

Units 20C, 42, 44A and 44B Adaptive Lion Management Plan



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APPROVED:

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Introduction

This Adaptive Lion Management Plan has been developed to address mountain lion management within the northern area of Region IV. Our objective is to manage lions in concert with the maintenance and reestablishment of multiple historic bighorn sheep herds within the project area. As such, this plan incorporates the ecological role lions play by collecting basic lion demographic data related to population dynamics, home range sizes, genetic relatedness, movement corridors, prey species selection and prey species population dynamics to be used in management decisions. Lions within the plan area are a small segment of a larger lion population that occupies relatively contiguous habitat in the western U.S to Central America.

This plan follows the spirit and guidance of the Arizona Game and Fish Commission contained within the Predation Management Policy, Species Management Guidelines, Hunt Guidelines and the Arizona Game and Fish Department (AZGFD) Predator Management Team Report.

Specifically, the Arizona Game and Fish Commission Predation Management Policy states:

“Actions by the Arizona Game and Fish Department (department) should be based on the best available scientific information. Mountain lions and coyotes will be managed to ensure their future ecological, intrinsic, scientific, educational, and recreational values, to minimize conflict with humans, and to minimize adverse impacts on other wildlife populations.

The department will develop site-specific management plans when either of these two species is considered to be inhibiting the ability of the Department to attain management goals and objectives for other wildlife species.”

Furthermore, the AZGFD Predator Management Team Report states that; “Predators and their prey cannot be managed separately” and that “as a Department we must strive to develop the biological and social data necessary to manage predators with a program that is biologically sound and publicly acceptable.”

This plan has been reviewed and commented on by all applicable Department work units.

Adaptive Management

Recent development and approval of Department Policy II.6, *Adaptive Management Practices; Approval of Management Plans*, offers new opportunities to use research tools and approaches to expand the knowledge base relative to predator/prey relationships of mountain lions and desert bighorn sheep in and around the management area. As part of an Adaptive Management process, managers will continually evaluate data/results from field work to identify areas where different or additional data is needed and where new or different management actions are warranted based on results. An annual progress report will be completed to compile/interpret results to date and how any changes to management practices have been justified and executed to meet plan objectives. Examples of management/plan changes would be;

- As additional bighorn sheep habitat scoring in relation to bighorn population data becomes available, herd management area population objectives for bighorn sheep may be adjusted.
- Based on bighorn sheep population changes or characteristics of lion predation patterns, lion removal criteria may be adjusted.

- If changes in the quality of bighorn population data are warranted, the frequency of population surveys may be increased or decreased.
- If funding becomes available additional research into bighorn sheep mortality factors may be conducted to more fully understand potentially additive and/or compensating mortality effects.
- Complete additional habitat improvements for bighorn sheep such as constructing planned water developments to investigate their contribution to herd dynamics.

Following the policy guidance, managers will enhance efforts to monitor bighorn sheep and mountain lion populations in this broader geographic area, to better understand this relationship in a biologically meaningful geographic context by continually testing assumptions and answering questions. Having a better understanding of lion population dynamics in this larger landscape is a critical component of effective management of mountain lions and bighorn sheep in the plan area.

Area Description

The project area consists of Game Management Units (GMU) 20C, 42 (Region 4 portion), 44A and 44B, in the Yuma Region of the AZGFD (Appendix 1). The project area covers approximately 12,950 km² in the Basin and Range province of southwestern Arizona and corresponds to the lion hunt structure contained within Commission Order 10. Topography is generally composed of vertical cliff faces, rugged canyons, boulder-strewn terrain, rolling hills, and broad alluvial valleys. Elevations range from less than 122 m asl on the Colorado River at Parker to approximately 2004 m asl on Weaver Peak in the Weaver Mountains. The predominant vegetation type ranges from lower Sonoran Desert Scrub to Chaparral and Pinyon/Juniper woodland on the highest peaks. The majority of the area under consideration falls within the boundaries of the Bureau of Land Management, Phoenix, Lake Havasu and Yuma Field Offices.

Palmer Drought Severity Index (PDSI) values for Arizona climatic divisions 5 and 6 (Appendix 2), indicate multiple severe drought periods since 1993. Since 1993 the project area had PDSI values below normal 72% of the time. During this period, extreme drought conditions, (PDSI < -2), have occurred in Division 5, 47% of the time and in Division 6, 54% of the time. This 17-year period dominated by drought has likely had a negative impact on plant communities, water distribution, and animal populations.

Statement of Need

As directed by the policies quoted above as well as standard wildlife management approaches, wildlife populations need to be managed in balance with their environment. This environment includes habitat as well as other wildlife populations, and in the case of predators such as the mountain lion, in balance with their prey populations. Maintaining this balance through active management is often required in order to mitigate long term impacts of human activity such as development and road/canal construction that fragments habitat and permanently disrupts natural processes (such as extirpation followed by re-colonization). Managers must consider these dynamics and make decisions that simultaneously manage lion populations for their intrinsic and ecological value while also ensuring sustainability of the prey populations.

This plan goes into detail to outline the management approach for lions as they affect sheep populations, but data gathered will also allow managers to investigate the relationship between lions and other prey species. What is learned about lion behavior will inform decisions for a number of species, and data will be analyzed comprehensively along with information and data related to these other species. Knowledge gained from implementation of the Kofa Adaptive Lion Management Plan

indicates there can be significant differences in prey selection between individual lions. The Kofa results have also shed light on home range size among other parameters for desert lions that were not well understood prior to its implementation. Under an adaptive approach, future iterations of this plan may shift focus to the relationship between other species and guide collection of different data and the consideration of different management decisions based on what is learned about lions and their prey within the management area. Current knowledge of wildlife populations in the area dictate that management decisions regarding lions within the management area are driven by the relationship with and impacts to relatively discreet bighorn sheep populations.

The AZGFD generally conducts bighorn sheep surveys on a rotational basis every 3 years. Sheep population estimates are calculated based on the Kofa Group Size Estimator methodology (Hervert et al., 1998) (Appendix 3). For purposes of this Adaptive Management Plan the project area has been divided into relatively discrete bighorn sheep Herd Management Areas (HMAs) that have minimal animal interchange between them (Appendix 4). Sheep population trends within the project area can be characterized as variable (Plomosa) to declining (Harcuvar) (Appendices 5 and 6).

Of the 6 bighorn sheep Herd Management Areas within the project area, 5 are primarily the result of translocations beginning in 1986. Federal Aid Project reports are completed annually for each translocation effort. In addition, Final Translocation Reports were written after 3 years for each translocation effort that document results of monitoring collared bighorn sheep, population surveys, animal mortality investigations and other factors deemed important to evaluate the success of the translocation project.

Based on the quantity and quality of habitat (Cunningham/Hansen, Modified Bighorn Habitat Scoring Model 1989), (Appendices 8-14), growth of these translocated populations has been significantly less than expected, even taking drought conditions into account. The presence of lions has been documented in all HMAs with the exception of the Plomosa HMA. The 5 translocated populations had a total of 141 bighorn fitted with 3-4 year duration radio telemetry collars. Of the 141 collared animals 75 died before the collar batteries failed. Of these 75 mortalities the causes were as follows; 43 (57%) mountain lions, 20 (27%) unknown, 5 (7%) capture related, 4 (5%) disease, 2 (3%) accidents, 1 (<1%) not recovered. This rate of loss to lion predation has likely caused significant additive mortality to collared sheep in the Black, Harcuvar, Harquahala and Bighorn HMAs (Appendix 7).

Background

The following are summaries of management actions, habitat scoring (Table 1), and lion occurrence and lion predation effects on sheep populations in each HMA:

Table 1. Bighorn Sheep Habitat Quality Scoring Areas for HMAs and Comparison Population.

HMA	BIGHORN SHEEP HABITAT QUALITY AREA				
	EXCELLENT	GOOD	FAIR	POOR	TOTAL
BUCKSKIN	0	158 km ²	321.2 km ²	88.4 km ²	567.6 km ²
BLACK	0	27.2 km ²	103.2 km ²	23.6 km ²	154 km ²

BIGHORN	20 km ²	100.4 km ²	245.2 km ²	47.6 km ²	413.2 km ²
HARQUAHALA	0	78.4 km ²	183.2 km ²	103.6 km ²	365.2 km ²
HARCUVAR	8 km ²	212.8 km ²	193.2 km ²	17.6 km ²	431.6 km ²
PLOMOSA	0	52 km ²	30.4 km ²	40.8 km ²	123.2 km ²
SADDLE	3.3 km ²	12 km ²	15.7 km ²	.2 km ²	31.2 km ²

Buckskin HMA (Appendix 8)

Historical information indicates this bighorn herd was essentially extirpated by the early 1980's. A comprehensive examination of this herd with recommended management actions (Remington 1980) attributed the primary cause of decline to the construction and subsequent paving of SR 95. This roadway is thought to have isolated this sheep herd from their primary source of water in the Colorado River. In addition, the human disturbance associated with the road construction and development along the Colorado River is assumed to have had additional negative impacts.

Based on management recommendations, 7 alternative water sources were constructed and 2 translocations totaling 22 bighorn (16 with radio collars) were completed. Population estimates from helicopter surveys, (Appendix 5) have been variable. Recent camera trap sampling at water sites during the summer has been promising as an alternative for aerial surveys to estimating the mature ram segment of the population.

Of the 16 collared animals, 1 instance of mortality from lion predation was documented. Reliable lion sightings and sign have been restricted to Planet Peak and the northern portion of the Buckskin Mesa adjacent to the Bill Williams River. Because there have been no collared sheep in this population since about 1989 there is little evidence that lion caused mortality has been a significant factor in limiting expansion of this population. Camera trap data from 6 of 7 water sites in late June – early July in 2009 and 2010 did not document any use by lions. Recent camera trap data (Conrad 2010) indicate that only one ewe is present on Planet Peak.

Black HMA (Appendix 9)

Very little historical bighorn herd information is available for this area. A translocation of 25 animals was completed in 1985. No water developments were constructed as it was assessed there were adequate natural perennial water sources in good sheep habitat. Subsequent monitoring indicated 3 of 8 collared sheep were mountain lion caused mortalities. No aerial surveys were initiated until ground observations in 1995 indicated that sheep were persisting in the Black Mountains. A partial helicopter survey in 1995 revealed that sheep were indeed persisting at least in the southern portion of this mountain range. A complete survey in 2002 indicated that sheep were present throughout the mountain range at relatively low densities (Appendix 5). This area is adjacent to higher elevation areas of central Arizona that are characterized by relatively high lion densities and therefore lions occur throughout this area and sign is commonly seen. Camera trap data from (Conrad 2010) monitored one water (#721) and documented the presence of lions.

Bighorn HMA (Appendix 10)

Historical surveys and information indicate a viable sheep herd in this area until about 1980. Causes of the decline are unknown but since an active public lands domestic sheep allotment overlapped this area in the past disease could have been the cause. An existing tinaja (Arch Tank) was enlarged and has been maintained as a perennial water source since 2005. Two water catchments designed to serve both sheep and deer were placed near the base of the mountain range as mitigation for construction of the Central Arizona Project (CAP) and are used by the translocated sheep. In addition, temporary water designed to serve only bighorn sheep was installed along CAP at Burnt Mountain and is receiving significant sheep use. Two additional planned water developments are identified in the sheep translocation proposal. Translocations were conducted in 2005 (26 sheep) and 2007 (12 sheep). Bighorn sheep population estimates based on partial surveys of the habitat have been variable, 2007 = 40, 2008 = 49, 2009 = 23 (Appendix 5).

Lion observations are common and lion sign is relatively common as well throughout this HMA. Research conducted by (Peirce 1993) documented the presence of lions in this area based on 4 collared lions. To date, of the total collared sheep mortalities, (16) 56% are from lion predation (Appendix 7). A female lion originally collared in the White Tank Mountains (8/08) moved into the Bighorn HMA in late 2008. This female has a spread spectrum collar from which locations are periodically downloaded. Data indicated this female spent most of her time in the Bighorn HMA but also ranges into the Harquahala HMA and into the Vulture and White Tank Mountains until the collar signal was lost in 8/09. Field checks of potential kill sites associated with this female in areas that are known to contain bighorn sheep were completed but no bighorn kills were documented.

Harquahala HMA (Appendix 11)

This herd supported hunting until 1982 when the population decline could no longer justify a sheep permit. A supplemental translocation of 25 sheep in 2000 was conducted to augment the remaining remnant population in the Harquahala Mountains. Of the 25 sheep translocated in 2000, 13 were radio collared. During the course of monitoring 9 mortalities of collared sheep were documented and of those, 8 were caused by lion predation (Appendix 5). Hunting resumed in this population as part of a larger hunt unit in 2007. A total of 1 hunt tag has been issued each of the 3 years and in 2 of 3 years the ram taken was from this HMA. Three bighorn specific water developments provide perennial water and camera trap data at these waters indicates they receive significant use by sheep. Lion observations are common and lion sign is relatively common as well throughout the HMA. Camera trap data (Conrad 2009) from 2 sheep waters in 2009 did not document lion presence and data from 1 of 3 waters in (Conrad 2010) confirmed the presence of lions. Of note, the mule deer herd has undergone a 95% decline in the Harquahala Mountains since 1995. Lion movement between this area and the Bighorn and Harcuvar HMAs was documented by Peirce 1993, as well as a recently collared female lion from the Bighorn HMA that was present in Oct. and Nov. of 2009.

Harcuvar HMA (Appendix 12)

A remnant population of bighorn was documented as recently as 1987, supplemental translocations occurred in 1994 (30), 1995 (26), 1998 (30), and 2001 (25), in order to reestablish a viable population. As part of the sheep herd recovery effort, 3 waters were constructed and 2 more are planned. Population estimates from helicopter surveys, (Appendix 6) are conservative since not all sheep habitat has been surveyed. Public and Dept. observations indicate that sheep have spread to the eastern extent of the herd area into habitat that has not been surveyed. Of the 111 sheep released, 72 were fitted with telemetry collars with 3-year batteries. Of the 72 collared sheep, 48 were recovered as mortalities of which, 23 (48%) were caused by mountain lion. The occurrence of lion sign throughout the herd area is common

and observations of lions within the herd area are common. Camera trap data from June/July of 2010 (Conrad 2010) documented the presence of lions at 5 of 7 potential sheep waters monitored.

Plomosa HMA (Appendix 13)

Although this population has fluctuated based on drought conditions and translocation removal over the years, (Appendix 6) it has remained robust and has provided 77 sheep since 1987 for translocation to other areas. A total of 6 perennial water developments have been in place since at least 1990. Population estimates range from 212 in 1994 to a low of 105 in 2007, (Appendix 6). Lion occurrence either through sign or observations has not been documented in this HMA. For many years the Dept. has received unsubstantiated public reports of lions around the periphery of this herd area in the valley bottoms. Camera trap data collected in June/July 2010 from 2 of 6 waters did not document lion presence.

Game Management Unit 20C and Non-HMA Areas

Unit 20C and portions of Units 42 outside the Bighorn HMA contain historical bighorn sheep habitat that is either too small in size to support a viable population (Vulture Mtns.) or is ranked (Lee 1999) as having a relatively low prospect of supporting a viable population (North Date Creek, South Date Creek and Weaver Mtns.). Generally, higher elevations and relatively dense deer, javelina and lion populations characterize this portion of the project area.

Management Goals, Strategies and Actions

The primary goals of this Adaptive Management Plan are to aid in the reestablishment of the above-mentioned translocated bighorn sheep populations and conservation of the donor population in the Plomosa HMA as well as enhancing our understanding of desert mountain lion ecology, use of intermountain movement corridors by lions, genetic relatedness of lions, prey species selection and frequency.

Although we are somewhat uncertain as to the primary cause of initial declines in bighorn sheep numbers, the presence of lions has the potential to further depress or inhibit recovery/reestablishment of a sheep herd that is already depressed. Research indicates that mountain lion predation can have significant population-level effects on bighorn sheep (Hoban 1990, Wehausen 1996, Creeden and Graham 1997, Ross et al. 1997, Rubin et al. 2002, Hayes et al. 2000, Sawyer and Lindzey 2002). Variables influencing mountain lion predation might include relative availability of alternate prey and escape terrain, vulnerability of individual prey, weather, and behavior of individual predators (Leopold and Krausman 1986, Ross et al. 1997, Krausman et al. 1999, Ballard et al. 2001). For example, impeded recovery of depressed bighorn sheep populations in the Peninsular and Sierra Nevada, which are currently listed as endangered by the USFWS, have been attributed, at least in part, to mountain lion depredation (Hayes et al. 2000, Wehausen 1996). Because a single mountain lion may kill, on average, one big game animal per week (Anderson and Lindzey 2003), even a small number of lions can inhibit the recovery of a sheep herd. Lions have the potential to not only take most recruitment but significant portions of the adult breeding population as well.

We conclude that any amount of predation on bighorn sheep by lions in the above mentioned populations is likely significant and represents additive mortality in these HMAs that have already been impacted by drought. Removal of individual lions known to be killing sheep will aid the recovery of these bighorn sheep populations. Removal of individual lions will be based on how many sheep each lion kills in a year and at what level the bighorn herd population estimate is relative to the HMA herd objectives (Table 2). The one-year time limit will begin when a lion kills its first sheep in a HMA. Lion removal will be accomplished lethally.

Predator control is most effective when problem individuals can be identified and removed (Sawyer and Lindzey 2002, Ernest et al. 2002). There is evidence that some mountain lions in bighorn sheep habitat may kill multiple sheep within a year, some may kill only one sheep within a year, and some may kill no sheep at all (Ernest et al. 2002). As we begin collaring lions, comparison data from tracks and camera work should provide us with increasingly refined lion population estimates for the project area thus allowing us to determine when a significant percentage of the lions within the proposal area have been collared. Once a significant number of lions have been collared, the investigation of kill sites can provide the necessary data for selective lion management. Tracking individual lions and their kills will allow for the removal of lions that are regularly preying on bighorn sheep as opposed to a less-discriminate landscape removal of lions. Lion removal will be accompanied by regular monitoring of bighorn sheep with surveys and/or collared sheep survival to determine if lion management is achieving the desired objectives.

A variety of methods will be used to gather data on mountain lions. Remote cameras, tracks, scat DNA analysis and collared individuals will be used to monitor lions throughout the area, allowing managers to generate a minimum estimate of the lion population size and to determine use patterns. This data will also allow managers to adapt their focus and efforts based on current lion activity. Snares will be used in the management area to capture lions that will be fitted with GPS tracking collars. In addition, project collared lions or collared lions (collared during other adjacent projects) entering the project area may be re-collared with active gps collars using either hounds or helicopter based capture personnel. The collaring and tracking effort will provide data on lion condition and real-time use patterns. The tracking data will also allow managers to locate and identify lion kills which will be recorded on a standardized kill site form (Appendix 15) to inform management decisions about whether a lion should be removed. Genetic analysis of collected lion scats has proven to be an effective technique for determining how many individual lions are using the Kofa area (Naidu 2009). The long-term collection of this data will allow managers to compare lion data to population and mortality data being collected on the sheep population, and assess the effectiveness of management efforts, management techniques, and the management plan itself. This approach is considered an adaptive management approach, and complies with the Department's Adaptive Management Policy (DOM 11.6).

Bighorn sheep population objectives were determined by scoring each HMA's habitat using 5 criteria as identified in (Cunningham 1989, Appendix 13) and comparing them to populations with similar habitat characteristics and relatively stable robust populations. This comparison of stable/robust sheep populations and their associated habitat scoring indicate that densities for the 4 categories of habitat quality display the following range, **excellent** 2 - 1.2 sheep/ km², **good** 1.5 - .8 sheep/ km², **fair** 1.2 - .4 sheep/ km², **poor** .8 - .2 sheep/ km². Because we are uncertain about our ability to accurately score bighorn habitat as well as the range in densities displayed in the comparison populations we decided to use population objectives for each HMA from the lower end of the density range (Table 2). Keeping in the spirit of an adaptive management plan, as we score more habitats that we feel are comparable and for which we have a history of reliable bighorn population estimates and we develop improved habitat scoring techniques we may adjust HMA population objectives accordingly.

Ballard et al. (2001) found several factors common in case studies that dictated when coyote reductions were effective and prey populations increased. These factors may provide guidance with predation by lions and included:

- Coyote control is implemented when the prey populations are below habitat carrying capacity
- Predation is identified as a limiting factor
- Control efforts reduce coyote populations enough to yield results (e.g. expected to be approximately 70% of a local coyote population.)
- Control efforts are timed to be most effective (just prior to predators or prey reproduction)
- Control takes place at a focused scale (generally <400 mi²).

We believe most of these criteria can be met in the HMAs. The best population estimate for the project area is between 5 - 12 lions. This estimate is based on discussions with local mountain lion experts, informal surveys and waterhole cameras. With an estimated minimum population of 5 - 12 mountain lions and a 70% removal rate, it will be necessary to remove 3 to 8 offending lions initially to potentially yield results if lion predation follows a similar model as coyotes according to Ballard (2001).

Table 2. Lion Removal Decision Matrix

HMA	HMA Population Objective/Lion Removal Decision Points		
	Lion removed for 1 sheep mortality in HMA within a year	Lion removed for 2 sheep mortalities in HMA within a year	Standard Statewide Lion Management Guidelines
BUCKSKIN	< 204	204 - 272	> 272
BLACK	< 53	53 - 71	> 71
BIGHORN	< 159	159 - 212	> 212
HARQUAHALA	< 118	118 - 157	> 157
HARCUVAR	< 196	196 - 261	> 261
PLOMOSA	< 113	113 - 151	> 151
UNITS 20C & 42(Outside HMA)	Lion Management Based On Standard Statewide Hunt Guidelines		

In addition to selective lion removal there are several other actions that may be used to reduce mountain lion numbers within the project area. A single lion bag limit for sport hunters has already been authorized for the entire project area except the southern portion of the GMU 42 (Bighorn HMA) which has a multiple bag limit of 2 lions and the eastern portion of GMU 44A (Harcuvar, Harquahala and Black HMAs) which has a multiple bag limit of 4 lions. Only recently have any of the multiple bag limit regulations met the intended objective (44A, 2010) and allowed harvest in excess of what normal guidelines would have allowed. While this strategy has potential, its effectiveness has not been consistently demonstrated. Management actions that can be used in this situation may be limited because of legal constraints. Restrictions listed in Arizona Revised Statutes (A.R.S.) 17-301, preclude the Department from the use of leg-hold snares on public lands other than for research or relocation purposes (this adaptive management plan will qualify for the exemption). Live traps (box traps) have shown some success and are being investigated for possible use. Our experience with live traps

concludes that they are much more inefficient to use than leg hold snares. As new information or a source of traps becomes available, this method will continue to be evaluated further. Pursuing lions with hounds has also been tried extensively with very limited success in these lower elevation deserts. We intend to continue to use hounds on a case-by-case basis when circumstances favor this technique. Another measure that could be used to remove mountain lions is shooting over predator calls. Hunting over predator calls has been used on a relatively limited basis and has proved to be rarely successful. To date only leg hold devices have proven consistently effective for capturing lions in desert habitats.

The Region and Department has conducted the following management actions:

- Directed sport hunters to the single harvest and multiple harvest objective areas.
- Region IV Staff and lion expert surveyed certain areas for lion sign.
- Maintained water developments.
- Re-collar lions moving into proposal area
- Springtime surveys to monitor lamb survival and population status.
- Responded to questions from the public

In addition, the following actions are being considered.

- Discussion and possible continuation of research opportunities regarding lion/sheep interaction, and other development impacts to the bighorn sheep population.
- Radio marking and monitoring of bighorn sheep and mountain lions
- Complete construction of planned bighorn sheep water developments
- Document, maintain and enhance movement corridors within the project area for both bighorn and lions.

Intensity and Duration of the Actions

Predator control targeted at offending mountain lions will continue until a sheep population (HMA) reaches objectives, or until predation no longer limits bighorn sheep population growth. It is difficult to predict how long it will take to meet removal objectives. The population targets for the bighorn sheep populations discussed above have been established to function as triggers for completion of this project. However, if lion depredation on bighorn sheep continues to be observed or documented in the project area, the use of contract services to remove additional offending lions or lions in areas where lions are known to be killing bighorn sheep may be used as an experimental approach and evaluated as to its efficacy in reaching project objectives. If at some future point direct removal using a contractor is implemented a Predation Management Plan will be completed if required by DOM A2.31.

Measurable Objectives

Measurable objectives include meeting HMA sheep population objectives within the project area (Table 2) and collaring a significant portion of the lion population in the project area. Monitoring of these objectives will be accomplished through sheep surveys conducted in the fall on a rotational basis (3 year interval) to monitor population parameters and by continuing the use of mandatory lion hunter checkout along with lion field work previously described that allows an approximation of the lion population.

Implementation

Funding for this project was secured through a Big Game Tag Fund proposal during the 2009 cycle and received the chargeable index code of 84264. Index code budget status is as follows;

<u>Approved Proposal Funding</u>	\$27,800.00
<u>Purchases</u>	
(3) Northstar GPS radio collars w/ VHF transmitters.....	\$8,250.00
Collar activation fee.....	\$75.00
(4) Trap alarms (GPS).....	\$6,800.00
Trap alarm activation fee.....	\$75.00
(3) VHF digital receivers.....	\$3,000.00
<u>Remaining Funds</u>	\$9,600

Remaining funds are intended for additional collars, refurbishing existing collars and miscellaneous supplies associated with capture packs such as medical supplies, capture drugs and snare parts.

Manpower needs for implementing this project will rely on Region 4 staff as well as volunteers. We intend to extensively use volunteers from cooperating organizations such as the Arizona Desert Bighorn Sheep Society (ADBSS) as well as former Dept. employees. In particular, volunteers will be helpful in checking snares during capture efforts as well as documenting the characteristics associated with lion kill sites. Employee time estimates per fiscal year are as follows:

Snaring efforts.....	40 man days/year
Lion kill site inspections.....	30 man days/year
Data management and report writing and project administration.....	50 man days/year

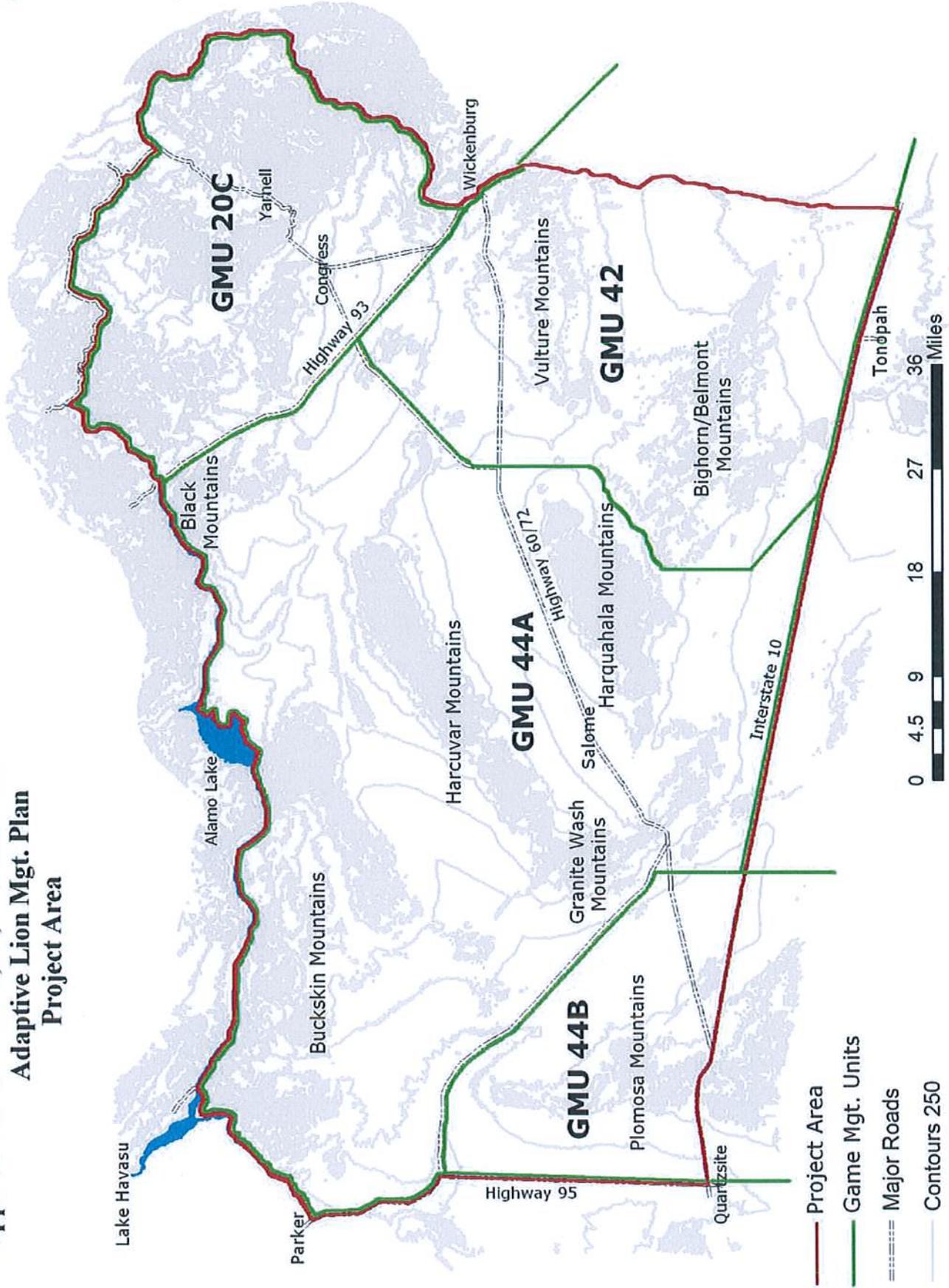
Outreach Plan

Routine public information coordination for this plan will include the Public Information Officers (PIOs) of Region IV, the Information & Education Division (IED) of the AZGFD in Phoenix, the Yuma, Lake Havasu and Phoenix Field Offices of the Bureau of Land Management (BLM).

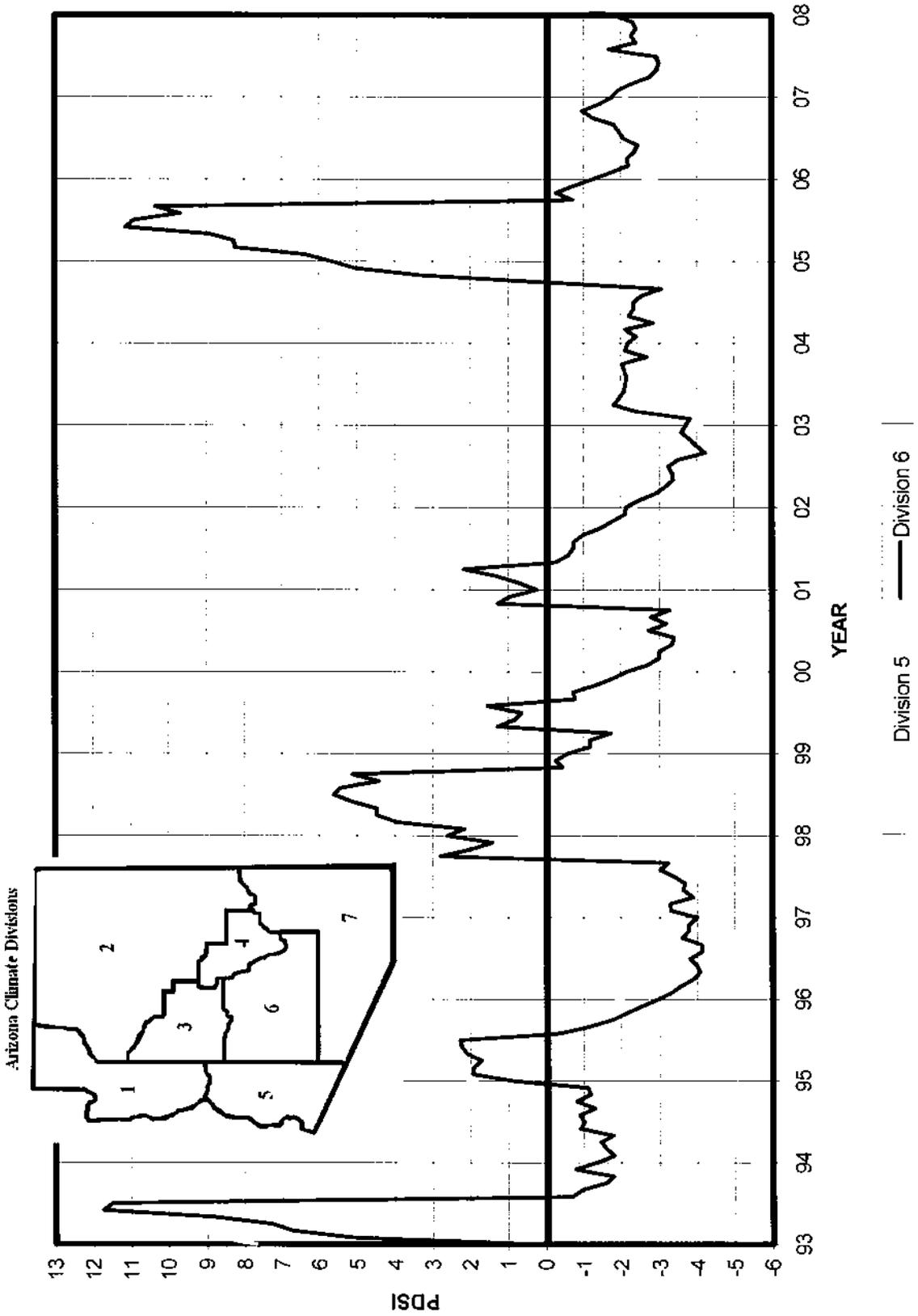
- Upon approval, a jointly coordinated news posting to the AZGFD website as well as a posting of the plan itself to the website will be coordinated through the Region IV PIO.
- A talking point paper for use by AZGFD customer service front counter staff should be prepared. The purpose of the paper will be to equip front counter staffs to answer the bulk of routine customer questions about the plan. .
- Based on the perceived level of interest following the website posting a public meeting to present the plan may be held at the Region IV office in Yuma. The date for this meeting should be noted in a subsequent press release and on the website posting.
- The Department will consider all requests from the public for presentations on the plan. Such requests should be considered likely.
- Given the somewhat emotional nature of the reaction to predator management in the southwest, we should expect follow-up media interest for some months (or years) following the initial launch of the plan. To the extent this is driven by individuals or organizations opposed to predator management, we should expect the initial tone of such media queries to be negative.
- Absent contrary guidance from IED, any media queries on the plan received by AZGFD should be forwarded to the Region IV PIO or designated acting.
- We should seek opportunities to periodically publicly highlight progress in the execution of this plan through press releases, media field visits, and other appropriate information venues.

- For specific events where public notification is required or recommended, only those agencies directly affected will be required coordination contacts for information release.

**Appendix 1. GMU 20C, 42, 44A and 44B
Adaptive Lion Mgt. Plan
Project Area**



Appendix 2. PDSI 1993 - 2008 Climate Divisions 5 and 6



Appendix 3. Kofa Group Size Estimator Model used to determine bighorn sheep population numbers and harvest permit numbers.

The goal of the survey program for bighorn sheep is to obtain absolute size estimates for all populations in the Region. The number of hunting permits issued is based on the actual number of mature males in the population. Estimates previously were calculated using a simultaneous double count estimator as described by Graham and Bell (JWM:1989 54(4):1009-1016). Region IV completed a study entitled "Sighting Rates of Bighorn Sheep during Helicopter Surveys on the Kofa National Wildlife Refuge" (Arizona Game Investigations 1996-97). From this study department personnel derived a new estimator to calculate bighorn population estimates. It uses different observation rates (to correct for visibility bias) for different group sizes of surveyed sheep. It tends to be somewhat more conservative than our earlier estimation procedure.

Regional biologists and wildlife managers conduct surveys using a methodology developed to ensure a systematic approach to estimating populations of bighorn sheep. The same method is applied to all of the Region's bighorn populations. The use of this method minimizes survey effort and produces estimates of bighorn numbers and sex-age ratios. Because of budget and time constraints, surveys are conducted only once every three years.

Surveys will be conducted using the sampling methodology outlined in "Surveying Bighorn Sheep" (Remington and Welsh 1993, in The Desert Bighorn Sheep in Arizona, edited by R.Lee). Helicopters will be used to do complete surveys of selected sample blocks.

Permit recommendation should be based on the calculation worksheet. Fill it out as follows:

1. Fill in the table using the survey numbers for the past 3 years. In most cases there will have been only 1 survey during that time. If the whole area was not surveyed, then extrapolate the survey numbers to the whole area before putting them in the table (only do this extrapolation if a substantial portion of known occupied habitat was not surveyed).
2. Calculate means for the past 3 years (not past 3 surveys).
3. Calculate a population estimate using the "Kofa Group Size Estimator". The formula for this is:

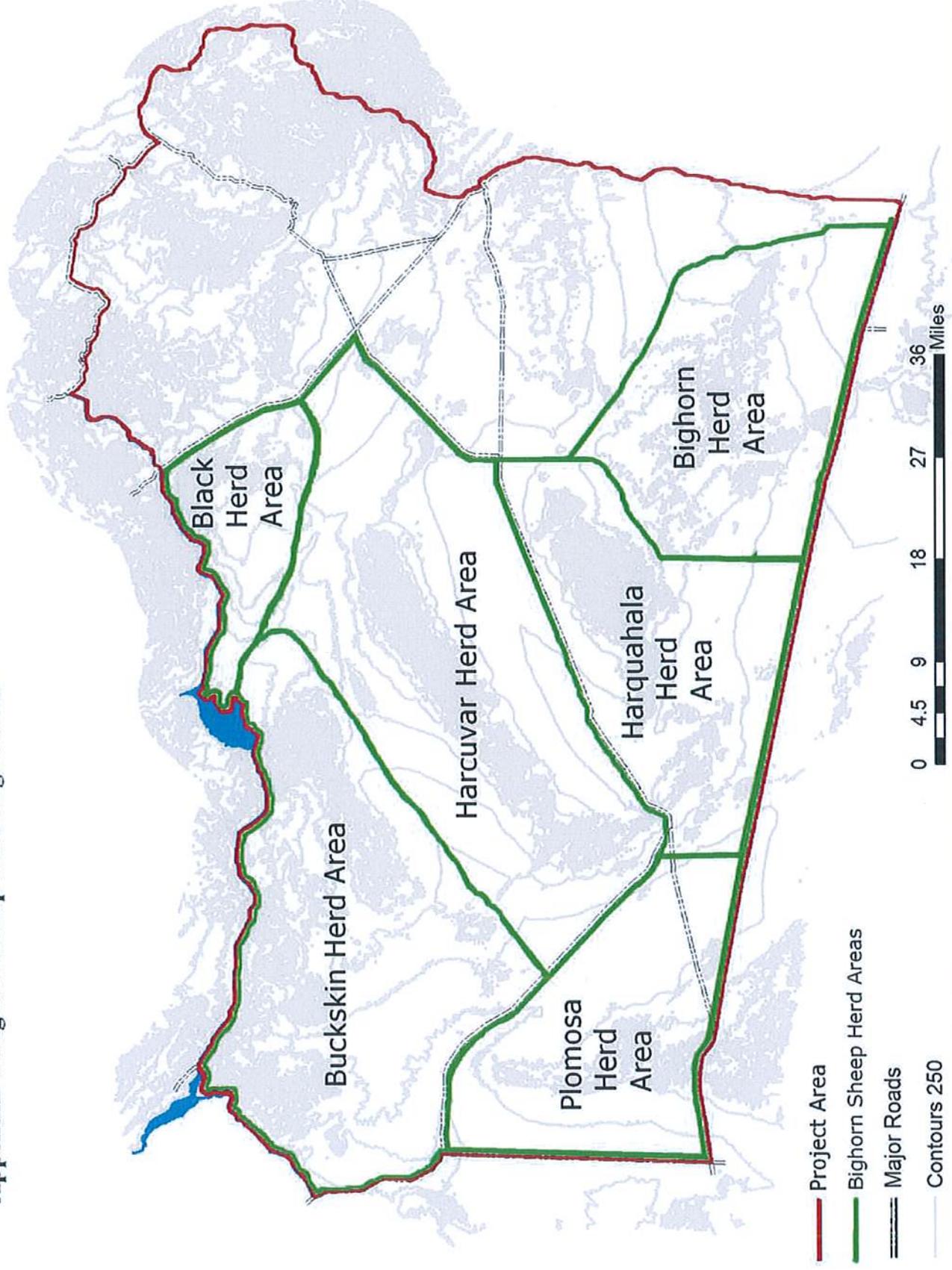
$$\text{Total Pop.} = (\text{Number of groups of size } 1/0.433 \times 1) + (\text{groups of size } 2/0.507 \times 2) + (\text{gps of } 3/0.581 \times 3) + (\text{gps of } 4/0.654 \times 4) + (\text{gps of } 5/0.728 \times 5) + (\text{gps. of } 6/0.802 \times 6) + (\text{gps of } 7/0.875 \times 7) + \dots(\text{gps of } n/0.949 \times n)$$

This gives a total population estimate. Use the ratios of the different classes of sheep in the survey data to calculate the portion of the total population for each of the sheep classes.

4. Calculate permit numbers. The permit recommendation should be based on 20% of estimated class 3 and 4 rams. We generally do not round the permit number up unless we have reason to (such as a large cohort of class 2 rams).

Use the "Management Recommendations & Notes" page to describe the surveys, the methodologies used, and anything else that may be relevant to your permit recommendation.

Appendix 4. Bighorn Sheep Herd Mgt. Areas

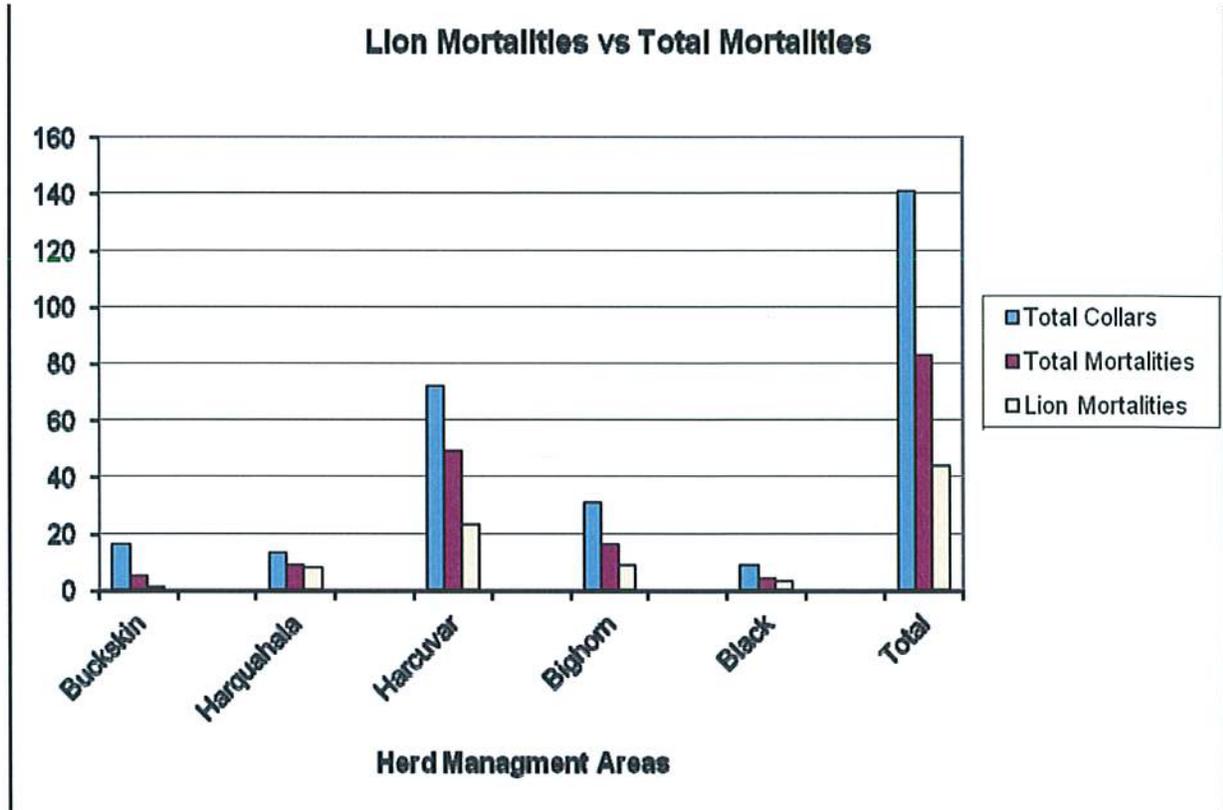


Appendix 5. GMU 42, 44A and 44B bighorn population estimates for 1985 through 2007. Arizona Game and Fish Department, Region IV, Yuma. (+ indicate translocation). (- indicate removal)

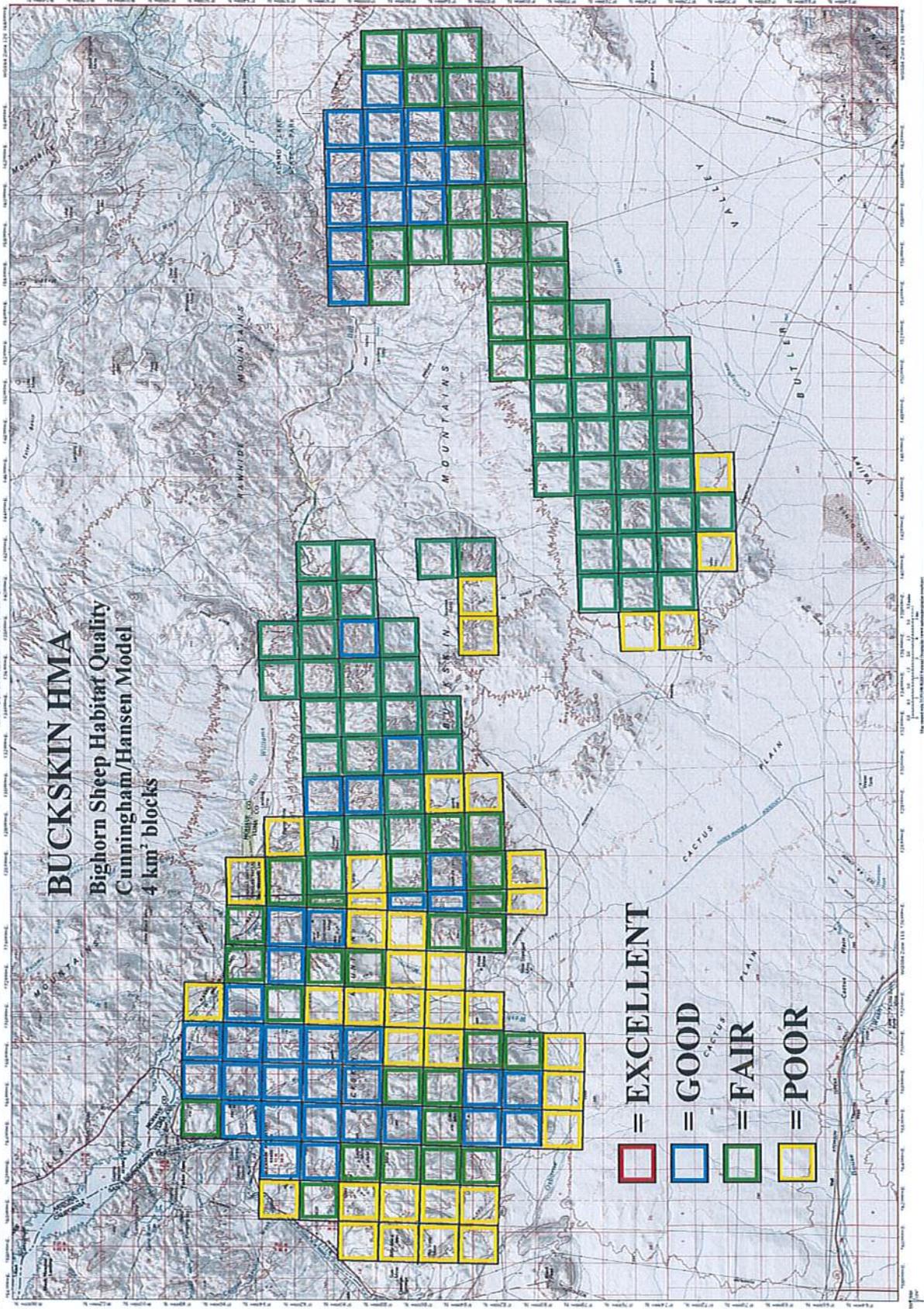
	Buckskin Mountains 44A W	Plomosa Mountains 44BN	Harcuvar/Granite Wash Mountains 44AE	Harquahala Mountains 44AE	Little Harquahala Mountains 44AE	Black Mountains 44AE	Bighorn/Belmont Mountains 42
1985						+21	
1986	(+22)	(-22)					
1987							
1988							
1989		(-16)					
1990							
1991							
1992							
1993		208 (-16)			33*		
1994		212	+30				
1995	57*	202 (+26)	20* (+26)			7*	
1996		157	27				
1997		124	28				
1998	21*		28* (+30)		26*		
1999		115	62				
2000			68	+25			
2001	26*		86* (+25)		21*		
2002		124		24*		15**	
2003		133 (-12)					
2004	29*		38**				
2005		125 (-11)		16*	28		+26
2006							
2007	24*	105	42*			13	40* (+12)
2008				13*	21		49*
2009							35***

Data are derived from standardized aerial (helicopter) surveys. (* Indicates a partial survey of available habitat consistent with previous survey) (** Indicates partial survey of available habitat inconsistent with previous survey)(***Indicates a minimum population estimate based on spring observations of collared animals)

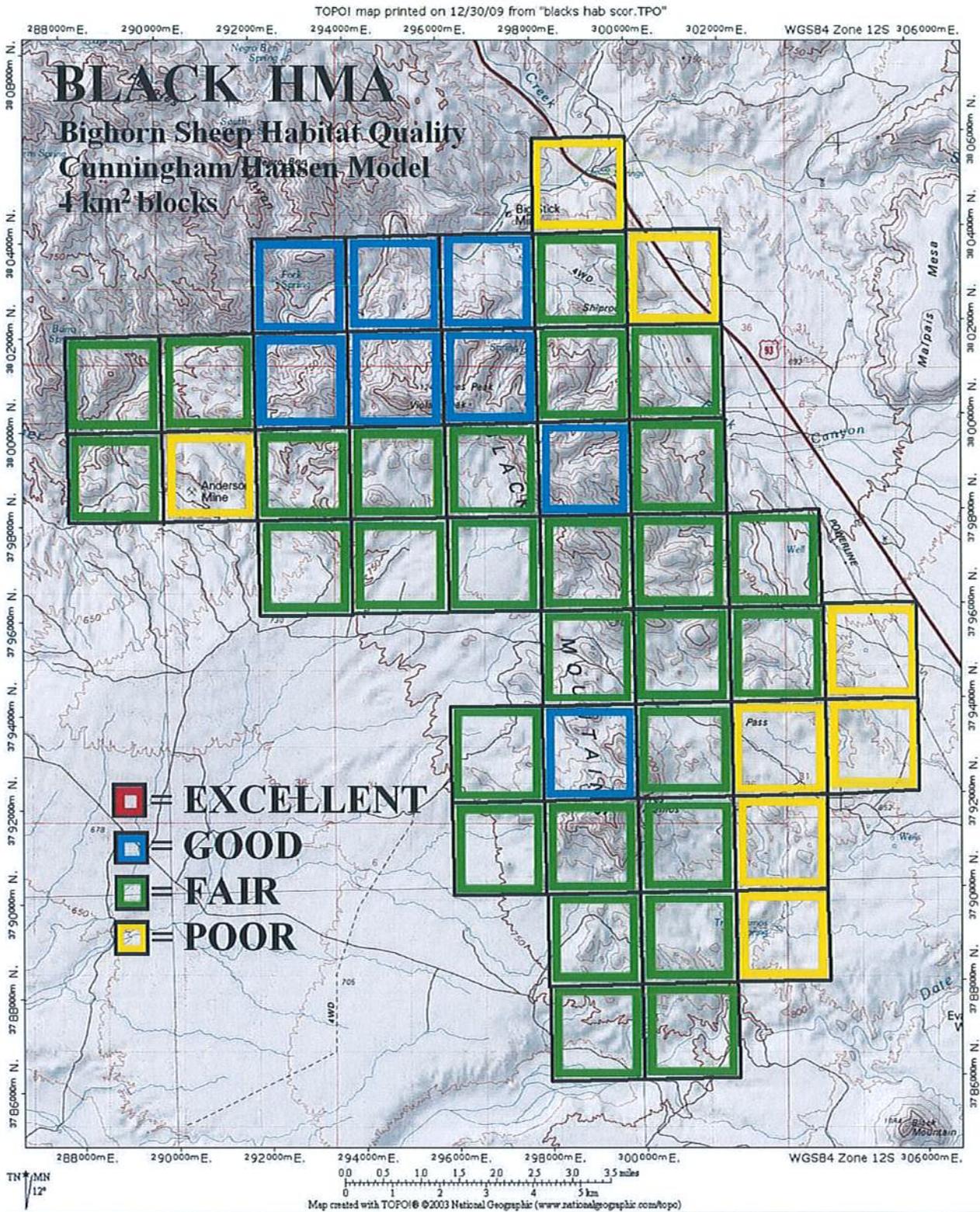
Appendix 7. Mountain Lion Mortalities of Collared Bighorn



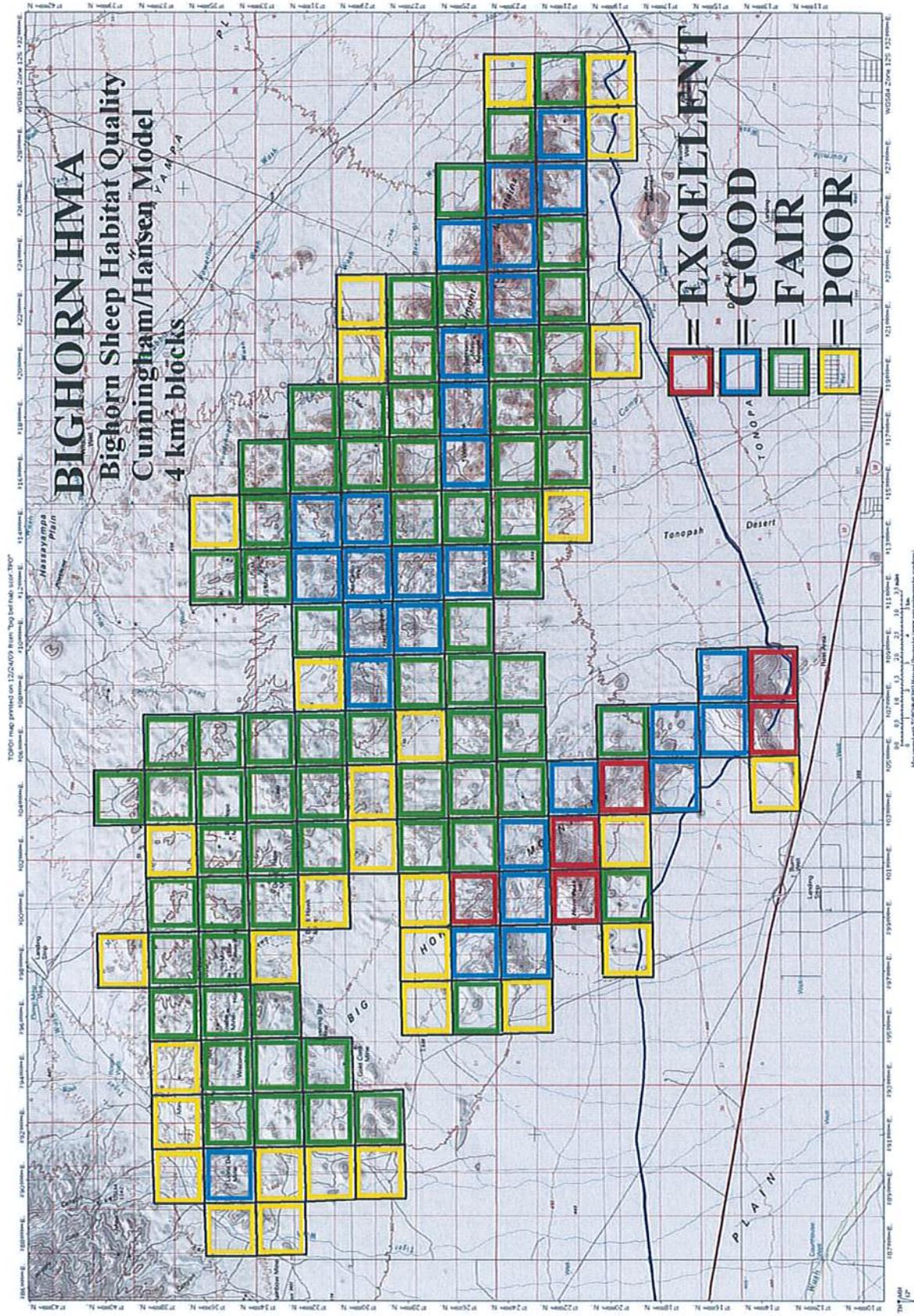
Appendix 8. Buckskin HMA bighorn habitat scoring (4 km² blocks)



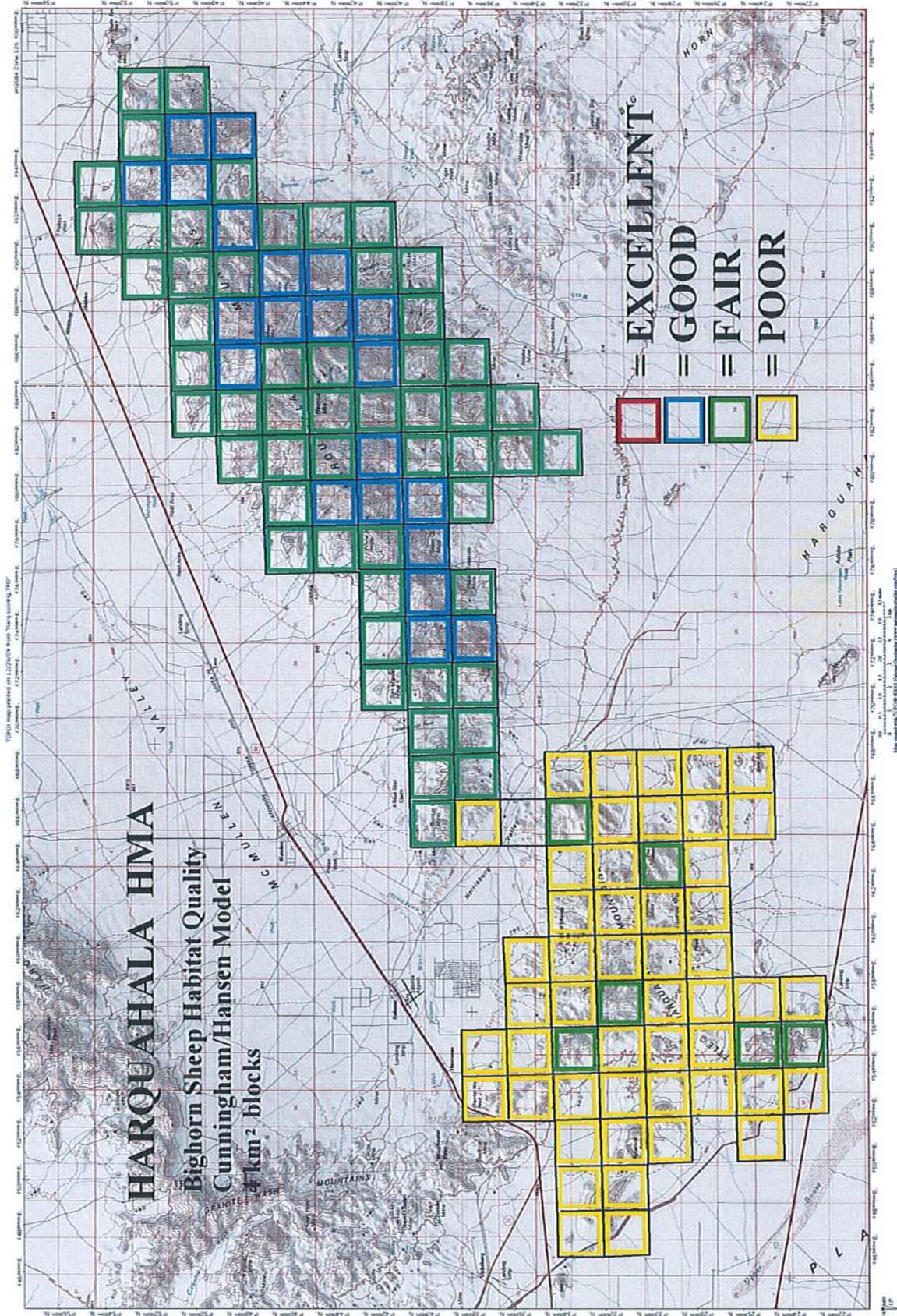
Appendix 9. Black HMA bighorn habitat scoring (4 km² blocks)



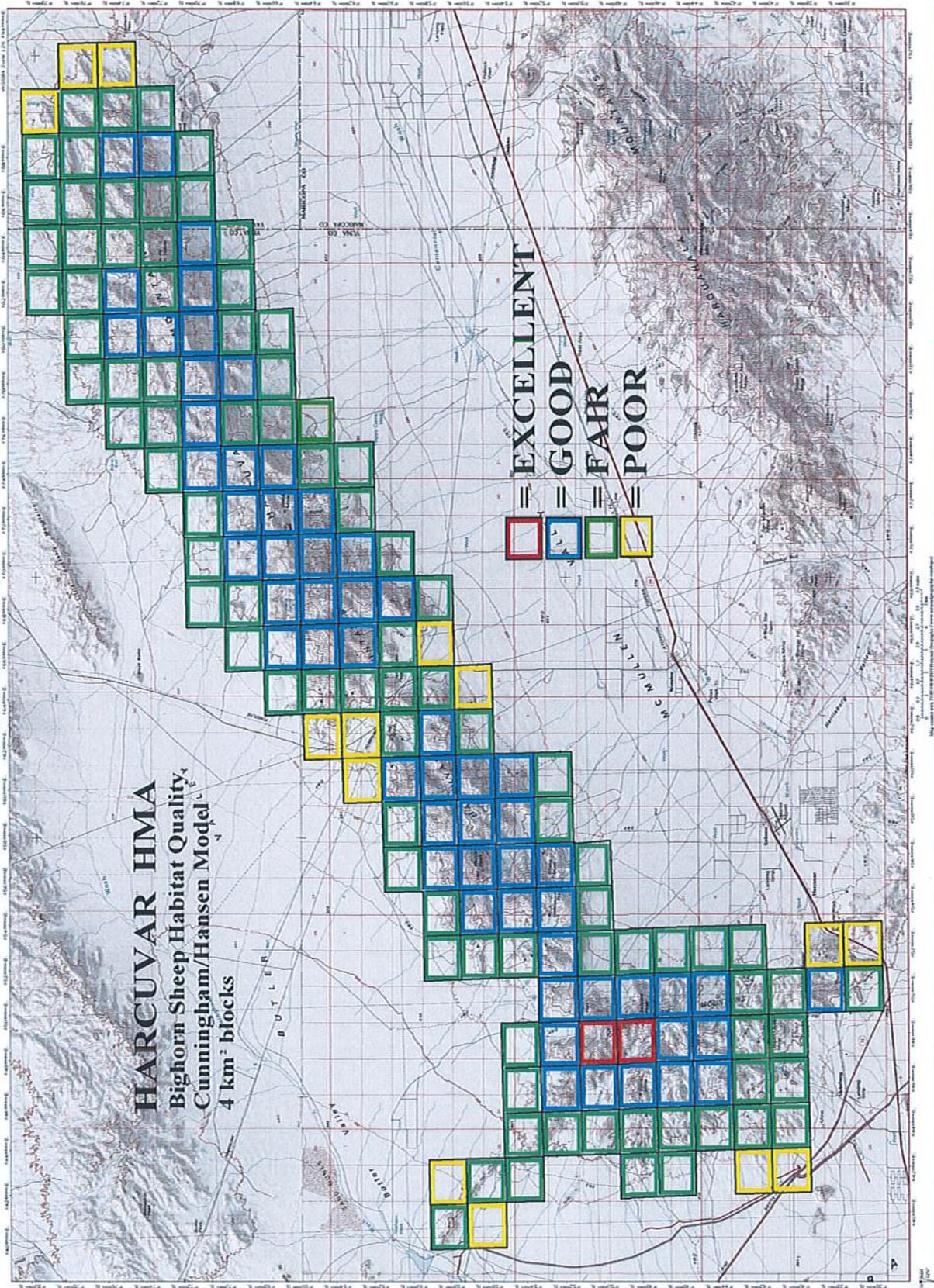
Appendix 10. Bighorn HMA bighorn habitat scoring (4 km² blocks)



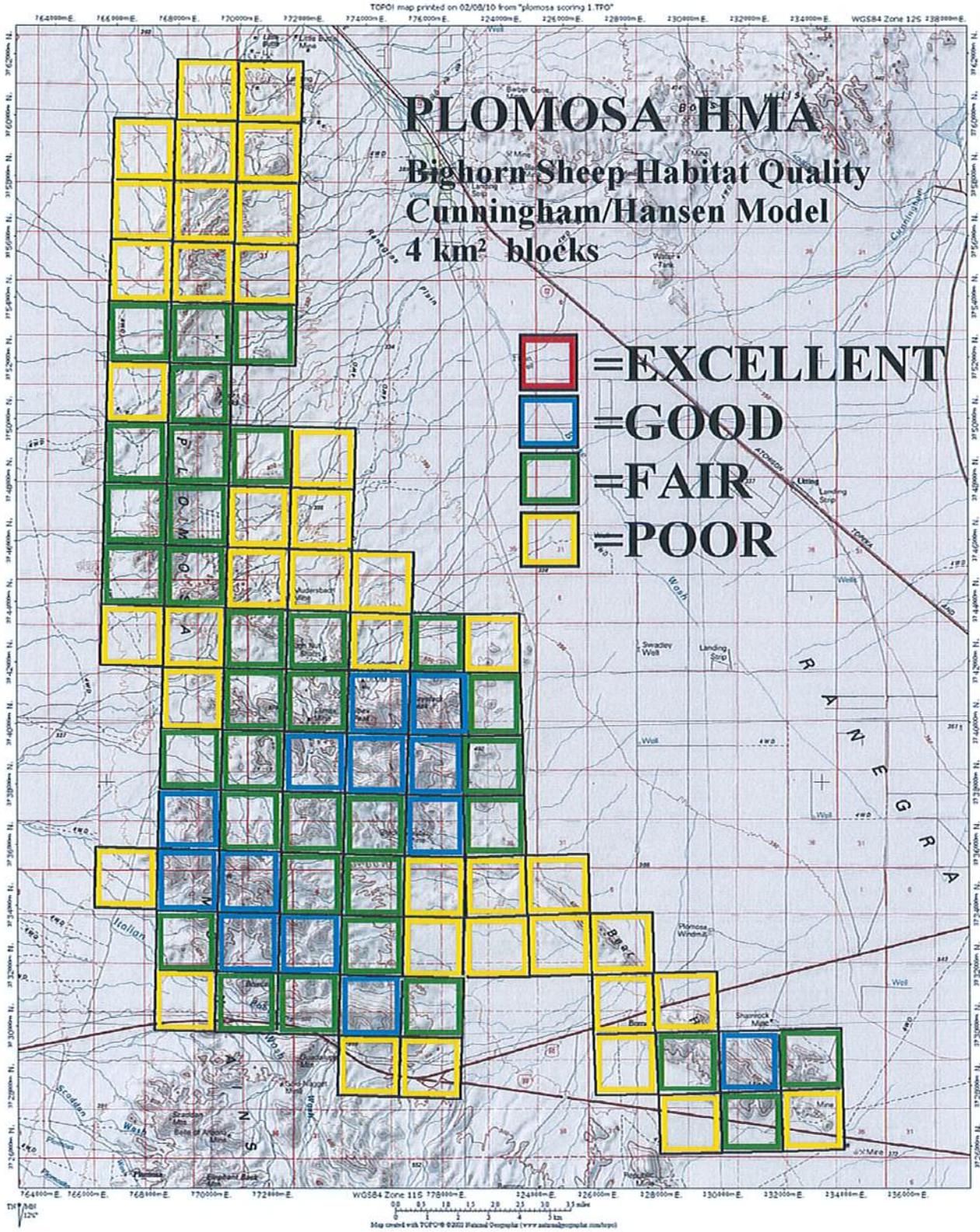
Appendix 11. Harquahala HMA bighorn habitat scoring (4 km² blocks)



Appendix 12. Harcuvar HMA bighorn habitat scoring (4 km² blocks)



Appendix 13. Plomosa HMA bighorn habitat scoring (4 km² blocks)



Appendix 14. Bighorn Sheep Habitat Scoring Model (Cunningham/Hansen).

The following is a method developed and used in Arizona to score bighorn sheep habitat. Ranking bighorn habitat based on scores is used to prioritize transplants and identify habitat or management action modifications. Each discrete habitat area is divided into 4 km.² blocks and each block is scored according to the model. Scores result in each block being categorized as poor, fair, good or excellent habitat.

Natural Topography

Score

- 0 Level or slightly undulating, 100% (dry lake beds and margins, blue clay, or slick rock); more than 1 mile from steep and rocky terrain

- 4 Level of slightly undulating, 100%; within one mile of steep and rocky terrain.

- 8 Rolling hills, such as alluvial fans, without washes over 15' wide and/or more than one mile from steep rocky terrain.

- 12a Greater than 80% steep and rocky with no cliffs, ledges, or washes;
 - b rolling hills, broken frequently by washes and within one mile of steep and rocky terrain;
 - c mesa-type terrain;
 - d steep and rocky terrain with washes; no cliffs or ledges, and <50% rolling hills or level stretches.

- 16 Steep and rocky terrain with washes; no cliffs or ledges, and <50% rolling hills or level stretches.

- 20 Steep and rocky terrain with cliffs and ledges, broken frequently by washes of varying widths, with at least one main wash about 50' wide, and side washes at various angles for protection from the weather and for escape

Vegetation

Score

- 0 Dry lake beds or playas, blue clay, or slick rock.

- 4 Densely vegetated interior Chaparral including turbinella oak (Quercus turbinella), mountain mahogany (Cercocarpus montanus), manzanita (Arctostaphylos pungens), and skunkbush (Rhus trilobata) or Pinyon-juniper woodland. Less than 1% grass cover in this vegetation type.

- 8 Low desert scrub including salt bush and creosote bush communities with < 1% Grass cover; or lightly vegetated interior Chaparral with > 10% grass cover; and Or Pinyon-juniper woodland.

- 12 Grassland-interior Chaparral transition zone that is not densely vegetated and/or middle desert scrub with <1% grass cover.

- 16 Desert grassland and/or middle desert scrub with 10-20% grass cover that is 100% available. Jojoba and/or other browse available.
- 20 Upper desert scrub with >10% grass cover, 100% available; and/or grassland-Desert scrub transition zone. Jojoba, ditaxis, and/or other browse available.

Precipitation

Score

- 1 2-3" annual precipitation primarily summer thunder showers.
- 2 3-8" winter primarily.
- 3 8-12" winter primarily.
- 4 4-8" about half in winter and half in summer.
- 5 8-20" about half in winter and half in summer.

Water Sources, Type, Use, Amount and Permanence

Score

- 1 Water present irregularly, mainly in winter.
- 2 Often dry when needed in summer during dry years.
- 3 Dry 50% of the time when needed during dry summers.
- 4 Seldom dry during the summer.
- 5 Sufficient and perennial

Type of Terrain and Obstruction

- 1 Flat land, water surrounded by fences or other barriers; steep dam or pothole.
- 2 Open rolling hills; surrounded by fences or other barriers that are passable by bighorn or .5 miles or more from steep or rocky terrain.
- 3 Rolling hills with timber or other natural or minor obstructions to vision.
- 4 Steep and rocky but with some timber, natural or minor obstruction.
- 5 Open, steep and rocky terrain with clear view for at least 150'

Competition

- 1 Frequent livestock use.
- 2 Some domestic livestock use and some native or feral animal use.
- 3 More use by deer or other big game than by bighorn.
- 4 No livestock and little native ungulate use.

Any 4 km.² block within two miles of a water source receives an additional 5 points. Any block 2-4 miles away receives no additional points and blocks greater than 4 miles from a water source are deducted 5 points.

Human Use

Score

- 0 High density human use and or economic potential.
- 4 Medium to low density human use and or economic potential unrestricted.
- 7 Medium density human use and or economic potential with some restrictions.
- 7 High density human use restricted and medium economic potential all with some emphasis on bighorn sheep.

- 10 Medium density human use restricted and low or no economic potential.
- 10 Planned development for wildlife with some unrestricted human use and some degree of economic potential or value.
- 15 Low density human use restricted and low or no economic potential.
- 20 Relatively no human use and no economic potential.
- 20 Planned development for bighorn sheep with human use where and when consistent with primary objective.

Total Score

0 – 50 = Poor

51 – 69 = Fair

70 – 79 = Good

80 – 85 = Excellent

Appendix 15.

Lion Kill Report

Date mortality investigated _____		Site investigated by _____	
Species _____	Sex _____	Age _____	(from capture data or current estimate?, circle one)
ID # _____	Collar frequency _____	Not collared _____	
How was the kill found? _____			
Estimated kill date _____			
General location and description of mortality site (i.e. canyon, Mt., etc.) _____ _____			
	<u>Carcass site</u>	<u>Kill site (if appropriate)</u>	
UTM/LatLong coordinates	_____	_____	
Elevation	_____	_____	
Slope	_____	_____	
Aspect	_____	_____	
Distance to water	_____	_____	
Description of terrain (i.e. rocky, sandy, etc.): _____ _____			
<u>Vegetation characteristics:</u>			
% Ground cover (>0.7m tall over 5m area)		_____	
Vegetation association (which classification system?)		_____	
Dominant plant species on site (list 5 in order)			
1.	_____		
2.	_____		
3.	_____		
4.	_____		
5. _____ Describe carcass remains (i.e. remains found/ missing, parts detached, distance between parts, etc.) _____ _____ _____			
Cache pile present? ___yes ___no Describe _____			
Number of cache sites _____			
Drag trail present _____		___yes _____no	
Describe _____		_____	
Rumen with carcass? ___yes ___no		Material in rumen? ___yes ___no	
Describe _____		_____	
Large leg bones broken? ___yes ___no		_____	
Describe _____		_____	
Skull crushed/eaten? ___yes _____no		_____no	
Describe _____		_____	
Maggots present? _____yes _____no		_____no	
Describe _____		_____	
Scat present? _____yes _____no		_____no	
Describe _____		_____	

Carnivore tracks present? _____ yes ___ no
 Describe _____

Scrapes present? _____ yes _____ no
 Describe _____

Signs of struggle/chase? _____ yes _____ no
 Describe _____

Lamb/fawn or lamb/fawn remains? _____ yes _____ no
 Describe _____

Separate mortality report for lamb/fawn?

Condition of carcass:

Pregnant? _____ Lactating? _____ Fat on internal organs? _____
 Signs of injury or disease (include horn/ antler condition)

Carcass fed upon? _____ Approx. % consumed? _____ Internal organs eaten? _____

Muscle, fat, bones eaten? _____ Point of first feeding? _____

Tooth marks present? _____ Location _____ Measurements between canines

Blood on carcass or ground?

Weather (rain, wind, temp) since last signal

Estimated date of death _____ Cause of death (i.e. lion, probable lion, non-predation)

Samples collected _____ skull _____ jaw _____ scat _____ collar _____ ear tag _____ photos taken
 _____ parasites _____ Femur

List other organs collected:

Additional Notes:

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