COUGAR POPULATION RESPONSE TO MANIPULATION IN SOUTHERN UTAH

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The management of large, solitary predators such as cougars (*Felis concolor*) is hindered by limited information on population dynamics. Harvest objectives are based either on past harvest levels that seem to allow a population to persist or on a desire to reduce depredation problems. In Nevada, Ashman et al. (1983:57) used the estimated recruitment rate in cougar populations of 30% as a harvest objective, although in practice, a more conservative 25% harvest level often was used. Alberta regulates its cougar harvest in an effort to assure no more than 10% of the population is harvested annually (Pall 1984). Harvest records in neither Alberta nor Nevada indicated cougar populations were declining under their respective harvest level objectives. However, the effect of harvests on cougar populations has never been examined experimentally. Our objective was to monitor the response of a cougar population with known characteristics to removal of individuals, simulating a sport-harvest.

STUDY AREA

The study area (4,500 km²) was located in the Boulder, Escalante, and Canaan mountains of Kane and Garfield counties in southern Utah. Elevation varied from 1,350 m in desert canyonlands to 3,350 m on high-elevation plateaus. Average temperature for Escalante in January was -2.8 C and in July 24.5 C. Precipitation, primarily snow, averaged 18 cm at low elevations and 60 cm on the Aquarius Plateau (U.S. Dep. Commerce 1979).

Desert grass and shrubs with a sparse overstory of pinyon pine (*Pinus edulis*) and juniper (*Juniperus osteosperma*) were the primary vegetation between 1,350 and 1,800 m. Between 1,800 and 2,400 m, pinyon pine and juniper formed a dense overstory, with sagebrush (*Artemisia* spp.) dominating the understory. Ponderosa pine (*Pinus ponderosa*) and Gambel oak (*Quercus gambelii*) communities were common between 2,400 and 2,700 m. Above 2,700 m, subalpine meadows were surrounded by stands of Engelmann spruce (*Picea engelmannii*), quaking aspen (*Populus tremuloides*), and white fir (*Abies concolor*). River canyons, characterized by steep, vertical walls and bare sandstone, traversed the area. Riparian communities were dominated by Fremont cottonwood (*Populus fremontii*) and willow (*Salix* spp.) (Ackerman 1982:3, Hemker 1982:3-5).

Human activities in the area consisted of logging, energy exploration, and livestock grazing. Most of the area was grazed, and over half of the merchantable timber stands had been logged. The human population of approximately 800 was centered in the towns of Boulder and Escalante. The study area was closed to cougar hunting in 1979 to facilitate our research. Regulated sport hunting continued adjacent to the study area, however.

METHODS

The cougar population in a 1,900-km² core portion of the study area had been monitored intensively since 1979. One to 4 people continually searched the core area, including home ranges of collared cougars, for signs of unmarked cougars. A rear toe was surgically removed from each adult resident cougar to allow its identification from tracks. This procedure facilitated rapid documentation of new cougars, reduced the probability of tracking marked cougars, and allowed presence of marked cougars to be documented even if radio-collars failed. We estimated population size each winter by summing the number of radio-collared cougars and their kittens and unmarked cougars documented in the core area in the previous month.

We removed cougars from the core area during the period of Utah's general cougar sport-harvest season (Jan-Jul). They were captured using trained dogs and

1 Deceased. The authors dedicate this paper to his memory.
immobilized with an intramuscular injection of ketamine hydrochloride and xylazine hydrochloride (Henker et al. 1984). Immobilized cougars were caged for transportation and were either taken to Hogle Zoo (Salt Lake City, Utah), released in the southern extremes of the study area, or released elsewhere in the state. Cougars were liberated only after full recovery from the drugs. Radio-collars were left on those cougars relocated to the southern portion of the study area.

Sex and age of cougars removed were based on the composition of Utah’s annual sport-harvest (Utah Div. Wildl. Resour. 1987), which consisted of about 40% adult males, 20% adult females, 20% young males, and 20% young females. Ages of harvested cougars were estimated by Utah Division of Wildlife Resources (UDWR) biologists on the basis of tooth wear. Removed adults were resident cougars that exhibited continuous use of a predictable area for >6 months or reproduced. Young cougars removed were both transient animals that displayed no fidelity to a site and the population’s >1-year-old kittens. Older kittens were included in the removal because they were likely to be included in sport-harvests. Although large kittens may still be associated loosely with their family, they were often alone when treed and not easily distinguished from adults by hunters. Our level of cougar removal from the study area simulated a 27% harvest of the harvest-age (>1-year-old) population.

Following the removal, we continued to monitor both the radio-collared cougars remaining in the core area and those we relocated to the southern part of the study area. We attempted to locate each radio-collared cougar at least once weekly from an airplane or ground and listened daily in the core area for radio signals of those cougars we relocated. The study area was continually searched for sign of uncollared cougars, emphasizing areas where the removed adults had ranged. New cougars were captured and radio-collared as detected.

RESULTS

Harvestable population size (adult residents, transients, and kittens >1 year old) on 1 January 1987 was 22 cougars (Table 1). Six cougars were removed (2 male and 1 female 1.5 year olds and 2 female and 1 male 3.5-year-old residents) during February and March 1987. Another adult resident male that we relocated was not included in the removal sample because he returned twice. In addition, 2 adult resident cougars died from natural causes during the year following the removal period. Combined removals and deaths represented 36% of the harvestable population.

By 1 January 1988, with the possible exception of 1 male, the adult resident segment of the population had recovered; however, the harvestable population (total cougars >1 year old) had decreased (Table 1). In September 1987, we found sign of an adult resident male whose radio-collar had failed, so he may have been present as well on 1 January 1988. Of the females that established home ranges during the year, 2 were transients present in the population before the removal and the third was a daughter of 1 of the removed females. By 1 January 1989, 2 years after the removal, 4 adult resident males were present, but the adult resident female cohort was reduced to 7, and harvestable population size was still 27% below the 1987 level. Three of the 6 adult resident females present in 1987 after the removal died in 1988, but only 2 females established home ranges during that year, resulting in a net loss of 1 resident female.

Because we occasionally observed small tracks but did not subsequently capture a cougar in the vicinity, we assumed some transients simply moved through the study area. Our annual winter population estimates, as a result, may underestimate the number of transients available over the full year that could have replaced the adult residents that died or were removed.

DISCUSSION

Although the simulated 27% sport harvest of cougars seemed to result in a 23% reduction in the harvestable population the next year, this reduction was likely caused, in part, by normal annual variation in number of kittens (n = 8, SD = 3.3; F. G. Lindzey, U.S. Fish and Wildl. Serv., Laramie, Wyo., unpubl. data, 1989) in the population. With the possible exception of 1 male, the adult resident segment of the population recovered in 9 months. Combined, removals (n = 3) and deaths (n = 2) during the year (1987) amounted to a 42% reduction of adult residents. The apparent inability of the population to replace 1 of 3 adult
Table 1. Size and composition of a southern Utah cougar population subjected to an experimental removal of 27% of its harvest-age (>1-year-old) members in 1987.

<table>
<thead>
<tr>
<th>Date</th>
<th>Adult resident</th>
<th>Young transient</th>
<th>Kitten</th>
<th>Harvestable population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Jan 1987</td>
<td>4</td>
<td>8</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Jan 1988</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Jan 1989</td>
<td>4</td>
<td>7</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

M = male, F = female, U = unknown.

* All cougars >1 year old.

† Probable presence of cougar with nonfunctioning radio-collar.

Resident cougars that died the second year following the removal suggests that the population would not have recovered as quickly from a similar harvest that next year. In fact, the harvestable population in 1988 was composed of proportionately more adults (71 vs. 55%) and fewer, more vulnerable (Barnhurst 1986: 40) young cougars than it was in 1987. A similar harvest level would probably have removed proportionately more adults than it had the previous year, making recovery even more difficult. Replacement-age female kittens were not present nor apparently were female transients in 1988.

In this unharvested population, annual adult resident mortality averaged 28% (Lindzey et al. 1988). The number of adult residents that died during the removal year, exclusive of the experimental removal (22%; 2 of 9), suggests that hunting losses may be largely additive to other mortality. The apparent lack of compensation for hunting losses by a reduction in other deaths may be partially explained by the generally density-independent character of causes of death (e.g., prey capture injuries, accidents; Hornocker 1970, Lindzey et al. 1988). Because intraspecific killing was common even in this low-density population (Lindzey et al. 1988), we expect it would occur in populations where density has been reduced by hunting.

Recovery of the adult resident female segment was facilitated by the establishment of young females that had immigrated to the study area and establishment of the population's female progeny. Resident males were replaced only by immigrants. This pattern of replacement was similar to that documented earlier on the study area for cougars that died of causes other than hunting (Laing 1988:49–51).

Resilience of cougar populations to hunting will depend on rate of immigration into the population and availability of recruitment-age female progeny. Immigration rates, particularly of females, will be influenced by harvest intensity in adjacent populations. Losses of adult resident females likely will have the greatest impact on the population because not only will they need to be replaced, but their loss will potentially reduce the number of female kittens available to replace lost residents. The effect of harvesting on cougar populations will undoubtedly vary with sex and age of cougars removed. Monitoring cougar harvests for changes in the proportion of adult females may provide insight into the impact the harvest is having on the population. An increase in the adult female harvest may indicate that the population cannot sustain the current harvest level if features of the environment such as the habitat and prey numbers remain constant.

**SUMMARY**

A cougar population in southern Utah did not recover in 9 months from the experimental removal of 27% of its harvest-age (>1-year-old) members. The adult resident segment, with the possible exception of 1 male, recovered
through replacement by transients and female offspring of the population. This recovery included the replacement of 2 other adult resident cougars that died during the year. Failure of the population to recover to preremoval level 2 years later, and its inability to replace 1 of 3 adult residents that died the second year, suggest that the population would not have recovered as quickly from a second year's harvest of similar intensity. The effect of hunting on cougar populations will depend both on level of harvest and sex and age of cougars removed; populations will be most sensitive to loss of adult resident females. Losses to hunting will not be totally compensated for by a reduction in other deaths normally incurred by cougar populations.

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LITERATURE CITED


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