Mountain lion sign survey synopsis 2005 – 2006

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INTRODUCTION

Through radiocollaring efforts in New Mexico over the last 10 years, we have documented that approximately 85% of known cause desert bighorn sheep mortality has been caused by mountain lions (Rominger and Weisenberger 1999, NMDGF 2003). As a result, the New Mexico Department of Game and Fish (NMDGF) contracted with houndsmen and snaremen in October 1999 to remove mountain lions in three desert bighorn sheep ranges (Peloncillos, Hatchets, Ladrones) to reduce predation on bighorn sheep and to help recover this state endangered species. During the first 2 years, October 1999-September 2001, no mountain lions were harvested under this program. Several mountain lions were removed by the hired contractors, but because they were guiding clients NMDGF did not pay for any of these lions. Some initial success occurred during the October 2001-September 2002 year, leading NMDGF to feel that partial control was attained in some of the mountain ranges. This allows for analyses of the effects of this partial mountain lion control on desert bighorn sheep survival in October 2002 - 2006 (Rominger and Goldstein 2006).

In conjunction with the bighorn sheep radiocollaring and mountain lion removal programs, mountain lion sign surveys have been conducted from 1999-2006. These surveys do not attempt to estimate mountain lion population numbers in each mountain range. Rather, they attempt to correlate mountain lion removal in a given year with a reduction in mountain lion sign at the end of that year. At a minimum, the surveys can confirm presence of mountain lions, and at best they can be used as an index to monitor large changes in population numbers. The surveys are unlikely to detect small annual changes (Beier and Cunningham 1996).

METHODS

Using methods similar to Beier and Cunningham (1996), biologists from NMDGF, BLM, and the Turner Endangered Species Fund (TESF) have conducted annual lion sign surveys in 4 mountain ranges to create an index of the effectiveness of lion removal. In the Fra Cristobal Mountains, the management plan for mountain lions has been different from the other ranges, and has been modified several times. All surveys have been conducted annually between 1999 and 2006, primarily in September through December. The exceptions are the 2003 Peloncillos and Ladron surveys, which were partially conducted in April 2004. Mountain lion sign was searched for along 1 km transects located in randomly selected washes and draws. Modifications were made to transects by eliminating transects that were essentially impassable, and adding transects to replace them. Usually there were few stretches of canyon left to choose from to form a new transect due to the small size of the mountain ranges. Transects were not eliminated because of poor substrate because scats and kills can be observed, even if tracks and scrapes might not be possible to detect. In addition, most transects contain poor tracking substrate and there are not enough drainages with good tracking substrate to replace them. Surveys were conducted by trained personnel who walked the transects at speeds $\leq$ 2 km/hr following at least 5 precipitation-free days. In many instances the same individuals have surveyed the same washes each year.

A lion scrape, a continuous set of similar-sized tracks, a lion scat, or a kill site were mapped and recorded as 1 Standardized Unit of Sign (SUS) (Smith 1987). In the absence of data supporting that multiple signs in one transect or consecutive transects came from multiple mountain lions, we pooled all sign in a 1 km transect, and all sign found in consecutive 1 km transects in the same wash, and considered it as a single SUS (Beier and Cunningham 1996). Heel-pad widths of tracks were measured with calipers to potentially differentiate individual lions (Shaw 1979, Smith 1987). Reported difficulties with this technique, particularly in marginal substrate (Grigione et al. 1997), has led us not to extrapolate individual track measurements to estimate the number of individual mountain lions. Multiple lion tracks within a single transect had to differ by $\geq$4mm to be considered an independent SUS. If transects were linked, i.e., not independent, and a similar sized set of lions tracks was recorded in >1 linked transect, these tracks were considered 1 independent SUS. Scats were collected using a minimum of a 29mm bore diameter to separate lion scats from mid-size carnivore scat (Cunningham et al. 1999). Track and non-track sign are reported separately and pooled.

An index of independent mountain lion abundance in each range was calculated as the percentage of transects in which lion sign was present. Additional data to index mountain lion abundance include the number of lions harvested annually in each range the year before and after the sign surveys. These lions are reported as sport harvested lions or lions specifically removed on contract or because of predation on bighorn sheep. An additional index is the number of lion-killed bighorn sheep documented within each of these ranges. Radiocollared bighorn were monitored from the ground, from monthly or semi-monthly fixed-wing flights, and during both autumn and spring helicopter surveys. All radiocollared bighorn sheep mortalities were investigated and mortality reports completed. Lion predation was determined by kill and kill-site characteristics including: presence of lion at kill, a dragline from kill site to cache site, lion tracks at kill site or cache site, lion scat at cache site, canine puncture wounds in neck or face, canine punctures or claw slices in radiocollar, rumen extracted and uneaten or buried, carcass partially or completely buried i.e., rocks, sticks, grass, etc. raked over carcass, broken neck, generally at cervical vertebrae 1 or more rarely 2, rostrum bones eaten back more than 10cm, braincase cracked in ewes (never rams), long bones i.e., humerus and/or femur cracked, lion hair present at kill site or cache site, lion scrapes at or near cache site, hair plucked from carcass, multiple cache sites.

RESULTS

Peloncillos (Tables 1 and 2)

In 2005, 6% of the transects had independent mountain lion sign, and in the year leading up to the survey no mountain lions were removed. In 2006, 3% of the transects had independent mountain lion sign. No mountain lions were removed in the year leading up to the survey. A mountain lion-killed ewe was found under a juniper tree just outside of a transect. The average percentage of transects with lion sign decreased from 21% in years before partial mountain lion control was achieved (1998-99 to 2001-02), to 7% during years after partial mountain lion control was achieved (2002-03 to 2005-06). Mountain lion sign surveys have been conducted by J. Barnitz and E. Rominger in all years.

Hatchet Mountains (Tables 1 and 3)

In 2005, none of the transects had independent mountain lion sign, and 1 mountain lion was removed from the range by contracted snaremen. Surveys were not conducted in 2006, though 6 mountain lions were removed by contract snaremen. Surveys have been conducted by a variety of NMDGF personnel, though E. Goldstein was one of the surveyors from 2001-2005. The average percentage of transects with mountain lion sign decreased from 18% in years before partial mountain lion control was achieved (1998-99 to 2001-02), to 7% during years after partial mountain lion control was achieved in other mountain ranges (2002-03 to 2004-2005), however it was not achieved in the Hatchet Mountains.

Ladron Mountains (Tables 1 and 4)

In 2005, 5% of the transects had independent mountain lion sign, and in the year leading up to the survey, 4 mountain lions were removed under contract from the range. In 2006, 17% of the transects had independent mountain lion sign, and 2 mountain lions were removed. Only 1/3 of the transects were searched for mountain lion sign in 2006. The percentage of sign dropped from an average of 31% before partial mountain lion control was achieved, to 14% after partial mountain lion control was achieved. With 15 mountain lions removed in the 2002-06 seasons combined, the decrease in the percentage of transects with sign may be a result of decreased mountain lion numbers.

Fra Cristobal Mountains (Tables 1 and 6)

In 2005, 25% of the transects had independent mountain lion sign, and in the year leading up to the survey 3 mountain lions were removed from the mountain. Mountain lion sign surveys were not conducted in 2006, though 2 mountain lions were removed from the range. Before partial control was achieved (1998-99 to 2001-02), the average percent mountain lion sign observed was 15%, versus 3% in 2002-03 when partial control was achieved, versus 23% in 2003-2005 when some lion control was in effect, but partial control was no longer in place.

Table 1. Mountain lion sign survey results 2005-2006

Year and Range	# of Transects surveyed	Scrapes	Scat	Kills	Total non-track	Tracks	% Transects w/ independant sign
Peloncillo 2005	34	0	0	0	0	3	6%
Peloncillo 2006 [a]	34	1	0	0	1	0	3%
Hatchets 2005	39	0	0	0	0	0	0%
Ladron 2005	37	0	0	0	0	2	5%
Ladron 2006 [c]	12	0	0	1	1	4	17%
Fras 2005 [b]	36	1	2	2	5	5	25%

a a lion killed ewe was found under a juniper just outside of the route.
b a scat was in the same transect as the scrape.
c a lion killed deer was found in the same transect as one of the tracks.

Table 2. Peloncillo Mountains Oct 1998-Sept 2006.

Year	Total adult lion harvest contract (noncontract)	% Transects w/independent sign	Total # lion killed bighorn (#collared; # uncollared)	Autumn bighorn population
Oct98- Sept99	0	31	4 (4;0)	55
Oct99-Sept00	0	24	1 (0;1)	48
Oct00-Sept01	1	21	6 (6;0)	30
Oct01-Sept02	4 (3)	6	0	25
Oct02-Sept03	4 (2)	12	0	55
Oct03-Sept04	6	7	3 (3;0)	65-75
Oct04-Sept05	0	6	0	60-70
Oct05-Sept06	0	3	0	70-75

Lion harvest and number of lion killed bighorns is measured throughout each time period. Percent transects with independent sign and autumn bighorn population were usually measured in October of the second year of each time period. This allows for an analysis of the impact of mountain lion removal on amount of sign detected, number of lion killed bighorn, and bighorn population size.

Table 3. Hatchet Mountains 1998-2005.

Year	Total adult lion harvest contract (noncontract)	% Transects w/independent sign	Total # lion killed bighorn (#collared; # uncollared)	Autumn bighorn population
Oct98- Sept99	1	17	0 (0;0)	60
Oct99-Sept00	1	37	3 (3;0)	43
Oct00-Sept01	0	11	2 (2;0)	40

Oct01-Sept02	1 (1)	5	2 (1;1)	50
Oct02-Sept03	2 (1)	8	2 (1;1)	35
Oct03-Sept04	0 (2)	13	1 (1;0) (only 4 collars present)	38-47
Oct04-Sept05	1 (3)	0	0 (only 2 collars present)	60-75
Oct05-Sept06	6	N/A	4	100-110

Lion harvest and number of lion killed bighorns is measured throughout each time period. Percent transects with independent sign and autumn bighorn population were usually measured in October of the second year of each time period. This allows for an analysis of the impact of mountain lion removal on amount of sign detected, number of lion killed bighorn, and bighorn population size.

Table 4. Ladron Mountains, 1998-2006.

Year	Total adult lion harvest contract (noncontract)	% Transects w/independent sign	Total # lion killed bighorn (#collared; # uncollared)	Autumn bighorn population
Oct98- Sept99	0	28	2 (2;0)	30
Oct99-Sept00	1	47	1 (1;0)	21
Oct00-Sept01	1	28	2 (2;0)	26
Oct01-Sept02	4	19	2 (1;1)	27
Oct02-Sept03	8 (1)	19	0	30
Oct03-Sept04	0	16	0	25-30
Oct04-Sept05	4	5	0 (only 1 collar present)	25-35
Oct05-Sept06	2	17	0 (only 3 collars present)	25-35

Lion harvest and number of lion killed bighorns is measured throughout each time period. Percent transects with independent sign and autumn bighorn population were usually measured in October of the second year of each time period. This allows for an analysis of the impact of mountain lion removal on amount of sign detected, number of lion killed bighorn, and bighorn population size.

Table 6. Fra Cristobal Mountains, 1998-2005.

Year	Total adult lion harvest contract (noncontract)	% Transects w/independent sign	Total # lion killed bighorn (#collared; # uncollared)	Autumn bighorn population
Oct98- Sept99	2	2	4 (3;1)	53
Oct99-Sept00	1	9	2 (2;0)	55
Oct00-Sept01	1	26	1 (0;1)	66
Oct01-Sept02	2	23	5 (2;3)	75
Oct02-Sept03	5	3	3 (1;2)	58
Oct03-Sept04	3	21	0	55-65
Oct04-Sept05	4	25	1 (1;0)	55-80
Oct05-Sept06	2	N/A	2 (2;0)	70-80

Lion harvest and number of lion killed bighorns is measured throughout each time period. Percent transects with independent sign and autumn bighorn population were usually measured in October of the second year of each time period. This allows for an analysis of the impact of mountain lion removal on amount of sign detected, number of lion killed bighorn, and bighorn population size.

DISCUSSION

Partial mountain lion control was achieved in the Peloncillo and Ladron Mountains starting in October 2002, allowing for a comparison of the percentage of transects with independent mountain lion sign before (October 1998-September 2002) and after (October 2002-September 2006) partial control was achieved. The amount of independent mountain lion sign was 3 times greater in the Peloncillos, and 2.2 times greater in the Ladrones, than during the period of partial control. These results suggest that the survey was able to detect a decrease in the mountain lion population.

In the Hatchet Mountains, the number of mountain lions removed from October 2002 – September 2005 is too small to consider this range partially treated. It is likely that the 9 lions removed in this time frame decreased the total mountain lion population and this might have been reflected in the survey results, especially in the 2005 survey. The percentage of transects with independent mountain lion sign was 2.5 times greater between October 1998 through September 2002, than it was during October 2002-September 2005. Decreased sign in the Hatchet Mountains could be the result of different surveyors, different weather patterns that made sign more difficult to detect, or a reflection of the decreased number of lions in the neighboring Peloncillos (those animals may have included the Hatchets in their home range). Much of the average of 18% transects with independent mountain lion sign between October 1998-September 2002 can be accounted for in the October 99-September 00 survey when 37% of transects had independent sign. If this year is excluded from the average, the average percentage of independent mountain lion sign decreases from 18% to 11%. This illustrates the highly variable nature of the amount of sign seen from year to year, which makes it difficult to conclude if the survey results reflected a changing mountain lion population.

In the Fra Cristobal Mountains, there was a graduate student studying causes of lamb mortality on the range until autumn 2002. Therefore, few lions were removed before this time, but we believe that partial control was achieved by October 2003 after the removal of 5 lions. Partial control was not maintained after this, though the lion removal from October 2003-September 2005 may have afforded some protection for the bighorn sheep during this time period. The number of transects with independent sign was 5 times greater during the period of no control from October 1998-September 2002 than during the period of partial control from October 2002-September 2003. Once partial control was lost, the amount of independent sign detected in the surveys was 7.6 greater than the amount when partial control was achieved, even though it is suspected that the 5 lions removed during the year of control decreased the lion population during the second period of no control. These results suggest that the survey was able to detect some of the changes in the mountain lion population, but it is unclear how well it reflects the change.

The ability of these surveys to detect a real change in mountain lion numbers from one year to the next is limited. Averaging several years together helps account for the variability from year to year, and may provide some insights on trends over a greater period of time. There are many sources of variability in running transects from one year to the next. A minimum of 5 precipitation-free days are required before running the surveys, but the actual number of days varied greatly from year to year. The longer the interval since the last precipitation event, the more sign will accumulate without being washed away. However, presence of high winds (also variable from year to year) may cover tracks, depending on substrate type. Different observers with different levels of experience from year to year are another source of variation in amount of sign observed. Additionally, individual mountain lion behavior may influence results. A lion that remains on the mountain a brief amount of time will leave behind less sign than a lion who travels over the mountain but remains in the area for several weeks. Beier and Cunningham (1996) evaluated the statistical power of mountain lion sign surveys to detect a change in mountain lion densities in a mountain range. They concluded that approximately 30 8-km transects (total of 240 km) should be run to detect a 50% decrease in a mountain lion population with 80% power at $\alpha=0.2$, and about 140 8-km transects (total of 1120 km) should be run to detect a 30% decrease in a mountain lion population with 80% power at $\alpha=0.05$. The mountains surveyed in New Mexico do not have drainages long enough to support one 8-km transect (the vast majority are long enough for only a 1-km transect), and most drainages at least 1 km long had transects placed in them. We believe that the number of mountain lions in each partially treated mountain range decreased by 65-95% compared to the number in each range during non-treated years, which was detected in varying extents in each mountain range.

We believe that it is important to monitor impacts of the mountain lion removal program in desert bighorn sheep range on desert bighorn morality rates, and on mountain lion population trends. Monitoring mountain lion population trends is very challenging given the difficulty in detecting mountain lion presence. Our survey results suggest a change in the percent of mountain lion sign detected may coincide with a change in the mountain lion population in some years, but the relationship between the percent change in mountain lion sign detected and the change in the size of the mountain lion population is unclear. At a minimum, from the surveys we can conclude that intensive mountain lion removal does not result in extirpation of mountain lions from the treatment area. It takes a minimum of 7 days per mountain range to complete the mountain lion sign survey each year, or 28 days per year, which is a large effort to accrue the information. Bighorn sheep monitors and mountain lion snaremen and houndsmen employed in these mountain ranges spend many hours a month year-round looking for mountain lion sign. Based on the amount of sign they see, they are able to offer a rough number, and an index from season to season, of mountain lions in these ranges. We believe that this measurement, while subjective, provides a better measure of the change in mountain lion numbers over time than the survey. They are able to track changes year round, as opposed to the survey which reflects conditions at one point in time. In conclusion, the large amount of time spent on the mountain lion sign surveys provides a small amount of information about mountain lion trends. The information gathered by bighorn sheep monitors and mountain lion snaremen and houndsmen during the course of their daily work provides a more useful index of mountain lion numbers. We suggest that the time spent conducting the mountain lion sign surveys would be better spent on other management activities.

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