SEASONAL MIGRATION PATTERNS OF MOUNTAIN LIONS IN CENTRAL IDAHO OVER A 35-YEAR PERIOD

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INTRODUCTION

Historically, the mountain lion (*Puma concolor*) occurred in high densities ranging from northern British Columbia to the southern end of South America (Young Goldman 1946). But in the early 1900's the mountain lions distribution and abundance was drastically reduced as a result of human settlement, development, habitat loss and hunting. At that time, human perceptions of mountain lions was of an undesirable species that depredated livestock and competed with humans for wild ungulates. Today mountain lions are being viewed as an ecologically important "indicator" species that can accurately assess the viability of whole systems (Beier, 1993, 1995). Currently mountain lion distribution is greatly influenced by habitat loss, prey availability and human intervention. Therefore, populations of migratory mountain lions and migratory prey are important in evaluating sustainable habitat areas.

Currently, little literature is available on seasonal migration, seasonal home range and social dynamics of mountain lions that feed on migratory prey populations of mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*). Hornocker (1969) reported "mountain lion winter home range was constant from year to year for males, but it varied for females, depending upon their reproductive status".

Mountain lion home range sizes in a non-migratory prey population demonstrated little change from season to season (Sweanor, 1990). Mountain lion populations in areas that have migratory prey, such as deer and elk, exhibit seasonal movements from higher elevation summer range to lower elevation winter range (Pierce et al., 1999: Seidensticker et al., 1973). Further long-term investigation is needed to better understand how social dynamics fluctuate in accordance with seasonal migratory prey populations.

There were four field studies conducted over the past 35 years of mountain lions in the Big Creek drainage (Hornocker 1970; Siedensticker et al. 1973,) (Quigely et al. 1989) and one unpublished (Akenson 2000). In this paper I compare the seasonal migration and seasonal home ranges of mountain lions from these four studies. I hypothesize that a mountain lion population that is dependent on a migratory prey population will migrate with the prey, particularly mule deer and elk.

STUDY AREA

The 500-km^2 study was located on the Big Creek drainage in the center of the Frank Church River of No Return Wilderness (RNRW) a 2.2 million acre road-less area in central Idaho. The RNRW is a very rugged mountainous region with elevations that range from less than 600 meters to over 3,000 meters. Big Creek was the winter range for a migratory population of mule deer and elk. The majority of mule deer and elk migrated from the south facing slopes of the lower Big Creek drainage in winter, to the northern high plateau of the Chamberlain

Basin and Cold Meadows in the summer. Lower Big Creek consists of high mountain peaks with the lower elevation south aspects remaining snow free for much of the winter. The Chamberlain Basin and Cold Meadows is characterized by rolling hills and open meadows with snow remaining from November through April.

The Big Creek drainage was dominated by Douglas fir (*Pseudotsuga menziesii*), Ponderosa pine (*Pinus ponderosa*) and at the higer elevations, Subalpine fir (*Abies lasiocarpa*) and White bark pine (*Pinus albicaulis*) habitat types. In the Chamberlain Basin, Lodgepole pine (*Pinus contorta*) was a dominant forest habitat type. Shrub-steppe habitat types present are various sagebrushes, mountain mahogany, bitterbrush, Idaho fescue, bluebunch wheatgrass and ninebark.

Grey Wolves (*Canis Lupus*), mountain lions (*Puma concolor*) , bobcats (*Lynx rufus*), coyotes (*Canis latrans*), black bears (*Ursus americanus*) were the major large carnivores in the area. Elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), and bighorn sheep (*Ovis canadensis*) were the major large herbivores.

METHODS

Information on mountain lion home range and migration patterns was collected in the Big Creek study area for periods spanning three decades. For the study period beginning with 1965 through 1972 the field methods of capture, hound use and radio-collaring are described in detail in Hornocker 1970 and Seidensticker et. al.

1973. Field methods for the study periods from 1983 through 1987 (Quigley et al. 1989) and 1998 through 2000 (Akenson 2000) followed a similar methodology as Hornocker 1970 with the addition of radio telemetry collars. We located mountain lions with radio telemetry during daylight hours from the ground daily and with a fixed wing aircraft for weekly locations. During the summer, only aerial locations were obtained to evaluate the summer home ranges. During winter, more intensive monitoring was conducted as a result of snow restricting mountain lions and prey to the lower elevations; therefore both aerial and ground locations were used in calculations.

Selection of seasonal periods for home range analysis was chosen based on weather characteristics of the Big Creek drainage. January 1 through March 31 was the primary winter season with the mountain lions and prey being centralized on the lower Big Creek winter range. June 1 through October 31 was selected as the summer season when snow was absent. November, December, late April and May were not used in seasonal analysis because these were transitional months of both seasons and prey/lion movement. Ground locations were plotted on 7.5 minute U.S. Geological Survey topographic maps and recorded as Universal Transverse Mercator Grid coordinates (U.T.M). Summer aerial locations for 1999 were recorded as Latitude Longitude coordinates, converted to U.T.M.s and then entered in a database.

The CALHOME (Kie et al., 1996) program was utilized to estimate the mountain lion home ranges for study periods Quigley 1983-1987 and Akenson 1998-2000. The methods for estimation used were 100%, 90% minimum convex polygon (MCP; Hayne 1949) and 90%, 60% adaptive kernal (ADK; Worton 1989). Hornocker's 1965-1969 winter range areas were estimated based on stream drainages and recreated into Arc View GIS for visual comparison, (figure 1 and 5). Seidenstickers 1970-1972 home range area determinators were based on the irregular polygons formed by connecting the outermost locations. This data was also approximated and recreated in Arc View GIS for visual comparison, (figure 2 and figure 6).

RESULTS

Mountain lions exhibited seasonal movement patterns in response to the migration of deer and elk. Some mountain lions moved from the lower elevations of the Big Creek drainage winter range to the higher elevation summer ranges of Chamberlain Basin and Cold Meadows in correlation with the deer and elk movements. Analysis of these mountain lions home range showed distinct summer and winter home ranges. Other mountain lion's home range movements were gradual with only one continuous home range. Mountain lions that moved to the higher elevations of Chamberlain Basin and Cold Meadows summer range presumably overlapped with other migrating lion populations.

Hornocker (1969) reported that the largest winter area occupied by a female was H-4 with 52 (km^2) in 1965-66 and the smallest winter area was H-29 with (13 km^2)

in 1966-67. (Figures 1, 6 & Tables 1) His data also indicated that the females studied appeared to change the extent of their ranges in different winter seasons as a result of their reproductive status.

Siedensticker et al, (1973) reported that resident mountain lions occupied fairly distinct but usually contiguous winter-spring and summer-fall home areas. They found that summer areas were larger than winter areas, but varied among years. They reported 4 female summer home ranges with a mean area of 147 (km^2) and 9 female winter ranges with a mean of 106.55 (km^2). (Figures 2, 6 and Tables 1 and 2)

Quigley et al. (1989) calculated home ranges from weekly aerial flights and found that 7 female home ranges with a mean summer range size of 61.1(km^2) MCP. They also calculated 11 female winter ranges with a mean area of 13.9 (km^2) MCP. I obtained Quigley's data points for female 303, ground and aerial locals, for the years 1983 and 1984 and calculated yearly home ranges at 173 (km^2) MCP and 150 (km^2) MCP, respectively. (Figure 3 and Table 1) Additionally, I calculated F-303's 1983 and 1984 yearly home ranges with the Adaptive Kernal Method. The 1983 90% ADK resulted in 191(km^2) and the 60% ADK resulted in 55(km^2). For the 1984 year 90% ADK resulted in 152(km^2) and the 60% ADK resulted in 48(km^2). (Figure 3 and Table 1)

For the current study we report that from November 1999 to early Feburary 2000 the C-1 male remained on his summer range near the town of Yellowpine. At the end of Feburary he moved to the mouth of Crooked Creek and Monumental Creeks where he overlapped with C-3 (Figure 5) It is presumed that a fight occurred between C-1 and C-3 resulting in the death of C-3. It is in the area of Crooked Creek, Acorn Creek and Coxey Creek that C-1 remained for the rest of the 1999-2000 winter season. It is this winter season, November 1, 1999- April 15, 2000, that 22 locations were obtained for male C-1 and home range areas were calculated and resulted in; 90% ADK 136(km^2), 60% ADK 28.5(km^2), 100% MCP 314(km^2) and 90% MCP 48.9(km^2).

Male C-3 was located in the upper forks of Monumental Creek in November 1999 to late December 1999. He then moved to lower Monumental Creek and the mouth of Crooked Creek where he was found dead on February 29, 2000. Only a sample size of 8 locations was obtained on C-3, therefore home range analysis was not included. Although, C-3 is included in (figure 5) to show overlap and movement relative to other lions.

Summer of 1999 locations for female C-4 were limited for home range analysis. Despite limited data, this lion demonstrated a gradual migration from the upper Rush Creek drainage summer range to the lower Rush Creek winter range. C-4 remained on the south side of the lower Big Creek drainage November 1999 through early April 2000. Home range estimations for the winter 1999-2000, (35

locations) for C-4 are as follows; 90% ADK 44(km^2), 60% ADK 15(km^2), 100% MCP 42(km^2) and 90% MCP 28(km^2).

Female mountain lion C-5 demonstrated a distinct separation of her winter and summer ranges (Figure 4). She spent the summer season (1999) in the higher elevation headwaters of Cabin Creek. She then migrated to the lower Cabin Creek drainage for the winter of 1999 through 2000. Home range estimations for C-5 for the year of 1999, February 1 through October 31, (summer and winter) resulted in; 90% ADK 196(km^2), 60% ADK 63(km^2), 100% MCP 102(km^2) and 90% MCP 87(km^2). Home range estimations for November 1, 1999 through April 15th (winter) resulted in; 90% ADK 35(km^2), 60% ADK 9.7(km^2), 100% MCP 47(km^2) and 90% MCP 21(km^2) (Figures 4,6 and Table 1).

DISCUSSION

Comparisons in home ranges of lions spanning the four study periods suggest that winter and summer migrations of prey and migrations of lions are related. Mountain lions that wintered on lower Big Creek exhibited distinct and gradual movement patterns. Some lions migrated with the deer and elk to the higher elevation summer range areas of Cold Meadows and Chamberlain Basin, while others migrated to other summer ranges of upper Monumental Creek and the headwaters of Rush Creek. These lions likely overlapped with and or interacted with subpopulations of mountain lions.

As described in Hornocker (1969, 1970) and Siedensticker et al. (1973) mountain lions land tenure system acts as a form of social organization among solitary mountain lions. In a population of lions that exhibit movements from winter and summer ranges, the land tenure system may be more complex in those summer ranges than what has previously been studied in the winter ranges. In the summer range were prey is more dispersed and lions have larger hunting areas subpopulations may overlap more than that of smaller ranges used in the winter. This raises the questions of, is mutual avoidance the mechanism in effect during the transition periods? Are interactions and conflicts occurring? Further investigation is needed to answer such questions.

Sample size of locations was too small to perform home range analysis on some individuals, although we were able to compare movements seasonally and relative to other years and lions. The methodologies of data collection for the four studies remained the same, although home range analysis differed from earlier studies as to those of recent studies. For example, the number of locations collected, evaluated and home range estimating techniques differed somewhat. Therefore, further location collection, analysis, and comparison would help address the possibilities of bias in sample size, i.e., choice of locations (near trails and Taylor Ranch) and bias toward lion kill locations.

Variable sizes in home ranges for different study areas has made it challenging to asses social dynamics, therefore in comparing changes and similarities in the same

study area over many years and many generations of mountain lions, we can evaluate other factors in the dynamic system. It is also here that we can view the role mountain lions have on shaping the biological community that they are a valuable part of.

Table 1- Size (km^2) of 100% minimum convex polygon home range areas for the resident mountain lions during 1970-72 (Seidensticker et al. 1973), 1983-85 (Quigley et al. 1989) and 1998-2000 (Akenson)

	Year						
	1965-69	**1970-71**	**1971-72**	**1982-83**	**1984-85**	**1998-99**	**1999-2000**
Lion #							
Males							
NA	64						
3			41				
26		220					
28		145	96				
575					73(6)		
504					61(16)		
C-1						NA	314
C-3						NA	NA
Females							
H-4	52						
H-29	13						
24		142					
29		62	93				
45		132	99				
46		243	52				
52			31				
93		105					
303				173(34)	150(42)		
405				20(10)	30(13)		
C-2						NA	92(30)
C-4						NA	42(35)
C-5						NA	47(46)

Table 2- Sizes of Seasonal and Yearly Total Home Areas (km^2) of Mountain Lions (Seidensticker et al. 1973)

				Winter-Spring			Summer-Fall			Yearly
				1970-71	1971-72		1970 or 71			Total Area
Lion #										
Males										
	3				41					NA
	26			220	NA		NA			NA
	28			145	96		293			453
Females										
	24			142			163			306
	29			62	93		106			173
	45			132	99		207			373
	46			243	52		NA			NA
	52				31					NA
	93			105			114			220

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RENAN USED Big Creek Spreadsheet 98-99.xls and Big Creek Spreadsheet 99-00.xls FOR THIS HOME RANGE ANALYSIS. THESE FILES ARE ON A DISKETTE. THEY ARE INCOMPLETE AND UNEDITED DATA SETS AND HAVE BEEN MODIFIED INTO WolfCougUTM1999.xls and WolfCoug2000UTM.xls FILES FOR FUTURE ANALYSIS.