of local habitat and prey, evidence of reproduction, credentials of confirming biologists and the possibility of fraud. Possible sources of these animals include remnant natives, escaped or released captives, and colonizers from known cougar populations in Florida, Texas and elsewhere. Since spring of 1998 at least 3 radio-collared Florida panthers have crossed north of the Caloosahatchee River for the first time since fieldwork began 20 years ago. The potential for reestablishment of a viable breeding population is more likely to be limited by human intolerance than biological constraints, especially in rural communities near public lands. An ecological benefit of a cougar population in the east might be to return an evolutionary selection force and population check on over-abundant deer. Outdoor recreationists and hunters are also likely to express interest in cougars.

INTRODUCTION

Native eastern cougars were believed extirpated throughout the east by the 1940s, but a growing number of sightings prompted the listing of *Felis concolor couguar* on the 1973 Endangered Species List (Bolgiano 1995). A field survey in the southern Appalachians by the U.S. Fish and Wildlife Service (USF&WS), however, failed to find conclusive evidence of cougars by the early 1980s, although a small number of possible deer kills, scrapes, and scats were identified. (Downing 1981).

Confirmed field evidence began to accumulate in the 1990s. The presence of at least a few individuals living wild in the east is now acknowledged by the U.S. Fish and Wildlife Service (Clark 2000). Issues of legal status, population viability, habitat management, and human acceptance are emerging. The Eastern Cougar Foundation (ECF), a 501(c)(3) organization, was founded by independent researcher Todd Lester in West Virginia in 1998 to compile the accumulating evidence, and to grapple with these issues.

As Vice President of the ECF, I'm here to present the evidence, and to grapple. Our Board of Directors includes David Maehr, former leader of Florida panther field research; Donald Linzey, in charge of mammal research for the All-Taxa Biodiversity Inventory in Great Smoky Mountains National Park; Melanie Culver, cougar geneticist who is also presenting a paper at this workshop; and Sue Morse, carnivore expert who gave the keynote address at the Third Mountain Lion Workshop in Prescott, AZ in 1988.

METHODS

Todd Lester of WV and Donald Linzey of VA have for many years passed out flyers asking people to call them if a cougar was seen, so communication networks were already established. Todd Lester expanded them through an eastern cougar web site and a listserv, which at times has included well over 100 people from South America to Alaska. Lester and Linzey standardized the procedures they use to narrow the large volume of sightings to the small percentage of credible prospects (Miller 1998). For those within a day's drive, they conduct field searches for hard evidence and scrutinize evidence collected by others. For more distant cases, one or more of us investigates through phone and email interviews. Written confirmation from recognized authorities is the only validation we accept. Melanie Culver at VA Tech tests samples and validates tests conducted by others.

RESULTS

Over the past two years we have compiled one dozen confirmed incidents from Ontario to North Carolina, some of them representing clusters of cougar activity (copies of any or all documentations are available from the ECF for the cost of photocopying and postage). Cases are categorized by type of evidence.

Three cases involve live animals, a dead body or a body part:here are four cases of scats:

1. In 1976, a male cougar was killed while killing sheep and a pregnant female was captured two days later in Pocahontas County, WV. The dead cougar was pictured in the local paper with WV Dept. of Natural Resources (WVDNR) officer Larry Guthrie. Correspondence between the USF&WS and the WVDNR focuses on discussion about whether the captured cougar is tame and would therefore constitute a threat to humans if released in the wild, but no documentation seems to exist on the actual fate of the cougar or any progeny.

2. In 1998, a cougar pelt was found along a road in Texas County, MO, near the Mark Twain National Forest and approximately 125 air miles west of the IL site. It is believed to be from a cougar that was treed and killed by raccoon hunters in 1994, the first cougar killed in MO since 1927. The MO Department of Conservation (MDC) uncovered a photo of the dead cat and successfully prosecuted two hunters, who admitted dumping the pelt. Gary Cravens of the MDC determined from witnesses that the hunted cougar had no tattoos and long, sharp claws, found also on the pelt. Genetic analysis of the pelt indicated a North American genotype. In addition, in the same general area, a video of a cougar was made by MDC agent Jerry Elliott in 1996, and two deer kills were confirmed as cougar kills by the MDC in 1998.

3. In July of 2000, a cougar was killed by a train in western Randolph County, IL near the Mississippi River and the Shawnee National Forest. A necropsy by Alan Woolf of the Cooperative Wildlife Research Laboratory at Southern Illinois University found a normal, healthy male aged 4 to 6 years belonging to the North American genotype, with normal claws, stomach contents of 100% fawn, and no tattoos. Many, if not most captive cougars are declawed and/or have tattoos.

There are four cases of scats:

1. In 1992 in central New Brunswick, Canada, Provincial wildlife biologist Rod Cumberland documented tracks and collected a scat that was analyzed by the Canadian Museum of Nature in Ottawa and found to contain showshoe hair bones and foot and leg hairs of cougar.

2. In 1994, a scat recovered by agents of the VT Fish & Wildlife Dept. near Craftsbury in north central VT was sent to the USF&WS Forensics Lab in Ashland, OR, where cougar foot hairs were found in it. These are presumed ingested during self-grooming. The sighting that prompted the search involved three cougars, and three sets of tracks were found, possibly indicating a family group.

3. In 1997, a scat collected in central MA by John McCarter, a staff member of the Paul Rezendes Tracking School, was sent to George Amato of the Wildlife Conservation Society in New York. DNA tests indicated cougar, a finding confirmed by Melanie Culver, who also found that the animal was of the North American genotype. The large, wild Quahbin Resevoir area of central MA has for many years been a locus of cougar sightings.

4. In 1999 in Ontario, Canada, Provincial wildlife biologist Lil Anderson collected a scat that was sent to the Alberta Natural Resources Service forensics lab in Edmonton for thin layer chromatography and found to be cougar.

There are three cases of tracks:

1. In 1990 in southwestern VA, Donald Linzey collected photos and cement casts of tracks that he confirmed as cougar. This is approximately 140 air miles from an incident in Russell County, VA in 1997, in which 25 goats were killed by an alleged cougar (not confirmed), and where personnel of the VA Dept. of Game and Inland Fisheries reported two separate cougar sightings, one of which included a kitten.

2. In 1994 in northwestern ME, approximately 150 air miles east of the confirmed New Brunswick site, two game wardens investigated a sighting of three cats near the St. Johns River and found tracks which they officially reported as cougar to Richard Hoppe, wildlife biologist for the ME Dept. of Inland Fisheries and Wildlife.

3. In 1996 in southern WV, approximately 100 air miles from the confirmed tracks in VA, Todd Lester made plaster casts of tracks that were confirmed by Lee Fitzhugh of the Extension Wildlife Service at University of CA, Davis, and by David Maehr. This is an area with a long history of cougar sightings and deer kills thought to be cougar.

There are two videos:

1. In the early 1990s in the western mountains of MD, a home video was obtained and verified by Leslie Johnston, District Wildlife Manager of the MD Dept. of Natural Resources, who made it available to MD public TV, where it was shown many times, and to various biologists' meetings.

2. In 1991 in NC just east of the Great Smoky Mountains National Park, a home video was obtained and verified by Donald Linzey. The Great Smoky Mountains was one of the areas that Bob Downing, who did the USF&WS field survey mentioned earlier, felt could have supported native cougars through the twentieth century, because roughly 20% of the park's 500,000 acres was never logged and remained an undisturbed refuge.

DISCUSSION

Fail-safe chain of custody documentation for all evidence is unattainable, and it's possible that one or a few incidents may be forgeries. But it is unlikely that all of them are. Questions are shifting to: 1) whether these are escaped or released animals other than the native eastern cougar or Florida panther subspecies (*Puma concolor couguar* and *Puma concolor coryi*, the only ones listed in the Endangered Species Act); and 2) whether these are individual, transient animals or a breeding population(s). The answer to the first question may never be resolved, because of the low genetic variability of North American cougars and perhaps more importantly because of the small sample size of known eastern cougars (Culver 1999).

In addition to remnant natives and escaped/released captives, a third possible source is colonizers from known cougar populations in Florida, Texas, and Montana, and suspected populations in Saskatchewan and Manitoba (Anderson 1983, Wrigley 1982). Since spring of 1998, at least three radio-collared Florida panthers have crossed north of the Caloosahatchee River west of Lake Okeechobee for the first time since fieldwork began twenty years ago (Maehr 2000). There is also evidence of increasing cougar activity in Kansas, Nebraska, Oklahoma and other areas of the west that could indicate that cougars are reclaiming former ranges or even expanding into new areas (Henderson 1992, Duggan 2000, Pike 1999).

It's also possible that cougars from two or all three sources are interbreeding in the east. Three clusters of confirmation raise intriguing questions about reproduction. First, the 1994 VT confirmation involved a possible family group, and New England, especially Maine, continues to report sightings of mothers with kittens, some with field evidence awaiting confirmation. Although there are concerns about development of the North Woods, at present there is a substantial amount of wild land there.

Second is a cluster in the Southern Appalachians. The ECF is biased toward receiving reports from this region because we are based there. However, there are some seven million acres of national forests and parks spread from Virginia to Georgia, the largest complex of public lands east of the Mississippi River. Included are 47 Congressionally designated wilderness areas, many of which are so remote and rugged that they still contain old growth that was never logged. It seems likely that if cougars are breeding, it would be in this region. A habitat analyses based on GIS layers of forest cover and human population, road, and deer densities showed that good cougar habitat in the central Appalachians does exist in and around these public lands (Taverna 1999).

Third is the cluster of activity in MO and the confirmation just across the Mississippi River in IL. It seems unlikely that cougars could cross the river, but it was also deemed highly unlikely that Florida panthers could successfully navigate through intense human development and cross the Caloosahatchee River. Given the remarkable capabilities of this animal, no possibility should be absolutely ruled out.

CONCLUSION

Given the well-known regrowth of forest cover and resurgence of deer herds across the east, it's likely that human rather than biological constraints will limit the establishment of viable cougar populations. There is a potentially positive public reaction to the animals. Fifty-six conservation groups across the east endorsed the recent ECF request that the USF&WS expand the Similarity of Appearances rule of the ESA from Florida throughout the east (Lester 2000). That request was denied pending documentation of a breeding population. If viable cougar populations with their potential for depredations are to be tolerated, however, much educational outreach remains to be done in rural communities, especially around public lands. It may be possible to persuade hunters to accept perceived cougar competition for deer, and simultaneously to reduce the possibilities of cougar attacks on humans and livestock, by allowing non-consumptive chasing with dogs in restricted areas as a means of aversive conditioning (Hebert 1996). There may also be possibilities for future ecotourism. Most importantly, a viable cougar population would return a native predator and offer ecosystem benefits such as an evolutionary selection force and population check on currently over-abundant deer.

Acknowledgements: We wish to thank the Sierra Club and the Southern Appalachian Forest Coalition for making it possible to present this paper.

LITERATURE CITED

Anderson, A. E. 1983. A critical review of literature on puma (Felis concolor). Special report no. 54. Colorado Division of Wildlife. 91 pp.

Bolgiano, C. 1995. Mountain lion: an unnatural history of pumas and people. Mechanicsburg, PA: Stackpole Books. 209 pp.

Brocke, R. H., and F. G. VanDyke. 1985. Eastern cougars: the verifiability of the presence of isolated individuals versus populations (comment on Downing, Cryptozoology, 3:31-49, 1984). Cryptozoology 4:102-105.

Clark, J.R. 2000. Letter of June 21 to Todd Lester, President, Eastern Cougar Foundation. 1 p.

Culbertson, N. 1976. Status and history of the mountain lion in the Great Smoky Mountains National Park. Research/Resources Management Report no. 15. Gatlinburg, TN: National Park Service Southeast Region, Uplands Field Research Laboratory, Great Smoky Mountains National Park. 51 pp.

Culver, M. 1999. Molecular genetic variation, population structure, and natural history of free-ranging pumas (Puma concolor). Dissertation. College Park, MD: University of Maryland. 225 pp.

Downing, R. L. 1981. The current status of the cougar in the Southern Appalachian [sic]. In: Proceedings of The Nongame and Endangered Wildlife Symposium, Athens, GA, August 13-14.

Downing, R.L. 1984. The search for cougars in the eastern United States. Cryptozoology 3:31-49.

Duggan, J. 2000. Examinations reveals [sic] shot cat was healthy, Lincoln Journal Star [NE] November 2. 1 p.

Hebert, D., and L. Lay. 1997. Cougar-human interactions in British Columbia. In: Proceedings of the Fifth Mountain Lion Workshop, 27 Feb.-1 March, 1996, p. 44-45. Southern California Chapter of The Wildlife Society.

Henderson, F. R. 1992. Update: Puma in Kansas? Kansas State University Cooperative Extension Service. 22 pp.

Lester, T. 2000. Letter of March 20 to Jamie Clark, Director, U.S. Fish & Wildlife Service. 2 pp.

Linzey, D. W. 1999. Cougars in the Southern Appalachians. In: Proceedings of the New River Symposium, April 15-16, Boone, NC, p. 10-15.

Maehr, D.S. 2000. Personal communication.

McBride, R. T., et al. 1993. Do mountain lions exist in Arkansas? In: Proceedings of the Annual Conference of the Southeastern Fish and Wildlife Agencies 47:394-402.

Miller, J. 1998. Evidence for an eastern cougar reassessment. M.S. Thesis. Oxford, OH: Miami University.

Nowak, R. M. 1976. The cougar in the United States and Canada. New York Zoological Society and U.S. Fish & Wildlife Service.

Pike, J. R., et al. 1999. A geographic analysis of the status of mountain lions in Oklahoma, Wildlife Society Bulletin 27:4-10.

Roof, J. C., and D. S. Maehr. 1988. Sign surveys for Florida panthers on peripheral areas of their known range. Florida Field Naturalist 16:81-104.

Taverna, K. et al. 1999. Eastern Cougar (Puma concolor cougar): Habitat suitability analysis for the central Appalachians. Charlottesville, VA: Appalachian Restoration Campaign. 23 pp. www.heartwood.org/arc

Tischendorf, J. W. and S. J. Ropski, eds. 1994. Proceedings of the Eastern Cougar Conference, Gannon University, Erie, PA, June 3-5. Ft. Collins, CO: American Ecological Research Institute. 245 pp.

Wrigley, R. E., and R. W. Nero. 1982. Manitoba's big cat: the story of the cougar in Manitoba. Winnipeg: Manitoba Museum of Man and Nature.

Young, S. P., and E. A. Goldman. 1946. The puma, mysterious American cat. Washington, D.C.: American Wildlife Institute. 358 pp.

MANAGING THE CAPTIVE MOUNTAIN LION POPULATION IN NORTH AMERICAN ZOOS

MICHELLE R. SCHIREMAN, Oregon Zoo, Portland, Oregon, 97221

Abstract: The Studbook Keeper for Cougar in the U.S. and Canadian zoos keeps all of the records for puma that have been held in our member institutions since the first cat entered the Philadelphia Zoo in 1874. This includes causes of death, transfers, Dams and Sires, and places of capture or release where applicable. Subspecies are included when known and all of the Florida Panther that have passed through our institutions. As this species of animal breeds easily in captivity, the Felid Taxon Advisory Group has mandated a temporary breeding moratorium on this population until we can get a handle on their genetic make up. As a result, no litters have been born at our institutions since 1995. An unfortunate result of this moratorium is that attrition is taking hold of our population. As individuals die and exhibits are left empty zoos are asking for help in locating cubs to fill these spaces. While some conservationists would like to see these exhibits filled with other endangered species, the public demands to see predators and the zoogeographic layouts of our zoos demand that they remain North American species. This is where careful genetic pairing of captive animals and placement of wild orphans will save this population. Our goal is to maintain 90% genetic variation in this population for the next 100 years.

The American Zoo and Aquarium Association (AZA) maintain records on captive cougar in zoos throughout the U.S. and Canada by merging all of the records each zoo had on individual cougars into one database. This would allow us to look at trends and to see where the cats are and where they had all come from. These databases would be called studbooks and the record keeper a studbook keeper.

The official title for the historical compilation for cougar is the Regional Studbook for Puma. We utilize a variety of database management programs including SPARKS (Single Population Animal Record Keeping System) and PM2000 (population Management 2000).

There are 2 types of studbooks: Regional Studbooks and International Studbooks. The Regional Studbooks can include Canada, the United States, Mexico, Central and South American facilities and individuals who fall into any of the following categories: AZA Institutional Members (this includes most of the larger zoos and aquariums in the US), AZA Affiliate Members (facilities that may not be open to the public), facilities and individuals who deal directly with our institutions, and who participate in and follow breeding recommendations, institute good record keeping, and who respond to the studbook keepers' requests for information or records. Basically, they cooperate with and follow the recommendations of the various Taxon Advisory Groups (in this case the Felid TAG) and their studbook keepers. There have been many private facilities that have not met these criteria, but have been included them in the printed book, nonetheless. Many zoos have dealt with questionable parties in the past and do not wish to be associated with them in the historical studbooks. These books are printed every 3 years and show all cougar that have passed through AZA facilities from the beginning of AZA institutional record keeping. In the case of Philadelphia, we have animals dating back to the 1870s. This type of data was gleaned from handwritten ledgers with information such as how many beaver pelts were traded by the zoo for these animals.

DATA INCLUSION

A variety of data are included as they are available including: dam and sire; birth, death, and transfer dates; the physical location of a cat at any given time; local identification numbers from every institution where an animal has been located; capture locations; whether hand or mother raised; whether wild or captive born; house names; transponder numbers; tattoos; type of contraception used if any; veterinary concerns and cause of death to name the major topics of interest.

Currently, there are approximately 3000 animals that have been historically entered in the studbook at AZA institutions. Animals that leave the AZA are considered "Lost To Follow Up" or LTF. In the past, LTFs were usually due to poor record keeping or animals being sold or given to private individuals (often as pets) or to disreputable dealers. Today LTFs are almost nonexistent. There is currently a breeding moratorium and no cubs have been born in our facilities in >4 years. As far as the present living population, I have listed 58.83 (136) in 60 Institutions.

USEFULLNESS OF DATA

Studbooks of living populations are published annually and distributed to all contributing facilities. In addition, the studbook keeper gives a report at the annual meeting of the appropriate Taxon Advisory Group (or TAG). At the Felid TAG meetings, representatives for every species of captive felid being held in AZA facilities get together to evaluate exhibit space and to make breeding recommendations. We report all births, deaths, transfers and new exhibits for our species for the year. The cats are then broken down into two groups. The groups are based on their physical size since these will be the species vying for the same cage space. The scores that are assigned to each species are based on many criteria such as: species endangerment, husbandry needs, on going husbandry or veterinary research taking place with this species, enclosure requirements, zoogeographical needs, educational value, and visitor interest. Next we look at available cage space, new exhibits coming on line, possible attrition taking place, and how we are presently filling these spaces.

These factors help us determine which species to continue breeding and which to stop reproducing. The next step is using the studbook information to recognize founderstock, find unrelated individuals, and locate genetically valuable animals in an attempt to pair them up. It also shows us trends in our population that we need to watch or attempt to correct, such as high infant mortality, difficult or dangerous introductions or other husbandry concerns over time.

Ultimately the AZA has various goals for our captive populations. In the case of cougars, we are shooting for 90% genetic variability over the next 90 years. Computer programs are used to assess the status of our population with no imported founders added.

REQUEST FOR ASSISTANCE

We presently have an aging cougar population with more and more demands for new exhibits. We believe the research community might be able to assist us with this problem.

The captive population needs more genetic variation that is in our free-ranging population. Instead of producing animals that might not have an immediate home or breed animals that are closely related, we are soliciting help with orphaned cougars. However, it may take time to find the appropriate captive location. To ensure proper placement, we will need the following information: the approximate age of the animal(s), nursing, gender, # of cubs/siblings, overall health, capture location, how soon do you need to ship, and any additional info on the dam.

Currently there are 42 founders in the captive population. However, only 21 that are under 10 years old, not contracepted, and wild caught in a known location. We hope that zoos cooperate in making the necessary moves to pair up unrepresented lines, cats cooperate in producing healthy offspring, and State Game officials help to infuse our present captive population with new bloodlines that we will be successful in maintaining not only the needed 90% genetic diversity, but 100 healthy, beautiful ambassadors of their species.

A SPATIAL EVALUATION OF COUGAR-HUMAN ENCOUNTERS IN U.S. NATIONAL PARKS: THE CASES OF GLACIER AND BIG BEND NATIONAL PARKS

JOHN P. TIEFENBACHER, Center for Texas-Mexico Applied Research, Southwest Texas State University, San Marcos, TX 78666

MICHELLE L. SHUEY, James and Marilyn Lovell Center for Environmental Geography and Hazards Research, Department of Geography, Southwest Texas State University, San Marcos, TX 78666

DAVID R. BUTLER, James and Marilyn Lovell Center for Environmental Geography and Hazards Research, Department of Geography, Southwest Texas State University, San Marcos, TX 78666

Abstract: Tourist visitation to national parks in the western United States has climbed to record numbers over the past few decades. With changing levels of tolerance to large carnivores during this time and reduced persecution of the mountain lions in some areas, it appears that their population in the West has rebounded. The chance of human encounters with mountain lions has increased due to these trends. Human response to encounters is guided by a number of characteristics that might be represented by awareness, attitudes and motivations. To improve the chances of avoiding negative outcomes from encounters reports of encounters with mountain lions in two western parks are evaluated to determine the spatial settings of these events. Large-scale analyses of the patterns of the encounters in Glacier National Park, Montana and Big Bend National Park, Texas help to understand the landscapes within which encounters occur. Evaluation of these settings provides information that can assist in the development of effective hazard-communication tools.

Aside from the day-to-day encounters experienced by humans residing in mountain-lion country, United States' national parks are the most frequent settings for human-mountain lion interaction. The ingredients for contact are enhanced in national parks by both the reduced persecution of mountain lions and the increased density of human use of natural environments. Encounters have the potential for negative outcomes for both people and the animals attacks on people and the resulting extermination of the offending lion. To reduce this risk, it is important to inform visitors to parks that they should not only expect to encounter mountain lions, but also should be educated in ways to avert a disastrous encounter. In some cases, however, the rather simple task of providing information to visitors increases in difficulty with increased resistance of visitors to receipt of educational messages.

Visitors to national parks originate from many different places and arrive with a wide range of attitudes toward wild animals and pre-conceptualizations of nature. In order to communicate the risk inherent in natural settings and to help visitors achieve safe and fulfilling experiences at parks, methods should be designed to reach the variety of conceptual and attitudinal paradigms possessed by the assortment of visitors. Luckily, these paradigms also predispose visitors to certain activities conducted in particular settings within parks because basic recreational motivations and preferences guide them. For instance, some visitors tend not to stray far from their vehicles and paved roadways because it is not necessary in order for them to achieve recreational satisfaction. Other park users will venture deep into park backcountry, some hiking and others in four-wheel drive vehicles. To begin to understand the risk posed to national park visitors resulting from awareness of and response to environmental hazards, we assessed the frequency and distribution of mountain lion encounters in two western national parks: Glacier National Park, Montana and Big Bend National Park, Texas. This paper describes the parks and the acquisition and manipulation of data from the parks. We discuss the ramifications of the spatial patterns of encounters.

HUMAN ENCOUNTERS WITH MOUNTAIN LIONS: DEFINITIONS AND DISTRIBUTIONS

This study differs from studies of reported attacks and/or fatalities of human-lion interaction because it focuses on the report of humans "encountering" mountain lions. An "encounter" is a recognizable interactive "moment" when a person believes they have "experienced" a mountain lion. This moment may involve seeing, hearing or coming face to face with a mountain lion. In some cases, individuals may report an encounter based upon their belief that they'd had one there may never have even been a lion present. These phenomena are just as important as "real" encounters, however, insofar as they may lead a visitor to seek both a deeper understanding of their recreational environment and more information about the inherent risks of natural places.

The tasks undertaken in this study are threefold and they are designed to understand the geography of visitors' experiences of mountain lions in national parks. We mapped the locations of encounters within national parks, identified the spatial types of recreational settings within which encounters occur, and sought to differentiate visitor types that tend to frequent the range of settings where encounters occur. By understanding the types of visitors likely to encounter lions in these parks, we may begin to understand the challenges to active prevention of encounters with negative consequences.

DESCRIPTION OF THE STUDY AREAS

Glacier National Park (GNP), Montana, is an International Biosphere Reserve of over 0.4 million hectares astride the Continental Divide in the northern Rocky Mountains. Approximately 2,000,000 people visit GNP each year (Table 1), primarily in the summer months, although park use in winter and transitional-seasons has accelerated in the past decade.

Table 1: Encounters and the number of annual visitors to Glacier National Park, Montana

Year	Encounters*	Visitation**
1985	1	1,603,011
1986	2	1,579,151
1987	3	1,660,737
1988	3	1,817,733
1989	6	1,821,523
1990	13	1,986,787
1991	5	2,096,966
1992	11	2,199,767
1993	20	2,141,704
1994	8	2,152,989
1995	2	1,839,518
1996	3	1,720,805
1997	4	1,708,856
1998	5	1,830,944
Total	86	

Sources: *Hungry Horse News; **National Park

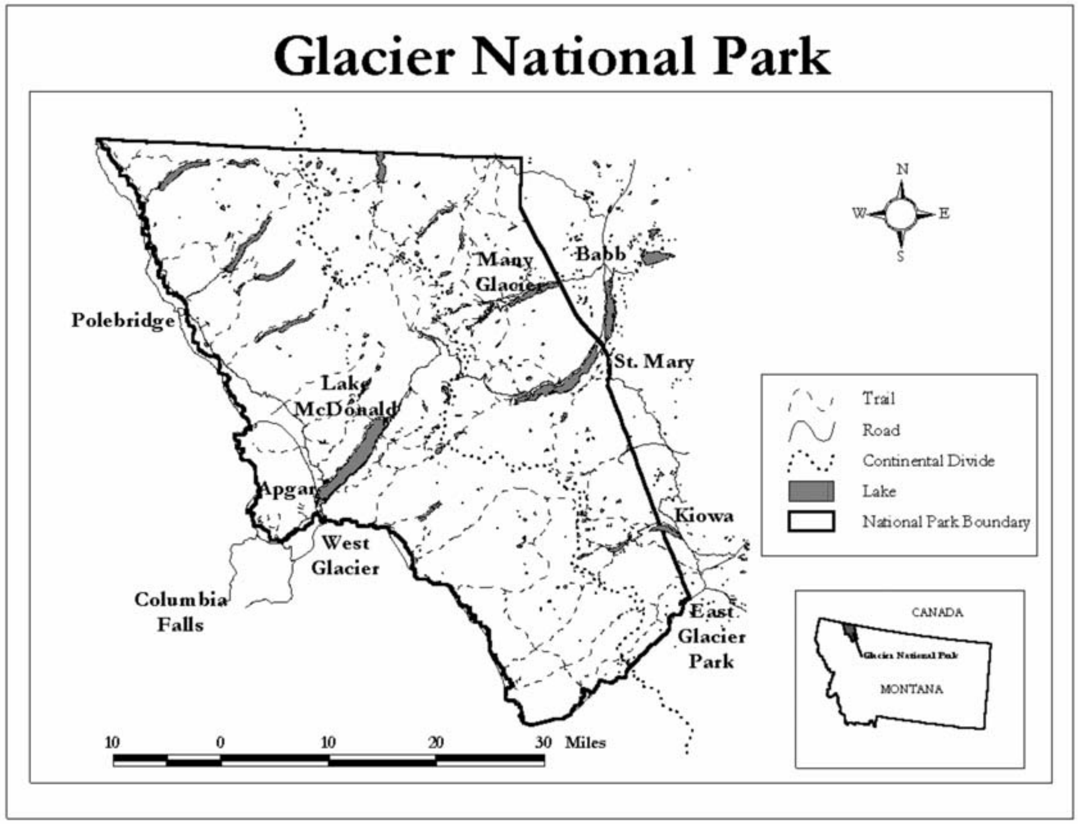


Figure 1. Developed areas in Glacier National Park, Montana.

Bear Creek and the Middle and North Forks of the Flathead River form the southeastern and western borders of GNP, respectively. The northern border is delineated by the international boundary with Canada. The eastern edge of the park also marks the western boundary of the adjacent Blackfeet Indian Reservation. Small communities whose economic base is primarily tourism ring the border of the park (Figure 1). The collective permanent population of these communities is only several hundred, concentrated primarily around park headquarters in West Glacier. During the summer tourist season, seasonal employees cause this number to swell to about 4-5 times the winter population.

Big Bend National Park (BIBE), Texas, is also an International Biosphere Reserve of over 0.3 million hectares at the southern termini of the Rocky Mountains and Great Basin. Approximately 350,000 people visit BIBE each year (Table 2), primarily from late fall through early spring. The Rio Grande forms the southern boundary of BIBE and the United States' boundary with Mexico. Eastern, northern and western portions of the boundary are geometric and follow the limits of federal land ownership. Units of the state park system abut BIBE to its east and west and private lands ring the central portion of the park's northern boundary. Small communities supported by ranching, hunting and other forms of tourism lie to the park's north and west (Figure 2). The permanent population of the region is low, but the seasonal population swells in park communities and surrounding towns like Marathon, Lajitas and Study Butte during the late fall, winter and early spring months.

Year	Encounters*	Visitation**
1985	31	188,045
1986	26	200,622
1987	78	227,291
1988	61	239,595
1989	49	281,728
1990	97	257,378
1991	76	269,470
1992	107	294,535
1993	119	327,907
1994	264	330,417
1995	157	295,460
1996	148	279,454
1997	161	305,882
1998	262	338,442
1999	145	N/A
2000	77	N/A
Total	1858	

Sources: *Big Bend National Park archives; **National Park Servic

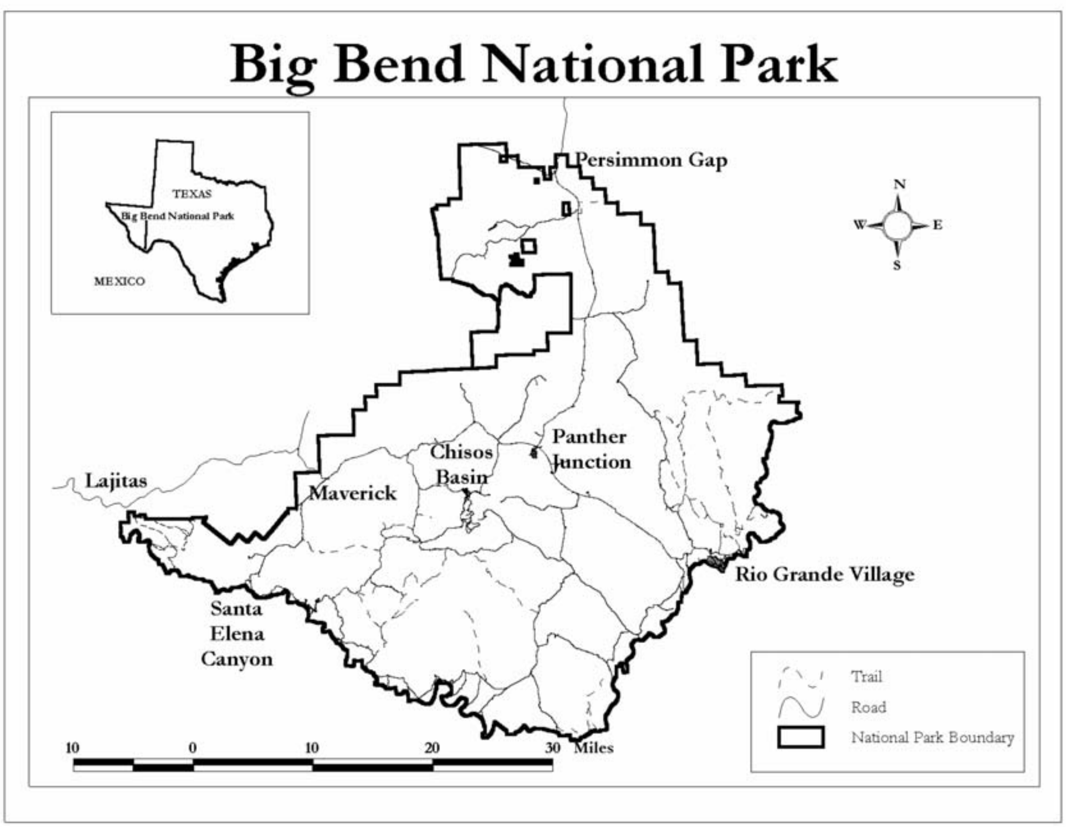


Figure 2. Developed areas in Big Bend National Park, Texas.

ACQUIRING DATA ABOUT HUMAN ENCOUNTERS WITH MOUNTAIN LIONS

Glacier National Park.-- By recommendation of the GNP park archivist we consulted the Hungry Horse News, a weekly newspaper published in nearby Columbia Falls, Montana, for information regarding mountain lion encounters. It was expected to have more thorough coverage of such encounters than available in the park's archives. This paper covers the news of GNP extensively and has served as a data source for many previous historical accounts of events in the park. Every issue of the newspaper published from 1985 through 1998 was reviewed for lion encounters. We recorded details of each encounter, its date and geographic location (as accurately as could be determined from the written descriptions). General descriptions, including place names, were used to establish event locations. The vagueness of descriptive geographic information in news reports (such as "at the head of Lake McDonald") unfortunately allowed only a general plotting of encounters in the park (Figure 3).e

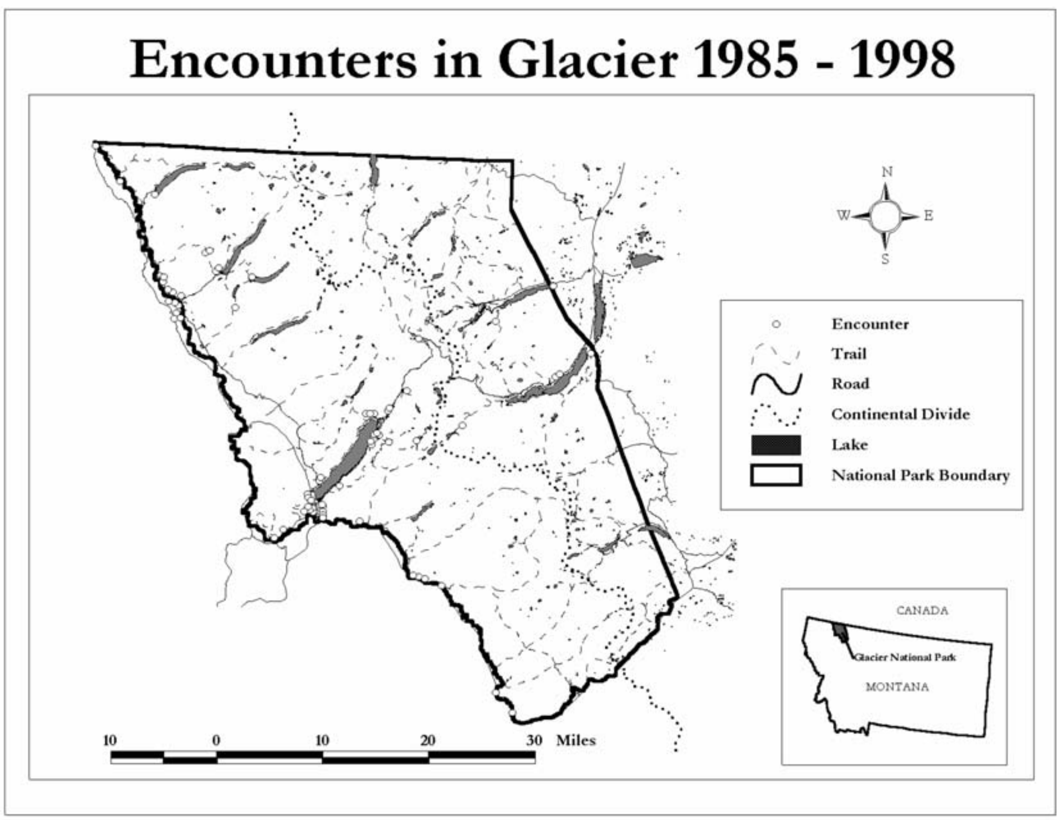


Figure 3. Distribution of encounters in Glacier National Park, Montana from 1985 to 1998.

Big Bend National Park.-- For BIBE, we acquired an electronic database from the National Park Service Research Station at Panther Junction in BIBE that included all recorded reports from 1947 to June 1999. Paper reports from July 1999 to October 2000 were also reviewed and amended to the data set. Only the reports from 1985 through 2000 were manipulated for the present study. Encounters in BIBE were mapped using ArcView GIS. One third of encounter reports in the database included UTM coordinates and verbal descriptions of the encounter locations. The balance of the events required translation of verbal descriptions into UTM coordinates. Most of the sites that could be located on large-scale park maps were identified with coordinates at an accuracy of about 100 meters (Figure 4).

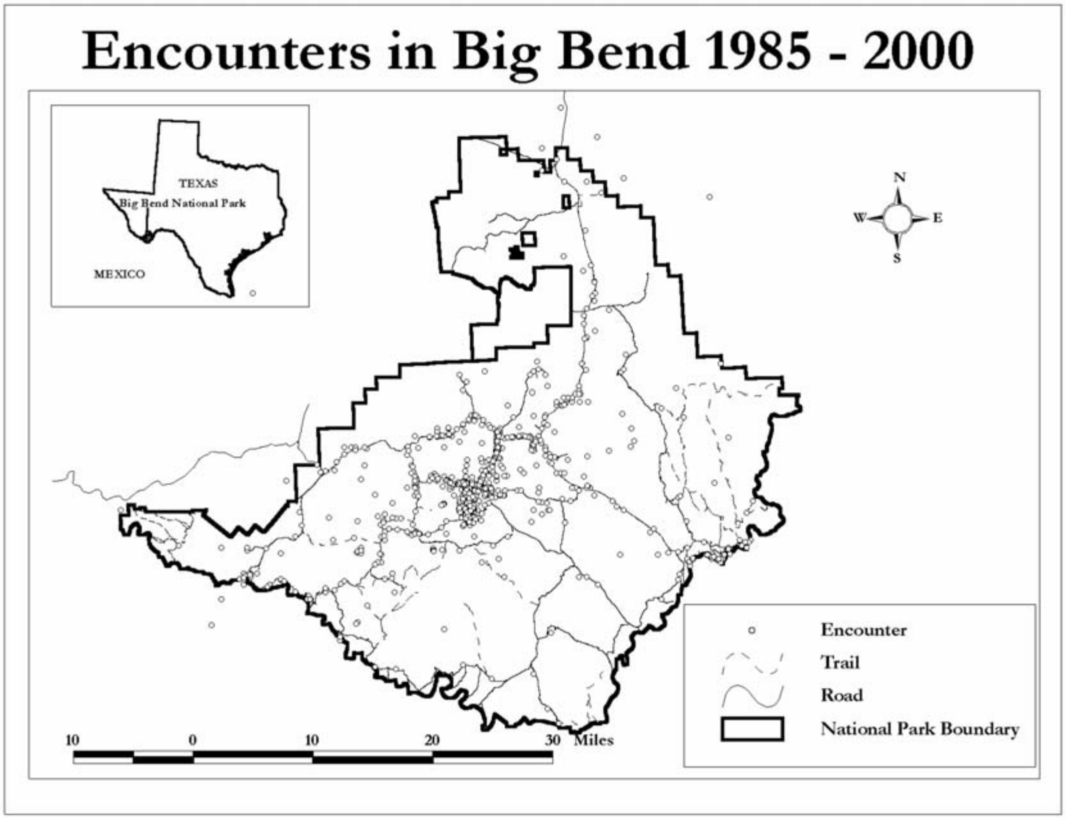


Figure 4. Distribution of encounters in Big Bend National Park, Texas from 1985 to 2000.

TEMPORAL AND SPATIAL DISTRIBUTIONS OF MOUNTAIN LION ENCOUNTERS

Glacier National Park.-- From 1985 to 1998, 86 mountain lion sightings or incidents were reported in the *Hungry Horse News* (Table 1). These cases include 73 sightings of lions (including several lions captured and collared by park researchers), discovery of 3 lion carcasses, 3 attacks on dogs, 5 cases where lions were observed stalking humans, and two verified attacks on young boys (in July, 1990, and August, 1992). All but 6 of the reported lion encounters occurred west of the Continental Divide (Figure 3). Of those 6, 3 were in the Many Glacier Valley and 3 were in the St. Mary Valley between Rising Sun and St. Mary. Given that these two valleys are among the most popular in the summer, this distribution is not unusual. We suspect that if more tourist facilities enticed visitors into other east-side valleys, a higher frequency of encounters might occur. Regardless of the eastside situation, however, the western distribution illustrates a large concentration of encounters (42) around the West Glacier-Apgar area, at the head of Lake McDonald and along Highway 2 (see Figures 1 and 3). Twenty more encounters were occurred in the vicinity of the northwestern portion of the park near Polebridge.

Big Bend National Park.--Since 1985, there have been 1,858 reported mountain lion encounters in BIBE (Table 2). These cases include visual, aural and physical contact with a lion. The encounters are most heavily concentrated in and around the Chisos Basin in the center of the park where 1,259 encounters occurred, primarily in areas near more heavily traveled roads and campgrounds. One hundred and seventy-nine encounters occurred in the portion of the park to the east and southeast of Panther Junction and 213 occurred west and south of Maverick. About 130 more encounters occurred between Panther Junction and the park's northern boundary near Persimmon Gap. The remaining events were scattered beyond the boundaries of the park, but were reported to and recorded by the Park Service.

SETTINGS AND THE PEOPLE THAT USE THEM

The typology of settings used in this paper are representative not of the specific kind of activity undertaken *in situ*, but rather the investment or level of commitment users exhibit to actively experience a park. The first "level" of commitment might be travelers' initial decision to visit a specific park. Often parks are distant from major east-west or north-south highways and in the process in which parks become destinations for vacationers, expenditure is made toward the experience. Commitment levels progress as visitors venture deeper into the park environs. Drives through parks take in scenery. The commitment and experience are limited. Short stops to read roadside interpretive signs and short "nature walks" invest more of users' time and energy and require a greater desire for experience. Overnight use at campgrounds is a logical step up of visitors' commitment to park experience. The culmination of commitment might be extended energy- and time-intensive excursions to use backcountry for backpacking, rock-climbing and forms of off-road vehicle use. These "levels" might also reflect increasingly focused motivations and goals for park use and further might be related to socioeconomic and cultural group factors that determine the limits of recreation.

TYPES OF PARK USERS AND THE PLACES THEY GO

As alluded to earlier in this paper, the paradigmatic goals and motivations of visitors might often determine the spatial pattern of their use of a park. We can, for instance, imagine that some types of visitors will not leave major thoroughfares in parks, while others will endeavor to venture deep into park backcountry. Likewise, campgrounds might be acceptable environs for some visitors, but will not appeal to all.

If we typify settings in parks by levels of common use, we might arrive at a list like this: main roads, visitor centers, campgrounds, front-country trails, backcountry trails, and backcountry campgrounds. We might then attempt to categorize the types of users commonly frequenting such settings. For discussion purposes, here is a sample list: "biophiliacs," adventure seekers, vacationers, grand tourists, and "autophiliacs." Nature-savvy seekers of bioregional knowledge, wisdom, and solitude might be referred to as "biophiliacs." They might be motivated to take extended, contemplative excursions throughout a park to acquire fulfillment. "Adventure seekers," however, might be activity oriented and might look for locations in parks that have the landscape characteristics that provide adventure. They might pursue heights for rock climbing, hike extensively, and generally orient their activities to the production of sweat and relief of stress. These settings might be front-country locations or might attract these users more deeply into the backcountry of the park. Families seeking to commune among themselves and to share growth experiences might be called "vacationers." The most limiting member of the group (perhaps a child or elderly relative) might establish the limits of their activities. Vacationers rarely venture into energy-demanding activities or deep beyond the front-country. Another group of visitors might be called "grand tourists." These people are whirlwind travelers that seek to visit only the major attractions as the prestige of the visit rather than the innate reward of the experience may motivate their travel plans. Invariably, grand tourists lack significant depth of knowledge of local environments. Finally, a group of travelers that move quickly through some parks might be called " autophiliacs" as they pursue vistas with a hasty examination of landscapes. Stops, if taken, are brief and never beyond main roads. Only superficial knowledge and awareness are gained during park experiences. Deeper experiences are serendipitous.

So who might be found at the types of locations mentioned above? Main roads will encompass the diversity of users. Autophiliacs, grand tourists, vacationers, adventure seekers, and biophiliacs will all be found on main roads, but will be found in decreasing percentages of the total users of each of those groups, respectively. Visitor centers seek to serve all visitors to parks, but certainly some tourists can't be bothered to stop and learn. Some of these groups (biophiliacs and adventure seekers) will need to stop to acquire more detailed information and use-permits to plan their visit, while others (vacationers and grand tourists) might stop briefly to determine their need for more information. Grand tourists and vacationers might head directly to campgrounds and nature trails to establish camp or to begin their exploration and might find little need to interface with park staff and exhibits. Front-country trails and campgrounds might see a similar mix of grand tourists, vacationers, adventure seekers and biophiliacs as would be found in visitor centers, but only some of these users will be equipped with localized knowledge and awareness of risks in such settings. The users of backcountry trails and campgrounds (i.e. more natural areas that require greater amounts of investment in equipment and preparation) will likely include only adventure seekers and biophiliacs. However these users are more apt to be equipped with knowledge, awareness and plans to respond to occasional encounters with natural hazards.

Glacier National Park.-- The setting of the 86 encounters in GNP has been categorized into three types of locations that occurred in the following frequencies: 65 front-country encounters, 9 backcountry encounters, and 12 encounters during capture and collar activities. Clearly the bulk of encounters are occurring in settings in which people might not be prepared with the proper knowledge, awareness and preparation for incidental mountain lion encounters. The nature of the composition of users of the front-country ought to be examined to determine the level of awareness and the motivation of these visitors.

Big Bend National Park.-- The setting of the BIBE encounters has been categorized into four types of locations and occurred in the following frequencies: 1,122 front-country encounters, 736 backcountry encounters, 377 campground encounters, and 18 residential encounters. Most encounters in BIBE are also in the settings of people that might not have the proper knowledge, awareness and preparation for incidental mountain lion encounters. The composition of these users also ought to be examined for awareness, their motivation, and clues to the best way to reach them with risk-communication messages.

DISCUSSION

Every visitor to a national park arrives with predetermined levels of awareness, perception, and attitudes that guide their planned activities and behavior in natural settings. We can call the combination of these factors their "paradigm." Their paradigm can be changed and molded through education programs. Awareness and knowledge can be raised. Perception can be enhanced. And attitudes can be molded. If we desire to improve the quality and safety of encounters for both people and mountain lions, the process of educating the visitor's awareness, knowledge, perception and attitude must be undertaken to assist in the mitigation of risk in encounters.

Though park managers in both Glacier and Big Bend already strive on a daily basis to effectively communicate guidelines for wise and safe behavior in mountain lion country, they very likely cannot reach every visitor. Patterns of visitor encounters might help us understand the people and "paradigms" that are coming into contact with mountain lions. When we fully understand the level of understanding and desires of users of national parks we will be able to design more effective means of communicating the risks inherent in mountain lion country and mitigation techniques that might be effective for them.

Acknowledgements: The authors would like to extend thanks to the following people for their kind assistance, provision of data and information. Big Bend National Park personnel who were very helpful were Mary Kay Manning, Raymond Skiles and Betty Alex. Glacier National Park personnel Steve Gniadek and Richard Menicke offered significant assistance. Paul Richardson of Texas Parks and Wildlife provided background information. Butler acknowledges funding from a Faculty Research Enhancement Grant from Southwest Texas State University, in support of archival work in Glacier National Park. Shari Forbes of the Department of Geography at Southwest Texas State University helped compile Glacier National Park mountain lion sighting reports from the Hungry Horse News.

ABSTRACTS

REPRODUCTION AND DISPERSAL OF MOUNTAIN LIONS IN SOUTHERN TEXAS

R. BILL ADAMS*, Department of Natural Resource Management, Sul Ross State University, Alpine, TX 79832.

LOUIS A. HARVESON, Department of Natural Resource Management, Sul Ross State University, Alpine, TX 79832.

PAUL B. ROBERTSON, Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, TX 78744.

MICHAEL E. TEWES, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, 700 University Blvd., MSC 218, Kingsville, TX 78363.

JAMES D. HILLJE, Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, TX 78744.

Abstract: In Texas, mountain lions (Puma concolor) are considered non-game animals and may be harvested throughout the year. Due to this status it is important for researchers to understand reproduction and dispersal characteristics of mountain lions if viable populations are desired. Data were collected regarding kitten/subadult mountain lion dispersal and reproduction in southern Texas from 1993-2000. Researchers observed/monitored 9 female kittens and 7 male kittens. Four subadult male and 5 subadult female mountain lions were collared and monitored, and dispersed at <13 months; male dispersal distances ranged from 9.40-53.8 km and female dispersal distances ranged from 6.30-23.1 km, and typically followed primary (rivers) or secondary (creeks) waterways to new habitats. The average home range size was 203.7 km^2 and 315.7 km^2 for females and males, respectively. Of the 16 litters produced over the study period, 6.25% occurred during the spring, 31.25% occurred during the summer, 25.00% occurred during the fall, and 37.50% occurred during the winter. Fourteen dispersals by 9 subadults occurred during the study with 43% of the dispersals occurring in the fall, 29% occurring during the winter, 21% during the spring, and 7% in the summer months. Knowledge of this information could be useful for determining future management needs.

ESTIMATING SEX REPORTING BIAS IN MOUNTAIN LIONS USING DNA ANALYSES

CHUCK R. ANDERSON, Jr., Wyoming Cooperative Fish and Wildlife Research Unit, Box 3166, University Station, Laramie, Wyoming 82071.

FRED G. LINDZEY, Wyoming Cooperative Fish and Wildlife Research Unit, Box 3166, University Station, Laramie, Wyoming 82071.

Abstract: Changes in the sex ratio of mountain lion (Puma concolor) populations can be an important parameter for documenting population trend where excessive harvest of females can result in population decline. Genetic samples were collected from 198 mountain lions in Wyoming between 1996 and 1999 that died from human-caused mortality. We determined sex from gender assays analyzing chromosomal DNA to evaluate accuracy of reported sex during mandatory inspection. Sex was incorrectly recorded for 17 of 198 (9%) mountain lions. Sex ratio between correctly (m:f = 100:79) and incorrectly (m:f = 100:70) sexed mountain lions did not differ ($P = 0.81$). Juveniles (<3 years old), however, were more likely to be misclassified than adults ($P = 0.005$) and comprised 82% (14 of 17) of misclassified mountain lions. Closer examination of juvenile mountain lions should enhance accuracy of sex ratio data for management and improve inferences on mountain lion population trend.

USING GPS COLLARS TO ESTIMATE MOUNTAIN LION PREDATION RATES AND SELECTION OF LARGE PREY

CHUCK R. ANDERSON, Jr., Wyoming Cooperative Fish and Wildlife Research Unit, Box 3166, University Station, Laramie, Wyoming 82071.

FRED G. LINDZEY, Wyoming Cooperative Fish and Wildlife Research Unit, Box 3166, University Station, Laramie, Wyoming 82071.

Abstract: We collared 10 mountain lions (Puma concolor) with Global Positioning System (GPS) transmitters between September 1999 and April 2000 to identify detailed winter movement patterns and evaluate prey selection and predation rates. GPS collars were fitted on 2 adult males (3 years old), 3 juvenile females (1.5-2.5 years old), and 5 adult females. We retrieved collars during spring 2000 and plotted GPS locations on 1:100,000-scale topographic maps in Arc-ViewTM to identify potential predation sites from location clusters. GPS positions averaged 3-5 locations/day/individual of the 6 programmed location attempts. We are verifying predation sites using hand-held GPS navigation units to locate clusters from GPS collars. We have detected prey remains at 53 location clusters (34 mule deer (Odocoileus hemionus), 14 elk (Cervus elaphus) , and 5 pronghorn (Antiliocapra americana)), and mean error from cluster center to prey remains was 39 m (range: 0-90 m). Preliminary results suggest that location clusters with nocturnal locations for 2 nights exhibit a high probability of being a predation site. Efficacy of GPS collars to estimate mountain lion predation rates and prey selection, and methods of estimation will be presented.

VIRAL DISEASES AND COUGAR DEMOGRAPHY

ROMAN BIEK*, Wildlife Biology Program, School of Forestry, University of Montana, Missoula, MT 59812.

CHUCK R. ANDERSON, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, WY 82071.

TONI K. RUTH, Hornocker Wildlife Inst., 2023 Stadium Drive, Suite 7, Bozeman, MT 59719.

KERRY M. MURPHY, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190.

MARK R. JOHNSON, Yellowstone Center for Resources, P.O. Box 168, Yellowstone National Park, WY 82190.

COLIN M. GILLIN, Center for Conservation Medicine, Tufts University School of Veterinary Medicine, North Grafton, MA 01536.

MARY POSS, Division of Biological Sciences, University of Montana, Missoula, MT 59812.

Abstract: Viruses are commonly detected in free-ranging cougars (Puma concolor) but little is known about the demographic implications of these infections. While viral pathogens can obviously have an effect on cougar survival and fecundity, cougar population parameters such as size and movement in turn are likely to influence the temporal and spatial dynamics of virus infections. Examining the patterns of virus occurrence might thus provide important insights into cougar population characteristics. We tested serum from more than 120 cougars from 2 locations, Northern Yellowstone (MT) and Snowy Range (WY), for evidence of exposure to several viral pathogens of wild felines. In addition, we used polymerase chain reaction (PCR) to detect current infections with feline immunodeficiency virus (FIV) in those animals. Samples were taken over periods of several years and included a high proportion of family groups as well as a number of sequential samples from the same individuals. We present results on the observed patterns of virus exposure and infection in the 2 populations and discuss possible implications for cougar demography. Furthermore, we introduce the idea of using the phylogenetic relationships of FIV, a retrovirus that genetically changes at extraordinary rates, to make inferences on cougar population structure and disease transmission history.

A TEST OF OPTIMAL FORAGING: MOUNTAIN LIONS AND MULE DEER

SCOTT A. BLUM*, Department of Biological Sciences, Idaho State University, Pocatello, Idaho 83209.

JOHN LAUNDRÉ, Institutio de Ecologia, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih. 32900 & Department of Biological Sciences, Idaho State University, Pocatello, Idaho 83209.

Abstract: Optimal foraging theories are based on the assumption that fitness is maximized by the most efficient use of resources and that selection will tend to favor optimal foragers. Traditional foraging models based on the relationship between active foragers seeking relatively inert forage are not suitable to describe a behaviorally complex relationship wherein an active predator pursues reactive prey. The interaction between mountain lions (Puma concolor) and mule deer (Odocoileus hemionus) in south central Idaho is one such complex relationship. Mule deer exhibit foraging behaviors consistent with predictions of optimal foraging theory, utilizing open areas to forage and forested areas to rest. This study will test optimal foraging predictions for mountain lions. Mountain lions are predicted to spend time in locations which optimize their hunting success by increasing their encounters with mule deer in areas providing adequate cover. Mountain lion locations determined by radio telemetry will be analyzed in a GIS by plotting them on USGS Digital Orthophoto Quadrangles digitized to delineate forested patches. Relative use of forest, edge, and open areas will be determined and compared to foraging theory predictions concerning patch size selection, patch use in optimizing hunting success, and time spent within patches. Techniques employed in testing these predictions and some preliminary results will be presented.

MOUNTAIN LION FOOD HABITS IN SIERRA SAN PEDRO MÁRTIR, BAJA CALIFORNIA, MEXICO

AARÓN BUENO-CABRERA, Escuela de Biología, Universidad Autónoma de Puebla, Bld. Valsequillo y Av. San Claudio, Edif. 76, C.U. Puebla, Puebla.

ROBERTO MARTÍNEZ-GALLARDO. Maestría en Manejo de Ecosistemas de Zonas Aridas, Facultad de Ciencias, Universidad Autónoma de Baja California, Carr. Tij-Ens, Km. 103, Ensenada, Baja California. C.P. 22800.

SERGIO AVILA-VILLEGAS.* Maestría en Manejo de Ecosistemas de Zonas Aridas, Facultad de Ciencias, Universidad Autónoma de Baja California, Carr. Tij-Ens, Km. 103, Ensenada, Baja California. C.P. 22800.

JORGE ALANÍZ-GARCÍA. Maestría en Manejo de Ecosistemas de Zonas Aridas, Facultad de Ciencias, Universidad Autónoma de Baja California, Carr. Tij-Ens, Km. 103, Ensenada, Baja California. C.P. 22800.

Abstract: Mountain lion (Puma concolor) is one of the most widely distributed mammals in Mexico, however, its food habits and influence on its main prey have been poorly studied. Mountain lion diet was studied from June 1999 trough July 2000 in Sierra San Pedro Mártir, a semiarid area in Baja California, México. Resident ungulates within the study area include mule deer (Odocoileus hemionus), desert bighorn sheep (Ovis canadensis), and livestock. We examined 29 scats from 8 different locations and detected 49 prey items finding an array of 11 vertebrate species. Mammals comprised 98% of the diet and only 2% were birds. Livestock (cattle and horses) comprised 50% of items detected and occurred in 92% of all scats. Small rodents (3 species) comprised 28.8% and lagomorphs 13.3% of items detected. Mean weight of vertebrate prey (88.3 lb) was similar to North American studies in contrast with Central and South American patterns. Livestock represented 80% of biomass consumed whereas rodents made up only 0.5%. Neither mule deer nor bighorn sheep were found in scats, although for the latter, this may be an artifact of the sampling locations. A Generalized Linear Model revealed differences ($P < 0.05$) within preys used and locations. The high incidence of predation on livestock on the study area may be explained both by husbandry practices and low mule deer densities. We recommend an evaluation of the availability of the main prey to better understand the switch from natural to introduced preys and the role of lagomorphs as alternative preys.

AN EVALUATION OF THE ACCURACY AND EFFICACY OF COUGAR POPULATION ESTIMATORS

DAVID M. CHOATE, Department of Fisheries and Wildlife, Utah State University, Logan, UT 84322-5210, USA.

MICHAEL L. WOLFE, Department of Fisheries and Wildlife, Utah State University, Logan, UT 84322-5210, USA.

GARY E. BELOVSKY, Department of Fisheries and Wildlife, Utah State University, Logan, UT 84322-5210, USA.

Abstract: Although numerous techniques have been proposed for the enumeration of cougar (Puma concolor) populations, few have been simultaneously applied and rigorously evaluated for their relative efficacy and accuracy. We evaluated the application of multiple census techniques to a cougar population in southern Utah. Capture-mark-release methods using radio-collared animals were used to determine cougar population size for the primary study site. We then compared this population size with indices derived from ground-based track counts, scent station visitation rates, aerial track surveys, hunter harvest, and catch-per-unit-effort. Over 600 scent station nights with different lures were monitored over 2 years; this effort yielded a single visitation by a cougar. Track-based indices each reflected a 54-69% reduction in population size, however absolute indices varied among techniques. Aerial helicopter surveys required sufficient fresh snowfall accumulations for adequate tracking coverage of a given unit. Since 1996 these conditions were met only once for the study site in each of 3 years. Population estimates derived from helicopter-survey probability sampling exceeded minimum population estimates by 120-284%. Jackknife estimates of standard deviations were 43-60% of the population estimates (e.g., 5.6 " 3.4 cougar/100 km^2). Low and high cougar population estimates predicted by the Utah Division of Wildlife Resources for the primary study site exceeded capture and radio-telemetry population estimates by 12.8 % and 79.5 %, respectively. We discuss changes in survivorship and age structure of cougars in relation to the efficacy of current management models, and their implications for future cougar management and conservation.

MOUNTAIN LION-HUMAN INTERACTIONS IN YOSEMITE NATIONAL PARK

LESLIE CHOW, U. S. Geological Survey, Yosemite Field Station, El Portal, CA 95318.

Abstract: In 1994, the National Park Service (NPS) recorded more than 55 reported sightings of mountain lions (Puma concolor) in Yosemite Valley, a 1428 ha area visited by more than 4 million people annually. Most of these sightings occurred in densely populated areas. In an effort to provide Yosemite's managers with information on the potential threat to human safety, we initiated a 4-year study to determine why lions had increased their use of Yosemite Valley, how much time lions were spending there, and what activities lions were engaged in. We captured and installed radio telemetry collars on 7 mountain lions in areas surrounding Yosemite Valley. We monitored their daily movements and activity patterns for two years. In addition, we established and monitored track and scat transects. Fieldwork for this study concluded in May 2000. We present the preliminary results of our work and possible implications for mountain lion management in Yosemite.

A SURVEY OF RECENT ACCOUNTS OF THE MOUNTAIN LION IN ARKANSAS

DAVID W. CLARK*, Department of Biology, University of Arkansas at Little Rock, Little Rock, AR 72204.

STEFFANY C.WHITE, Department of Biology, University of Arkansas at Little Rock, Little Rock, AR 72204.

ANNALEA K. BOWERS, Department of Biology, University of Arkansas at Little Rock, Little Rock, AR 72204.

LEAH D.LUCIO, Department of Biology, University of Arkansas at Little Rock, Little Rock, AR 72204.

GARY A. HEIDT, Department of Biology, University of Arkansas at Little Rock, Little Rock, AR 72204.

Abstract: In 1998, we documented (through tracks and fecal material) the presence of one or more mountain lions (Puma concolor) in Arkansas. In this study, we examined 16 Arkansas Game and Fish Commission records of reported sightings and/or sign over the past 5 years. We also solicited information on mountain lion occurrences from hunting clubs, and mailed 850 sighting and sign surveys to professional biologists, county agriculture agents, and Arkansas trappers in an effort to determine presence and localities of mountain lions in Arkansas within the past 5 years. A large number of reports were followed-up by personal telephone conversations. From these inquiries, we received 284 responses indicating the presence of mountain lions. Data were analyzed using Geographical Information Systems. While occurrences were reported state-wide, there were concentrations in Washington and Crawford counties in the Ozark Mountains, Yell and Logan counties in the Ouachita Mountains, and near the confluence of the Saline and Ouachita rivers in the southern part of the state. Few occurrences were reported from the Mississippi Delta. We also surveyed the USDA, Arkansas wildlife officers, and state veterinarians in an effort to locate captive animals. Over 170 captive animals were reported to occur in the state. It is not known whether reported free-ranging animals were released or escaped mountain lions or their descendants. The taxonomy of mountain lions in the state is not known.

INVESTIGATING COUGAR ATTACKS ON HUMANS: THE BRITISH COLUMBIA APPROACH

CORBETT

Abstract: An increasing number of cougar (Puma concolor) and bear (Ursus spp.) attacks on humans prompts British Columbia (BC) conservation officers to develop better procedures for doing investigations. Photographs from 2 cougar attacks and one murder mistaken for a cougar attack will be shown and discussed. Lack of procedure resulted in unfounded speculation and loss of evidence in the murder. Contents and highlights of the procedure and investigation form will be discussed. Copies of the procedure as handouts. Photographs and description of kit contents. Photographs of the kit in use. Training for the kit has been done by CD-ROM. Photos and excerpts from the training will be shown. Sample CDs will be available as handouts.

Description of the function and purpose of attack teams. Photos of attack teams in training. Description of training and special equipment. We are willing to share our knowledge and learn from other agencies.

A PHYLOGEOGRAPHIC STUDY OF PUMAS (PUMA CONCOLOR) USINGMITOCHONDRIAL DNA MARKERS AND MICROSATELLITES

MELANIE CULVER*, Virginia Polytechnic Institute and State University, Department of Fisheries and Wildlife Sciences, Blacksburg, VA.

WARREN JOHNSON, Genetics Section, Laboratory of Genomic Diversity, National Cancer Institute, Frederick Cancer Research and Development Center, Frederick, MD.

JILL PECON-SLATTERY, Genetics Section, Laboratory of Genomic Diversity, National Cancer Institute, Frederick Cancer Research and Development Center, Frederick, MD.

STEPHEN J. O'BRIEN, Genetics Section, Laboratory of Genomic Diversity, National Cancer Institute, Frederick Cancer Research and Development Center, Frederick, MD.

Abstract: In this research project, several molecular markers were used to ascertain the level of genetic differentiation among natural puma (Puma concolor) populations, and also use this differentiation to understand genetic structure and infer natural history and evolution of the puma. Samples were obtained from throughout the geographical multi-habitat range of pumas and encompass all 32 described subspecies. Population level genetic differentiation in the puma was assessed using 2 independent molecular markers. These are several regions of mitochondrial DNA and 10 feline nuclear microsatellites. Results from both mirochondrial and nuclear markers indicate a low level of genetic variation in North American pumas relative to abundant variation observed in South American pumas. Regional differences are observed for Central and South American pumas with a total of 6 phylogeographic groups identified using both mitochondrial and nuclear markers. Furthermore, extant puma lineages appear to have originated in South America. The North American genetic lineage is younger than the South American lineages and younger than the North American fossil record. This indicates the potential occurrence of an historic extinction and re-colonization event among North American pumas.

TWO SIMPLE METHODS OF HANDLING RADIO-LOCATION ERROR FOR WIDE-RANGING ANIMALS IN LARGE COMPLEX STUDY AREAS

BRETT G. DICKSON*, School of Forestry, Northern Arizona University, Flagstaff, AZ 86001.

PAUL BEIER, School of Forestry, Northern Arizona University, Flagstaff, AZ 86001.

Abstract: The study of second-order habitat selection (how an animal selects a home range within a larger area of potential habitat) analyzes the differences between habitats used by an animal versus habitats available on the study area. Most studies of cougar (Puma concolor) habitat use assigned each radio-location to a single vegetation polygon, ignoring the fact that radio-locations are imprecise estimates of the animal's true location (we refer to this as "naive estimator" of habitat use). Herein, we describe 2 simpler alternative procedures to accommodate location error, readily implemented in a GIS. One alternative ("circular error estimator") is to treat each point as the center of a circle with radius equal to the estimated average error, and assign each location to habitat types with probability proportional to area of that habitat type within the circle. Another alternative ("nonpoint estimator") is to use estimated locations solely to construct a home range contour and compare the habitat composition of the home range (rather than of individual points) to available habitat. We compared both of these simple estimators of habitat use to the naive estimator, and compared all 3 estimators to available habitat, for 10 radio-tagged adult cougars monitored in southern California. All 3 estimators showed similar patterns of habitat use, and all showed selection for riparian and scrub habitats and against grassland habitats. Although neither procedure has a precise analytic estimate of precision, the procedures are simple to understand and the results are consistent with expected patterns of use and selection. These procedures take a middle ground between pretending errors don't exist (naive estimator) and pretending that statistical headstands have reduced such errors to negligible levels.

CHANGING DYNAMICS OF PUMA ATTACKS ON HUMANS

E. LEE FITZHUGH, Department of Wildlife, Fish, and Conservation Biology, University of California, Davis CA 95616.

Abstract: Claude T. Barnes (1960) compiled an extensive list of attacks by puma (Puma concolor) on humans. This stimulated a chain of publications treating puma attacks on humans. Most recent are those by Harold P. Danz (1999) and Kathy Etling (in press). My analysis includes data from all of the previous accounts. In addition, I have considered attacks from Latin America and many unverified attacks and "attacks" that did not involve contact between humans and pumas. The various types of data are categorized to allow direct comparison with Beier's (1991) and other lists. I consider a few accounts in which the puma behavior appeared not to be an attack behavior, at least at first. I analyzed the data in various ways to illustrate a possible decline in attacks extending from 1890 through 1950, with an increase above the 1881-1890 level beginning in 1970. The increased number of documented attacks also allows some speculation about clues to puma behavior.

LIONS AND TIGERS AND COWS: JAGUAR DENSITIES IN SONORAN CATTLE COUNTRY

CARLOS A. LOPEZ GONZALEZ*, Dept. of Conservation Biology, Denver Zoological Foundation, 2300 Steele St., Denver CO 80205-4899.

GUSTAVO LORENZANA PIÑA, Centro de Estudios Superiores del Estado de Sonora, Hermosillo, Sonora.

BRAD McRAE, School of Forestry, Northern Arizona University, Flagstaff AZ.

Abstract: As recently as the middle part of the 20th century, a small population of jaguars (Panthera onca) lived in the temperate forests of Arizona and New Mexico. Currently, the northernmost breeding population of jaguars lives 135 mi south of the international border, in the Mexican State of Sonora. The principal habitat in this area consists of a mosaic of oak woodlands and thornscrub, with cattle ranching being the primary use. Our purpose was to assess the number of jaguars present in this population; from July 1999 to August 2000, we deployed camera traps covering an approximate area of 700 km^2, with sample units varying in size from 40-130 km^2. We obtained 579 records encompassing 22 species, and computed mark-resight estimators of jaguar abundance using Program NOREMARK. Estimated jaguar densities were 1.3 ± 0.6 ind/100 km^2, and local population sizes varied from 1-6 jaguars on a given sample unit. Jaguars had a capture success rate of 2.76%, compared with 2.07% for mountain lions (Puma concolor). Efforts to maintain the resilience of this population should concentrate on restricting poaching and improving ecological understanding of the species.

MOUNTAIN LION POPULATION ESTIMATION USING AERIAL SAMPLING OFTRACKS IN SNOW

MICHAEL W. GRATSON*, Idaho Department of Fish and Game, Lewiston, ID 83501.

PETE ZAGER, Idaho Department of Fish and Game, Lewiston, ID 83501.

OZ GARTON, University of Idaho, Moscow, ID 83584.

LEONA BOMAR, University of Idaho, Moscow, ID 83584.

Abstract: There are few methods available to estimate mountain lion (Puma concolor) population sizes. We hybridized LIPS (line intercept probability sampling) and SUPE (sample unit probability estimation) approaches of aerial sampling of tracks in snow. In 13 hours flying time, we sampled 42, 2-km^2 polygons using a helicopter in our 880 km^2 study area of rugged, timbered and brush habitats in north-central Idaho. Polygons were long, thin, and followed elevation contours, and were thus uniquely shaped, in contrast to line transects, which are difficult and inefficient to fly in rugged terrain, and large blocks, which likely decrease the probability of detecting long track lengths (compared to line transects) but increase the probability (over line transects) of meeting an assumption of perfect sightability. Use of a Geographic Information System (GIS) allowed us to identify unique polygons. Using SUPE algorithms, we estimated 76 (90% CI, 8-163) lions after detecting 8 lions, for a density of 8.6 lions/100 km^2. Although bias is unknown and must be investigated, precision should improve with additional sampling and knowledge of stratification.

MOUNTAIN LION PREDATION ON ELK CALVES IN NORTH-CENTRAL IDAHO

MICHAEL W. GRATSON*, Idaho Department of Fish and Game, Lewiston, ID 83501.

PETE ZAGER, Idaho Department of Fish and Game, Lewiston, ID 83501.

Abstract: Knowledge of variation in mountain lion (Puma concolor) predation on elk (Cervus elaphus) neonates in relation to elk numbers, lion numbers, other predators, and other prey is poor. We investigated lion predation on elk calves from 1997-2000 in 3 study areas in north-central Idaho using radiocollared elk neonates. On 2 areas, elk populations declined 50% from the early 1990's, calf:cow ratios are poor, and there are few deer (Odocoilius spp.). On the third area, the elk population has remained fairly stable, calf:cow ratios are generally good, and there are many deer. Lions generally took a slightly smaller proportion of calves than black bear (Ursus americanus) each year and, despite large differences in calf survival rates among areas, the proportion of calves killed by lions was generally constant among areas. In contrast to black bear, which were generally unbiased in their selection of calves with regard to predicted body mass at birth, blood trace mineral values, and serum parameters, lions took calves that were a biased subset. Interpretation of our findings would be greatly improved with estimates of lion populations in each area.

WHAT IS REVEALED IN A MOUNTAIN LIONS HEEL: USING HEEL SHAPE TO ASCERTAIN IDENTITY

MELISSA M. GRIGIONE, Division of Environmental Studies, University of California, Davis, CA 95616

PRABIR BURMANB, Department of Statistics, University of California, Davis, CA 95616

Abstract: This study refines a method developed by Smallwood and Fitzhugh (1993), which attempted to discriminate between individual mountain lions (Puma concolor) in the field by using measurements of their tracks. During January-March 1996, we followed 10 radio-collared mountain lions in the Sierra Nevada mountains of California and obtained photographs of their tracks in the soil and snow. In addition, track measurements were obtained from 4 mountain lion carcasses from different parts of California in 1996-1997. We analyzed heel pad variability to discriminate between mountain lions. Measurements of each track were taken every 10 degrees from the center of the heel pad until the entire heel pad was characterized by a series of linear measurements, corresponding to a particular angle measurement. After measurements of each heel pad were made, a curve was produced by cubic spline modeling which was indicative of a particular heel pad for each mountain lion. Confidence bands were placed around each curve and a graphical comparison was then made between track sets. The results of this analysis indicate that for both types of track sets, it is difficult to distinguish between mountain lions based on levels of heel pad variability. We conclude that measurements associated entirely with mountain lion heel pad lack discriminatory power and make recommendations about what types of measurements could be used to efficiently and accurately assess an animal's identity.

STATUS OF THE PUMA IN THE MEXICAN CHIHUAHUAN DESERT

LUCINA HERNÁNDEZ*, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900.

JOHN W. LAUNDRÉ, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900 and Department of Biological Sciences, Idaho State University, Pocatello, ID 83209.

Abstract: The puma (Puma concolor) was one of the most widely distributed large carnivores in the western Hemisphere. Currently, its range is greatly reduced but apart from the United States and Canada, the extent of this reduction is unknown. This is the case in Mexico, especially in the north, specifically, the Chihuahuan desert. As the Chihuahuan desert of Mexico provides a critical link between populations to the north and south, it is important to assess the status of that link. In April of 2000, we initiated a survey of the Chihuahuan desert to assess the status of the puma. We choose 15 widely dispersed priority areas (mostly isolated mountain ranges), as designated by the Consejo Nacional para el Estudio de la Biodiversidad (CONABIO). In each area, we attempt to determine the presence and prevalence of pumas via interviews with local persons, surveys of the areas for puma sign, and with the use of camera traps. Through these efforts, we will be able to assess the current status (absent/present; rare/occasional/common) of pumas in each area. We will relate this information with data on mountain range size, amount of human development, etc. and predict with a GIS analysis, the probable occurrence of pumas within the remaining areas of the Chihuahuan desert. Here, we will report the preliminary results of our survey efforts.

MOUNTAIN LION USE OF OPEN, EDGE, AND FOREST HABITAT: EVIDENCE FOR OPTIMAL FORAGING?

BRIAN R. HOLMES*, Department of Biology, Idaho State University, Pocatello, ID 83209.

JOHN L. LAUNDRE, Department of Biology, Idaho State University, Pocatello, ID 83209.

Abstract: Previous quantitative assessments of habitat use by mountain lions (Puma concolor) have indicated that mountain lions prefer areas with woody vegetation that provide hiding cover, and avoid areas with less woody vegetation and less hiding cover. This suggests that, for mountain lions, forest structure that affects prey vulnerability is more important than type of forest. More recently, mountain lion kill locations of ungulates have been shown to have a positive relationship with preferred vegetation type, escape cover, and water. In south-central Idaho/northern Utah, predation data indicate that mountain lions are more successful at killing mule deer (Odocoileus hemionus) in edge habitat, even though overall, deer showed the highest utilization of open habitat. Powell (1994) stated that optimal foraging models needed to be combined with information on habitat preference to design models of habitat selection. If mountain lions are more successful at killing deer in edge habitat, then the prediction from optimal foraging theory is that mountain lions should use edge habitat significantly more than availability as well as significantly more than open or forest habitat. We used compositional analysis to test this prediction with mountain lion snow-tracking data. Mountain lions did not use habitat randomly (Chi-square = 48.3, $P < 0.0001$). The analysis supports the prediction that edge habitat is used significantly more than open habitat, but does not support the prediction that edge habitat is used significantly more than availability or forest habitat. With further research, optimal foraging may be the model that most adequately explains mountain lion habitat use.

ARE EXOTIC PUMAS BREEDING IN BRITAIN?

TERRY HOOPER, Exotic Animals Register, 85 Risdale Rd, Ashton Vale, Bristol BS3 2RB, UK.

F. ALAYNE STREET-PERROTT*, Department of Geography, University of Wales Swansea, Singleton Park, Swansea SA2 8PP, UK.

D.R. PHEBE COOPER, Exotic Animals Register, 85 Risdale Rd, Ashton Vale, Bristol BS3 2RB, UK.

Abstract: Introductions of alien big cats (ABCs) have a long history in Britain. The Romans probably imported lions (Panthera leo) and leopards (P. pardus) for their circuses. From the 12th Century onwards, ABCs were kept in the Royal Menagerie in the Tower of London. Pumas (Puma concolor) had been introduced by 1805, when an advertisement for Polito's Travelling Menagerie boasted of 'noble male and female panthers (sic), from the river La Plata, South America' (Bostock, 1927). Pumas became common in small zoos during the 20th Century, because they bred easily in the British climate. Others were imported as mascots by American troops during the two World Wars, or were kept as 'designer pets'. In 1976, the Dangerous Wild Animals Act made it illegal to keep ABCs without a very expensive licence. Unfortunately, this Act omitted to prevent owners from releasing their animals into the wild, a serious loophole belatedly closed by the Wildlife and Countryside Act 1981. At least 5 pumas and 2 melanistic panthers were freed in Wales. Since 1995, the Exotic Animals Register has systematically recorded sightings of ABCs and other non-native species in Britain, with cooperation from various police forces and volunteers. Hundreds of reports of exotic cats every year, including cubs, strongly suggest that both pumas and panthers are breeding successfully in the wild. We will describe the ecology of pumas in Britain, based on sightings, published reports, and detailed case studies from West Wales, including evidence for attacks on farm livestock.

REGIONAL SCALE COUGAR HABITAT MODELLING IN SOUTHWESTERN ALBERTA, CANADA

MARTIN G. JALKOTZY, Arc Wildlife Services Ltd., 3527 - 35 Ave. S.W., Calgary, AB T3E 1A2, CANADA

P. IAN ROSS, Arc Wildlife Services Ltd., 3527 - 35 Ave. S.W., Calgary, AB T3E 1A2, CANADA

JACK WIERZCHOWSKI. Geomar Consulting Ltd., P.O. Box 1843, Grand Forks, B.C. V0H 1H0, CANADA

Abstract: Regional scale habitat modeling for cougars (Puma concolor) has not been described in the Canadian Rockies. We developed habitat models using radio-telemetry data (n = 2,172) collected in the foothills of the Rocky Mountains in southwestern Alberta between 1981 and 1989. We constructed radio-location density maps for male and female cougars during winter and non-winter periods. Higher radio-location densities were assumed to represent areas of higher quality cougar habitat. Radio location density classes and the locations of kills were quantitatively defined in terms of a variety of environmental and human attributes. Significant attributes associated with high radio-location densities for both males and females in both winter and non-winter periods included lower elevations, increased terrain ruggedness, heavier stalking cover, and greater distances from high-use human features. Kills were found at lower elevations, closer to good prey habitat, and in areas with greater terrain ruggedness than would be expected by chance. The results of our modeling are being used in the development of a comprehensive conservation strategy for carnivores in the Rocky Mountains of the U.S. and Canada.

FLORIDA PANTHERS IN A WETLAND ECOSYSTEM

DEBORAH JANSEN, Big Cypress National Preserve, Ochopee, FL 34141

Abstract: Pumas (Puma concolor) demonstrate a wide degree of adaptability in the diverse habitats they occupy. Today, a large portion of the Florida panther's (P. c. coryi) range is the wetlands found in Big Cypress National Preserve, and they are thriving in it. These wetlands were spared because they were less favorable for agriculture and urban development and now are a unit of the National Park Service. Some researchers have mischaracterized all but the northern portion of Big Cypress as unsuitable for panthers. Critics stated that it was a "population sink" and, at best, could support only a transient population, due to its sparse forest cover, nutrient-starved soils, and the resultant poor prey base. Although there was not a reproducing population in this area for many years, the primary causes weren't inherent in the ecosystem, as demonstrated by the panthers' positive response to a variety of management actions. Steps taken to lessen human impacts included the elimination of hunting deer with dogs and a reduction in the number of backcountry camps. The most important measure taken was the introduction of Texas mountain lions in 1995 to address the negative effects of inbreeding depression. Since then, the population in southern Big Cypress has gone from 2 to 20. The expanding panther population was sustained by a corresponding expansion in the deer herd. Deer responded to a longer wet season that increased nutritious wetland forage. As the wetlands got wetter, the panthers did better.

MOUNTAIN LION PREDATION ON ENDANGERED WOODLAND CARIBOU, MULE DEER, AND WHITE-TAILED DEER

DONALD D. KATNIK*, Large Carnivore Conservation Lab, Department of Natural Resource Sciences, Washington State University, Pullman, WA 99164

JON ALMACK, Washington Department of Fish & Wildlife, 12645 Sullivan Lake Rd., Metaline Falls, WA 99153-9701

ROSS CLARKE, Columbia Basin Fish & Wildlife Compensation Program, 103-333 Victoria St., Nelson, B.C. V1L 4K3

HUGH ROBINSON, Large Carnivore Conservation Lab, Department of Natural Resource Sciences, Washington State University, Pullman, WA 99164

ROBERT WIELGUS, Large Carnivore Conservation Lab, Department of Natural Resource Sciences, Washington State University, Pullman, WA 99164

Abstract: The last population of woodland caribou (Rangifer tarandus) in the contiguous United States has been declining despite efforts to recover it through augmentation. Mule deer (Odocoileus hemionus) have been declining, also. Mountain lion (Puma concolor) predation may be the primary cause of mortality, possibly because an abundance of white-tailed deer (O. virginianus) is sustaining a high lion population. Our objectives were to determine 1) seasonal overlap and movements of lions and their ungulate prey, 2) the role of lion predation in survival and population decline in caribou and mule deer; 3) whether all or only specific lions kill caribou; 4) the effect of removing "caribou-killing" lions on caribou survival rates; and 5) the influence of forest cover types and fragmentation on lion predation. Since 1997, we have radio-collared 28 lions, 52 caribou, 43 mule deer, and 28 white-tailed deer in the 3,465 km^2 caribou recovery zone. Mule deer and lions both moved to higher elevations during late summer when most caribou mortalities occurred. Lion predation accounted for 23-83%, 55%, and 40% of caribou, mule deer, and white-tailed deer deaths, respectively. Only 2 lions (1 M, 1 F) overlapped spatially with caribou although most of the lions' home ranges were adjacent to caribou areas. One male lion killed 3 caribou and was removed in Spring 2000. This study will continue through 2001. We will present preliminary analyses of seasonal movements in relation to elevation, habitat selection by lions, and effects of forest fragmentation on lion predation of caribou.

MOUNTAIN LION HOME RANGE USE IN A FRAGMENTED LANDSCAPE

JOSEPH H. KOLOSKI*, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, WY 82071.

FREDERICK G. LINDZEY, Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, WY 82071.

Abstract: Coal-bed methane development and associated roading has led to habitat fragmentation on the western portion of the Southern Ute Indian Reservation in southwest Colorado. A moratorium on gas development is in place on the eastern portion of the reservation however, and habitats remain relatively intact. Fourteen mountain lions (Puma concolor) were captured and equipped with radio transmitters across the reservation between January 1999 and July 2000. We estimated home ranges (95% utilization distributions) and core use areas (50% utilization distributions) for 6 female mountain lions using the eastern portion of the reservation and for 5 mountain lions (3 M, 2 F) using the western portion. We compared indices of habitat fragmentation between the east and west portions of the reservation and between mountain lion home ranges and core areas within their respective portions of the reservation. Patch size and patch perimeter were larger ($P = 0.001$) in the east (0.047km^2 and 1.00km, respectively) than the west (0.035 km^2 and 0.84km, respectively). Patch density, edge density, and road density were higher in the west (28.3 patches/km^2 vs. 21.5 patches/km^2, 23.8km/km^2 vs. 21.93 km/km^2, 2.54 km/km^2 vs. 1.88km/km^2, respectively). Within mountain lion home ranges and core areas, patch size, patch perimeter, patch density, edge density, and road density did not differ from values for the east and west portions encompassing them. These results suggest that mountain lions are not selecting home ranges or core areas based of levels of habitat fragmentation on the Southern Ute Indian Reservation.

HABITAT FACTORS AFFECTING HUNTING SUCCESS OF COUGARS AND WOLVES IN NORTHWESTERN MONTANA

KYRAN KUNKEL*, Turner Endangered Species Fund, 1123 Research Dr., Bozeman, MT 59718

DANIEL H. PLETSCHER, Wildlife Biology Program, University of Montana, Missoula, MT 59812

TONI K. RUTH, Hornocker Wildlife Institute, 2023 Stadium Dr., Suite 7, Bozeman MT, 59719

Abstract: To assess impacts of wolf (Canis lupus) recolonization on prey and other predators, we examined factors affecting hunting success of cougars (Puma concolor) and wolves in a multi-prey system in northwestern Montana. Cougars killed white-tailed deer (Odocoileus virginianus) at sites with greater slope, more mature trees, and greater canopy coverage than were present at sites where wolves killed deer. Cougar kill sites were closer to water than were wolf kill sites. Cougar kill sites had lower densities of deer and were further from deer trails than were control sites. Compared to control sites, more deer were killed by wolves at flatter sites and at sites with lower densities of deer. Antipredator strategies used by deer to avoid wolves may not be as successful for avoiding cougars and vice versa. Managers interested in reducing vulnerability of deer to wolf and cougar predation should consider maximizing deer density in a few large wintering areas and thinning stalking cover while maintaining browse species in those areas.

FLORIDA PANTHER GENETIC RESTORATION: A STATUS REPORT

E. DARRELL LAND, Florida Fish and Wildlife Conservation Commission, 566 Commercial Blvd., Naples, FL 34104-4709.

ORON L. BASS, Everglades National Park, Homestead, FL.

DEBORAH K. JANSEN, Big Cypress National Preserve, Ochopee, FL.

ROY T. McBRIDE, Rancher's Supply, Alpine, TX .

DAVID SHINDLE*, Florida Fish and Wildlife Conservation Commission, 566 Commercial Blvd., Naples, FL 34104-4709.

Abstract: An estimated 60-70 Florida panthers (Puma concolor coryi) exist currently in the wild in Florida, following a population increase over the past decade. The panther's distribution in the state remains largely south of the Caloosahatchee River, but panthers range north nearly to Orlando. Most effort in panther management is presently directed toward genetic restoration, specifically monitoring the pedigree, molecular, and physical effects of purposefully releasing 8 young female pumas from Texas into the core range of the Florida panther in 1995. This release was intended to infuse Texas puma (P. c. stanleyana) genetic material into the Florida panther population to correct physical abnormalities attributable to low genetic diversity. Our stated goal was to have each Texas female produce at least 2 recruited offspring and this level of genetic infusion was expected to augment the panther population genetic make-up over time such that 20% of its diversity could be traced back to Texas puma genes. Five of the 8 Texas females bred, producing 18 known offspring. First-generation offspring have now produced at least 18 second-generation offspring of their own and 25 of these 36 descendants are thought to be alive today. Preliminary pedigree analysis suggests that we have achieved our genetic goal, but additional monitoring will be necessary to determine if desired physical improvements are achieved.

RECOVERY OF THE FLORIDA PANTHER: ACCOMPLISHMENTS AND FUTURE NEEDS

E. DARRELL LAND*, Florida Fish and Wildlife Conservation Commission, 566 Commercial Blvd., Naples, FL 34104-4709.

JOHN W. KASBOHM, U.S. Fish and Wildlife Service, 6620 Southpoint Dr., South, Suite 310, Jacksonville, FL 32216-0912.

DAWN JENNINGS, U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, FL 32960-3559.

Abstract: Florida panthers (Puma concolor coryi) ranged historically from Louisiana and Arkansas eastward into South Carolina and southward through Florida. Currently, 60-70 panthers exist in the wild in southern Florida. The panther was listed as an endangered species by the Department of the Interior in 1967 and a recovery plan was first developed in 1981 followed by 2 revisions in 1987 and 1995. All versions share the objective of achieving 3 viable, self-sustaining populations within the historic range. Steps to achieve this include 1) managing, protecting and restoring areas within the panther's current range, 2) identifying areas within the historic range of panthers where reintroduction may be possible, and 3) managing panthers directly, through either captive breeding or genetic restoration, to offset negative consequences of inbreeding and small population size. Significant progress has been achieved under 2 of the 3 steps. Two decades of

intensive panther research and monitoring has yielded a panther telemetry data set of >50,000 locations on 94 panthers and more than 200 published research papers and internal agency reports that detail findings on panther life history, ecology, and conservation needs. These data have been utilized to guide decisions regarding use of public lands, harvest of game species that also serve as panther prey, mitigating impacts of highways and new development, and identifying lands that have important panther conservation values. State and Federal land acquisition programs have brought 870,000 acres of panther habitat into public ownership since 1974. A genetic restoration plan has been implemented to mimic natural gene flow into the panther population. Currently, the U.S. Fish and Wildlife Service (FWS) has assembled a team to develop a spatially-explicit habitat model that will further delineate key areas for conservation and will have application as a regulatory tool. A new recovery team has been appointed by the FWS to revise the recovery plan. The Florida Fish and Wildlife Conservation Commission and FWS will be working closely with other agencies and stakeholders to incorporate results from the genetic restoration study and the existing panther database into a coordinated management strategy for maintaining the current population. Reintroduction remains the final and crucial step toward panther recovery.

AGING COUGARS IN THE FIELD FROM BIRTH TO DEATH

JOHN W. LAUNDRÉ*, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900 and Department of Biological Sciences, Idaho State University, Pocatello, ID 83209

LUCINA HERNÁNDEZ, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900.

Abstract: The ability to accurately age mountain lions (Puma concolor) in the field would be a valuable tool for management. However, no reliable nor standardized technique is currently available. We tested the accuracy of using gum recession and mass gain as aging techniques. We measured gum recession of the upper canine teeth in 13 known-aged free ranging individuals (12 F, 1 M). Additionally, we fit body mass data from 94 known-aged cougars with a Richards curve function. Gum recession was first noticable at approximately 20 months and was significantly related to age in months thereafter (R2 = 81.0; t28 = 10.16; P < 0.001). The 95% confidence intervals for age estimations of lions based on gum recession ranged from + 0.5 to 1.3 years. The Richards curve provided good fits of the data for mass (males: R2 = 0.958; females: R2 = 0.89). Weights became quite variable after approximately 14 months and could not be used as a reliable estimator of age. However, for animals < 14 months, the model performed well in back estimating ages. We proposed that with combined gum recession in adults and mass growth in kittens, biologists can accurately age mountain lions of almost all age classes.

ENERGETICS OF FREE ROAMING MOUNTAIN LIONS IN THE GREAT BASIN

JOHN W. LAUNDRÉ*, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900 and Department of Biological Sciences, Idaho State University, Pocatello, ID 83209

LUCINA HERNÁNDEZ, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900.

Abstract: Estimating energetics of free roaming animals has many obvious benefits relative to their management, e.g. estimating food resource needs, carrying capacity, etc. This is additional true for large predators such as mountain lions (Puma concolor) whose food base often are ungulates that are also popular game species. In this case, energetics calculations could help provide estimates of the impact mountain lions might have on these species. Previous energetics calculations were based on broad categories of lion activity (resting, walking, running) and estimates of time budgets in each. Here we present energetic estimates based on actual activity levels as determined via radio telemetry. We relocated selected animals every half hour over 24 hours and used these data to calculate distance moved. Estimates of distance moved were converted to amount of energy expended via standard physiological formulae. These data were then used to calculate a total daily and annual energy budget for females and males and then used to estimate annual prey needs. The results of these calculations will be presented.

HABITAT COMPOSITION OF SUCCESSFUL KILL SITES FOR LIONS IN SOUTHEASTERN IDAHO AND NORTHWESTERN UTAH

JOHN W. LAUNDRÉ*, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900 and Department of Biological Sciences, Idaho State University, Pocatello, ID 83209

LUCINA HERNÁNDEZ, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900.

Abstract: It is well known that mountain lions (Puma concolor) stalk their prey, specifically, deer (Odocoileus spp.) and elk (Cervus elaphus). Because of this predatory behavior, they need to remained concealed from their prey until they approach to within striking distance (estimated by many to be 20-25 m). As not all types of habitat can provide the needed cover for such approaches, we predicted that the sites where lions successfully killed animals should have specific structural characteristics (e.g. tree/shrub density) that aid lions in their hunting efforts. For 65 sites where we verified that lions killed mule deer, we subjectively classified them as either being in the open (>25 m from the nearest forest), edge of the forest (<25 into the open and < 15 m into the forest), and within the forest (> 15 m into the forest. Of these, 72% were in the edge of the forest and 14% each in the open and forest areas. We also quantified the structural characteristics of each site relative to tree and shrub density and shrub height. The sites objectively classified as edge differed significantly in tree density and shrub height from those classified as open and forest. Thus we concluded that edge or edge like habitat constituted successful hunting habitat for lions. We suggest the reason for this is that this type of habitat structure provides the lions with the visibility needed to locate their prey at a distance but still provide the cover they need to make a successful approach.

LONG TERM POPULATION TRENDS OF MOUNTAIN LIONS IN SOUTHEASTERN IDAHO AND NORTHWESTERN UTAH

JOHN W. LAUNDRÉ*, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900 and Department of Biological Sciences, Idaho State University, Pocatello, ID 83209

LUCINA HERNÁNDEZ, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900.

Abstract: Between 1987 and 2000 we studied mountain lions (Puma concolor) in a 2000 km^2 area in southeastern Idaho and northwestern Utah. Each winter we spent extensive time in the field trapping lions and also interacted with other lion hunters in the area. Based on our field efforts and the information provided by others, we were able to obtain a reliable estimate of the minimal number of lions present in our area. We found that numbers of adult lions varied in a cyclic pattern, reaching a high in 1996 and then declining again. The increase in lions was attributed to the high deer numbers in the area while the decline was a result of high winter mortality of deer in 1994. As harvest levels were relatively constant over the time, the decline was attributed to low recruitment of young individuals in 1996-1998 and additional mortality due to starvation. Our data suggest that lion numbers are self regulated and controlled by the deer population, with the survival of young individuals being the most susceptible to declines in deer numbers.

REGULATING HUNTING OF MOUNTAIN LIONS: A METAPOPULATION APPROACH

JOHN W. LAUNDRÉ*, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900 and Department of Biological Sciences, Idaho State University, Pocatello, ID 83209

LUCINA HERNÁNDEZ, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900.

TIM CLARK, Northern Rockies Conservation Cooperative, Box 2705, Jackson, WY 83001

Abstract: Traditionally there are three methods of regulating mountain lion (Puma concolor) harvest. The first is no control (unlimited in time and numbers or unlimited in numbers within a specific season) and relies on low hunter effort/success to prevent over harvest. The second is a permit system that specifies a certain number of permits which are assigned via a lottery system. The third is a quota system where the taking of a certain number of females closes the season. Of these approaches, the least defendable to a court challenge is the first because it has no safeguard to prevent over harvest. Although the second two methods provide protection to the base population (permit numbers and quota levels can be changed), the degree of protection is strongly dependent on accurate assessments of population levels of lions. As accurate assessment techniques have yet to be developed, these two methods are also susceptible to court challenges. We propose a fourth management approach that incorporates the metapopulation concept of source and sink populations. Source populations would consist of areas (hunting units) where the take of lions would be prohibited except for damage control. Sink populations would be areas open to hunting. Dispersal of individuals from the source populations would replenish sink populations. This system of management would insure a secure base level population regardless of the hunting pressure exerted in the sink areas. Such a system also does not rely on accurate estimates of population levels. An example of this approach is presented and discussed.

THE APPLICATION OF A RICHARDS CURVE GROWTH MODEL TO COUGARS IN THE NORTHERN GREAT BASIN

JOHN W. LAUNDRÉ*, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900 and Department of Biological Sciences, Idaho State University, Pocatello, ID 83209

LUCINA HERNÁNDEZ, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900.

Abstract: Previous applications of a Richards curve for cougars (Puma concolor) indicated its possible use in modeling mass growth. Use of such a model could be helpful in estimating energetics and productivity of cougar populations. The final model incorporated sex and population effects for adult mass and population effects for growth rates. However, additional analyses were recommended to improve on the model, especially in estimating birth mass. We analyzed mass growth of 94 cougars from south-central Idaho and north-western Utah with a Richards curve. We also tested the applicability of a Richards curve for total body length and tail length. The Richards curve provided good fits of the data for mass (males: R2 = 0.958; females: R2 = 0.89), total length (males: R2 = 0.949; females: R2 = 0.913) and tail length (males: R2 = 0.93; females: R2 = 0.92). The model for mass growth provided a reasonable (0.34 kg) estimate of birth mass. The analysis also indicated that mass growth rates differed between the sexes. The proposed growth model for total length included a sex effect for adult total length. The model for tail length was free of any sex or population effects. We proposed that all three models could be useful in studying the biology and ecology of cougar populations.

USE OF DISPERSAL DISTANCE TO ASSESS THE LONG TERM CONSERVATION OF MOUNTAIN LIONS

JOHN W. LAUNDRÉ*, Instituto de Ecología, A.C. Centro Regional Chihuahua, Km. 33.3 Carr. Chihuahua-Ojinaga, CD Aldama, Chih 32900 and Department of Biological Sciences, Idaho State University, Pocatello, ID 83209

Abstract: Dispersal is an important conservation concern, especially regarding large mammalian carnivores. An importance aspect of dispersal is effective population size (Ne). We tested if Ne could be applied to a regional conservation strategy, by using the dispersal patterns of mountain lions (Puma concolor) in Northwestern United States. We determined dispersal distance and endpoints of 28 (12 M, 16 F) mountain lions. Twelve females exhibited philopatry. Dispersal distances of the remaining individuals averaged 160.7, SE = 37.4 km for males and 89.2, SE = 28.0 km for females. Inbreeding effective population size (Ne) was 1,076 resident individuals in a neighborhood area of 107,600 km^2. Within this area, habitat types under control of the U.S. Forest Service and U.S. Bureau of Land Management areas provided the important landscape elements for maintaining the existing dispersal patterns. Urban areas and cultivated landscapes greatly impacted pumas' ability to disperse. We concluded that to maintain current dispersal patterns, it is necessary to maintain the existing landscape of public multiple use lands. This type of analysis can be a pro-active tool in preventing the decline of a species.

ECOLOGY AND MANAGEMENT OF THE "EUROPEAN MOUNTAIN LION" (LYNX LYNX)

JOHN D. C. LINNELL, Norwegian Institute for Nature Research, Tungasletta, 7485 Trondheim, Norway

JOHN ODDEN, Norwegian Institute for Nature Research, Tungasletta, 7485 Trondheim, Norway

REIDAR ANDERSEN, Norwegian Institute for Nature Research, Tungasletta, 7485 Trondheim, Norway

Abstract: In a world of limited research funds it is important to make use of all existing data when making management decisions for large carnivores such as mountain lions (Puma concolor). Transferring data and experience from other species with a similar ecology is a possible approach of efficiently using resources. Our goal in this paper is to argue that Eurasian lynx (Lynx lynx) are such a species, and that much of the research and management experience associated with lynx in Europe may be relevant for mountain lion management. Eurasian lynx have been intensively studied throughout western Europe during the last 15 years. Telemetry based projects have been run in Norway, Sweden, Switzerland, Poland, France, Slovenia, Romania and the Czech Republic. Unlike Canadian lynx (Lynx canadensis), the Eurasian lynx feed mainly on ungulate prey (roe deer, red deer, reindeer) in western Europe. Intra-sexual territoriality has been observed in all populations of Eurasian lynx that have been studied using telemetry so far. Home range / territory sizes vary in size from 50-1,000 km^2 for females and 100-1,500 km^2 for males, mainly depending on prey density. Dispersal distances have been observed up to 450 km. These results are very similar to mountain lions, however there is one major difference, cases of intra-specific killing are virtually unknown among Eurasian lynx. Eurasian lynx currently face a range of management issues, ranging from enormous conflicts with livestock, through management discussions about regulating hunter harvest and establishing monitoring programs, to reintroduction and translocation projects. International cooperation in research, conservation and management is very good. Therefore, there are many ecological and management parallels between Eurasian lynx and mountain lions where the potential for information transfer exists.

THE RELATIONSHIP BETWEEN DISPERSAL AND GENE FLOW AMONG POPULATIONS OF MOUNTAIN LIONS (PUMA CONCOLOR) IN FRAGMENTED HABITAT

JANET L. LOXTERMAN*, Department of Biological Sciences, Idaho State University, Pocatello, ID 83209.

JOHN W. LAUNDRÉ, Department of Biological Sciences, Idaho State University, Pocatello, ID 83209.

MARGARET B. PTACEK, Department of Biological Sciences, Idaho State University, Pocatello, ID 83209.

Abstract: The relationship between dispersion patterns of organisms and the actual movement of genes is difficult to address. While direct measurements of the movement of individuals between populations can shed light on their degree of geographic connectedness, knowing whether or not dispersers contribute to gene pools outside their natal subpopulation is essential to understanding the genetic structure of a species. Two methods are commonly used to estimate migration. Indirect estimates of gene flow are based on genetic markers and direct estimates of dispersal are based on mark-recapture data, however, each have their respective applications and limitations. Many of these limitations can be overcome by combining data gathered using each method with knowledge about dispersal patterns and population structure. Our study provides an opportunity to combine indirect estimates of gene flow using nuclear microsatellite data with direct estimates of dispersal using radio-telemetry data. Preliminary results for 12 loci from 4 subpopulations in south

central Idaho and surrounding states suggests concordance between the degree of genetic differentiation and gene flow estimates between pairs of subpopulations (FST = 0.0 - 0.02, Nm =10 - infinite: RST = 0.0 - 0.13, MR = 1.7 - infinite) and estimates of dispersal (30 dispersers: 23 males and 7 females) based on radio-telemetry data. Results of this study will provide information on the relationship between indirect and direct estimates of gene flow in a large, vagile species and may be important in assessing the impact of habitat fragmentation on the population genetic structure of mountain lions in Idaho.

CRITERIA USED TO IMPLEMENT PUBLIC SAFETY COUGAR REMOVALS WITH THE USE OF DOGS

DONALD A. MARTORELLO, Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia WA 98501-1091

JOHN PIERCE, Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia WA 98501-1091

Abstract: Documented cougar (Puma concolor) complaints have increased significantly (P = 0.03) in Washington State, with approximately 2,900 human-cougar encounters from 1995-99. In 1999 the Washington State legislature passed a law reinstating the use of dogs, which was banned by Voter Initiative in 1996, to address public safety concerns related to cougar. Prior to implementing the law, the Washington State Fish and Wildlife Commission was required to adopt conditions warranting the use of dogs. At the direction of the Commission the Washington Department of Fish and Wildlife (Department) developed a public safety cougar removal recommendation for their consideration. The objectives of that recommendation were to 1) develop a predictive model identifying Game Management Units (GMUs) with a high probability of serious human-cougar encounters and 2) develop a cougar removal level (quota) that would significantly decrease cougar density in those GMUs prone for complaints. We divided all human-cougar encounters from 1998-99 into two categories: category 1 (i.e., human attacks, human-cougar incidents, human-cougar chance encounters, and pet or livestock depredations) and category 2 complaints (i.e., cougar sightings and nuisance activities). To identify GMUs with a relatively high probability of human-cougar interactions, we compared the observed level of category 1 complaints to the expected level if complaints were evenly spaced across all GMUs. We defined chronic complaint areas as those GMUs with statistically more category 1 complaints than expected (P < 0.01). We then used regression tree analysis to identify thresholds of variables that best predicted chronic category 1 complaint areas. We used program PUMA to simulate the affects of various removal levels on population growth overtime to select a removal level (and associated permit levels) which would substantially reduce population size. PUMA model input parameters were estimated from cougar studies in Washington or peer-reviewed literature sources. Regression tree analysis identified the number of previous year category 1 and 2 complaints as the best variables for predicting future category 1-complaint levels. Moreover, the model identified >4 category 1 complaints and >7 category 2 complaints as the levels best predicting chronic areas. Finally, results from PUMA analysis indicated that permit levels designed to remove approximately 30% of the animals in selected GMUs may be necessary to substantial reduce cougar population size overtime. The model provides wildlife managers with an example of developing objective criteria for removing cougar due to human safety concerns. We discuss some strengths and weaknesses of the public safety cougar removal model and the corresponding public perceptions.

PREY ITEMS OF MOUNTAIN LIONS IN A FORESTRY SYSTEM IN BRAZIL

MARCELO MAZZOLLI, Projeto Puma, R.J. Pio Duarte Silva 535, Horto Florestal, 88037-000 Florianópolis-SC, BRAZIL

Abstract: Mountain lion (Puma concolor) scats were collected during two years in a forestry system in Brazil. One hundred and fifty scats were analyzed, revealing that nine-banded armadillo, peccaries, and brocket deer accounted for the bulk of the diet of mountain lions in the area.

DENSITY AND RESILIENCE OF MOUNTAIN LIONS IN A FORESTRY SYSTEM IN BRAZIL

MARCELO MAZZOLLI, Projeto Puma, R.J. Pio Duarte Silva 535, Horto Florestal, 88037-000 Florianópolis-SC, BRAZIL

Abstract: Density of mountain lions (Puma concolor) based on tracks discrimination and camera-trap photography was estimated in a 100 km^2 area embedded in an larger 1,255 km^2 property intensively managed for timber extraction. Additionally, over 300 fixes were obtained from a radio-tracked female mountain lion during seven month yielding information on activity patterns near villages, paved roads, and other disturbances. Results reveal a healthy mountain lion and prey base population, suggesting that commercially productive forestry systems can become suitable habitats when straight-forward management strategies are implemented.

THE EFFECTS OF PREDATOR CONTROL ON MOUNTAIN LIONS IN TEXAS

ROY MCBRIDE, Livestock Protection Company, Alpine, TX 79831

Abstract: Predator control has played a more significant role than habitat loss in the density and distribution of mountain lions (Puma concolor stanleyana) in Texas. They have historically been viewed as a problem animal, especially by the sheep industry. Early predator control efforts were conducted mainly by ranchers, but the federal government played an increasing role as the sheep industry expanded westward. Catch records beginning in the 1930s indicate that mountain lion populations remained low in Texas. In fact, by 1960, there were probably less than 30 residents in the state. Even this small population was under intensive pressure for removal that would have been accomplished had there not been dispersers from Mexico. Following a severe drought in the 1950s, the sheep industry vacated a large portion of the Trans-Pecos. They left behind permanent water, an abundant mule deer herd, and a reduced need for predator control. These factors provided fertile conditions for the recolonization of mountain lions, which they quickly seized. During the next 30 years, the population reached record numbers and expanded its range into areas that had been vacant for decades. Currently, the mountain lion population in west Texas is maintaining its distribution but the density has declined since a peak in the 1980s. Reasons for this decline include a precipitous drop in the mule deer herd and a resurgence of predator control. Mountain lions in Texas will continue to persist with or without legal protection as long as their habitat remains intact.

PREDATION RATES OF FEMALE MOUNTAIN LIONS IN NORTHEAST OREGON

M. CATHY NOWAK*, Cat Tracks Wildlife Consulting, P.O. Box 195, Union, OR 97883-0195.

GARY W. WITMER, USDA National Wildlife Research Center, 4101 La Porte Avenue, Fort Collins, CO 80521-2154.

Abstract: Wildlife managers are increasingly expected to balance populations of mountain lions (Puma concolor) and their prey, often with little data about their interactions. We investigated the foraging ecology of mountain lions in the Catherine Creek Wildlife Management Unit in northeast Oregon from June 1996 through June 1998. We present predation rate data from this investigation. We located individual lions by ground radio telem-etry each day during 25-day predation sequences and subsequently searched those sites for kills. Kill date was estimated based on location data, degree of consumption, and general condition of the kill when located. Interkill interval was calculated and recorded as the number of days between consecutive ungulate kills made by a single lion. We documented 75 ungulate kills and 40 interkill intervals from 5 adult female mountain lions. The mean annual interkill interval was 7.7 days with a shorter interval in summer-fall than winter-spring.

PREY SELECTION OF FEMALE MOUNTAIN LIONS IN NORTHEAST OREGON

M. CATHY NOWAK*, Cat Tracks Wildlife Consulting, P.O. Box 195, Union, OR 97883-0195.

GARY W. WITMER, USDA National Wildlife Research Center, 4101 La Porte Avenue, Fort Collins, CO 80521-2154.

Abstract: Wildlife managers are increasingly expected to balance populations of mountain lions (Puma concolor) and their prey, often with little data about their interactions. We investigated the foraging ecology of mountain lions in the Catherine Creek Wildlife Management Unit in northeast Oregon from June 1996 through June 1998. We present prey selection data from this investigation. We located individual lions by ground radio telemetry each day during 25-day predation sequences and subsequently searched those sites for kills. Species, sex, and relative age of the prey were recorded and an incisor collected for aging of animals older than 1 year. We documented 75 ungulate kills from 5 adult female mountain lions. Of the documented kills, 65% were mule deer (Odocoileus hemionus); 35% were elk (Cervus elaphus). Mountain lions selected for fawns and older adult females from among the mule deer and calves from among the elk. Mountain lion use of ungulate species, age, and sex classes did not differ seasonally.

ECOLOGY OF THE MOUNTAIN LION ON BIG BEND RANCH STATE PARK IN THE TRANS-PECOS REGION OF TEXAS

MICHAEL T. PITTMAN, Texas Parks and Wildlife Department, 905 W. Ave. B, Alpine, TX 79830

GILBERT J. GUZMAN, Texas Parks and Wildlife Department, 610 Oak, Junction, TX 76849

BILLY PAT MCKINNEY, Texas Parks and Wildlife Department, P.O. Box 354, Marathon, TX 79842

Abstract: Twenty-one mountain lions (Puma concolor) were captured on Big Bend Ranch State Park (BBRSP), 18 December 1992 -31 August 1997, using leghold snares or trained hounds. Captured lions were examined, aged, and a series of morphological measurements were recorded. Sixteen lions were fitted with radio transmitters operating on individual frequencies. Collared lions were monitored from the ground and fixed-wing aircraft. A total of 711 locations was recorded for 10 male and 5 female mountain lions. Home ranges were delineated for 6 male and 5 female lions. Average annual ranges (100% minimum convex polygon) for adult male lions (348.6 km^2) were larger ($P < 0.05$) than for adult female mountain lions (205.9 km^2). Average percent overlap (100% minimum convex polygon) of annual female-female, male-male, and female-male lion ranges were 26.1, 22.9, and 28.9, respectively. Annual shifts were apparent ($P < 0.05$) for female lions and for the cumulative male mountain lion ranges. Analysis of fecal samples (n=135) indicated collared peccary (Tayassu tajacu) and mule deer (Odocoileus hemionus) were preferred prey and were consumed almost equally. Genetic analysis, as compared to South Texas lions, defined two distinct groups of mountain lions with evidence of reduced gene flow between the groups and indicated the effective number of breeding individuals in the West Texas population may be greater than for South Texas. Mountain lion density (#/l00 km^2) ranged from 0.26-0.59. Observed and deduced lion litters (n = 13) indicated minimum mean litter size was 1.54. A total of 19 mountain lions was killed, 17 during and 2 after the study, on or near BBRSP as a result of predator control practices on private lands (n = 15), capture activities (n = 3), and shooting (n = 1). The mountain lion population on BBRSP was limited by high mortality rates of female and male mountain lions.

DISPERSAL CHARACTERISTICS OF JUVENILE MOUNTAIN LIONS IN SOUTHWEST OREGON

LISA K. ROBERTSON, Oregon Department of Fish & Wildlife, 4192 North Umpqua Hwy., Roseburg, OR 97470.

DAVID E. JONES, Oregon Department of Fish & Wildlife, 4192 North Umpqua Hwy., Roseburg, OR 97470.

DEWAINE H. JACKSON*, Oregon Department of Fish & Wildlife, 4192 North Umpqua Hwy., Roseburg, OR 97470.

Abstract: Limited long-term data are available documenting dispersal movements of juvenile mountain lions (Puma concolor) in the Pacific northwest. During January 1994 - August 2000 we investigated the movements of 29 mountain lions (10 M, 19 F) that were radio-collared as dependent kittens from a 518 km^2 study area in the southern Cascade Mountains of Oregon. The average age young lions became independent (separated from their mother) was 16 months of age (range 9-23 months). Male offspring delayed an average of 18 days prior to leaving the natal home range while females averaged an additional 47 days in their mother's home range prior to leaving. After leaving the natal home range, at an average age of 18 months, the mean movement distance from the natal home range center to the farthest documented location was greater for males than females (82 km for males, 36 km for females, t = 3.67, P = 0.002). Dispersal direction from the home range center was random (z = 0.609, P > 0.5). Twenty-six dispersing young

survived sufficient time to established an independent home range (IHR). Dispersing females required an average of 55 days to established an IHR compared to 103 days for males. All the males established an IHR that was not adjacent to the natal home range while 78% of the females' IHRs were adjacent to or overlapped the natal home range. No dispersing juvenile male survived >2 years after becoming independent, compared to 75% of the females surviving >2 years past independence. An interstate located 37 km from the study area appeared to restrict juvenile movement to the west and may be a potential barrier to dispersal movement.

TEXAS MOUNTAIN LION STATUS REPORT

PAUL ROBERTSON*, Texas Parks and Wildlife Department, Austin, TX 78701

CHARLES DAVID ALTMAN JR., Texas Parks and Wildlife Department, Sanderson, TX 79848

Abstract: A statewide survey of mountain lion (Puma concolor) mortalities and sightings has been conducted. Data through 1999 were combined with previous data beginning in 1983 for a 17-year summary of lion mortalities and sightings. Data were recorded by county, date, number and age of the lion, and location for each mortality or sighting. A total of 2,273 lion mortalities was reported in 67 of 254 Texas counties from 1983-1999. The Trans-Pecos Ecological Region ranked first in total mortalities (73%) and had the highest total for each survey year. A total of 87 lion mortalities was reported in 18 counties during 1999. The Trans-Pecos Ecological Region ranked first with 69% of the mortalities. Edwards Plateau Region was second with 16%. Lion mortalities also occurred in South Texas (11%) and in the Gulf Prairies and Marshes (3%). A total of 2,374 lion sightings was reported in 218 Texas counties from 1983-1999. A total of 178 sighting was reported in 1999. The Pineywoods and Post Oak Ecological regions were the highest ranked with 28 and 27 verified sightings respectively. This is the first year two eastern ecological regions recorded the most verified sightings. Although sightings have decreased to 178 in 1999 from a high of 363 in 1994, five additional counties with sightings were added to the statewide county totals during this report period. Texas has a widely distributed mountain lion population. The number of Texas lion sightings appears stable, but more research is needed to confirm population status in each region. Research on population levels, recruitment, survival, age structure and reproduction rate is being conducted in West, Central and South Texas. This information should be integrated with mortality and sighting data to address the future management needs of this species.

HOME RANGES AND MOVEMENTS OF COUGARS IN A NON-HUNTED POPULATION IN WESTERN WASHINGTON

ROCKY SPENCER, Washington Department of Fish and Wildlife, Olympia, WA 98501 USA.

KELLY ALLEN, Central Oregon Community College, Bend, OR 97701-5998 USA.

LORINDA SHEELER-GORDON, The Institute of Environmental and Human Health, Texas Tech University, Lubbock, TX 79416, USA.

SAMUEL R. ANDERSON, Greenville, SC 29607

KENNETH R. DIXON, The Institute of Environmental and Human Health, Texas Tech University, Lubbock, TX 79416, USA.

Abstract: Since 1974, 43 cougars (Puma concolor) were immobilized and radio equipped in protected (non-hunted or "refugia" areas) and unprotected (hunted) watersheds in the western Cascade Mountains of Washington State. The cougars were tracked (some for as long as 5 years) until their death. Home ranges were calculated for the 17 cougar with sufficient numbers for radio relocations. We determined and compared home ranges of males and females; results showed adults had larger home ranges than juveniles and male home ranges were larger than females. There were no clear relationships between home range size and season. A limited number of females, collared up to 5 years, showed yearly "shifts" in home range use areas. Overlaps among adult males, adult females, subadults, and kittens were analyzed. Some home ranges showed overlaps in space but not in time. Other objectives of the study included determination of: 1) dispersal distances of primarily subadult males and some females, 2) documentation of mortality sources for resident and dispersing subadults (primarily males), 3) cougar age at dispersal, and 4) the number of live months after dispersal (LMAD). We evaluated hypothesized factors that likely influenced dispersal patterns, direction, and mortality. We also examined 74 prey items and determined age and sex of deer (Odocoileus spp.) and elk (Cervus elaphus) taken by cougar. There was significant selection for old deer (> 7 years old) and young (< 1 year old) elk.

HISTORICAL BIOGEOGRAPHY OF WILD CATS AND THEIR ENVIRONMENT IN TEXAS

MICHAEL E. TEWES*, Feline Research Center, Caesar Kleberg Wildlife Research Institute, 700 University Blvd., MSC 218, Texas A&M University-Kingsville, Kingsville, TX 78363.

Abstract: Historically, 6 species of wild cats are recorded for Texas: mountain lion (Puma concolor), jaguar (Panthera onca), ocelot (Leopardus pardalis), margay (Leopardus weidii), jaguarundi (Herpailurus yaguarondi), and bobcat (Lynx rufus). Our knowledge of the historical distribution of these felids is strongly related to human history, particularly from accounts of early settlers and the expansion of the frontier. Human settlements were influenced by presence of rivers, fertile soils, and climate. Reports of mountain lion, jaguar, ocelot, and bobcat cover most of occupied eastern Texas during the 1800s. Range constriction occurred for mountain lion, ocelot, and jaguar during the late 1800s and early 1900s with the last documented jaguar in southern Texas occurring during 1948. The jaguarundi was never documented north of the Rio Grande Valley during the 1800s or 1900s. Only a single margay is recorded from Eagle Pass along the Rio Grande. Consequently, the 4 felids currently occupying Texas are the mountain lion, bobcat, ocelot, and possibly jaguarundi.

A CASE OF MOUNTAIN LION LIMITING AN ELK POPULATION: THE GREEN RIVER WATERSHED, WASHINGTON

DAVID J. VALES, Muckleshoot Indian Tribe, 39015 172nd Ave. SE, Auburn, WA 98092

ROCKY D. SPENCER, Washington Department of Fish and Wildlife, Mill Creek, WA 98012

Abstract: Predation by mountain lions (Puma concolor) is well known to potentially affect prey populations. We report on a case of mountain lion limitation on an elk (Cervus elaphus) population in a 598 km^2 watershed of which approximately 400 km^2 are restricted-access to protect public water supply. Early spring elk numbers in the Green River watershed were estimated at 612 in 1994 but by 1997 were down to 227. Known hunter-harvest mostly regulated by permit-only hunting during that time was 131 of which 91 were antlerless elk. Elk hunting was stopped for the restricted-access portion of the watershed starting in 1997. Based upon territory overlap from a mountain lion telemetry study mountain lion numbers were estimated to be about 18 to 25 in the early 1990's. Mountain lions have not been hunted in 2/3 of the watershed since the mid-1980's when the watershed was closed to public access. To assess mortality rates and causes we radio-marked adult cow elk and calves starting in April 1998. Annual adult cow mortality rates due to mountain lion predation were 16%. Annual calf mortality rates due to mountain lion were at least 40% in 1998 and 79% in 1999. We captured and radio-marked 7 adult mountain lions. Individuals

were also identified using DNA analyses of fecal samples collected from kill sites. The mountain lion population during the 1998 to 1999 period was estimated at 7 to 12 adults. Alternative prey include black-tailed deer and mountain goat while the primary alternative predator is black bear. The data clearly show the potential impact unregulated mountain lion numbers have on a prey population resulting in restricted opportunity for hunter harvest.

MOUNTAIN LION PREDATION ON CATTLE IN SIERRA SAN PEDRO MÁRTIR, BAJA CALIFORNIA, MÉXICO

SERGIO AVILA-VILLEGAS.* Maestría en Manejo de Ecosistemas de Zonas Aridas, Facultad de Ciencias, Universidad Autónoma de Baja California, Carr. Tij-Ens, Km. 103, Ensenada, Baja California. C.P. 22800.

ROBERTO MARTÍNEZ-GALLARDO. Maestría en Manejo de Ecosistemas de Zonas Aridas, Facultad de Ciencias, Universidad Autónoma de Baja California, Carr. Tij-Ens, Km. 103, Ensenada, Baja California. C.P. 22800.

AARÓN BUENO-CABRERA. Escuela de Biología, Universidad Autónoma de Puebla, Bld. Valsequillo y Av. San Claudio, Edif. 76, C.U. Puebla, Puebla.

JORGE ALANÍZ-GARCÍA. Maestría en Manejo de Ecosistemas de Zonas Aridas, Facultad de Ciencias, Universidad Autónoma de Baja California, Carr. Tij-Ens, Km. 103, Ensenada, Baja California. C.P. 22800.

Abstract: Mountain lion (Puma concolor) is a well studied species in North America; its wide distribution implies a great adaptability to diverse habitats and for prey use. Basic and applied research, which involves rural communities, has sociological, ecological and economic importance, and is useful for generating management plans aimed to reduce conflicts with human activities and economic loses. The study area is located in northwestern Baja California, between 30° 15' 00″ and 31° 15' 00″ N, and 115 00' 00″ and 116 00' 00″ W; and is 360,000 ha. approximately. Our aims were to determine the impact of mountain lion predation on livestock. We used scat analysis; surveyed human population to know their relationship and conflicts with wildlife, and generated descriptive maps to identify the potential conflict areas with human activities. From June1999 trough July 2000, we collected 29 scats, and registered mountain lion evidence. Seven food items were identified from hair characteristics; cattle and horse accounted for 50% of the diet; mule deer hair was not found on the scats. We surveyed 28% of land owners to know about their interest and involvement with wildlife, to identify the causes of cattle loses and their recommendations to reduce those loses. Principal causes of cattle loss are drought (23%), predation (23%), rustling (18%) and diseases (15%). Mountain lion and cattle management recommendations were generated according to people needs and researchers opinions; as well as future research topics on mountain lion as a key species in Sierra San Pedro Mártir, Baja California.

AN EVALUATION OF COUGAR MANAGEMENT STRATEGIES IN UTAH

MICHAEL L. WOLFE, Department of Fisheries and Wildlife, Utah State University, Logan, UT 84322-5210

BILL BATES, Utah Division of Wildlife Resources, 1594 West North Temple, Salt Lake City, UT 84114

DAVID M. CHOATE, Department of Fisheries and Wildlife, Utah State University, Logan, UT 84322-5210

Abstract: Recently several western states have increased the sport take of cougars (Puma concolor) substantially, thus prompting concerns regarding the sustainability and demographic effects of these removals. We analyzed statewide statistics for the sport take and other mortality of cougars in Utah for the past two decades. The years 1993-1999 witnessed a period of aggressive efforts to reduce cougar numbers in many areas of the state, including implementation of a quota

system in 1997 on approximately one third of the management units. From the early 1970's to 1996 the annual sport take increased approximately 5-fold from 92 to 452 animals, while hunter numbers increased from approximately 200 to 800. An average of 69 additional cougars (21.4% of the sport take) was killed annually between 1990 and 1996 due to depredation control, highway mortality and miscellaneous causes. Adoption of the quota system resulted in a further increase of 75% in hunter numbers and an additional 27.4% increase in the kill. This level of exploitation occasioned changes in certain parameters of demographic importance. These included an increase in the average proportion of females in the kill from 35.1% to 47.5%, attenuation of the age structure of the kill and an 8.9% decrease in time-specific adult survival rates from 0.67 to 0.61. Population projections revealed that recent levels of exploitation are not sustainable. We compare cougar survival rates across ecoregions within the state and discuss the influence of environmental variables, including terrain ruggedness, road density, and weather conditions, on an index of cougar mortality.

COUGARS AND DESERT BIGHORN SHEEP IN THE FRA CRISTOBAL RANGE: SCALE, GEOGRAPHY, AND SEASONALITY

ANTHONY L. WRIGHT*, Hornocker Wildlife Institute, HC32 Box 191, Truth or Consequences, NM 87901.

KYRAN KUNKEL, Turner Endangered Species Fund, P.O. Box 190, Gallatin Gateway, MT 59730.

MAURICE G. HORNOCKER, Hornocker Wildlife Institute, 2023 Stadium Drive, Suite 1A, Bozeman, MT 59715

HOWARD QUIGLEY, Hornocker Wildlife Institute, 2023 Stadium Drive, Suite 1A, Bozeman, MT 59715

Abstract: Desert bighorn sheep (Ovis canadensis mexicana) (n = 44) were translocated to the Fra Cristobal Range of southcentral New Mexico during 1995 and 1997. This population has grown (September 2000, n = 57) despite documented predation by cougars (Puma concolor) on both naive and non-naive (surviving > 1 year after translocation) sheep. Of 11 cougar-caused mortalities of non-naive sheep 10 occurred during lambing season (January - May). During February 1999 - August 2000 the average number of observations/month of cougar sign was 31.3 + 8.2 (95% C.I.) during lambing season versus 12.0 + 5.3 (95% C.I.) during other months. This difference may reflect a pulse of subadult dispersal into the area during winter as well as reduced movements by females with litters during summer and fall. The Rio Grande River and Elephant Butte Lake form both a barrier to east-west dispersal and a riparian corridor for north-south movement. Thus, the Fra Cristobal Range and Caballo Mountains, which lie parallel to and just east of the river valley, are spatially ideal as a dispersal corridor for subadult cougars. The composite home ranges of 7 cougars that used the Fra Cristobal Range (66 km^2 of sheep habitat) covered approximately 2,000 km^2. Because the cougar population functions at a geographic scale at least 2 orders of magnitude greater than the sheep population, non-targeted removal of cougars probably will not reduce predation on desert bighorn sheep in the Fra Cristobals unless cougar numbers are reduced over a broad portion of southern New Mexico. If lambing and an influx of dispersing cougars typically are synchronous, occasional removal of specific cougars may be necessary to increase the sheep population to the point where it is regulated by food supply. Whether targeted predator control will be needed over the long-term to maintain the sheep population near this level is still unknown and may be largely a function of habitat quality. We warn against generalizing these results to other bighorn sheep ranges in different geographic contexts and where mule deer (Odocoileus hemionus) are not the primary prey of cougars as they are in the Fra Cristobal Range.

HOSTS:

Texas Parks and Wildlife Department

Department of Natural Resource Management, Sul Ross State University

Mountain Lion Foundation of Texas

SPONSORS:

Texas Parks and Wildlife Department

Department of Natural Resource Management, Sul Ross State University

Mountain Lion Foundation of Texas

Texas Chapter of The Wildlife Society

Rob and Bessie Welder Wildlife Foundation

Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville

Department of Wildlife and Fisheries Sciences, Texas A&M University

Student Chapter of The Wildlife Society, Sul Ross State University

Student Chapter of The Wildlife Society, Texas A&M University

Summerlee Foundation

PLANNING COMMITTEE:

Louis A. Harveson

R. Bill Adams

Paul B. Robertson

Dede Armentrout

TEXAS PARKS & WILDLIFE

4200 Smith School Road
Austin, Texas 78744

PWD BK W7000-893 (3/03)