

# DRAFT MOUNTAIN LION MANAGEMENT PLAN

FOR

## Lion DAU L-19

Game Management Units  
83, 85, 140, 851



Colorado Parks and Wildlife  
Southeast Region  
December 2018

## EXECUTIVE SUMMARY

|  |  |
|--|--|
| GMUs 83, 85, 140 and 851   |  |
| Land Ownership: 90% Private, 5% Federal (USFS or BLM), 2% State Land Board, 2% CPW |  |
| Strategic Goal: Previous: <u>Stable</u>  | Recommended: <u>Stable</u>                       |
| Harvest objective: Previous: <u>22-28</u>  | 2019 Recommended: <u>39</u>                      |
| Total mortality objective: Previous: <u>29</u>                                     | 2019 Recommended: <u>41</u>                      |
| Monitoring Metric: Previous: <u>None</u>   | Recommended: <u>≤20% adult female in harvest</u> |

### STRATEGIC GOAL

The strategic goal of this plan is to manage for a stable mountain lion population while maximizing recreational hunting opportunities. This will be measured by not exceeding a monitoring threshold of 20% adult female in the harvest on a 3-year running average.

### ISSUE IDENTIFICATION

During the scoping process for this plan, we identified three issues of concern to both CPW staff and stakeholders: 1) Game Damage, 2) Human Conflict, and 3) current levels of harvest do not appear sufficient to limit population growth. Through scoping and other examinations of data and harvest from L-19, we believe the mountain lion population can sustain a higher harvest while still being maintained as a stable population.

### ADAPTIVE MANAGEMENT APPROACH

Four independent research projects indicate total harvest comprised of 20-25% adult females provide an inflection point for population trajectory, as proportions of harvest exceeding 20-25% adult females are associated with declining population trends; harvests comprised of lower proportions of adult females in harvest were not associated with population declines (Logan 2015, Robinson and DeSimone 2011, Laundre et al. 2007, Anderson and Lindzey 2005).

In L-19, the proportion of adult females in the harvest has remained low, averaging only 10% during 2014-2016 (Figure 1). During this time, harvest averaged 34.3 lions (Figure 2). This suggests that recent harvest limits in L-19 may have been too conservative to limit population growth.

We are using an adaptive management approach to better understand how changing lion harvest affects population trajectory. To determine whether we are meeting the Plan's strategic goal of stable lion management, the proportion of adult females in the harvest will be used as our monitoring metric with the overall goal of not exceeding 20% on a 3-year running average. Given that we are currently under the 20% metric, we propose for the 2019 season (April 2019 - March 2020) an initial increase in the harvest limit of 5 lions with a new harvest limit of 39 lions. In subsequent years, we will make decisions annually about whether to maintain, increase, or decrease the harvest limit for the following season based on the proportion of adult females in the harvest relative to the management threshold.

**HARVEST SUMMARY**

From 2008-2017, hunter harvest in L-19 ranged from 12 to 36 lions, with an average of 25 harvested lions per year (Figure 2). The most recent 3-year average harvest is 33 lions and the average total mortality is 35. Ten-year average percentage of adult females in the harvest is 18% with a 3-year average of 10% (Figure 1).

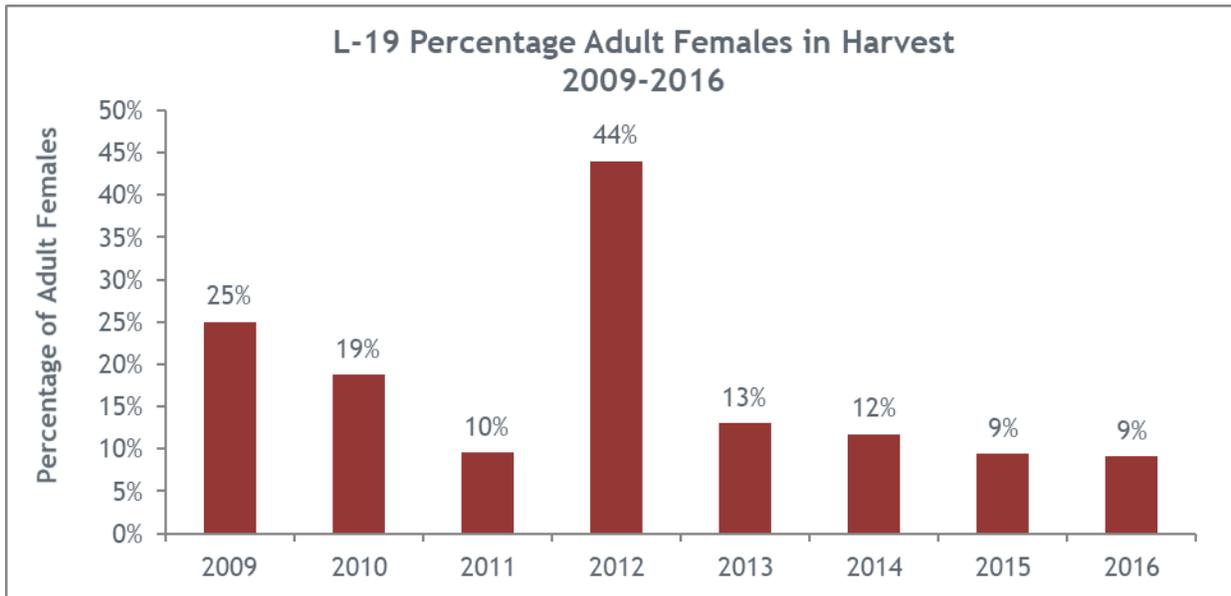


Figure 1. Percentage of adult females in total harvest: 2009-2016. Adult female is defined as a female with tooth cementum age 3 years or older.

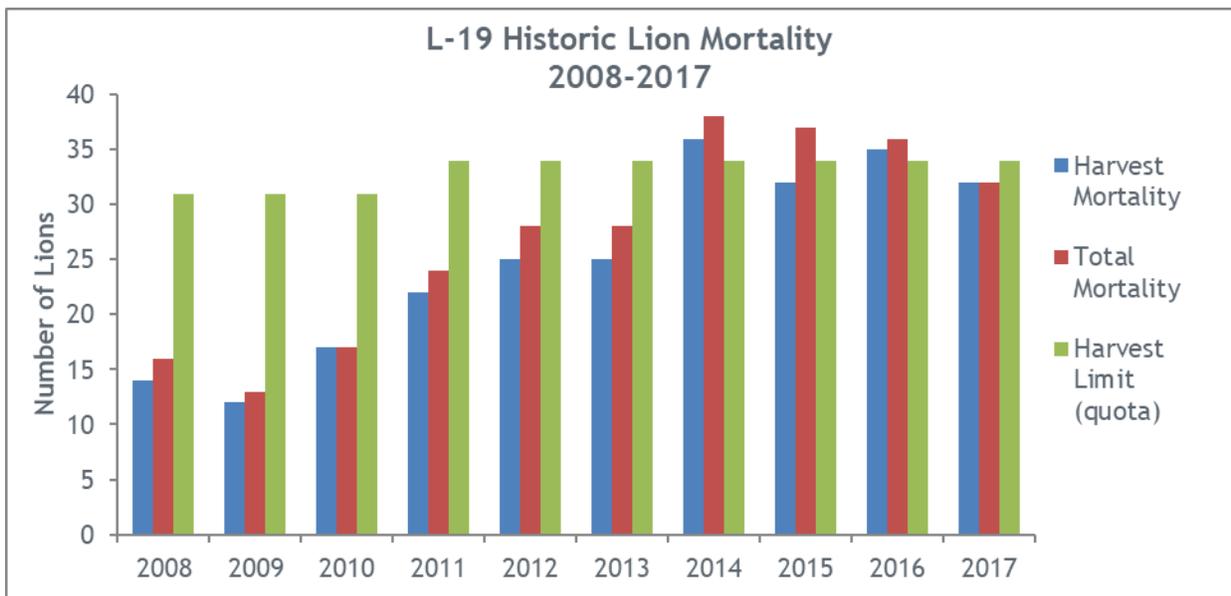


Figure 2. L-19 Mountain lion mortality: 2008-2017.

*This Mountain Lion Management Plan was approved by the Colorado Parks and Wildlife Commission on xxxx xx, xxxx*

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## DESCRIPTION OF DAU AND HABITAT

Mountain Lion Data Analysis Unit (DAU) L-19 is located in south-central Colorado and comprises Game Management Units (GMU's) 83, 85, 140, and 851 (Figure 3). It covers 3,321 mi<sup>2</sup> (8,577 km<sup>2</sup>) ranging in elevation from 3,860 ft. from where San Francisco Creek flows under Colorado Highway 160 to 14,345 ft. at the top of Blanca Peak in the Sangre de Cristo Mountains. Topography ranges from gentle rolling hills to ridges and valleys to steep alpine slopes and cliffs. Annual precipitation ranges from 20 inches at higher elevations to less than 6 inches in the lower elevations, mainly in the form of winter and spring snowfall and late summer thunderstorms.

DAU L-19 is bounded on the north by US highway 160, the Alamosa-Costilla County line, Pass Creek Road, and Colorado 69; on the east by I-25, US highway 160, and Colo. 389; on the south by the New Mexico state line; and on the west by the Rio Grande River. Drainages include the Apishapa River, Culebra Creek, San Francisco Creek (Las Animas County), Rio Grande River, Trinchera Creek (Las Animas County), Trinchera Creek (Costilla County), Huerfano River, Cucharas River, Sangre de Cristo Creek and the Purgatoire River.

Over 90% (3,000 mi<sup>2</sup>) of L-19 is privately owned (Figure 4). The remaining parts of the DAU are managed by the following agencies: U.S. Forest Service - 109 mi<sup>2</sup> (3.3%); State Land Board - 69 mi<sup>2</sup> (2.1%); Colorado Parks and Wildlife (CPW) - 59 mi<sup>2</sup> (1.8%); Bureau of Land Management - 52 mi<sup>2</sup> (1.6%); U.S. Fish & Wildlife Service - 18 mi<sup>2</sup> (0.5%) and City or County - 7 mi<sup>2</sup> (0.4%).

Predominate vegetative communities include alpine tundra, sub-alpine conifer, montane conifer, montane shrub, great basin desert shrub, and plains grassland (Figure 5). Land use is primarily agriculture, with livestock grazing occurring on public and private lands. Irrigated and dry land farming produces grass hay and alfalfa. Early Spanish lands grants resulted in large tracts of land being held by one owner and large ranches still persist. Human occupancy is scattered among river valleys and the large towns of Trinidad and Walsenburg located in GMU's 85, 140 and 851. Public use for hunting, hiking, biking, camping, and fishing is limited to national forests, public campgrounds, and recreation areas. Currently three ranches in L-19 are enrolled in the CPW's Ranching for Wildlife Program (RFW), which provides public recreation and wildlife habitat improvement on private lands. Mountain lion is not an enrolled species on RFW properties, but mountain lion hunting is leased on most of these ranches by private outfitters.

Several large ranches have been sold as housing developments, and communities based on 40-acre lots are quickly impacting large expanses of the region, further reducing mountain lion hunting access. Several area ranches have been placed in conservation easements preserving these habitats.

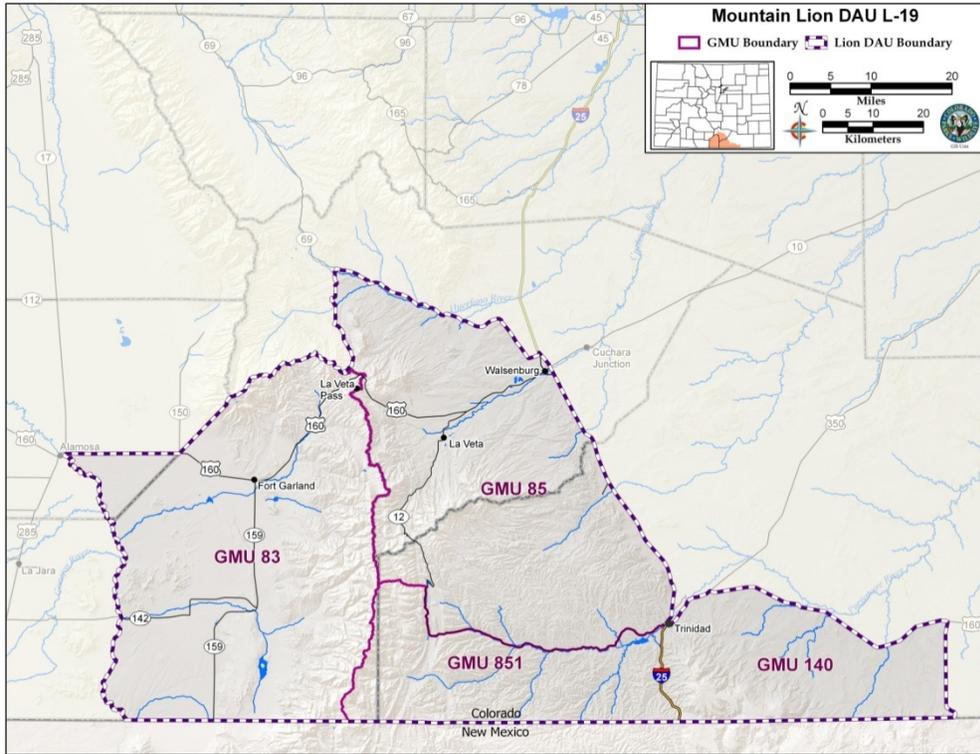


Figure 3. Location and boundaries of L-19.

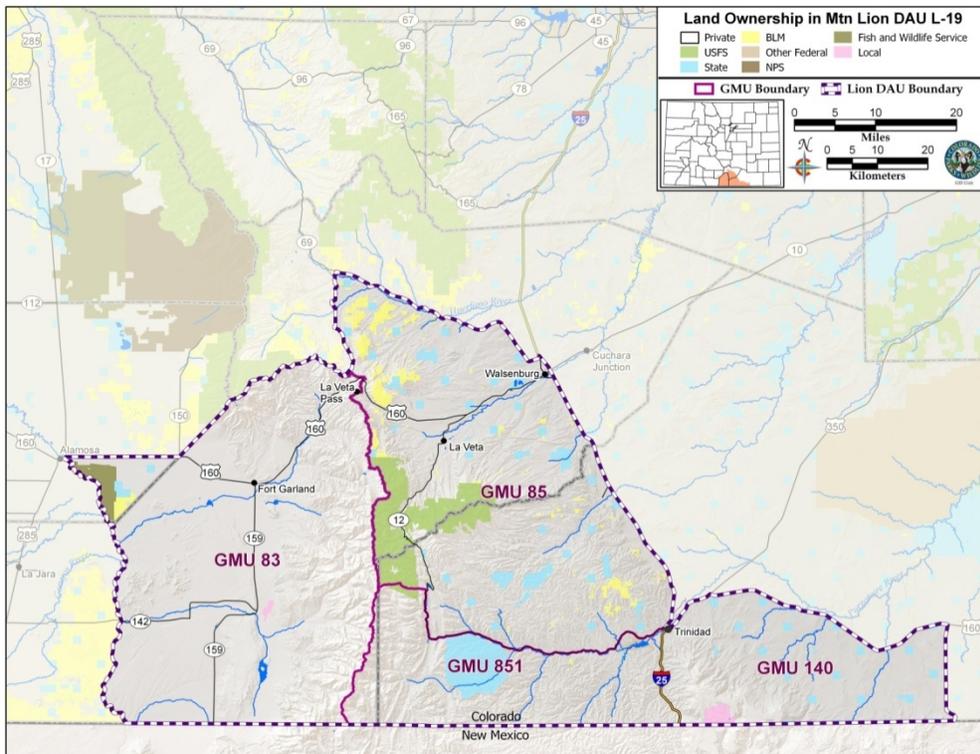


Figure 4. Landownership in L-19.

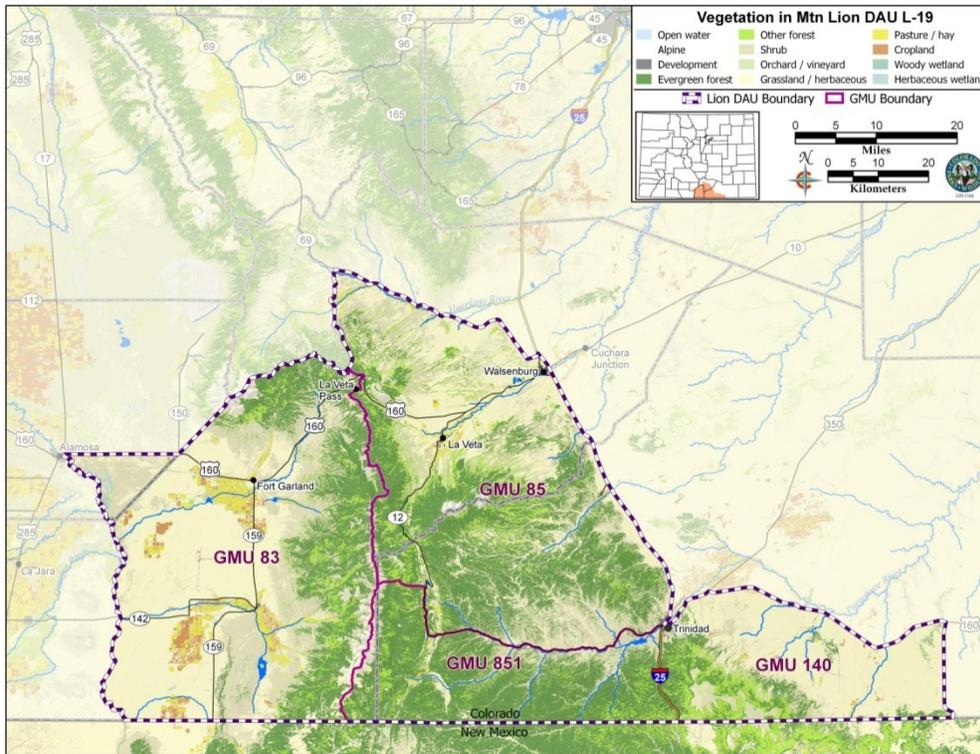


Figure 5. Vegetative communities in L-19.

## DAU MANAGEMENT HISTORY AND BACKGROUND

### L-19 Harvest History

Harvest limits (previously called quota) in L-19 have been divided between two huntcodes, one that includes GMUs 85, 851 and 140 (LE08501R) and the second that is valid for GMU 83 (LE08301R). The DAU harvest limit from 1990 through 2003 was as high as 40 lions, 30 for LE08501R and 10 LE08301R. Historic harvest averaged between 5 and 10 lions a year until 1996 when several new outfitters started operating in the area. This resulted in a sustained increase in harvest.

In 2004, a new mountain lion management plan was approved for L-19 (Vitt 2004). The goal of the 2004 plan was to maintain a rich vegetative and wildlife community that was in balance with the available habitat, which would minimize game damage complaints and support a self-sustaining mountain lion population. The 2004 L-19 plan specified that we would manage for a stable mountain lion population.

Harvest limits do not always reflect the harvest objective for a DAU. When harvest is below the harvest objective, we often allocate a higher harvest limits than reflected in the harvest objective. This is often done in units like L-19 with multiple huntcodes to distribute harvest and hunting opportunity between the geographic areas. As harvest approaches the harvest objective, limits are often reduced to ensure harvests do not exceed the harvest objective.

Under the 2004 plan, the population projection was 145 to 194 harvestable lions. We set a harvest objective of 22 to 28 lions with total mortality objective of 29 to maintain a stable population. Following approval of the plan, the harvest limits for 2005 were reduced to 30, with 24 allocated to LE08501R and 6 for LE08301R. Hunters harvested 11 lions in the entire DAU under that limit. In 2005, we increased the harvest limit for LE08301R by 1; the DAU harvest limit remained at 31 until 2011.

Historically when setting harvest limits in L-19, we used 5-year running averages to estimate predicted harvest for the following season. For the 2011 season, the 5-year running average harvest for L-19 was 14 lions, well below the DAU harvest objective of 28. Per CPW staff and landowner requests, we increased harvest limits for LE08301R to 10 so the overall harvest limit for L-19 was 34 lions.

Prior to 2014, neither the total mortality or harvest mortality thresholds were met. However, beginning in 2014, harvest mortality in L-19 (36 lions) exceeded the harvest objective of 28 lions (Figure 6 and Table 1). Limits were not changed because the 5-year running average remained below the total mortality objective. Following the 2015 season, we achieved a 5-year running average harvest of 28 which met the harvest objective and exceeded the total mortality objective for the first time. Starting in 2016 on a statewide basis, status quo harvest limits were recommended pending the development of a statewide lion plan and therefore, changes were not made to the L-19 harvest limit. The total mortality and harvest objectives were exceeded in 2016 and 2017.

Exceeding the mortality thresholds in the 2004 plan has allowed us to examine assumptions made in the existing plan, the optimal duration of time used to calculate mortality (5-year average) and the need for additional monitoring metrics for mountain lion management. These will be examined below.

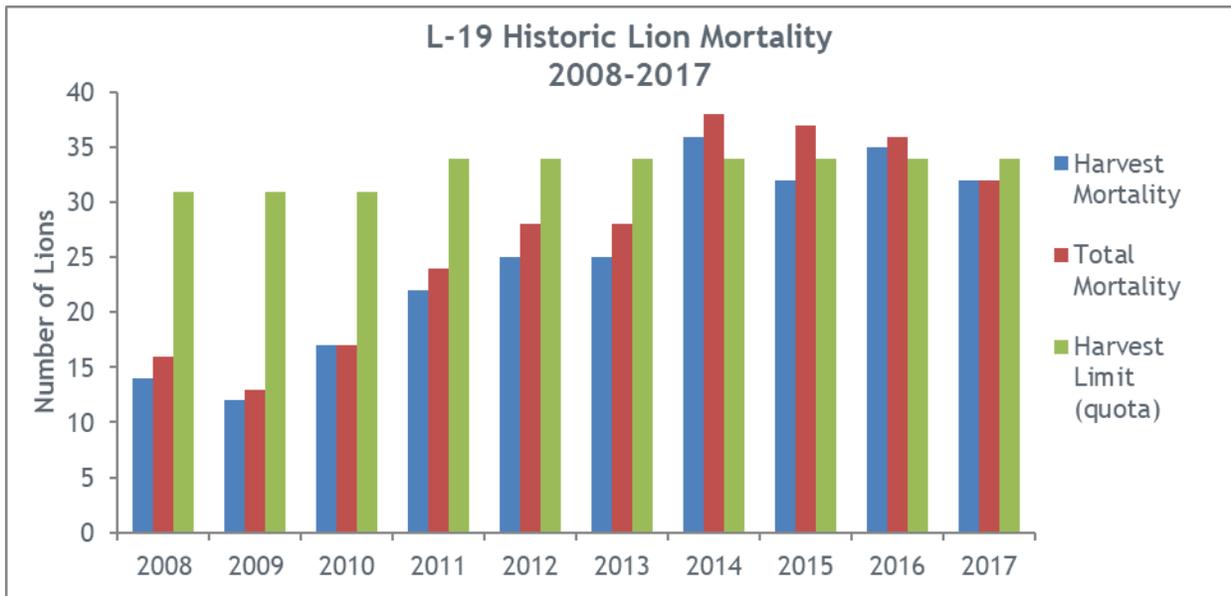


Figure 6. L-19 Mountain lion harvest, total mortality, and harvest limits: 2008-2017.

**Table 1.** Number of mountain lions harvested by gender (males/females) in L-19 by GMU from 2008-2017.

| GMU         |         | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 10 Year Average Harvest |
|-------------|---------|------|------|------|------|------|------|------|------|------|------|-------------------------|
| 083         | Total   | 4    | 4    | 6    | 3    | 7    | 5    | 9    | 9    | 10   | 5    | 6.2                     |
|             | Female  | 2    | 1    | 3    | 1    | 5    | 3    | 6    | 3    | 5    | 1    | 3.0                     |
|             | Male    | 2    | 3    | 3    | 2    | 2    | 2    | 3    | 6    | 5    | 4    | 3.2                     |
| 085         | Total   | 3    | 4    | 5    | 12   | 11   | 12   | 14   | 11   | 14   | 13   | 9.9                     |
|             | Female  | 0    | 1    | 2    | 4    | 5    | 5    | 3    | 3    | 8    | 6    | 3.7                     |
|             | Male    | 3    | 3    | 3    | 7    | 6    | 7    | 11   | 8    | 6    | 7    | 6.1                     |
|             | Unknown | 0    | 0    | 0    | 1    | 0    | 0    | 0    | 0    | 0    | 0    | 0.1                     |
| 140         | Total   | 2    | 0    | 0    | 0    | 0    | 2    | 6    | 2    | 1    | 5    | 1.8                     |
|             | Female  | 0    | 0    | 0    | 0    | 0    | 1    | 2    | 1    | 0    | 1    | 0.5                     |
|             | Male    | 2    | 0    | 0    | 0    | 0    | 1    | 4    | 1    | 1    | 4    | 1.3                     |
| 851         | Total   | 5    | 4    | 6    | 7    | 7    | 6    | 7    | 10   | 10   | 9    | 7.1                     |
|             | Female  | 0    | 3    | 3    | 2    | 4    | 1    | 3    | 5    | 5    | 3    | 2.9                     |
|             | Male    | 5    | 1    | 3    | 5    | 3    | 5    | 4    | 5    | 5    | 6    | 4.2                     |
| Grand Total |         | 14   | 12   | 17   | 22   | 25   | 25   | 36   | 32   | 35   | 32   | 25.0                    |

### PUBLIC OUTREACH

A public meeting was held on September 5, 2018 in Trinidad, Colorado at the Trinidad State Junior College. The press release for this meeting can be found in Appendix A. The 27 people in attendance were encouraged to leave written feedback on this proposed plan. Written comments can be found in Appendix B.

In addition, this plan was placed on the CPW website for a 24-day review from September 14 - October 8, 2018. No feedback was received during the comment period.

### ISSUE IDENTIFICATION

Based on CPW staff observations, public comments, and feedback from public meetings, we have identified three issues that need to be addressed by this plan: 1) Game Damage, 2) Human Conflict, and 3) current management does not appear to be limiting population growth.

#### Game Damage

In some parts of L-19, large ranches have been developed into 40-acre parcel subdivisions, which has led to a higher human population, an increasing number of hobby farms, and a loss of historical knowledge on how to coexist with large carnivores. Mountain lion damage has

shifted from mainly cattle and sheep depredation to alternative livestock including llamas, alpacas, and domestic pets (See Appendix B).

When mountain lions became listed as game animals, CPW became financially liable for livestock and agricultural damage caused by mountain lions. CPW has paid an average of \$1,518 per year over the last 10 years (2008-2017) in lion-caused game damage in L-19; annual payments have predominantly been low with occasional spikes (Figure 7). Payments in 2014 were the highest in all 23 years reviewed; 4 separate claims for “other stock” totaled \$7,560 that year.

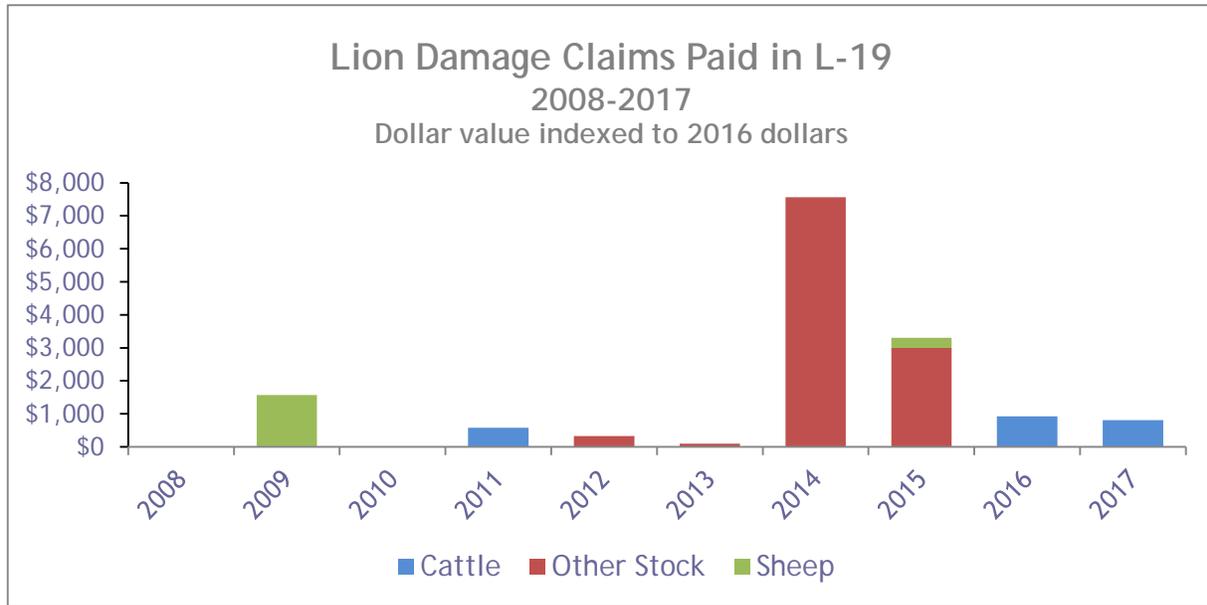


Figure 7. Mountain lion game damage paid by year in L-19: 2008-2017.

Human Conflict

Anecdotal evidence from CPW field staff suggests that human conflict has been increasing in L-19. Human conflict with lions can be found throughout L-19, but is more common where human densities are the highest. In addition, the region has observed the increase of lower density housing communities (ranchette developments) that both fragment habitat and also increase the potential for conflict with the presence of hobby livestock. Human interaction with lions includes sightings, roadkills, depredation on pets and livestock, and predation on deer and other wildlife in close proximity to development (Appendix B). Human concerns over these conflicts are varied with some people being very concerned about interaction, or potential interaction, and others valuing lions in the ecosystems where they reside.

### Current Population Status

We have several supporting indicators to suggest that the L-19 lion population is higher than presented in the 2004 management plan, including CPW staff and public field observations, harvest limit achievement, and a new more-robust method of population projection.

#### *CPW Staff and Public Field Observations*

As stated above, CPW staff and observations from landowners, hunters, and outfitters suggest the lion population is increasing (Appendix B).

Additionally, the lion population in L-19 may be augmented by dispersal of lions from three adjacent units where lion harvest is limited. First, to the north of L-19, CPW initiated a long term research project in 2016 to examine how changes in mountain lion densities affect mule deer demographics (Alldredge et al. 2016). For the first 6 years (2016-2021) of this study, mountain lion densities in the study area will be allowed to increase. Second, to the south, there is a very large ranch located in New Mexico where lion harvest is restricted. Third, to the east, there is a system of canyons that consists of lion habitat. Harvest in this area has historically been limited because of the lack of persistent snowfall. These 3 factors may all be contributing to increased and sustained immigration into L-19, which may explain the quick achievement of harvest limits in recent years.

#### *Harvest Limit Achievement*

Harvest limit achievement is also suggesting that the L-19 lion population is larger than presented in the 2004 plan. After three years of harvest limit achievement (2014-2016), the 2017 quota in GMUs 85, 140, and 851 was met 11 days after the season opened.

#### *New Population Projection: Static Mountain Lion Abundance Index*

CPW has developed a statewide resource selection function (RSF) model to project a potential static lion abundance index within management areas of Colorado (Appendix C). The static abundance index extrapolation is not a representation of actual population size of lions in a given area, but rather the relative probability of resource selection by an animal population at a snap shot in time with the assumptions used at that time. It is a way to derive a mortality limit and/or harvest levels that are appropriate for an area with each given management scenario or goal.

The model stratifies resource selection results into 4 strata related to the probability of lion presence in winter based on a suite of predictive variables that have been examined with Colorado-specific lion data. The model assumes that lions exist in greater density in strata with high probability of presence and at decreasingly lower densities in the next three strata, based on lower probabilities of winter lion occurrence.

The RSF model generated the amount of habitat by strata in each GMU in L-19 (Table 2). The model then applies assumed independent lion densities to each stratum to arrive at an extrapolated abundance index. An interdisciplinary team of managers and biologists in CPW examined lion densities reported in literature and considered habitat quality, prey base, abundance of alternative prey, vegetation characteristics, and the RSF model outputs and decided that the following density of independent (legally-harvestable) lions per 100 km<sup>2</sup> would be applied to each strata:

Strata 0 (extra-low), East of Interstate 25: 0.1 lions/100 km<sup>2</sup>  
Strata 1 (low), West of Interstate 25: 1.0 lions/100 km<sup>2</sup>  
Strata 2 (medium-low): 2.5 lions/100 km<sup>2</sup>  
Strata 3 (medium-high): 3.5 lions/100 km<sup>2</sup>  
Strata 4 (high): 5.0 lions/100 km<sup>2</sup>

The literature used to develop these lion densities was evaluated using reported density estimates for independent lions. As such the RSF-generated static lion abundance index does not include kittens or dependent young in the projection and would represent an approximation of the legally-harvestable lion abundance in L-19. It also is static, or non-changing, by its very nature. Projections are generated from assumptions, densities and conditions at the time the model is run and unless they are updated, result in fixed lion abundance indexes over time.

Under this plan the static abundance of independent harvestable lions is projected to be 239 in L-19 (Table 2). When compared to the approach taken for the 2004 plan, this more detailed approach suggests that more harvestable lions exist within the DAU (145-194 lions projected in 2004 plan).

**Table 2.** Output of resource selection function projecting a static independent harvestable lion abundance index in L-19.

| Relative probability of lion occurrence in RSF habitat strata               | <i>Extra Low Strata</i>   | <i>Low Strata</i> | <i>M-Low Strata</i> | <i>M-High Strata</i> | <i>High Strata</i> |
|---|---------------------------|-------------------|---------------------|----------------------|--------------------|
| Km <sup>2</sup> of each RSF habitat strata in L-19                          | 467                       | 1743              | 2581                | 2238                 | 1573               |
| Assumed lion density per km <sup>2</sup> in each RSF strata                 | <i>0.001</i>              | <i>0.01</i>       | <i>0.025</i>        | <i>0.035</i>         | <i>0.05</i>        |
| Project lion abundance index in each RSF strata in L-19                     | 0                         | 17                | 65                  | 78                   | 79                 |
| <b>Total projected independent harvestable lion abundance index in L-19</b> | <b>239 Mountain lions</b> |                   |                     |                      |                    |

## PROPOSED MANAGEMENT GOAL

The 2004 L-19 mountain lion management plan was based on the best available information at the time it was written. Since then, additional information has become available to help inform lion management decisions. In this plan, we are retaining the stable management objective. However, we are updating harvest limits to reflect the current state of knowledge regarding the lion population in L-19. We will employ a novel adaptive management framework using cementum tooth age analysis and gender of harvested animals to evaluate and adjust harvest limits over time to achieve the goal of stabilizing the lion population. The foundation for this concept and approach is presented below.

Wildlife managers, through the use of hunting harvest, have the ability to limit lion population growth (Robinson and DeSimone 2011). On the Uncompahgre Plateau, Colorado, during the 5-year population decline phase of the research project, *adult females* comprised 23% of the total cumulative harvest (Logan 2015). In this study, lion harvest was considered additive mortality and male lion survival rates declined when compared to the preceding reference phase with no lion hunting.

In the Garnet Mountains of Montana, lion hunting harvest was found to be an additive source of mortality, not compensatory. In the un-hunted period, 71% of the growth rate in the population was related to reproduction (maternity and kitten survival) while adult female survival accounted for only 22% of the population growth rate. Hunting reversed this; increasing the reliance on adult female survival accounted for 40% of the variation in population growth and reproduction accounted for only 17%. Monitoring and population modeling efforts in this population indicated that when accounting for all forms of known human-caused mortality, *adult female* mortality greater than 20% is likely to cause a decrease in the resident lion population level (Robinson and DeSimone 2011).

In southern Idaho - northern Utah, Laundre et al. (2007) tested the effects of changes in prey abundance on lion population dynamics. Through their monitoring of the change in population size and social-age class structure, they suggest that an annual harvest of 15 to 20% of *resident (adult) females* would not reduce a population.

Anderson and Lindzey (2005) conducted experimental population reduction and recovery in the Snowy Range of Wyoming to examine how various gender and age classes are exposed in hunter harvest when a population is increasingly exploited. Because of the differences in daily movement distances they predicted that males would be more vulnerable to hound hunting, which relies on discovery of tracks in snow. Increasing hunting pressure exposes different genders and age classes until they are relatively less available, subsequently exposing the next most vulnerable age class. Sex and age classes of lions exhibit different and relatively predictable movement patterns, where males move longer distances than females and subadults (1-2.5 years old) generally move longer distances than adults (Barnhurst 1986, Anderson 2003). In the absence of hunter selection, the likelihood of a specific sex or age class of lion being harvested would reflect its relative abundance in the population and its relative vulnerability based on daily movement patterns. Thus, where hound hunting methods are applied, those lions that typically move longer distances would most likely be detected first (males/subadults). The least vulnerable individuals (adult females) should become prominent in the harvest only after males become scarce in the population. Anderson and Lindzey (2005) tested these predictions by applying varying levels of hunter harvest to the Snowy Range mountain lion population. In a high-density population with low harvest rates,

they found that the composition of lions in the harvest was dominated by subadults. As harvest levels increased, the composition shifted to adult males. As predicted, with a continued high harvest, the composition shifted to adult females as the population started to decline. Likewise, Cooley et al. (2009) noted that adult females increased in harvest composition when hunting increasingly removed other age/gender classes in a population. When harvest levels were reduced, composition of the harvest returned to primarily subadults. The male segment of the reduced population recovered within 2 years due to male immigration from other populations and the female segment within 3 years from an increased number of females producing young within the population (Anderson and Lindzey 2005). They concluded that the population appeared to support a harvest composed of 10-15% adult females. When *adult female* composition in hunter harvest reached about 25%, the population declined.

An examination of these four independent studies suggests that a threshold of 20-25% adult female in the harvest is an inflection point in a population trajectory. Given our desire to manage L-19 for a stable population and due to the relatively small scale of this DAU, we are proposing to set a ceiling of 20% adult females in hunter harvest. We believe that harvest proportions maintained below this ceiling will not suppress the L-19 population. Because there can be a high degree of annual variation due to sample size, environmental conditions that alter hunting strategies and hunter success, we will use a 3-year running average when examining adult female hunting harvest mortality proportions. The 3-year average was selected because prior experience suggested that a 5-year average was too long to be adequately responsive to changes in both the mountain lion population and hunter harvest.

Starting in 2009, CPW began collecting premolars for cementum ring aging analysis to examine the age of lions at harvest. We defined an adult female as a female with tooth cementum age 3 or older. In L-19 from 2009-2016, the average proportion of adult females in the harvest was 18% and ranged from a low of 9% to a high of 44% (Figure 8). At the time this plan was drafted, the 2017 cementum age data were not available. The most recent 3-year average (2014-2016) is 10% and reflects a period where harvest limits were met. Based on our current proportion of adult females in the harvest, the current harvest limits are likely below the threshold that would initiate a population decline. Thus, we can increase harvest limits while still maintaining a stable lion population in L-19.

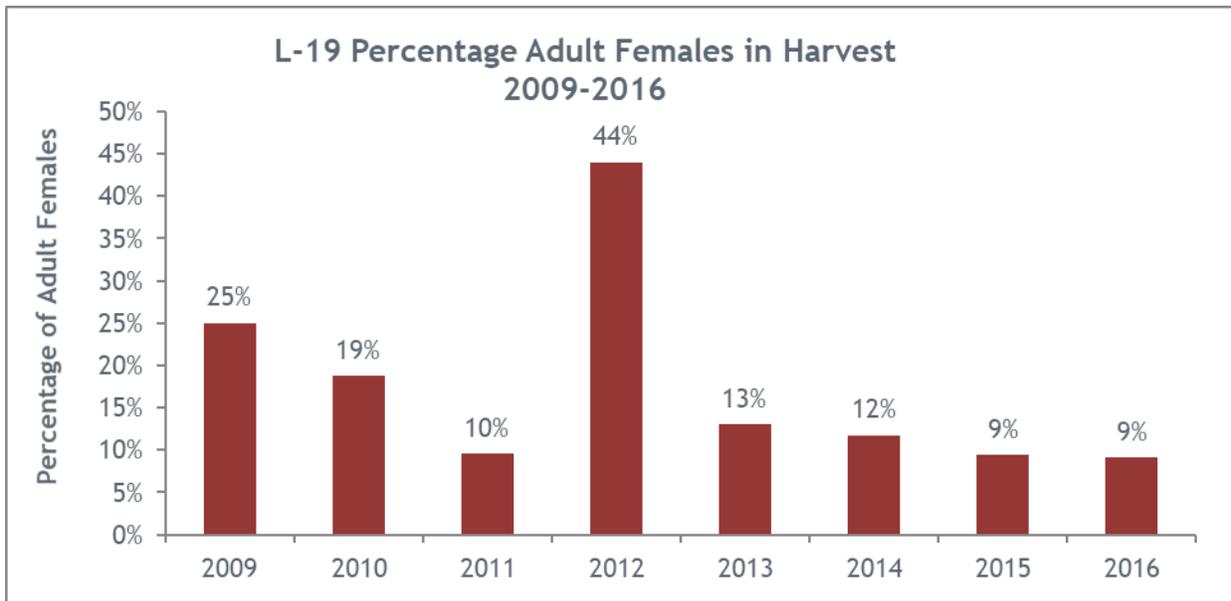


Figure 8. Percentage of adult females in harvest: 2009-2016. Adult female is defined as a female with tooth cementum age 3 years or older. Tooth collection began in 2009.

## STRATEGIES TO ACHIEVE AND MONITOR STRATEGIC GOAL

### Strategic Goal

The strategic goal of this plan is to manage for a stable mountain lion population while maximizing recreational hunting opportunities. This will be measured by not exceeding a monitoring threshold of 20% adult female in the harvest on a 3-year running average.

Given that the current harvest limits (34 total for L-19) are being achieved and the proportion of adult females in the harvest remains below the 20% threshold, an increase of 5 in the harvest limit is warranted and expected to retain a stable population trend. In addition to harvest, we also need to account for other sources of human-caused mortality, which averaged 1.5 lions over the past ten years. Therefore, the harvest mortality objective will be initially set to 39 lions and the total human-caused mortality objective will be 41 lions.

### Monitoring

The harvest limit achievement and proportion of adult females in the harvest will be monitored annually. Due to high year-to-year variation in both of these metrics due to small samples, environmental conditions, and hunter success, we will base management decisions on the 3-year running averages of the percent adult female in harvest. This will be calculated by summing the total adult females (and unknowns) in the harvest over each 3-year window, divided by the total number of lions harvested over that same 3-year period.

### Management Decisions

We are using an adaptive management approach to better understand how changing lion harvest affects population trajectory. To determine whether we are meeting the Plan's strategic goal of stable lion management, the proportion of adult females in the harvest will be used as our monitoring metric with the overall goal of not exceeding 20% on a 3-year running average. Given that we are currently under the 20% metric, we propose for the 2019 season (April 2019 - March 2020) an initial increase in the harvest limit of 5 lions with a new harvest limit of 39 lions. In subsequent years, we will make decisions annually about whether to maintain, increase, or decrease the harvest limit for the following season based on the proportion of adult females in the harvest relative to the management threshold.

This plan represents a new approach to managing lions in Colorado and therefore close monitoring will be required to determine the efficacy of this strategy for managing other lion DAUs.

## STRATEGIES TO ADDRESS MANAGEMENT CONCERNS

### Game damage and human conflict

Each mountain lion depredation and conflict situation is based on a unique set of circumstances, requiring an individualized solution. Agency responses will be based on education programs to reduce mountain lion depredation and conflict. Each event will be addressed using several different management strategies that focus on the individual lion. Strategies could include using Wildlife Services staff to capture and euthanize the lion. Additionally, CPW actions may run a continuum from public outreach and education to euthanizing the offending lion. In situations where there is an open season, strategies may utilize the services of an outfitter with a licensed hunter to remove the individual offending lion. For the duration of this plan, we will be evaluating game damage and human conflict events to assess trends in response to our management prescriptions.

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## APPENDIX A - Press Release for Public Meeting

Aug. 23, 2018

### Public opinion sought as CPW updates goals for managing mountain lion population

TRINIDAD, Colo. - If you want to have a voice in how Colorado Parks and Wildlife manages the mountain lion population in the areas around Trinidad, your time has arrived.

CPW is revising its population management plan that will guide the agency as it sets harvest objectives over the next 10 years.

As part of the process, the wildlife agency has scheduled a public hearing at 6 p.m., Wednesday, Sept. 5 at Trinidad State Junior College. CPW is inviting hunters, ranchers and the general public to speak out on its management plan and influence policies governing the population.

The targeted mountain lion population spans Game Management Units 85, 851 and 140 - essentially from Walsenburg and La Veta Pass south along the Sangre de Cristo Divide to New Mexico and east of Trinidad along Colorado Highway 160 to Highway 389.

CPW has a goal of updating objectives in its herd management plans every 10 years. The existing management plan, also called a Data Analysis Unit or DAU, for the herd was approved in October 2005.

Public feedback is being sought on whether to maintain the current objectives for the next 10 years.

Under the existing management objectives, hunters seem to be generally happy and CPW has not received a tremendous number of complaints about game damage.

If you disagree with those observations, please speak up. Your opinions and evidence could cause CPW to take a different approach in revising this plan.

### BOX:

**What:** Colorado Parks and Wildlife to host a public hearing on its 10-year mountain lion population management plan

**When:** 6 p.m., Wednesday, Sept. 5

**Where:** Student Center, Pioneer Room, Trinidad State Junior College, 600 Prospect St, Trinidad, CO 81082

**APPENDIX B - Feedback from Trinidad Public Meeting**

Written comments from the September 5, 2018 meeting in Trinidad received as of September 7, 2018. Names and contact information, if provided, have been removed. Twenty-seven people attended the meeting.

|   |  |
|---|--|
| 1 | <ul style="list-style-type: none"> <li>• Suggestions:             <ul style="list-style-type: none"> <li>• Work w/ subdivision presidents and boards to allow lion hunting</li> <li>• Increase female percentage</li> <li>• Increase total quota</li> <li>• Split units in Quota up 85/851/140</li> <li>• Control sub-adult harvest: Special license for experienced hunters who can differentiate adults and sub adults with different or additional quota.</li> </ul> </li> <li>• Experience:             <ul style="list-style-type: none"> <li>• I have seen many deer. Elk, and sheep kills from lions in the past 3 years, more than the previous than in the past 10. Same for seeing lions w/out dogs.</li> <li>• In the past 3 years I have seen tracks in the dirt archery hunting and have not in previous years.</li> <li>• Lions on game cams much more common in last few years</li> </ul> </li> </ul> |
| 2 | <ul style="list-style-type: none"> <li>• Raise the quota for annual hunts. April thru March more female adults.</li> <li>• Some developed areas want the wildlife but not the wild with these places. Quit feeding the deer and turkey! They have helped to make an increase lion population due to the deer coming to feed. These cats are being squeezed out of ground and getting less afraid of people.</li> </ul>   |
| 3 | <ul style="list-style-type: none"> <li>• Consider a male quota and a female quota.</li> <li>• Also, I would like to see a process to stop the youth cats from being killed?</li> <li>• Is there a way to limit young cats from being killed!</li> </ul>  |
| 4 | <ul style="list-style-type: none"> <li>• Lion quotas need to be increased in units 140, 85, 851. I also think that the lion quotas should be broke up separately for the 3 units.</li> <li>• I feel by giving all 3 units 85, 851, 140 separate quotas will be better for managing the lion population. Putting these 3 units together you can have an over kill within a population of lions.</li> <li>• I feel the 3 unit 85, 851,140 should have at least 12 lions per unit.</li> <li>• I feel it could easily go to 36 lions in these 3 units.</li> </ul>  |
| 5 | <ul style="list-style-type: none"> <li>• In unit 140 in Frisco pass and Sugarite Ranch the population has increased. Have seen more kills than ever.</li> <li>• Bear are on the increase also. This year during calving season I know we lost 2 calves in the Spring to bear didn't turn in.</li> </ul>  |
| 6 | <ul style="list-style-type: none"> <li>• Having watched lion population over the last 14 years there is no doubt the population is increasing.</li> <li>• We would like to see an increase in the quota and separate quota for each unit.</li> </ul>   |

|    |  |
|----|--|
| 7  | <ul style="list-style-type: none"> <li>I feel like population is increasing yearly. I would like to see an increase in the quota.</li> </ul>   |
| 8  | <ul style="list-style-type: none"> <li>I live SE of La Veta where I own 700 acres adjacent to my dad's 5,000 acres. I spend a lot of time out on foot horseback managing the land, livestock and trails.</li> <li>I can vouch that there are a lot of cats out there. One just killed one of my ducks and I just about stepped on his tail in my high fenced coop.</li> <li>I've also hit one on my ranger (side by side) on a ranch road.</li> <li>There are fresh tracks every day on my training trails where I ride.</li> <li>P.s. if cats start killing my foals it will be a serious problem.</li> </ul> |
| 9  | <ul style="list-style-type: none"> <li>Would like to see quota increased.</li> <li>Would like to be able to hunt in April.</li> <li>Maybe not have GMU 83 as part of the GMU.</li> <li>See a little increase in number of females or bigger increase in total number of lions taken.</li> </ul>  |
| 10 | <ul style="list-style-type: none"> <li>Put 140 in separate unit.</li> <li>Put limit on harvesting young cats.</li> <li>Up quota 5 - 7 cats.</li> </ul>   |
| 11 | <ul style="list-style-type: none"> <li>Raise quota.</li> <li>Break up units quota wish.</li> <li>Also with the turkey, deer, elk population: What happens when we take too many cats.</li> </ul>   |
| 12 | <ul style="list-style-type: none"> <li>Less females wanted killed, that means more toms that are killed that otherwise would have killed a percentage of kittens to control the population.</li> <li>Most times lactating females can be seen when hair is missing around the tits, and if you need to verify by re treeing that lion for a better look. But how many would do that?</li> <li>With weather conditions on the East of 25 plains why not open those areas year round - the hunting conditions would be the kill factor.</li> </ul>   |
| 13 | <ul style="list-style-type: none"> <li>Increase female killing.</li> <li>Only let mature cats be harvested.</li> <li>Split the units up and up quotas.</li> <li>Have DOW talk to subdivisions to let hunters in.</li> <li>More people seeing cats now than ever.</li> </ul>  |

## APPENDIX C - Description of Colorado Resource Selection Function

Colorado Parks and Wildlife modeled statewide lion winter habitat using a resource selection function (RSF) approach which compares where species are present to habitat that is available in the landscape. The winter period is defined as December -February and all lion locations used in our model correspond to those dates. We used 2,470 male and 1,603 female mortality locations documented through mandatory checks from 2000-2013 as our presence sample in the model. We created a list of 18 variables considered important to how lions choose habitat in Colorado (Table C.1). We first calculated Pearson Correlation coefficient <sup>®</sup> for all the variables in program R and removed variables with high correlation to other variables ( $r > 0.65$ ). Between paired variables, the variable kept is the one thought to be most biologically relevant. This resulted in 6 variables chosen for model development which included distance to mule deer winter range, elevation, low vegetation, short shrub, tall shrub, and slope. We standardized these variables (mean=0, SD=1; McAlpine et al. 2008) to directly compare our coefficients for variables measured at different scales. We generated an equal number of random locations (n= 4,100) within lion habitat documented within CPWs species activity maps (<http://gisweb/webmaps/sam/sam.html>) and used these as the “available” sample. Both the presence locations and the available locations were buffered based on the sex of the harvest location. These buffers were 3.2 km diameter to represent mean winter daily movement distances for male lions and 2.0 km for females (K. Logan and M. Alldredge, CPW, personal communication 2015). We used a binomial generalized linear model with a logit link with all 6 variables using the glm package in the program R (Development Core Team 2014). We calculated odds ratios from the resulting coefficients using  $\exp(\beta_i)$ (Table C.2).

Table C.1. Variables originally considered for development of the Colorado winter mountain lion habitat resource selection function model.

| Variable                           | Keep or Remove | Why Removed                         |
|------------------------------------|----------------|-------------------------------------|
| NE aspect                          | Remove         | Correlation with another aspect     |
| SE aspect                          | Remove         | Correlation with another aspect     |
| SW aspect                          | Remove         | Correlation with another aspect     |
| NW aspect                          | Remove         | Correlation with another aspect     |
| Distance to mule deer winter range | Keep           |                                     |
| Distance to elk winter range       | Remove         | Correlation with mule deer dist     |
| Distance to bighorn winter range   | Remove         | No contribution to model            |
| Elevation                          | Keep           |                                     |
| Urban                              | Remove         | Less than 1% of landscape           |
| Suburban                           | Remove         | Less than 1% of landscape           |
| Bare                               | Remove         | Less than 1% of landscape           |
| Low vegetation                     | Keep           |                                     |
| Short shrub                        | Keep           |                                     |
| Tall shrub                         | Keep           |                                     |
| Forest                             | Remove         | Correlated with elevation and TRI   |
| Water                              | Remove         | Less than 1% of landscape           |
| Slope                              | Keep           |                                     |
| TRI (roughness)                    | Remove         | Correlated with slope and elevation |

Table C.2. Mountain lion winter habitat model variables with the corresponding coefficients and odds ratios.

| Model Variable                                  | coefficient | odds ratio |
|---|-------------|------------|
| Elevation                                       | - 0.410     | 0.66       |
| Low vegetation                                  | - 0.476     | 0.62       |
| Short shrub                                     | - 0.147     | 0.86       |
| Tall shrub                                      | 0.273       | 1.31       |
| Distance to mule deer winter range <sup>a</sup> | - 0.500     | 0.61       |
| slope   | 0.338       | 1.40       |

<sup>a</sup> the negative value for distance means that harvest locations are closer to the range; i.e. mountain lion harvest locations are located nearer to mule deer winter range.

The final coefficients were used to create a prediction surface in ArcMap 10.1 (ArcGIS 10.1; Environmental Systems Research Institute, Redlands, CA). We applied the logic equation in the following form to create the relative probability of presence of lions in winter across Colorado:

$$w^*(x_i) = \frac{\exp(B_0 + B_1x_1 + \dots + B_nx_i)}{1 + \exp(B_0 + B_1x_1 + \dots + B_nx_i)}$$

Where observations  $i=1\dots n$ ,  $B_0$  is the mean intercept and  $B_n$  are the estimates for covariates  $x_i$ . The logistic function was used to create a probability of presence surface with values between 0 and 1 across the study area for winter occupancy (1=high, 0=low). The model produced a continuous surface which represented the relative probability of lion presence in winter across Colorado. From a management perspective, the continuous surface output has limited practical value. Therefore, we elected to stratify the prediction surface into 4 categories: strata 1 probability of lion winter presence = 0.01-0.25, strata 2 probability of lion winter presence 0.26-0.50, strata 3 probability 0.51-0.75, strata 4 probability 0.76-1.

In a final step, three independent datasets were used for model validation: 164 winter lion predation sites on mule deer documented through CPW mule deer survival monitoring, 14,793 GPS locations from 33 female and 9 male lions researched on the Uncompahgre Plateau from 2004-2015, and 58,593 GPS locations from 45 female and 32 male lions researched in the Northern Front Range west of Denver-Longmont, CO from 2007-2015. For each validation set, we assigned each validation point to one of the 4 categories of the relative probability surface and determined the percentage of those points that were within the two highest stratas which correspond to > 50% relative probability of presence. We found that 86% of the Uncompahgre GPS locations were within stratas 3 and 4 of our model, 82% of northern Front Range GPS locations were within stratas 3 and 4, and 73% of the deer predation sites were within stratas 3 and 4.

Results from the coefficients indicate that lions are closer to mule deer winter range, at lower elevations, within steeper slopes, and within tall shrub habitats compared to the habitat available. Lion were less likely to be located within low vegetation or short shrub

habitats compared to the habitat available in the landscape. Based on the odds ratios, the most important variable for lions is to be close to mule deer winter range (Table C.2).

The densities derived from this extrapolation process in 12 GMUs in Colorado subjectively representing a range of medium to high winter lion habitat quality mostly ranged from 2.5 to 3.5 lions/100 km<sup>2</sup>; a few were as low as 2.2 lions/100 km<sup>2</sup> and one was 3.8 lions/100 km<sup>2</sup>. The RSF extrapolation density within Uncompahgre Plateau research area was 3.1 lions/100 km<sup>2</sup> which compares reasonably to the maximum estimated density of 3.4 lions/100 km<sup>2</sup> after five years of no hunting and 2.2 to 3.3 lions/100 km<sup>2</sup> (average of 2.7) after 4 years of hunting (Logan and Runge 2018). When averaging across all four applied strata densities in L-19, the DAU-wide extrapolated lion density yielded a mean of 2.7 lions/100 km<sup>2</sup>.