Colorado Mountain Lion Management
Data Analysis Unit Revision & Quota Development Process

Until 2000 specific Data Analysis Unit (DAU) plans for mountain lion did not exist. In 1999 the Department of Natural Resources Director formulated a predator management advisory committee to review and recommend changes to predator management efforts at that time. An outcome of that process was the formulation of mountain lion DAU plans and objectives. Attention drawn to lion management by the advisory committee, along with increasing levels of harvest limit quotas, harvest, and relative proportion of females in mortality led to increased scrutiny by internal and external interests.

Harvest limit quotas have been used as the sole method of allowing hunters to pursue and kill lion since 1975. The quota system is a system designed to balance a high degree of hunter opportunity with control of the number of animals killed by hunters. Since quotas had increased to 790 by 1999, they would not have guarded against harvest at levels unacceptably high. In order to provide for long-term conservation of lion populations, if high levels of total or female harvest occurred managers would have to correct with significant reductions in the quota in subsequent years. Since quota levels were established in the 2000 DAU plans, they did not provide flexibility to raise or reduce the quota as management needs changed or as we gained new information about lion populations.

The foregoing led Division of Wildlife staff to conclude that revision and improvement of the year 2000 DAU plans was necessary and initiated in early 2004. A description of DAU revision elements and processes follow.

DAU STRATEGIC GOAL or DAU MANAGEMENT PRESCRIPTION

This provides the most fundamental, influential aspect of management and describes the ultimate goal for lion management in the DAU. There are two choices: to suppress the population, or to maintain a stable or increasing population. It is not a numeric target for the population level, because lion population levels cannot be precisely determined.

If the management prescription is to suppress the population, then the rationale for this prescription must be explicitly explained in the DAU plan. Suppression may be chosen for the entire DAU or for one or more smaller geographic areas within the DAU, so long as desired results can be monitored at the smaller geographic scale.

POPULATION PROJECTION

A population estimate is derived from sampling some aspect of a population. Currently there are no credible and cost effect means of sampling lion populations, so an estimate is not possible. Instead, a possible population can be formed by extrapolating from densities reported in scientific literature. With unknowns about the accuracy of a population projection managers provide a bracketed range, within which the actual population is most likely to occur. Uncertainty about the actual population is kept in mind throughout DAU planning and quota development processes.

Projecting a population begins with applying densities reported in literature to a land base. Studies sometimes use differing techniques to estimate lion population in study areas. Season or timing of population estimates, size of the study area, and habitat-vegetation type of study areas all can influence population estimates. For consistency, studies that used mark-recapture methods and have habitat types similar to Colorado's occupied lion habitat were applied. Managers could use densities reported in literature that most closely reflected habitat conditions and lion population in their respective DAU. The following table is a brief summary of population structure, size of study areas, and density range within the study areas. Managers went directly to the literature for more detailed description of study area habitat and vegetation.

Location	Area Size km²	Adults		Sub-adult	Kittens	Total lions/100 km²	Source
		Male	Female				
New Mexico (TA)	703	4-6	3-9	0-5	3-15	2.0-4.3	Logan and Sweanor 2001
New Mexico (RA)	1,356	7-11	6-16	1-5	6-23	1.7-3.9	
Alberta*	780	4-5	8-12	2-10	6-18	2.7-4.7	Ross and Jalkotzy 1992
British Columbia*	540	1-2	4	2-4	11	3.5-3.7	Spreadbury et al. 1996
Idaho*	520	3	2-6	0-5	1-7	1.7-3.5	Seidensticker et al. 1973
Utah*	1,900	0-4	5-8	0-10	3-14	0.6-1.4	Lindzey et al. 1994
Wyoming*	741	3	7-9	1-7	13-17	3.5-4.6	Logan et al. 1986
Mean		3.1-4.9	5.0-9.1	0.9-6.6	6.1-15.0	2.2-3.7	

*All but the New Mexico study areas are densities derived from population estimates on winter range. Caution must be used in applying these densities to entire DAUs. Doing so will probably exaggerate the projected population from actual.

The next step in projecting a possible population is to apply the selected density (or density range) to an area of land. There are no DAUs in which the entire land base could all be considered lion habitat. Therefore, managers adjusted the land area, deducting those areas not considered lion habitat. GIS mapping functions served to provide a more refined land base. As a general guide the following areas were not considered lion habitat: areas above 11,500 feet, large reservoirs, highways, cities and towns, grassland type habitats, intensively farmed areas. Unless there was evidence of viable lion populations in these areas they were deducted from the land area of a DAU. Managers considered primarily mule deer and elk winter range, density of these prey within their winter range, vegetative cover types and degree of canopy closure, and degree of topographic variation as factors that influence the quality and thus density ranges chosen. The area of effective lion habitat, expressed in km^2 was then multiplied by the selected density range to produce a projected population range.

The final step in projecting a population distributes the population to a possible structure. The purpose of this is primarily to separate out what proportion of the population is likely to be kittens and thus not considered part of the huntable population. The foregoing table provides a summary of structures reported in various study areas. Managers reviewed literature for more detailed information about these studied populations since some were not hunted, some simulated hunting through removal and recovery phases, and others were lightly or moderately hunted. The degree of exploitation has some degree of influence on population structure.

ESTIMATING ACCEPTABLE TOTAL MORTALITY

Using the portion of the projected population that is huntable (adults and sub-adults), managers estimated an acceptable level of mortality within DAU. Logan and Sweanor (2001) suggest that the level of hunting and non-hunting mortality can be gauged relative to the rate of population growth. They further suggest that managers can use the rate of growth they documented (11%) provided managers have a reliable estimate of the lion population and that the population is increasing. Neither is known for any DAU, thus caution was important when generating an estimate of supportable mortality. The authors advised more caution when managers have these unknowns and their guidance is very conservative; within the 8% adult male to 11% adult lion range when management is directed toward sustained recreational hunting. Conversely, the authors documented the relatively high resilience of lion populations when they recorded a 28% rate of growth in their treatment area following a period with a high rate of removal. They suggest that for population control managers may have to apply rates of removal exceeding 28% of the population for a period of several years in order to suppress a population. Ashman et al. (1983) concluded that sustained removal of about 30% annually was sustainable, whereas Ross and Jalkotzy (1992), Lindzey et al. (1994) found annual growth rates of 21% and 24% respectively, and Anderson (2003) asserted that the Ashman conclusion was likely correct provided there is adequate source areas from which immigration can supplement local population recruitment.

A factor to be considered in estimating acceptable total mortality levels is the abundance of available prey. The San Andres Mountains of New Mexico where the 28% growth rate was documented had a relatively low prey base compared to Colorado - considering Colorado densities of mule deer, elk, and in some places bighorn sheep and white-tailed deer. The degree to which a greater prey base might affect population growth is not known, but is reasonable biological inference that growth rates are greater when there is higher density of available prey. Caution was maintained at this point, however, since human caused mortality in lion populations has been shown to be mostly additive mortality. Presumably, mortality above a population's growth rate would result in a reduction in the number of lion within that population, excluding immigration influences.

A guide of 8-15% of the huntable population was used as a range of acceptable total mortality for populations managed for a stable-increasing DAU management strategy. For suppression management strategies, the total mortality guide was >15% to 28% of the huntable population. Within the range of 8% - 28%, managers could select a range of removal that fit conditions within their DAU and consistent with the desired management prescription. The broad 8% - 28% range was viewed as a continuum. Removal rates at the lower end of the scale would most likely result in population growth, whereas removal rates at the upper end would most likely result in population suppression. Whatever removal rate that managers chose to apply was included within the DAU plan and justified.

Basic population modeling of lions has demonstrated the fairly high degree of sensitivity populations have regarding female harvest. Models and reproductive biology have demonstrated that lion populations that are hunted at or near their rate of population growth can be impacted and shifted to a declining mode with a minor amount of additional mortality – especially female mortality. Moreover, while male lions disperse into new areas as they reach adulthood, females disperse only relatively short distances – typically at most only one or two home areas distant. Thus, high rates of female removal over large geographic areas may not be rapidly replaced by reproduction or dispersal. As a consequence, DAUs with stable-increasing management strategies included a benchmark proportion of acceptable female mortality somewhere between 35% - 45% of mortality objectives. There is recognition that a DAU with low mortality relative to total acceptable levels could sustain a higher proportion of females, whereas if total mortality is at or approaching acceptable levels then stricter adherence to the benchmark would be more important.

ESTIMATING ACCEPTABLE HUNTER HARVEST

When managers determined the acceptable total mortality level, then the level of acceptable harvest was determined. This is done by deducting 5-year running average level of non-hunter mortality from the acceptable total mortality level.

HARVEST LIMIT FORMULATION

Normally when managers determine a desired harvest level then the remaining step to setting licenses needed to achieve that harvest is to divide the desired harvest by the historic or anticipated hunter success rate. For lions, since licenses are unlimited and hunters can hunt in any open unit, there is no unit specific hunter success rate on which to rely. Instead, for at least the initial harvest limit following DAU plan revision, managers used the historic rate of quota achievement as a surrogate for hunter success rates.

Harvest limit quotas act as a stop point to guard against over harvest. They represent the maximum amount of harvest managers consider acceptable in any single year and the harvest objective is the acceptable level of harvest calculated on a 5-year running average. Since hunting conditions are variable from year to year, the harvest objective could be exceeded in one or two years in five if there are several other years in which it is not exceeded. Other factors considered in forming the harvest limit quota include: the level of access and hunt-ability of terrain, landownership, hunting conditions over recent years, hunter behavior and hunter demographics that might influence rates of quota achievement compared to historical levels.