Final Environmental Assessment

Mountain Lion Management to Protect the State Endangered Desert Bighorn Sheep

New Mexico

Cooperating Agencies: State of New Mexico
New Mexico Department of Game and Fish

U.S. Department of the Army
White Sands Missile Range
Environmental Stewardship

Prepared by
Cooperating Agency: U.S. Department of the Interior
Fish and Wildlife Service
San Andres National Wildlife Refuge

September 2002

***Prepared Under Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act 40 CFR Parts 1500-1508 (as of July 1, 1986).**

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List of Acronyms and Abbreviations Used for this Document

ac	acre
APHIS	Animal and Plant Health Inspection Service (USDA agency)
AVMA	American Veterinary Medical Association
CCP	Comprehensive Conservation Plan
CEQ	President's Council on Environmental Quality
CFR	Code of Federal Regulations
DoD	Department of Defense
DM	Department of the Interior's Departmental Manual
EA	Environmental Assessment
ha	hectare
INRMP	Integrated Natural Resource Management Plan
km	kilometer
mi	mile
NEPA	National Environmental Policy Act
Service	United States Fish and Wildlife Service (USDI agency)
T&E	Threatened and Endangered
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
VHF	very high frequency
WS	Wildlife Services (USDA-APHIS program)

CHAPTER 1: PURPOSE AND NEED FOR ACTION

1.0 Introduction

The San Andres National Wildlife Refuge (Refuge) was established in 1941 by Executive Order 8646 for "conservation and development of natural wildlife resources." Primary emphasis of the Refuge has been restoration and management of desert bighorn sheep (*Ovis canadensis mexicana*), currently a state-listed endangered species in New Mexico under the Wildlife Conservation Act (New Mexico Department of Game and Fish 1995). The declining trend of desert bighorn in New Mexico prompted the New Mexico Department of Game and Fish (Department) in 1972 to use Red Rock Wildlife Area, a captive propagation facility managed by the Department, for desert bighorn sheep and listing the subspecies as State-Endangered in 1980. The Refuge presently maintains the last indigenous desert bighorn sheep in the Chihuahuan desert, a 13-year old ewe, along with eight other desert bighorn sheep: seven rams transplanted from Red Rock Wildlife Area between 1999-2001, and a lamb born February 2002, sired by one of the Red Rock Wildlife Area rams on the Refuge. Currently, between 275-285 animals occur in New Mexico, of which approximately 35% are in captivity (Rominger and Goldstein 2001a, Rominger and Goldstein 2002a,b).

To meet the objective of restoring the San Andres Mountains desert bighorn sheep population, the Refuge has identified the following management actions for recovery: 1) continue with a prescribed burn program to direct habitat restoration efforts; 2) augment the remnant San Andres desert bighorn herd with similar taxonomic source stock from New Mexico and Arizona; and 3) protect the remnant and supplemented San Andres desert bighorn herd from unacceptable losses due to predation. Compliance with National Environmental Policy Act (NEPA) requirements with respect to prescribed burning and augmentation of native species on the Refuge can be addressed through a Categorical Exclusion. Categorical Exclusions are classes of actions which do not individually or cumulatively have a significant effect on the human environment (Federal Register 1997). However, the Refuge Fire Management Plan includes a separate Environmental Assessment (EA) related to prescribed burning (Gavin and Sullivan 1999). Moreover, the Refuge Comprehensive Conservation Plan (CCP) (U. S. Fish and Wildlife Service 1998) also includes a separate EA which discusses restoration and augmentation of the San Andres desert bighorn sheep population.

1.1 Purpose

The federal action proposed is to conduct limited control of mountain lions (*Puma concolor*) to protect the endangered desert bighorn sheep. The purpose of the action is to protect bighorn from predation by mountain lions during restoration efforts of desert bighorn sheep in the San Andres Mountains. The purpose of this document is to assess the environmental impacts of conducting a limited predator damage management program to protect desert bighorn sheep in areas where mountain lions threaten the

already precariously low numbers of bighorn sheep and to protect the bighorn that will be released onto the Refuge to recover the population. The effects of lion predation are considered the critical factor limiting desert bighorn sheep population recovery in New Mexico. (Rominger et al. 2001).

This EA evaluates predator damage management methods that can be conducted to protect desert bighorn sheep from predation and support restoration efforts. The historical range of the desert bighorn includes the entire San Andres mountain range, with the majority of bighorn inhabiting the Refuge in the southern portion of the range. Predator damage management would be limited to mountain lions given the actual and potential threats to desert bighorn sheep from this species. Control of mountain lions would be concentrated in a limited area around the desert bighorn release site(s).

1.2 Need for Action

The primary threats to desert bighorn sheep are the direct and indirect effects of predation from mountain lions, risk of disease from domestic sheep, environmental catastrophes (U. S. Fish and Wildlife Service 1999a), human disturbance, fire suppression (Etchberger et al. 1989), overgrazing, and habitat loss (Wishart 1975, 1978). Resource managers are also concerned about small populations of bighorn with fewer than 50 individuals because of empirical evidence that indicates many may be susceptible to extinction (Berger 1990, 1999, Krausman et al. 1993, Krausman et al. 1999), however, population size alone may not always be an accurate indicator of bighorn sheep persistence (Krausman et al. 1996, Wehausen 1999, Sawyer and Lindzey 2002). Disease risks, habitat improvement, and augmentation are discussed briefly for the reader's understanding of other issues pertaining to desert bighorn sheep, but are outside the scope of this assessment. As explained below, it is essential to address the impacts of mountain lion predation on desert bighorn sheep irrespective of what efforts are taken to address habitat improvement, disease transmission, and other threats to the desert bighorn sheep. Reducing the threat posed by mountain lions will be beneficial to desert bighorn sheep in addition to other restoration-related efforts.

1.2.1 Mountain lion predation

Since the late 1980s and early 1990s, mountain lion predation has become a limiting factor for bighorn sheep populations (U. S. Fish and Wildlife Service 1999b, Wehausen 1996). The recent decline of desert bighorn sheep is attributed to mountain lions which impact bighorn sheep in two ways: direct predation and an indirect effect of bighorn sheep avoiding use of former habitat. Figure 1 describes the declining numbers of the desert bighorn sheep in the San Andres Mountains from 1941 to 2002. Population estimates for this herd were derived from ground and aerial surveys (Department files, Refuge files).

From 1980 to 2002, mountain lion predation accounted for 49% of all San Andres Mountains bighorn mortalities (Figure 2), and 85% of all known non-hunter adult desert bighorn sheep mortalities in New Mexico statewide bighorn populations since 1992 (Rominger et al. 2001).

Mortality data on desert bighorn sheep in the San Andres Mountains was limited, at best, from 1941-1979, prior to instrumentation of radiocollars on the bighorn (Refuge files). Of 20 bighorn that were estimated on the Refuge in 1996, nine radiocollared bighorn mortalities occurred February 1996-August 1997. Previous to these losses, there had been no radiocollared bighorn mortalities in the San Andres Mountains since October 1994. Six of the nine mortalities were due to mountain lion predation, one to an accidental fall, and the other two were undetermined natural causes. Five of the six bighorn killed were adult ewes aging 7-12 years. This decrease in the San Andres bighorn sheep population coincided with a rapid decline in the mule deer population. Logan and Sweanor (2001) suggested the increased mountain lion predation resulted from concurrent mule deer declines that forced lions to hunt more intensively, thus increasing encounter rates with bighorn sheep. By 1998 the Refuge bighorn population had dropped to 1 animal. Six rams were released throughout the San Andres mountains as part of the Sentinel Ram project in 1999. During the course of the study, four mortalities to the rams occurred. Three of the four were due to lion predation with the other attributed to unknown causes.

Predation can be a substantial cause of mortality in bighorn sheep herds and, in some instances, may have population-level impacts (Hoban 1990, Wehausen 1996, Ross et al. 1997, Hayes et al. 2000, Rominger and Weisenberger 2000, Logan and Sweanor 2001). Mountain lions appear to be the sole predators capable of causing appreciable mortality in small bighorn sheep populations (<100) that occupy suitable habitats (Sawyer and Lindzey 2002). Sustained high levels of mountain lion predation may hinder the recovery of bighorn sheep populations (Hayes et al. 2000), cause population declines (Wehausen 1996), or in severe cases, lead to the biological extinction of very small (<40) bighorn sheep populations (Logan and Sweanor 2001).

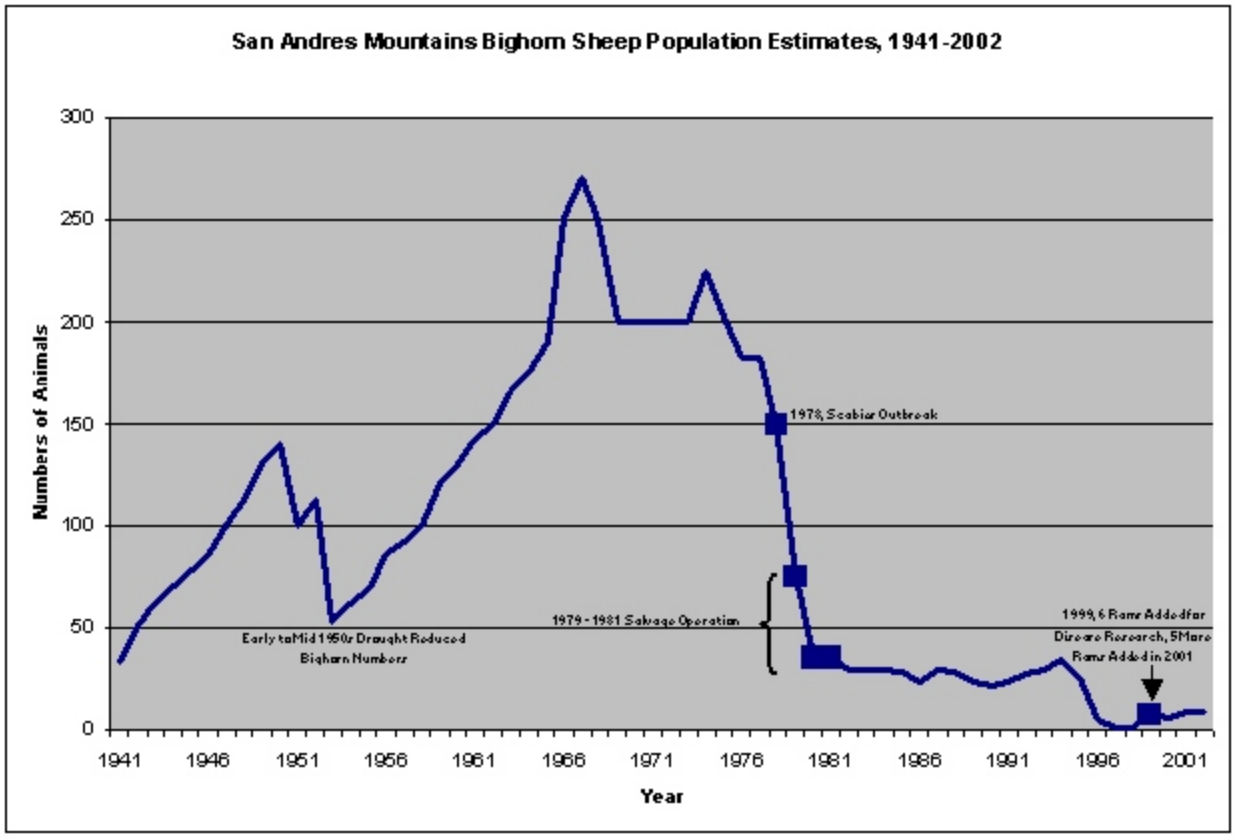

Figure 1. San Andres Mountains desert bighorn sheep numbers, 1941-2002.

Mountain lions are thought to affect bighorn sheep indirectly by forcing the sheep to abandon former habitat to avoid predation (Sawyer and Lindzey 2002). Wehausen (1996) indicates that habitat abandonment has the potential to lead to extirpation of some bighorn sheep populations. These problems tend to be exacerbated in transplanted herds that are often small (<100), isolated, and nonmigratory (Sawyer and Lindzey 2002).

Bighorn sheep have a social structure that favors traditional use of home ranges (Geist 1971), thus, when bighorn sheep are transplanted they may be predisposed to mountain lion predation because normal escape routes are unknown (Krausman et al. 1999). Predator control may be more readily needed and implemented in small or newly transplanted bighorn herds, rather than well-established sheep populations (Sawyer and Lindzey 2002).

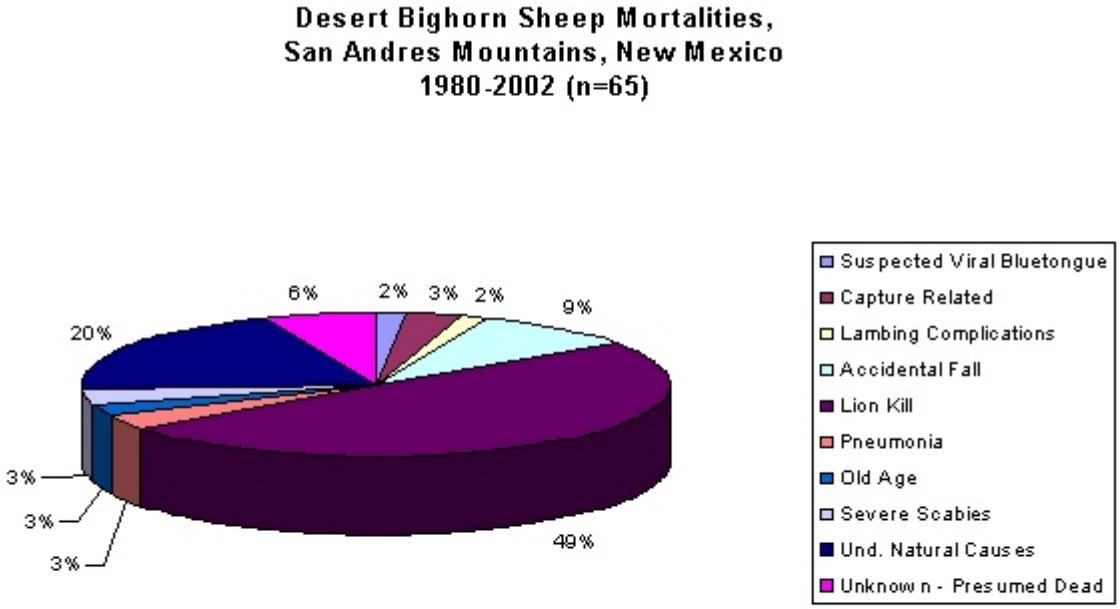

Figure 2. Causes of mortality for radiocollared San Andres Mountains bighorn sheep, 1980-2002.

1.3 Background

When the Refuge was established in 1941, 33 desert bighorn sheep inhabited the San Andres Mountains. By 1967, the bighorn population increased to 270 animals, the highest number of desert bighorn recorded on the Refuge. There have been two documented desert bighorn sheep declines in the San Andres Mountains since 1941 (Hoban 1990). In 1955, the population estimate was 70, following a peak of 140 animals in 1950. The decline was attributed to severe drought, an overpopulation of desert mule deer (*Odocoileus hemionus*), overgrazing by domestic livestock, and human disturbance during the annual deer hunts (Lang 1956). Livestock grazing discontinued in 1952 with the establishment of White Sands Missile Range (Range) (Hoban 1990).

The San Andres Mountains have the potential to maintain the largest single herd of desert bighorn sheep in New Mexico (New Mexico Department of Game and Fish 1995). In the early to mid 1970s, the San Andres Mountains desert bighorn population was the largest in New Mexico with an estimated 200 ± 18 individuals (Sandoval 1979). The direct and indirect effects of a virulent scabies (*Psoroptes ovis*) outbreak first documented in 1978 caused the San Andres Mountains desert bighorn population to decline to 75 animals by 1979. Indirect effects of virulent scabies have led to increased susceptibility to predation and accidental falls from loss of equilibrium (Clark and Jessup 1992). The San Andres Mountains bighorn population further declined to approximately 40 animals following a salvage operation during 1979 – 1981.

The San Andres desert bighorn population estimate in November 1979 was 80 animals (Sandoval 1980). During the salvage operation, 49 desert bighorn were captured and transported to a handling facility and treated for scabies. Thirty-five desert bighorn sheep survived treatment, of which seven rams were sent to New Mexico State University for experimental control of scabies and cross-transmission research (Hoban 1990). The remaining 28 animals were translocated to Red Rock Wildlife Area where they remained for 13 months. While in captivity, the San Andres desert bighorn endured a second disease-related die-off that lead to a 60% loss of the remaining population (Sandoval 1981). Causes of mortality identified were confirmed viral blue-tongue in the adult desert bighorn population, and suspected contagious ecthyma in five of seven lambs that had been born at Red Rock Wildlife Area (Sandoval 1981). The fourteen San Andres desert bighorn sheep that survived the second epidemic were radiocollared and returned back to the Refuge in January 1981. However, two rams died in transport (Hoban 1990). The San Andres desert bighorn population estimate in 1981 was 23 animals, following the reintroduction of the 12 desert bighorn sheep transplanted from Red Rock Wildlife Area (Hoban 1990). The population declined to one animal by 1998. The current population is nine bighorn with one ewe, seven rams, and a lamb.

Since 1980, the primary cause of mortality was mountain lion predation (n=22) (see Figure 2). Other causes included accidental falls, old age(n=2), capture (n=2), lambing (n=1), undetermined natural causes (n=7) and continued scabies infestation (Hoban 1990, Refuge files). The first of five goals denoted in the Refuge Comprehensive Conservation Plan (CCP) is "*to protect and enhance wildlife, plant and habitat resources within the San Andres Mountains Ecosystem including strategies that benefit native flora and fauna, the status of desert bighorn sheep, neotropical migratory birds and other species of concern.*" To accomplish this goal, Refuge, in cooperation with the Department and Range, proposed to "establish and protect an augmentable scabies free desert bighorn population leading to the establishment of a widely distributed, self-sustaining population comprising greater than 100 sheep in the San Andres Mountains" (U. S. Fish and Wildlife Service 1998).

The goals of the Document for the Recovery of Desert Bighorn Sheep in the San Andres Mountains, New Mexico (New Mexico Department of Game and Fish 1998) support the CCP with respect to enhancing the San Andres desert bighorn sheep population. This document, prepared by the Department, Refuge, and Range, was designed to be a flexible guide for management decisions from 1999-2003. The following two goals were included in the document:

Short-term goal:	*to have a scabies free San Andres Mountain desert bighorn population into which desert bighorn sheep from Red Rock Wildlife Area can be safely augmented to begin the recovery of desert bighorn sheep.*
Long-term goal:	*to establish a widely distributed, self-sustaining population comprising >100 desert bighorn sheep in the San Andres Mountains*

The goal of the New Mexico Long Range Plan for Desert Bighorn Management 1995-2002 (NMDGF 1995) is to have sufficient numbers of desert bighorn to remove them from the state-endangered species list. Problem 4 of that plan states the importance of restoring bighorn to the San Andres mountains in support of that goal.

1.4 Location

The Refuge is located approximately 48 km (30 miles [mi]) northeast of Las Cruces, New Mexico, in Dona Ana County, and encompasses 23,154 hectares (ha) (57,215 acres[ac]) of the southern portion of the San Andres Mountains. The San Andres mountain range is approximately 128 km (80 mi) long, forming an arc 10-14 km (6-12 mi) wide that concaves to the east (Figure 3). The Refuge is surrounded by federal lands belonging to the Range, which also overlays the Refuge in entirety; the Agricultural Research Service-Jornada Experimental Range has research rights on approximately 40% of the western half of the Refuge; and the National Aeronautical and Space Administration-White Sands Test Facility borders the southwestern corner of the Refuge.

1.5 San Andres Mountains Bighorn Sheep Restoration Efforts

Restoration of the San Andres Mountains desert bighorn sheep population is essential to the recovery of desert bighorn sheep and removal from the New Mexico Department of Game and Fish (Department) list of endangered species (New Mexico Department of Game and Fish 1998). The Refuge, Range, and Department continue to join management efforts to ensure desert bighorn remain a viable component of San Andres Mountains biodiversity. The general approaches we have taken to reach this goal are to 1) evaluate scabies mite infestations in the San Andres Mountains bighorn population, 2) protect and

restore habitat for native species, 3) augment the San Andres Mountains bighorn population with transplanted animals from Arizona and the Red Rock Wildlife Area facility as available, and 4) initiate or continue mountain lion control programs necessary to guide recovery efforts.

1.5.1 Evaluation of Scabies Mites in the San Andres Mountains

As part of the Document for the Recovery of Desert Bighorn Sheep in the San Andres Mountains, New Mexico, the Sentinel Ram Project was initiated in November 1999 with two objectives: 1) to determine whether extant desert bighorn sheep inhabited the San Andres Mountains (in addition to the known ewe); and 2) to determine whether the sentinel rams contracted scabies. Six "sentinel" rams, equipped with satellite radiocollars, were released individually throughout the San Andres Mountains from Red Rock Wildlife Area. The one remaining ewe was previously fitted with a very high frequency (VHF) transmitter collar. Desert bighorn were intensively monitored over a two-year period to determine whether they associated with any extant bighorn. The sentinel rams were captured every four to six months, tested for scabies and redistributed individually throughout the San Andres Mountains to cover the entire mountain range. Bighorn are gregarious animals and it was expected that the sentinel rams would associate with extant bighorn in the San Andres Mountains, should any exist.

With respect to the first goal of the Sentinel Ram Project, *to determine whether extant desert bighorn sheep inhabit the San Andres Mountains (in addition to the known ewe)*, we concluded that extant bighorn sheep ostensibly no longer inhabit the San Andres Mountains. Intensive monitoring demonstrated that sentinel rams moved frequently and extensively throughout the entire mountain range. No extant bighorn were observed during 161 visual observations.

The second goal of the Project, *to determine whether the sentinel rams contracted scabies*, revealed that none of the desert bighorn sheep, including the ewe, contracted scabies during the two years of study. Bighorn were documented using the entire length of the San Andres Mountains; notably important is that some rams migrated up and down the range numerous times. Having a scabies-free population into which desert bighorn sheep can be safely augmented is the goal the cooperating agencies have been working toward for more than twenty years.

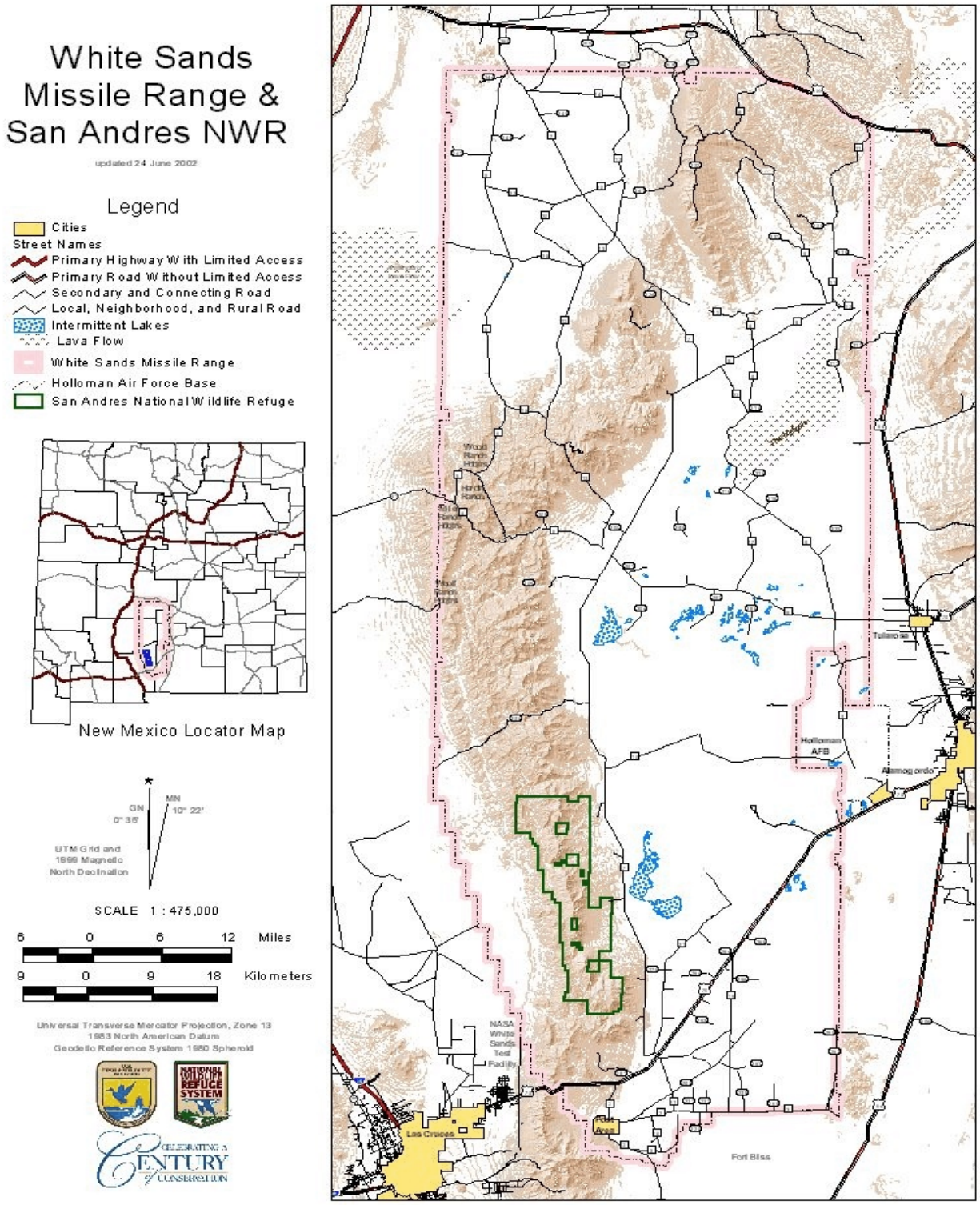

Figure 3. Locator map for White Sands Missiles Range and the San Andres National Wildlife Refuge, New Mexico.

1.5.2 Habitat Restoration

Bighorn sheep evade predation through their exceptional eyesight, climbing ability, and use of open areas adjacent to and within rugged habitat (Wishart 1978). Preference for terrain rendering sufficient visibility results from the predator evasion strategy of bighorn sheep, whereby predators are visually detected and the presence of danger is communicated among sheep by visual cues (Geist 1971). Increases in bighorn sheep predation may be related to changes in plant communities over time. Decades of fire suppression have allowed historic bighorn sheep ranges to become overgrown with trees and shrubs that obstruct visibility and reduce the amount of high-visibility habitat needed by bighorn sheep (Risenhoover and Bailey 1985, Etchberger et al. 1989). The invasion by pinyon-juniper stands is considered to make bighorn sheep more vulnerable to ambush predators (e.g., mountain lions) due to decreased visibility (Risenhoover and Bailey 1985, Wakelyn 1987). Bighorn sheep are habitat specialists that depend on steep, rocky terrain with open visibility and limited snow cover (Sawyer and Lindzey 2002).

The Refuge implemented a prescribed fire program in 1999 to restore bighorn habitat, focusing on pinyon-juniper habitat in the higher elevations. To date nearly 8,094 ha (20,000 ac) have been burned with plans to continue the fire program. Fire suppression has been demonstrated to limit bighorn sheep distribution (Wakelyn 1987, Etchberger et al. 1989, Etchberger et al. 1990) as bighorn identify predators more efficiently in open habitat (Risenhoover and Bailey 1980). Wilson (1975) described that "the key to management of desert bighorn is habitat protection, maintenance, and/or enhancement" and prescribed burning is recommended to increase the availability of bighorn habitat (Wilson 1975, Wright and Bailey 1982, Etchberger et al. 1990). Habitat loss is potentially the most severe threat to bighorn sheep populations (Risenhoover and Bailey 1985, Wakelyn 1987, Risenhoover et al. 1988, Etchberger et al. 1989).

1.5.3 Augmentation of the San Andres Mountains Desert Bighorn Population

Reintroductions and augmentation programs are recognized conservation tools and have been used extensively to manage bighorn sheep populations (Bleich et al. 1990, Ramey 1993). We propose to augment the San Andres Mountains desert bighorn population with approximately 30 desert bighorn, predominantly ewes, transplanted from the Kofa National Wildlife Refuge beginning no earlier than November 2002. Additional rams from the Red Rock Wildlife Area will be transplanted in 2002 or in following years. Subsequent transplants from Arizona, Red Rock Wildlife Area, and other locations which may include Mexico will be

necessary to successfully restore desert bighorn sheep in the San Andres Mountains. To accomplish the initial transplant, it is tentatively proposed that the Department will trade the Arizona Game and Fish Department Rocky Mountain bighorn sheep for desert bighorn sheep.

During November 2001, pasturella samples were collected from the Kofa, Red Rock, and San Andres desert bighorn sheep herds. Based on these results and the technological advances in evaluating pasturella bacteria, the 2001 tests were evaluated to lend support to management decisions. The current tests indicated that there are some differences in the biotypes of bacterias that the Arizona and New Mexico desert bighorn herds have been exposed to. However, understanding that the test results are a tool, and not an absolute measure, is recognized in the risks associated with augmentation.

The Department was concerned about the disease compatibility between Arizona and New Mexico desert bighorn sheep herds. This concern related to a November 1980 transplant in which 28 desert bighorn sheep (10 ewes from Arizona, 10 rams from Red Rock Wildlife Area, and eight lambs sired in Arizona) were released from a 16 ha (40 ac) temporary paddock into the central Peloncillo Mountains (Sandoval et al. 1987). The ewes had been retained for seven months, and the rams for two months in the paddock prior to release. All 10 rams and five of eight lambs died within two and five months post-release, respectively. The population was subsequently augmented with two rams from Red Rock, four rams and 10 ewes from Arizona. Clinical signs and laboratory results indicated chronic fibrinopurulent bronchopneumonia as the cause of death (Sandoval et al. 1987).

1.5.4 Long-term Management of the San Andres Mountains Bighorn Sheep Population

Successful restoration of the desert bighorn sheep in the San Andres Mountains depends on a number of factors not limited to bighorn sheep survival (especially adult ewe survival), source stock availability, habitat conditions, and interagency cooperation. All desert bighorn sheep transplanted will be radiocollared; some animals may be fitted with satellite radiocollars based upon availability. Intensive monitoring of the bighorn sheep will be necessary to ensure causes of mortality are determined in a timely fashion, to document movements, and overall herd health and status. The Refuge staff and a Department biotech contractor will conduct monitoring. The Department contractor will be employed for a minimum of 20 months following the transplant(s).

1.6 Objectives and Scope

The objectives of this proposal are twofold:

1) protect desert bighorn sheep from mountain lion predation, with a short term goal of no further losses due to predation; and,

2) protect desert bighorn sheep from being displaced from their former range by the presence of mountains lions.

The selected action must answer the following question: How can the Refuge and cooperating agencies best respond to the need for action and meet the goals to protect the bighorn sheep from further decline by predation and/or displacement from former habitat by mountain lions, while other management actions to protect and restore the population are being developed or implemented?

The decision would include a determination of whether or not the proposal would be likely to have a significant impact on the human environment.

The Refuge and Department goal and objective with respect to management of desert bighorn sheep and mountain lion management are covered in Section 1.3. The Department goal and objective regarding mountain lion management are as follows:

Goal: the management of cougars by the Department satisfied people's recreational and ecological interests, and successfully resolves cougar-related issues.

Objective: That by 2004, the Department has achieved 75% public satisfaction in managing cougars to meet people's recreational and ecological interests, and in resolving cougar-related issues.

1.7 Relationship of this Environmental Assessment to other Environmental Documents

San Andres National Wildlife Refuge Comprehensive Conservation Plan (CCP). This Plan serves as a management tool to be used by the Refuge staff and its partners in the preservation and restoration of the refuge's and the surrounding ecosystem's natural resources. In that regard, the plan will guide management decisions over the next ten to twenty years and set forth strategies for achieving Refuge goals and objective within that time frame. The CCP contains an EA for Refuge activities related to management goals. Any decision made as a result of this EA process will be consistent with guidance in the CCP.

San Andres National Wildlife Refuge Fire Management Plan. This plan, which includes an EA, was written to address the Appropriate Management Response for managing wildland fire and the use of prescribed fire for accomplishing resource management objectives. The intent of this plan is to operationally bind all agencies involved (Refuge, White Sands Missile Range, and Jornada Experimental Range) with the implementation of the plan, especially with respect to fire management operations and objectives, irrespective of jurisdictional issues and local differences in agency mandates.

White Sands Missile Range Integrated Natural Resource Management Plan (INRMP). The INRMP complies with standards set by the National Environmental Policy Act and the Endangered Species Act. The principal intent of the INRMP is to support and sustain the operational military mission of the Range while meeting natural resource management and conservation requirements. The plan serves as a vehicle to ensure and streamline compliance with federal and state laws, regulations, and executive orders pertaining to management of natural resources on military installations. One of sixteen INRMP rangewide goals is to "conserve all species on the installation listed by the state of New Mexico as threatened or endangered in accordance with state laws and Army regulations and guidance." The INRMP also contains an EA for the Range activities in relation to natural resources.

New Mexico's Long-range Plan for Desert Bighorn Sheep Management, 1995-2002. This management plan outlines strategies for the New Mexico Department of Game and Fish and cooperating agencies to increase the numbers and distribution of desert bighorn sheep in New Mexico so they may be removed from the state-endangered list.

Document for the Recovery of desert bighorn sheep in the San Andres Mountains, New Mexico. This recovery plan was jointly written by the New Mexico Department of Game and Fish, San Andres National Wildlife Refuge, and White Sands Missile Range to be a dynamic guide for bighorn management decisions from 1999-2003.

Long-range Plan for the Management of Cougar in New Mexico. This plan describes the schedule, personnel, and budget required for implementing management actions and is currently being revised to include a new mountain lion zone management delineation for New Mexico. Annual harvest goals for each zone will be addressed, in addition to listing a series of tasks and strategies to achieve each task.

1.8 Authority and Compliance

Based on agency relationships, missions, and legislative mandates, the Refuge is the lead agency for this EA, and therefore responsible for the EA's scope and content. As cooperating agencies, the Department and Range have provided input for this EA and would provide advice and recommendations to the Refuge on when, where, and how mountain lion damage management could be conducted.

1.8.1 Authority of Federal and State Agencies in Wildlife Damage Management

U.S. Fish and Wildlife Service. The Refuge System is the principal federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats. Administration of the refuges takes into account a myriad of bills passed by the United States Congress and signed into law by the President of the United States. These statutes are considered to be the law of the land as are executive orders promulgated by the President.

White Sands Missile Range. White Sands Missile Range, covering 2.2 million ac, is the Department of Defense's (DoD) largest single land holding. It is managed by the U.S. Department of the Army and operated to support DoD readiness programs, including research, development, testing, and evaluation of weapons and space systems. It is the objective of the Range to support and sustain the operational military mission while meeting natural resource management and conservation requirements and complying with federal and state laws, regulations, and executive orders.

New Mexico Department of Game and Fish. The New Mexico Department of Game and Fish is the principal state agency responsible for managing the state's wildlife. The Department is charged to provide for propagation and protection, to the extent necessary, to provide and maintain viable populations of wildlife. Additionally, the Department is charged to maintain and enhance state-listed endangered species within the carrying capacity of the habitat.

1.8.2. Compliance with Federal Laws

The following federal laws are relevant to the actions considered in this EA.

National Environmental Policy Act (NEPA). All of the cooperating agencies are subject to National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321-4347). This EA has been prepared in compliance with NEPA (42 USC Section 4231, et seq.,); the President's Council on Environmental Quality (CEQ) Regulations, 40 Code of Federal Regulations (CFR) Section 1500-1508; and Department of the Interior's Departmental Manual for NEPA compliance, Fish and Wildlife Service (516 DM 6). The Department receives funding for bighorn sheep management and restoration from the U.S. Fish and Wildlife Service's Federal Aid in Wildlife Restoration Program and is therefore subject to NEPA.

National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee). This Act, derived from sections 4 and 5 of Public Law 89-669, "consolidated 'game ranges,' 'wildlife ranges,' 'wildlife management areas,' 'waterfowl production areas,' and 'wildlife refuges,' into a single 'National Wildlife Refuge System.' It (1) placed restrictions on the transfer, exchange, or other disposal of lands within the system; (2) clarified the Secretary's authority to accept donations of money to be used for land acquisition; and (3) most importantly, authorized the Secretary, under regulations, to 'permit the use of any area within the System for any purpose, including but not limited to hunting, fishing, public recreation and accommodations, and access whenever he determines that such uses are compatible with the major purposes for which such areas were established."

National Wildlife Refuge System Improvement Act of 1997 (H.R. 1420, 105th Congress). This law is the first "organic" act for the National Wildlife Refuge System. The Act amends portions of the National Wildlife Refuge System Administration Act and the Refuge Recreation Act, and reiterates into law Executive Order 12996.

Migratory Bird Treaty Act. The Migratory Bird Treaty Act provides the U. S. Fish and Wildlife Service regulatory authority to protect species of birds that migrate outside the United States. All cooperating agencies coordinate with the Service on migratory bird issues. Migratory birds would not be affected by this proposal except in an unlikely event on non-target capture or lead poisoning from scavenging on predators shot with lead containing ammunition. Any impact on a migratory bird would be reported to the Service, Migratory Bird Management Office. See Chapter 4, Impacts on non-target species.

Sikes Act (16 United States Code [USC] 670a-670o, *et seq*.). This Act authorizes the Secretary of Defense to carry out a program of planning for, and the development, maintenance, and coordination of, wildlife, fish, and game conservation and rehabilitation in each military reservation in accordance with a cooperative plan mutually agreed upon by the Secretary of Defense, the Secretary of the Interior, and the appropriate State agency designated by the State in which the reservation is located. The Act also requires the preparation and implementation of an INRMP for any military installation in the United States with significant natural resource management responsibilities. INRMPs ensure that activities on military lands are consistent with natural resource conservation and federal stewardship requirements.

1.8.3 New Mexico State Laws

New Mexico Wildlife Conservation Act. In general, Chapter 17 provides the authority for the Department to manage wildlife in order to maintain viable populations for the benefit of the New Mexican public. This law mandates management and recovery of state-listed endangered species. The Act, founded in 17-2-37, N.M.S.A. 1976, as amended. requires recovery, management, and protection of al state-listed endangered species. As identified in the Desert Bighorn Sheep Management Plan, reintroduction of desert bighorn sheep into the San Andres Mountain is essential to fully recover the species.

CHAPTER 2: DESCRIPTION OF ALTERNATIVES

2.1 Alternative 1 - Preemptive and Offending Lion Management (Proposed Action Alternative)

The Proposed Action would implement a mountain lion damage management program whereby the Department would request that their contractor, in consultation with the Refuge and Range, take immediate action to protect the endangered desert bighorn sheep from both direct and indirect impacts from mountain lions.

Mountain lion damage management is founded on interagency relationships, which involves close coordination and cooperation because of overlapping authorities and legal mandates. Mountain lion control is one of three proposed management tools to support the restoration of desert bighorn sheep in the San Andres Mountains range. The program would remove a limited number of mountain lions by discerning the location, distribution and activities of mountain lions in relation to desert bighorn sheep. Control would be directed toward individual problem ("offending") mountain lions and those posing a direct threat based on their proximity to the release area(s) for bighorn sheep. Offending, or problem, mountain lions are those that predate on any one desert bighorn sheep. The

proposed action would employ expert trackers to locate, track, capture and dispatch mountain lions in a definite area around release site(s).

The proposed action has several components:

- Any mature mountain lion perceived to be a threat to desert bighorn sheep would be killed. Factors that determine a threat might include proximity to bighorn sheep release area, availability of alternative prey, approximate weight of the mountain lion related to age, or overall behavior and movement of the mountain lion. The "perception" of a threat is difficult to anticipate because it would depend on many factors, many of which are dynamic, as are listed on the following pages. Determinations would be jointly made based on the professional judgement of the cooperating agencies. Preemptive (population-level reduction) control of mountain lions would continue for a total of five months, preferably with a minimum of two months pre-release of a bighorn sheep transplant. Snares would be placed on the Refuge, concentrating on the area around the desert bighorn release site, and/or specific drainages in a small buffer zone around the release site on the Range where there is a high likelihood that the presence of a mountain lion indicates a threat to desert bighorn sheep. The contractor would contact a Refuge or Range designated official, identified within the contract, for approval to place snares on those lands.

- One or more of the release sites may be used over the next five years for bighorn sheep transplants. Proposed release sites and corresponding lion control areas are:

release site	*lion control area*
Bennet/Black Brushy Mountains	Bear Canyon north to Salt Canyon, following Refuge east/west boundaries
San Andres Mountain	Salt Canyon north to San Andres Canyon, following Refuge east/west boundaries

- Following a bighorn sheep transplant and the five months of preemptive lion control, only offending mountain lions that have preyed on any one bighorn sheep would be killed. Offending mountain lions would be snared at the kill site and removed by shooting. If snaring the mountain lion is unsuccessful, trailing mountain lions from the kill site with trained scent hounds and dispatching by shooting may be considered.

- This policy would remain in effect as long as lions are killing less than 5% of the San Andres desert bighorn population during any consecutive 12 month period. Each year the number of bighorn corresponding to 5% would be determined. This threshold was chosen based on the results of a Population and Habitat Viability

Assessment modeling conference which concluded that 5% additive mountain lion mortality would be sufficient to drive a small herd to extinction (Fisher et al. 1999). If this threshold is exceeded, we would revert to removing lions in the manner of the pre-release removal. Approximately 80% of all mountain lion predation on bighorn sheep in New Mexico occurs between December and May. Therefore, lion removal would occur for six months, or through the following May, whichever is longer. At that time, we would return to an offending lion policy, as described above.

- The cooperating agencies would periodically review the program's progress and impacts. Preemptive mountain lion control and the 5% threshold, would discontinue once the San Andres desert bighorn sheep population reaches a minimum of 100 animals including at least 75 adult ewes, and the offending lion control would cease with a total of 200 animals including at least 100 adult ewes. Should desert bighorn population numbers fall below the animal levels described above, the preemptive and offending lion control policies may take effect until the desert bighorn population numbers increased to the required level.

- Preemptive and offending lion control would cease if the desert bighorn sheep experience an all herd die-off.

The Department would be the agency that conducts mountain lion control after consultation with the Refuge and Range. One contractor to the Department would be permitted to remove mountain lions from a limited area (around release site(s)) on the Refuge for a total of five months. According to Department rules and regulations, the final disposition of the lions removed from the San Andres Mountains, would be delineated in the contract for the Department contractor. In selecting management techniques for specific damage situations, consideration would be given to the following:

- extent of threat or predation;
- geographic proportion of threat;
- other land uses (i.e., military activities);
- feasibility of implementation of the various allowed techniques;
- mountain lion movement patterns and life cycle of the lion;
- status of target and non-target species (i.e., listed or sensitive species);
- local environmental conditions such as terrain, vegetation, and weather;
- humaneness of the available options; and
- costs of control options.

2.2 Alternative 2 - Offending Mountain Lion Management

This alternative involves the removal of offending mountain lions. The Department would request that their contractor, in consultation with the Refuge and Range, take immediate action to protect the endangered bighorn sheep from direct impacts from mountain lion predation. Control would only be directed toward individual problem (offending) mountain lions.

This alternative would selectively remove mountain lions by controlling any mountain lion which kills a bighorn sheep. Expert trackers would be employed by the Department as described in Alternative 1, and a zero tolerance policy would be in place whereby offending lions would be removed after preying on any one bighorn sheep.

This alternative includes the following components:

- Only mountain lions that have killed bighorn sheep would be snared at the kill site and removed by shooting. If snaring the mountain lion has been unsuccessful, trailing mountain lions from the kill site with trained scent hounds and dispatching by shooting may be considered.

- Offending mountain lion control would cease once the San Andres bighorn sheep population reaches a minimum of 200 animals, including at least 100 adult ewes. Should bighorn population numbers fall below the level described above, offending lions would be subject to removal until the San Andres desert bighorn population numbers increased to the required level.

The Department would be the agency that conducts mountain lion damage management, after consultation with the Refuge and Range. One contractor to the Department would be permitted to remove mountain lions from a limited area on the Refuge.

An effective program requires that site specific consideration of the many variables be given to allow the resource manager to select and implement the most appropriate technique to resolve each predation situation. Adaptive management is essential because of the high variability found in the natural environment.

2.3 Alternative 3 - No Action

Under this alternative, present management would be continued and the cooperating agencies would not take any action to prevent mountain lion predation on desert bighorn sheep on the Refuge. The cooperating agencies would continue other management efforts to restore the San Andres desert bighorn sheep population, such as prescribed burning and augmentation, but without mountain lion control. Present management also includes

monitoring bighorn population status, movements, and mortalities of sheep through radiotelemetry and ground observations. No action, in this case, means no Federal Action, as is consistent with the Council on Environmental Quality's definition and requirement for a "no action" alterative. The no action alternative serves as a baseline from which to compare the action alternatives.

2.4 Alternatives Considered but Rejected with Rationale

Non Lethal Control of Mountain Lions - Under this alternative, mountain lions deemed to be a threat, either directly or indirectly, relative to the criteria defined under Alternative 1, would be controlled through non-lethal means.

After determining that a mountain lion is a threat to bighorn sheep, the option would be to capture, tranquilize, and relocate the target mountain lion to a suitable location away from the project area. This option would be used if the resource manager determined that the mountain lion was an imminent threat to bighorn sheep, and must be removed immediately. This would require identification of a suitable new location, upon Department approval, and the cooperation of the recipient land management agency.

The Department has determined that there are no suitable transplant sites in New Mexico in which to move mountain lions (R. Beausoleil 2002, pers. comm.). Furthermore, between 1989-1991, Ruth et al. (1998) translocated fourteen mountain lions from the southern San Andres Mountains to nine release sites in northeastern and one site in northwestern New Mexico. Mountain lions were translocated and radio-monitored through January 1993; these mountain lions were moved 338-477 km (210-278 mi) from the San Andres Mountains. Nine of 14 translocated lions died during this study; translocation was most effective for animals between 12-27 months of age. Ruth et al. (1998) described that higher mortality rates for translocated mountain lions compared to animals in the San Andres Mountains suggest translocations produce a high risk of death for mountain lions.

Another nonlethal option is to harass the mountain lion away from the site and bighorn sheep, by trailing with trained scent hounds until bayed or treed, shot with a tranquilizer, radiocollared, and released unharmed. Hebert and Lay (1996) argued that harassment techniques can teach some mountain lions to avoid the location where they were harassed because of the unpleasant experience associated with it. However, MacArthur et al. (1982) found that heart rates of bighorn sheep increased in response to disturbance by domestic dogs. Several studies described that the closer the human disturbance, the farther the bighorn sheep moved to get away from the source of stimuli (Hicks and Elder 1979, MacArthur et al. 1979, 1982, Krausman and Hervert 1983, and Papouchis et al. 2001). Results from these studies raise concerns about predisposing bighorn to predation and less desirable habitat conditions as a consequence of these types of human activities.

CHAPTER 3 - ISSUES IMPORTANT TO THE ANALYSIS OF IMPACTS

3.1 Issues Driving the Analysis

The cooperating agencies have determined that the following issues should be considered in the decision making process for this EA to help compare the impacts of the various alternative management strategies:

- **Impacts on mountain lion populations** - What would be the impacts of a mountain lion damage management program on the San Andres mountain lion population? What would be the cumulative direct and indirect impacts of the proposal?

- **Effectiveness** - What is the relative effectiveness of the alternative strategies in protecting the bighorn sheep from predation? Do they meet the objectives of the proposal?

- **Impacts on non-target species** - Would there be potential impacts on other species not targeted in mountain lion damage management?

- **Humaneness** - How humane are the respective alternative strategies? Because humaneness can be dependent on perspective, how is humaneness perceived by various interests?

3.2 Issues Not Analyzed in Detail with Rationale

- **Impacts on the San Andres ecosystem** - No wildlife damage management would be conducted to extirpate native or indigenous wildlife populations. The number of individual mountain lions taken would be a small number of the total population as analyzed in Chapter 4.

- **Other resources** - The actions discussed in the EA do not necessitate any ground disturbance or construction. Therefore, the following resource values are not expected to be significantly impacted by any of the alternatives analyzed: soils, geology, minerals, water quality/quantity, flood plains, wetlands/aquatic resources, air quality, vegetation, or cultural resources. There are no significant irreversible or irretrievable commitments of resources. These resources will not be analyzed further.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Chapter 4 provides information needed for making informed decisions on the mountain lion damage management objectives identified in Chapter 1. Each of the issues would be analyzed for its environmental consequences under each alternative. Cumulative impacts are addressed with respect to each of the key species analyzed in this EA. Indirect impacts are discussed throughout this chapter where applicable.

4.1 Alternative 1 - Preemptive and Offending Lion Management (Proposed Action Alternative)

4.1.1 Impacts of preemptive and offending control on mountain lions

Mountain lion population information

Mountain lions are the most widely distributed terrestrial mammal in the western hemisphere, covering 100º of latitude; ranging from the southern tip of South America to British Columbia (Iriarte et al. 1990) in which they inhabit many habitat types from desert to alpine environments, indicating a wide range of adaptability Prey species may vary depending on local abundance and vulnerability, but mule deer are the principal food source for the majority of mountain lions (Logan and Sweanor 2001), while bighorn sheep are generally considered alternate prey (Anderson 1983). Most evidence indicates mountain lions permanently occupy areas inhabited by bighorn sheep only where deer occur sympatrically and at densities sufficient to provide a primary food source (Schaefer et al. 2000). Mountain lion predation on alternate prey species may increase when mule deer populations are depressed (Leopold and Krausman 1983). Thus predation on bighorn sheep may be exacerbated when mule deer populations are low. Logan and Sweanor (2001) believed mountain lion predation on bighorn sheep was reduced when mule deer were abundant, and Rominger and Weisenberger (2000) found increased mountain lion predation on bighorn sheep in New Mexico associated with a rapid decrease in a mule deer population.

Female mountain lions typically breed for the first time between 22 and 29 months of age (Ashman et al. 1983), but initial breeding may be delayed (Hornocker 1970). Mountain lions breed and give birth year round but most births occur during late spring and summer following a 90-day gestation period (Ashman et al. 1983, Seidernsticker et al. 1973, Robinette et al. 1961). One to six offspring per litter is possible, with an average of two to three young per litter.

Specifically in the San Andres Mountains, Logan et al. (1996) found that males first exhibited reproductive behavior at an average age of 24.3 months, and

although females first exhibited reproductive behavior at an average of 21.4 months, they conceived for the first time at an average age of 26.1 months and had their first litters at an average of 29.1 months old. Although mountain lion cubs were born year-round, there was a birth pulse documented during July - September, which coincided with the mule deer fawning period. Logan et al. (1996) observed an average litter size of 3.38 for first litters compared to 2.95 for subsequent litters.

Mountain lion density is closely related to prey availability and the social tolerance for other mountain lions. Prey availability is directly related to prey habitat quality that directly influences mountain lion nutritional health, and reproductive and mortality rates. Studies indicate that as available prey increases, so do mountain lion populations. The relationship of the mountain lion to its prey and to other mountain lions is why densities do not reach levels observed in a number of other predator species (Oregon Department of Fish and Wildlife 1993).

Mountain lion densities in New Mexico

Statewide, the mountain lion population density estimate generally ranges from 1.5 to 2.0 adults per 100 km^2 (R. Beausoleil 2002, pers. comm.). During a ten-year field study to research the ecology of mountain lions, Logan et al. (1996) had three primary objectives including 1) describe the dynamics of the San Andres mountain lion population; 2) describe the social organization of mountain lions in the population; and 3) quantify some of the relationships between mountain lions and mule deer and desert bighorn sheep. As part of that study, 13 subadult and adult mountain lions were experimentally removed from the Treatment Area of the San Andres Mountains to measure how quickly a mountain lion population can recover, about the patterns of replacement of breeding adults, and to evaluate translocation as a feasible option to manage problem individuals (Logan et al. 1996, Ruth et al. 1998). A fourteenth mountain lion was translocated after it killed three desert bighorn sheep. The Treatment Area was defined as the southern one third of the study area, including all of the San Andres National Wildlife Refuge. The San Andres mountain lion population increased during 1988-1995 (Logan and Sweanor 2001). Table 1 describes mountain lion densities as reported during that study.

Following the onset of the recent drought conditions in the mid 1990's, the mule deer herd in the San Andres Mountains rapidly declined. Mountain lions in the San Andres Mountains were primarily dependent upon mule deer for food; consequently, a steep decline in deer abundance would likely result in a decline in mountain lion numbers, albeit after a lag period (Logan and Sweanor 2001). Current mountain lion numbers in the San Andres Mountains are anticipated to be

less than or similar to those reported by Logan and Sweanor during 1988 (K. Logan 2002, pers. comm.; P. Morrow 2002, pers. comm.; and M. Weisenberger 2002, pers. comm.). For this reason, now is an opportune time to augment the San Andres desert bighorn sheep population.

Table 1. Estimated density of mountain lions each January in the San Andres Mountains, New Mexico, 1988-1995 (Logan and Sweanor 2001).

	Mountain lions/100 km²			
Year	***Adult Males***	***Adult Females***	***Total Adults***	***Total Mountain Lions[a]***
		Treatment Area		
1988	0.73	0.43	1.16	2.01
1989	0.84	0.86	1.70	2.63-2.88
1990	0.64	1.25	1.89	2.91-3.60
1991	0.90	1.20[b]	2.10	3.24-3.91
1992[c]	0.38	0.46	0.84	2.93
1993	0.58	1.17	1.75	3.06-4.25
1994	0.76	1.31	2.07	2.78-3.20
1995	0.82	1.17	1.99	3.27-4.12
		Reference Area		
1989	0.50	0.44	0.94	1.72-1.96
1990	0.52	0.82	1.34	2.23-2.52
1991	0.58	0.78	1.36	2.09-2.71
1992	0.61	1.05	1.66	2.39-2.83
1993	0.71	1.09	1.80	3.19-3.90
1994	0.66	1.07	1.73	2.69-3.24
1995	0.82	1.19	2.01	2.60

[a]Total mountain lions includes adults, subadults, and cubs.

[b]The January 1991 estimate reflects the absence of one adult female that was removed in December 1990.

[c]Mountain lions were experimentally removed from the Treatment Area from 9 December 1990 to 22 June 1991.

Accuracy of mountain lion population estimates

Mountain lions are exceptionally difficult to census or study because they are cryptic (highly secretive and difficult to observe), solitary, and live at low densities in rugged or densely vegetated habitat. Thus, they cannot be readily observed from the ground or aircraft for purposes of counting their numbers or to monitor population trends (Logan et al. 1996). Logan et al. (1996) used intensive capture-mark-recapture and radiotelemetry techniques to estimate and describe the mountain lion population in their study area in the San Andres Mountains, which is generally accepted as the most reliable means currently available for estimating mountain lion numbers (U. S. Department of Agriculture 2000). Track counts have been used by some researchers to estimate population densities, but even that technique can require extensive costs to detect even 30% changes in track densities (Beier and Cunningham 1996).

Therefore, the best scientific information currently available for estimating the mountain lion population in New Mexico is that which can be derived from the 10-year study by Logan et al. (1996). The Department has estimated that mountain lion density in lion habitat in the State averages 1.5 to 2.0 adults per 100 km^2 which is mid range of the 0.9-2.1 adults per 100 km^2 that Logan et. al (1996) reported in the San Andres Mountains. Table 2 describes the estimates of the adult mountain lion population in the San Andres Mountains from 1988 to 1995.

Under the above assumptions based on the best scientific information available, the Department estimated the 2002 overall mountain lion population in the State to be approximately 2,100 animals (includes adults and subadults) (R. Beausoleil 2002, pers. comm.). This estimate was derived by quantifying the amount of suitable mountain lion habitat in the State (based on areas occupied by the mountain lion's principle prey species which is mule deer), and applying the assumed density of 1.5 to 2.0 adults per 100 km^2.

Logan et al. (1996) reported that the rate of increase in the unhunted, uncontrolled population in the San Andres Mountains averaged 17% per year for the first 4 years of the study, and then dropped to 5% per year for the last 4 years. The authors felt the rate of increase declined because the population approached carrying capacity or that carrying capacity dropped because of lower prey availability resulting from drought. The average rate of increase for the population was approximately 11% during the entire study (Logan et al. 1996).

Table 2. Estimated mountain lion population each January in the Treatment Area (1988-1995) and Reference (Control) Area (1989-1995), San Andres Mountains, New Mexico[a] (Logan and Sweanor 2001).

	Adults		Subadults			
Year	**Males**	**Females**	**Males**	**Females**	**Cubs**	**Total**
			Treatment Area			
1988	5.14	3.02	0	0.00	6	14.16
1989	5.94	6.04	1	2.59	2.89-4.67	18.46-20.24
1990	4.47	8.82	1	2	4.19-9.01	20.48-25.30
1991[b]	6.34	8.47[b]	0	1b	7-11.68	22.81-27.49
1992	2.67	3.22	0.68	4	10	20.57
1993	4.08	8.20	2-3[c]	0-1[c]	6.20-14.60	21.48-29.88
1994	5.32	9.20	0	0	5-8	19.52-22.52
1995	5.78	8.20	0	0	9-15	22.98-28.98
			Reference Area			
1989	6.81	5.96	1	0.41	9.11-12.33	23.29-26.51
1990	7.04	11.18	1	1	10-14	30.22-34.22
1991	7.84	10.53	0	1	9-17.32	28.37-36.69
1992	8.33	14.28	0.32	1	8.50-14.50	32.43-38.43
1993	9.66	14.80	2	3	13.80-23.40	43.26-52.86
1994	8.97	14.54	2	2	9-16.48	36.51-43.99
1995	11.16	16.10	1	1	6	35.26

[a]Radiocollared mountain lions that lived along either the Treatment Area-Reference Area boundary or the study area boundary were included in the Treatment Area or Reference Area based on the proportion of their aerial locations in the area during each year. Cubs were included in areas in identical proportions as their mothers.

[b]Mountain lions were experimentally removed from the Treatment Area from 9 December 1990 to 22 June 1991. The January 1991 estimate reflects the absence of one adult female and subadult female that were removed in December 1990.

[c]Subadults present in January 1993 consisted of either three males, or two males and one female.

The 11% observation was calculated when habitat conditions were good and the mule deer population, the lions' primary prey species, was stable or increasing, and was not hunted. With the persistence of the drought and the extremely low mule deer numbers, the current mountain lion population growth rate in the San Andres Mountains may be stable at low numbers, or may still be declining. Thus, with the current environmental conditions substantially different as were during

the Logan et al. (1996) study, we can speculate there is a lower mountain lion density related to the crash of the mule deer population.

Mountain lion population impact analysis

Mountain lion populations can sustain relatively moderate to heavy losses of adults and still maintain viable populations. Robinette et al. (1961) reported an annual mortality of 32% in Utah, while Ashman et al. (1983) noted a sustained annual mortality of at least 30% in Nevada. Ashman et al. (1983) believed that under "moderate to heavy exploitation (30-50 %)" mountain lion populations within their study area had the recruitment (reproduction and immigration) capability to rapidly replace annual losses. The allowable annual harvest level for mountain lion cited by the U. S. Department of Agriculture (1995) is 30% of the population.

The Department has established harvest objectives at just under 11% of the estimated adult mountain lion population in zones where the objective is to maintain the population and 21% of adults in several zones where the objective is to decrease the lion population. A general rule that has been applied to all sport mountain lion hunting is that any spotted kittens or females accompanied by spotted kittens may not be taken (New Mexico Game and Fish Commission Big Game Reg. 31.8, item 12.3).

New Mexico currently conducts two mountain lion control programs. The first program was passed by the New Mexico Game and Fish Commission in January 1985 in response to the increasing number of livestock being killed by lions in game management unit 30. This Order instructed the Department to remove lions on ranches that had more than four verified livestock animals killed by lions. Each year, the Department could remove up to 14 lions from all ranches in the southern portion of the Unit combined. In 1986 the Order was revised and the number of verified livestock killed required for lion removal was increased to six within a three-year period; the maximum number of lions that could be removed yearly remained at 14. In 2002, it was revised again to allow a maximum of 20 mountain lions to be taken, and expanded the control area to the entire unit.

The second lion control program was initiated in response to declining low-elevation Rocky Mountain and desert bighorn sheep populations (Rominger and Dunn 2000). Currently six wild populations of Rocky Mountain bighorns with a total population estimate of 700 and 5 wild populations of desert bighorns with a population estimate of 175 occur in New Mexico (Rominger 2000, Rominger and Goldstein 2001a,b,c). Approximately 110 Rocky Mountain bighorn occur in three low-elevation populations (Rominger and Goldstein 2001b). Of 93 radiocollared

mortalities on desert bighorn sheep between 1993 and 2002, 71 (76%) were killed by mountain lions (NMDGF unpubl. data). In 1997, the Commission passed a regulation that required the Department to kill any lion that was known to have killed a bighorn sheep. Between 1997 and 1999 1-3 lions were harvested annually because of bighorn predation, however predation rates continued to be high. In 1999, the Commission passed another regulation allowing the removal of up to 34 lions/year, for 5 years, in 4 bighorn sheep populations (Rominger and Dunn 2000). These populations are in the Peloncillo, Hatchet, Sierra Ladron, and Manzano Mountains. Currently year-round sport harvest can occur in these 4 bighorn ranges. The Commission, in April 2002, approved a second lion permit for public lion hunters to be used only in these 4 bighorn sheep ranges. Beginning in 1999, The Department hired contract houndsmen to remove lions from these 4 bighorn ranges. However, between 1999 and September 2001 only 1 lion was removed. During the 2001-2002 season, The Department continues to use houndsmen in the Peloncillo and Hatchets mountain ranges and a snareman in the Manzano and Sierra Ladron mountain ranges. Since October 2001, 9 lions have been removed from these ranges by contract hunters/trappers. The Department has conducted lion sign surveys in these 4 mountain ranges since the initiation of lion control in 1999 (Rominger et al. 2002).

Mountain lion harvest and depredation take

There were 214 (97F, 117M) mountain lion pelts tagged from 63 game management units during the 2001-2002 hunt season (Table 3). The five-year (1997-1998 through 2001-2002) average mountain lion harvest in New Mexico is 184 mountain lions (71F, 113M); the 10-year average harvest (1992-93 through 2001-2002) is 160 (61F, 98M). Mountain lion hunting license sales have increased in New Mexico. Sales began to escalate during the 1990-91 hunting season and increased 62% (482 to 781) from the previous year (Table 2). Since that time, numbers have fluctuated but continued in an upward trend. In the past five years hunting permit sales have increased 81% (974 to 1,761).

It is the policy of the Department to resolve depredation and to minimize property damage, conflict, and threat to human safety by mountain lions. The legal definition of depredation in New Mexico is "property damage by protected wildlife on privately owned or leasehold interest land, where the damage value exceeds applicable income earned on that site from the wildlife species causing damage." When a depredation complaint is received, a Department investigator and the complainant visit the complaint site within 24 hours, or as soon as the complainant is available.

Table 3. Mountain lion hunting licenses issued and sex of harvest in New Mexico, 1981-2002.

Hunt Year	Licenses Issued	Male Harvest	Female Harvest	Unknown Sex	Total Harvest
1981-1982	360	78	44	3	125
1982-1983	481	55	44	1	101
1983-1984	661	67	65	0	132
1984-1985	443	47	32	0	79
1985-1986	472	56	48	0	104
1986-1987	437	55	46	0	101
1987-1988	456	43	35	0	78
1988-1989	450	58	33	0	91
1989-1990	482	71	41	0	112
1990-1991	781	73	35	0	108
1991-1992	765	77	42	0	119
1992-1993	826	68	37	0	105
1993-1994	926	75	52	0	127
1994-1995	1145	87	61	2	150
1995-1996	842	74	45	0	119
1996-1997	980	114	62	1	177
1997-1998	974	108	58	2	168
1998-1999	1485	95	58	0	153
1999-2000	1702	98	58	0	156
2000-2001	1430	145	86	0	231
2001-2002	1761	117	97	0	214

The on-site investigation is to identify the complaint type as a depredation, conflict, or human safety problem and to verify if any human actions are contributing to the problem. If a depredation situation exists, a permit authorizing a kill may be issued to the investigator or directly to the landowner. Permits issued have a specific start and end date and all kills are reported immediately. When the permit expires, the investigating officer submits a detailed narrative of the incident and outcome to the depredation coordinator. In the previous five years, The Department has issued an average of 31 permits per year, the highest being 45 permits in 1999 (Table 4).

Table 4. Number of mountain lion depredation permits issued and lions killed in New Mexico, 1981-1999 (Beausoleil 2000).

Year	# Depredation Permits Issued	# Male Lions Killed	# Female Lions Killed	# Unknown Sex Killed	Total # Lions Killed
1981	13	0	0	0	0
1982	22	0	0	0	0
1983	11	3	4	0	7
1984	6	0	0	0	0
1985	5	0	0	0	0
1986	14	4	1	2	7
1987	15	3	2	2	7
1988	7	0	1	0	1
1989	17	2	3	1	6
1990	24	1	3	0	4
1991	31	7	3	0	10
1992	32	3	5	0	8
1993	23	4	5	0	9
1994	16	5	4	0	9
1995	27	3	2	0	5
1996	26	6	4	0	10
1997	29	6	3	0	9
1998	28	3	2	0	5
1999	45	5	14	1	20

During the 2000-2001 harvest season, the Department began obtaining a tooth from each mountain lion taken to determine ages (Beausoleil 2000). This will provide for more accurate determination of the effect of harvest/control on the overall population, and improved ability to compare take against harvest objectives.

The cooperating agencies propose to remove all mountain lions that are determined to be a threat to the bighorn sheep, as defined by the criteria established in Chapter 2. It is likely that only a few mountain lions would be removed, but the exact number is not known at this time, nor could it be predicted annually with any certainty (for the reasons discussed under Section 2.1).

Therefore, this analysis will focus on 2 scenarios; on the impact of removing up to three mountain lions per year, and on the scenario of removing five or more mountain lions per year. It is important to stress that only a mountain lion that is determined to be a threat to the desert bighorn sheep would be removed.

Impact of removing up to three mountain lions per year

Based upon field observations to date, it is likely that up to three mountain lions would be removed in the upcoming year from the proposed project area. We speculate that the mountain lion population in the southern third of the San Andres Mountains (analogous to the Logan et al. [1996] Treatment Area), is currently similar to the estimate in 1988 (n = 14 lions). The impact of removing two to three mountain lions would then be a reduction of 14-21% of the southern San Andres estimated mountain lion population. At the end of the experimental removal period of the Logan et al. (1996) study, the entire Treatment Area mountain lion population had been reduced by 47%; adult lions had been reduced by 53%. Thirty-one months post-treatment, the adult segment of the lion population had nearly recovered to the 1991 pre-removal level, with a difference of -0.27 mountain lions (Logan and Sweanor 2001). The mountain lion population is resilient, and the impact on the population would be low and within the allowable harvest levels for the mountain lion management zone set by the Department.

Impact of removing five mountain lions or more per year

Five or more mountain lions could potentially be removed per year from the southern portion of the San Andres Mountains bighorn sheep habitat. The higher figure is based on the potential that a replacement mountain lion emerges and creates another threat within a short period of time or that the mountain lion population is larger than predicted. These are factors that cannot be predicted with certainty. If five mountain lions were removed each year from the low density estimate of 14 mountain lions in the southern San Andres Mountains, then 35% of the mountain lions in the southern San Andres habitat area would be removed (assuming no recruitment of mountain lions). Based on the low density estimate for the entire San Andres mountains, removal of three to ten lions would be a 6-20% reduction in the estimated mountain lion population.

If five mountain lions were removed from the southern San Andres habitat, the immediate impact in that area would be a loss of five individual mountain lions from an estimated total of 2,100 mountain lions statewide. This equates to removing 0.24% of the mountain lions from New Mexico. Removal of 15 lions equates to 0.72%. This is a low magnitude impact. When we look at the overall

mountain lion population in the state, impacts are negligible. Sweanor et al. (2000) observed that the San Andres mountain lion population was a subpopulation in a configuration of mountain lion subpopulations in the Southwest. The physical geography of the landscape of the basin and range naturally fragments lion habitat and the accompanying lion population. Logan and Sweanor (2001) documented that ≥45% of immigrant recruits produced progeny. Likewise, emigrants from the San Andres Mountains were contributing recruits to other mountain lion subpopulations as part of a metapopulation inhabiting southern New Mexico (Logan and Sweanor 2001). However, it should be reiterated that environmental conditions in the study area have markedly changed since the Logan et al. (1996) study.

Impacts would be interim as young or transient mountain lions would be recruited as replacements, and mountain lions would be removed only until the desert bighorn sheep population reached viable levels as described in Chapter 2. The overall impact of taking five or more mountain lions would be low.

The proposed action would be within management objectives as defined by the Department to temporarily suppress a local mountain lion subpopulation to restore a healthy State-Endangered desert bighorn sheep population. For all of these reasons, the proposal would not have a serious impact on the viability of the mountain lion population in the San Andres Mountains, or in New Mexico. Therefore, because the intensity of the impact would be low and temporary, and because the context is limited in scope and consistent with relevant laws, the biological impact on the mountain lion population is not considered to be detrimental.

The proposal emphasizes monitoring mountain lions around the project area. This would give agency experts more information on the status and trends of the mountain lion population in the San Andres Mountains. The information would be used to continue to assess the impacts of the proposed project.

Cumulative impacts on the mountain lion population

Mountain lion survival is functionally related to the status of their prey base (Logan and Sweanor 2001). In comparison to the total number of mountain lions that have been hunted statewide between 1998-2002, the proposed action could add approximately 2.7 % to the total average number of mountain lions hunted (see Table 3). In comparison to the total number of mountain lions that have been removed each year statewide because of predation on livestock and pets, this proposal could add the following to that mortality: the proposed action could add about 10% to the total average number of mountain lions that have been killed

statewide under depredation permits between 1995-1999 (see Table 4). It is more likely that the proposed program would add between four and six percent to the average number of mountain lions killed between 1995-1999, based on existing environmental conditions.

When all other known sources of mountain lion mortality are added to the number of mountain lions that may be killed to protect the bighorn sheep, figures still remain low. The impact on the mountain lion population in New Mexico is too small to detect a measurable response. Biologically, there would not be an important effect on the viability of the mountain lion population in the San Andres Mountains or in New Mexico. The proposed project would be well within Department goals for managing mountain lions as discussed in this chapter and Section 1.6.

Indirect impacts on mountain lions

Sex ratios of adult mountain lions in the southern San Andres Mountains remained unchanged when individuals were experimentally removed between 1990-1991. Those that were removed were replaced numerically by same-sex recruits (Logan and Sweanor 2001). Studies evaluating mountain lion populations in Idaho (Seidensticker et al. 1973) and Utah (Laing and Lindzey 1993) also found a similar pattern of replacement of adult mountain lions. Lindzey et al. (1992) observed the adult resident segment of a mountain lion population in southern Utah, with the possible exception of one male, recovered within nine months of experimentally removing 27% of the lions > 1-year-old. As discussed previously, Logan et al. (1996) experimentally removed 47% of the entire mountain lion population in the southern San Andres Mountains; adult lions had been reduced by 53%. Thirty-one months post-treatment, the adult segment of the lion population had virtually recovered to the 1991 pre-treatment level, with a difference of -0.27 mountain lions (Logan and Sweanor 2001).

Another indirect impact that could result from removing mountain lions, the dominant predator, from its range is a possible ingress of other predators such as coyotes *(Canis latrans)* or bobcats *(Lynx rufus)*. Most accounts of bighorn sheep predation involve coyotes or mountain lions, with occasional cases of bobcat, golden eagle *(Aquila chrysaetos)*, lynx *(Lynx canadensis)*, gray fox *(Urocyon cinereoargenteus)*, wolf *(Canis lupus)*, or bear *(Ursus sp.)* predation (Sawyer and Lindzey 2002). Several authors have recorded coyote-bighorn sheep interactions (McCann 1956, Buechner 1960, Woolf and O'Shea 1969, Geist 1971, Demarchi and Mitchell 1973, Shank 1977, Berger 1978, Thorne et al. 1979, Kelly 1980, Creeden and Schmidt 1983, Ashcroft 1986, Dekker 1986, Festa-Bianchet 1988,

Berger 1991, Bleich 1996, Bleich 1999), but none indicated coyote predation limited bighorn sheep populations.

4.1.2 Effectiveness

Mountain lion control is one of three proposed management tools to support the restoration of desert bighorn sheep in the San Andres Mountains range. The effectiveness of predator damage management is dependent upon the careful and skilled use of the appropriate combination of proven tools. The management methods proposed are snaring (leg snares only) or trailing, and shooting.

Snares would be checked every 24 hours and the captured target animal would be shot. Snares would be placed in the target animal's travel lane and/or baited with the target animal's preferred food to attract the animal. Effective snare placement contributes to the selectivity of capturing the targeted animal. The smaller non-target animals can be avoided, and larger animals can usually be released unharmed, especially by using legs snares instead of neck snares. This is the most effective "tool" that is available to manage mountain lion control in rugged remote terrain, such as the proposed project area.

Ernest et al. (2002) theorized that broad scale habitat removal of mountain lions was most beneficial for bighorn populations that consisted of <30 ewes, especially in small populations with <10 ewes. They further noted that by removing one or two mountain lions per year when bighorn populations contain 15 to 30 ewes, reduces extinction risks to <15% (Ernest et al. 2002).

After the first desert bighorn release from Red Rock in 1979 in the Big Hatchet mountains in southwest New Mexico, in which heavy losses occurred due to lion predation, Bavin (1980) recommended that " . . . intensive control of predators should be undertaken in any area where introduction of bighorn is planned. The loss of only a few sheep in such a program could spell success or failure of desert bighorn introduction efforts."

Preemptive mountain lion removal to protect desert bighorn sheep has proven successful on every occasion that it has been employed in New Mexico (Goldstein pers. com. 2002). In the San Andres mountains, 41 mountain lions were removed from late 1980 to early 1984. During this time, bighorn mortality rates from lion predation decreased from 35% to less than 5% (NMDGF files). In 1980, mountain lion control was initiated prior to release of 20 desert bighorn from a paddock in the Peloncillo mountains. Twenty-two mountain lions were removed (15 for livestock depredation). From 1980-82 only two bighorns were killed by lions and both those losses occurred in 1982. Goldstein (pers.com. 2002) states

that desert bighorn re-introductions in New Mexico have been most successful when a combination of preemptive and offending lion removal has been conducted while the bighorn herd remains small.

Dogs are often essential to the successful capture of mountain lions. Trained dogs may be considered as an option to locate and pursue the target mountain lion only after snaring has been found ineffective. Training and maintaining suitable dogs requires considerable skill. Mountain lion tracking specialists, contracted by the Department, with their own hounds would be employed. Specialists with years of experience with first hand knowledge of the project area would be used.

Removing mountain lions has the potential to increase both desert mule deer and bighorn sheep populations. The proposed action is to take mountain lions which have either preyed on desert bighorn sheep or are likely to adversely affect bighorn sheep. The proposed action is designed to reduce bighorn sheep predation and displacement from available habitat while limiting the number of mountain lions removed.

The effectiveness of the proposed action would be dependent upon numerous factors such as the skill of the Department contractors and cooperation of the respective agencies and project personnel. Some factors that may influence effectiveness cannot be predicted, such as weather, predator movement patterns, and exact desert bighorn sheep movement patterns.

4.1.3 Impacts on non-target species

Based on the experience of the Department contractors to control mountain lions in desert bighorn sheep habitat around the proposed project area and throughout the state, under the proposed action, we anticipate a very small number of individual non-target animals taken each year. All non-target species captured by the Department contractors are recorded and reported to the appropriate management agency. During the past year, no non-target animals were taken in New Mexico as a result of four Department contractors employed to remove mountain lions in desert bighorn sheep habitat (Department files). The proposed action would not have an important impact on non-target species.

4.1.4 Impacts on threatened and endangered species

There are no federally listed threatened or endangered species on the San Andres National Wildlife Refuge.

For the reasons described above, the proposed action would not have an appreciable adverse effect on federally or state-listed threatened or endangered species.

4.1.5 Humaneness

The issue of humaneness, as it relates to the killing or capturing of wildlife, is an important and very complex concept that can be interpreted in a variety of ways. Humaneness is a person's perception of harm or pain inflicted on an animal, and people may perceive the humaneness of an action differently (U. S. Department of Agriculture 1995). Some individuals and groups may be opposed to some of the management techniques proposed. Most animal welfare organizations do not oppose the concept of wildlife damage control, but they support more restrictions on those control methods perceived by them as inhumane, and support greater use of nonlethal controls (Schmidt 1989). Behavior modification (harassment) of mountain lions could be construed by some as stressful.

The proposed action contains measures to minimize animal suffering as much as possible, and to eliminate unnecessary suffering. The Department contracts highly specialized, well-trained and experienced individuals to control mountain lions and has improved the selectivity of devices such as break-away snares and chemical immobilization/euthanasia procedures that minimize or do not cause pain. Therefore, the magnitude of the impact is considered minor because wounding would be minimized, and selectivity would be maximized.

4.2 Alternative 2 - Selective Mountain Lion Management

4.2.1 Impact of selective control on mountain lions

Under this alternative, only "offending" mountain lions would be captured as discussed under the proposed action alternative. In this case, potentially fewer mountain lions would be removed from the local population because only mountain lions that preyed on any one desert bighorn sheep would be killed.

Once the San Andres Mountains bighorn population reaches a minimum of 200 animals, including at least 100 adult ewes, selective mountain lion control would cease. Ross et al. (1997) recommended that managers should expect highly variable predation rates on bighorn populations of less than 200 individuals. Should bighorn population numbers fall below the level described above, offending lions would be subject to removal until the bighorn population numbers increased to the required level, per Department rule NMAC 19.30.6, Procedures for Conducting Preventative Cougar Control in Bighorn Sheep Ranges.

4.2.2 Effectiveness

The effectiveness of selective mountain lion control is dependent upon the careful and skilled use of the appropriate combination of proven tools. The management method proposed is snaring (leg snares only) and shooting. Because this alternative would only take mountain lions that have preyed on bighorn sheep, it is reasonable to assume that this action would be likely to have a positive effect on reducing predation of desert bighorn sheep, while minimizing the number of mountain lions removed. However, since bighorn have to be killed by a lion before this method is used, losses of bighorn may be high before the lion(s) are removed and the initial losses may slow or reduce the success of recovery. Under Alternative 2, use of snares and trailing with dogs would be carried out similar to the proposed action.

During a study in southwest Alberta, Ross et al. (1997) observed that of the five mountain lions intensively monitored, two never preyed on bighorn sheep, one lion killed only one bighorn, and another preyed on 17 bighorn sheep. The home range of the radiocollared mountain lion responsible for the most bighorn sheep predation did not overlap habitat used by rams. Prey-class vulnerability to mountain lion predation was largely due to the behavior of individual lions, namely the single mountain lion (Ross et al. 1997). Because individual mountain lions are usually responsible for most of the bighorn sheep predation within a given bighorn population (Hoban 1990, Ross et al. 1997, Hayes et al. 2000, Logan and Sweanor 2001), prey-class vulnerability to mountain lion predation, at least with bighorn sheep, is primarily a function of the behavior of individual mountain lions and the sex and age class of bighorn sheep that inhabit the mountain lion's home range (Sawyer and Lindzey 2002). Several other studies also found that predation on bighorn sheep is related to the behavior of individual mountain lions (Hornocker 1970, Hoban 1990, Ross et al. 1997, Logan and Sweanor 2001) rather than the total number of mountain lions.

Wehausen (1996) and Hayes et al. (2000) reported that even a small number of mountain lions may affect bighorn sheep survival, and population-level impacts may be exacerbated if adult female sheep are heavily preyed upon. Rominger and Weisenberger (2000) corroborate these findings and suggested individual behavior of mountain lions may influence population dynamics of prey independent of mountain lion density.

The effectiveness of Alternative 2 would be dependent upon the same factors as in the proposed action alternative such as weather, predator movement patterns, and exact bighorn sheep movement patterns as well as the response time of personnel getting to the kill site. Successfully taking offending lions is dependent on getting

to the kill site shortly after the kill in order to catch the offending lion on the carcass. The longer getting to the kill site, the less effective this method is. Overall, the effectiveness of this alternative would also be rated as higher than Alternative 3, but this method is likely to be less effective than Alternative 1 at preventing losses of bighorn to mountain lion predation.

Once the bighorn population has been augmented in Fall 2002, a no-tolerance offending lion course of action would be enforced. At that time, an offending mountain lion would be removed once it preys on one bighorn sheep. Offending mountain lions would be snared and removed by the Department contractor.

Mountain lion predation on bighorn sheep is highly sporadic and varies annually (Ross et al. 1997, Logan and Sweanor 2001). The small size of most bighorn sheep populations and changes in availability of alternative prey likely result in variable predation rates among bighorn populations and among years for the same population (Jorgenson et al. 1997). Hoban (1990) speculates that preemptive removal or population-level reductions of mountain lions may not be successful in reducing the number of lion-related bighorn sheep mortalities, but Goldstein (pers. com. 2002) states that the history of desert bighorn population status and lion management in New Mexico doesn't tend to support this claim. Identification and selective removal of individual mountain lions has been an effective method for minimizing lion predation on some bighorn sheep populations (Sawyer and Lindzey 2002).

4.2.3 Impacts on non-target species

The impacts on non target species would be similar to the proposed action.

4.2.4 Impacts on threatened and endangered species

The impacts on threatened and endangered species would be similar to the proposed action.

4.2.5 Humaneness

The humaneness of the alterative would be similar to the proposed action.

4.3 - Alternative 3 - No Action

4.3.1 Impact of no management control on mountain lions

Under this alternative, the cooperating federal agencies would take no action to protect the bighorn sheep from predation by mountain lions. Therefore, no mountain lions would be killed by federal or state agencies.

4.3.2 Effectiveness

The immediacy of threats to the bighorn sheep as a result of the continuous exposure to predation (primarily by mountain lions), and the effects of avoidance of important habitat, are crucial to the San Andres population of desert bighorn sheep. If the recent population trend of the remaining native population continues, it will soon approach extirpation. A "No Action" alternative would continue the status quo where bighorn sheep could be expected to continue to decline, and the cooperating federal and state agencies would not provide the potential for the bighorn sheep to recover.

The effectiveness of mountain lion control is dependent upon the skilled use of the appropriate combination of proven effective tools. This alternative would have no direct effectiveness since there would be no program. The current mountain lion hunting program on White Sands Missile Range is open to military personnel exclusively and would provide only random removal of mountain lions.

The no action alternative would have no effectiveness, because no action by federal agencies would be taken to protect desert bighorn sheep.

4.3.3 Impacts on non-target species

No non-target species would be removed by federal or state agencies under this alternative.

4.3.4 Impacts on threatened and endangered species

The impacts on threatened and endangered species would be similar to the proposed action.

4.3.5 Humaneness

The No Action Alternative would be more humane for the target species than the proposed action. Mountain lions would not be tracked, captured and killed by Department contractors.

The No Action Alternative would continue the current scenario for the bighorn sheep. They would likely suffer continued predation and displacement. Some people may consider allowing the bighorn sheep to continue to be killed by mountain lions and to be displaced from available superior habitat to be inhumane.

4.4 Summary and Conclusions

Table 5 presents the major conclusions drawn from the analysis. All of the alternatives would result in no significant adverse impacts on the environment.

The effectiveness of the alternatives, given no significant impact in any of the other evaluation criteria, is probably the most important evaluation criteria (issue) in this assessment because of the current low numbers of desert bighorn sheep in the project area. The effectiveness of each alternative will likely determine if the proposal's objective to prevent further decline or demise of the desert bighorn sheep is met. Other measures of habitat improvement and augmentation are ongoing to recover the San Andres desert bighorn population.

Table 5. Summary of Impacts			
Issue	**Proposed Action (Alt. 1)**	**Selective Control of Lions (Alt. 2)**	**No Action (Alt. 3)**
Mountain Lion Control	Removal of low numbers of individual lions would have negligible effects on the San Andres mountain lion population	Removal or loss of low numbers of individual lions would have negligible effects on the San Andres mountain lion population	None
Effectiveness	Most likely to protect desert bighorn sheep from mountain lions	Less likely to protect desert bighorn sheep from mountain lions.	None
Nontarget Species	Low	Low	None
T&E Species	No adverse effect.	No adverse effect.	No adverse effect
Humaneness	Some people opposed to capture and killing of any wildlife. Methods used to minimize pain and suffering	Some people opposed to capture and killing of any wildlife. Methods used to minimize pain and suffering	Humane for mountain lions. No program to protect desert bighorn sheep would be desired
Cumulative	Low	Low	None

CHAPTER 5: CONSULTATIONS AND REFERENCES

5.1 Consultation and Coordination with Others

The proposal has been thoroughly coordinated with all interested and/or affected parties. Parties contacted include:

Tom Baca, Chief Division of Planning, U.S. Fish and Wildlife Service, Southwest Region

Penny Bartnicki, Wildlife Program Manager, Federal Aid, U.S. Fish and Wildlife Service, Southwest Region

Rich Beausoleil, Cougar/Furbearer Biologist, New Mexico Department of Game and Fish

Larry Bell, Director, New Mexico Department of Game and Fish

Carl Benz, Division Chief, U.S. Fish and Wildlife Service, Pacific Region

Scott Brown, Assistant Director, New Mexico Department of Game and Fish

Dom Ciccone, Regional Chief, U.S. Fish and Wildlife Service, Southwest Region

Kevin Cobble, Refuge Manager, San Andres National Wildlife Refuge, U.S. Fish and Wildlife Service

David Dall, Regional NEPA Coordinator, U.S. Fish and Wildlife Service, Southwest Region

Elise Goldstein, Bighorn Sheep Program Coordinator, New Mexico Department of Game and Fish

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Mara Weisenberger, Wildlife Biologist, San Andres National Wildlife Refuge, U.S. Fish and Wildlife Service

Darrel Weybright, Big Game Supervisor, New Mexico Department of Game and Fish

5.2 Literature Cited

Anderson, A. E. 1983. A critical review of literature on puma (Felis concolor). Colorado Division of Wildlife. Special Report Number 54. 91pp.

Ashcroft, G. E. 1986. Attempted defense of a lamb by a female bighorn sheep. Journal of Mammalogy 67:427-428.

Ashman, D. L., G. C. Christensen, M. L. Hess, G. K. Tuskamoto, and M. S. Wickersham. 1983. The mountain lion in Nevada. Nevada Department of Wildlife, Reno. 75pp.

Bavin, B. 1980. Post-release study of desert bighorn sheep in the Big Hatchet Mountains, New Mexico. Desert Bighorn Council Transactions 24:12-14.

Beausoleil, R. A. 2000. Status of the mountain lion in New Mexico 1971-2000. Proceedings of the 6th Mountain Lion Workshop, San Antonio, Texas. *In press.*

Beier, P., and S. C. Cunningham. 1996. Power of track surveys to detect changes in cougar populations. Wildlife Society Bulletin 24(3):540-546.

Berger, J. 1978. Maternal defensive behavior in bighorn sheep. Journal of Mammalogy 59:620-621.

Berger, J. 1990. Persistence of different sized populations: an empirical assessment of rapid extinctions in bighorn sheep. Conservation Biology 4:91-98.

Berger, J. 1991. Pregnancy incentives, predation constraints and habitat shifts: experimental and field evidence for wild bighorn sheep. Animal Behavior 41:61-77.

Berger, J. 1999. Intervention and persistence in small populations of bighorn sheep. Conservation Biology 13:432-435.

Bleich, V. C., J. D. Wehausen, K. R. Jones, and R. A. Weaver. 1990. Status of bighorn sheep in California, 1989 and translocations from 1971 through 1989. Desert Bighorn Council Transactions 34:24-26.

Bleich, V.C. 1996. Interactions between coyotes (*Canis latrans*) and mountain sheep (*Ovis Canadensis*). Southwestern Naturalist 41:81-82.

Bleich, V.C. 1999. Mountain sheep and coyotes: patterns of predator evasion in a mountain ungulate. Journal of Mammalogy 80:283-289.

Buechner, H. K. 1960. The bighorn sheep in the United States, its past, present, and future. Wildlife Monographs 4.

Clark, R. K., and D. A. Jessup. 1992. The health of mountain sheep in the San Andres Mountains, New Mexico. Desert Bighorn Council Transactions 36:30-35.

Creeden, P.J., and J.L. Schmidt. 1983. The Colorado desert bighorn introduction project, a status report. Desert Bighorn Council Transactions 27:34-36.

Cunningham, S. C., L. A. Haynes, C. Gustavson, and D. D. Haywood. 1995. Evaluation of the interaction between mountain lions and cattle in the Aravaipa-Klondyke area of southeast Arizona. Arizona Game and Fish Department Technical Report No.17, Phoenix. 64pp.

Dekker, D. 1986. Coyote (*Canis latrans*) preys on two bighorn sheep (*Ovis canadensis*) in Jasper National Park, Alberta. Canadian Field Naturalist 100:272-273.

Demarchi, D. A., and H. B. Mitchell. 1973. The Chilcotin River bighorn population. Canadian Field Naturalist 87:433-454.

Dunn, W. C. 2000. Cougar predation on bighorn sheep in New Mexico. A case study for the Western Association of Fish and Wildlife Agencies. New Mexico Department of Game and Fish, Santa Fe, New Mexico.

Ernest, H. B., E. S. Rubin, and W. M. Boyce. 2002. Fecal DNA analysis and risk assessment of mountain lion predation of bighorn sheep. Journal of Wildlife Management 66:75-85.

Etchberger, R. C., P. R. Krausman, and R. Mazaika. 1989. Mountain sheep habitat characteristics in the Pusch Ridge Wilderness, Arizona. Journal of Wildlife Management 53:902-907.

Etchberger, R. C., P. R. Krausman, and R. Mazaika. 1990. Effects of fire on desert bighorn sheep habitat. Pages 53-57 in P. R. Krausman and N. S.. Smith, eds. Proceedings, Managing Wildlife in the Southwest. Arizona Chapter of the Wildlife Society.

Federal Register. 1997. Categorical Exclusions. Volume 62, Number 11, Notices, Section 1.4.

Festa-Bianchet, M. 1988. Seasonal range selection in bighorn sheep: conflicts between forage quality, forage quantity, and predator avoidance. Oecologia (Heidelberg) 75:580-586.

Fisher, A., E. Rominger, P. Miller, O. Byers. 1999. Population and Habitat Viability Assessment Workshop for the desert bighorn sheep of New Mexico (Ovis canadensis): Final Report. IUCN/SSC Conservation

Gavin, T. M., and J. Sullivan. 1999. Final San Andres National Wildlife Refuge Fire Management Plan. 115 pp.

Geist, V. 1971. Mountain sheep: a study in behavior and evolution. University of Chicago Press. 383pp.

Hayes, C. L., E. S. Rubin, M. C. Jorgensen, and W. M. Boyce. 2000. Mountain lion predation of bighorn sheep in the Peninsular Ranges, California. Journal of Wildlife Management 64:954-959.

Hebert, D., and D. Lay. 1996. Cougar-human interactions in British Columbia. Pages 44-45 in Proceedings of the Fifth Mountain Lion Workshop.

Hicks, L. L., and J. M. Elder. 1979. Human disturbance of Sierra Nevada bighorn sheep. Journal of Wildlife Management 43:909-915.

Hoban, P. A. 1990. A review of desert bighorn sheep in the San Andres Mountains, New Mexico. Desert Bighorn Council Transactions 34:14-22.

Hornocker, M. G. 1970. An analysis of mountain lion predation upon mule deer and elk in the Idaho Primitive Area. Wildlife Monographs 21:1-39.

Iriarte, J. A., W. L. Franklin, W. E. Johnson, and K. H. Redford. 1990. Biogeographic variation of food habits and body size of the American puma. Oecologia 85:185-190.

Jorgenson, J. T., M. Festa-Bianchet, J. M. Gaillard, and W. D. Wishart. 1997. Effects of age, sex, disease, and density on survival of bighorn sheep. Ecology 78:1019-1032.

Kelly, W. E. 1980. Predator relationships. Pages 186-196 in G. Monson and L. Sumner, eds. The desert bighorn: life history, ecology, and management. University of Arizona Press, Tucson.

Krausman, P. R., and J. J. Hervert. 1983. Mountain sheep responses to aerial surveys. Wildlife Society Bulletin 11:372-375.

Krausman, P. R., Etchberger, R. C., and R. M. Lee. 1993. Mountain sheep population persistence in Arizona. Conservation Biology 7:219.

Krausman, P. R., Etchberger, R. C., and R. M. Lee. 1996. Persistence of mountain sheep populations in Arizona. The Southwestern Naturalist 41:399-402.

Krausman, P. R., Sandoval, A.V., and R.C. Etchberger. 1999. Natural history of desert bighorn sheep. Pages 139-179 in R. Valdez and P.R. Krausman, eds. Mountain sheep of North America. University of Arizona Press, Tucson.

Lang, E. M. 1956. Sheep survey. Performance report. New Mexico Department of Game and Fish, Federal Aid in Wildlife Restoration Project W-75-R-3, Job 8. 29pp.

Laing, S. P., and F. G. Lindzey. 1993. Patterns of replacement of resident cougars in southern Utah. Journal of Mammalogy 74:1056-1058.

Leopold, B. D., and P. R. Krausman. 1983. Status of bighorn sheep in Texas. The Texas Journal of Science 35:157-160.

Lindzey, F. G., W. D. Van Sickle, S. P. Laing, and C. S. Mecham. 1992. Cougar population response to manipulation in southern Utah. Wildlife Society Bulletin 20:224-227.

Linnell, J. D., J. Odden, M. E. Smith, R. Aanes, and J. E. Swenson. 1999. Large carnivores that kill livestock: do "problem individuals" really exist? Wildlife Society Bulletin 27:698-705.

Logan, K. A., L. L. Sweanor, T. K. Ruth, and M. G. Hornocker. 1996. Cougars of the San Andres Mountains, New Mexico - A Final Report for New Mexico Department of Game and Fish. Hornocker Wildlife Institute, Inc. Santa Fe, New Mexico.

Logan, K. A., and L. L. Sweanor. 2001. Desert Puma: evolutionary ecology and conservation of an enduring carnivore. Island Press, Washington. 463pp.

MacArthur, R. A., R. H. Johnston, and V. Geist. 1979. Factors influencing heart rate in free-ranging bighorn sheep: a physiological approach to the study of wildlife harassment. Canadian Journal of Zoology 57:2010-2021.

MacArthur, R. A., V. Geist, and R. H. Johnston. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. Journal of Wildlife Management 46:351-358.

McCann, L. J. 1956. Ecology of mountain sheep. The American Midland Naturalist 56:297-324.

New Mexico Department of Game and Fish. 1995. New Mexico's long-range plan for desert bighorn sheep management, 1995-2002. Final Report, Federal Aid in Wildlife Restoration Project W-127-R10, Job 1. New Mexico Department of Game and Fish, Santa Fe. 40pp.

New Mexico Department of Game and Fish. 1998. Document for the Recovery of desert bighorn sheep in the San Andres Mountains, New Mexico. 23pp.

Oregon Department of Fish and Wildlife. 1993. Oregon's cougar management plan 1993-1998. Portland, Oregon. 28pp.

Papouchis, C. M., F. J. Singer, and W. B. Sloan. 2001. Responses of desert bighorn sheep to increased human recreation. Journal of Wildlife Management 65:573-582.

Ramey, R. R. II. 1993. Evolutionary genetics and systematics of American mountain sheep: implications for conservation. PhD dissertation. Cornell University, Ithica, New York. 212pp.

Risenhoover, K. L., and J. A. Bailey. 1980. Visibility: an important habitat factor for an indigenous, low-elevation bighorn herd in Colorado. Proceedings of the Biennial Symposium for Northern Wild Sheep and Goat Council 2:18-28.

Risenhoover, K. L., and J. A. Bailey. 1985. Foraging ecology of mountain sheep: implications for habitat management. Journal of Wildlife Management 49:797-804.

Risenhoover, K. L., J. A. Bailey, and L. A. Wakelyn. 1988. Assessing the Rocky Mountain bighorn sheep management problem. Wildlife Society Bulletin 16:346-352.

Robinette, W. L., J. W. Gashwiler, and O. W. Morris. 1961. Notes on cougar productivity and life history. Journal of Mammalogy 42:204-217.

Rominger, E. M., and W. C. Dunn. 2000. Reducing mountain lion predation on bighorn sheep in four New Mexico mountain ranges: A study design. Unpublished Report. New Mexico Department of Game and Fish. 17pp.

Rominger, E. M. 2000. Pecos Wilderness, Latir Wilderness, and Culebres Mountain bighorn sheep helicopter census report. Unpublished Report. New Mexico Department of Game and Fish. 5pp.

Rominger, E. M., and M. E. Weisenberger. 2000. Biological extinction and a test of the "conspicuous individual hypothesis" in the San Andres Mountains, New Mexico. Pages 293-307 in Transactions of the 2nd North American Wild Sheep Conference. April 6-9, 1999, Reno, Nevada.

Rominger, E. M., H. Whitlaw, D. Weybright, and W. C. Dunn. 2001. Predation and bighorn sheep transplants in New Mexico: a tale of two herds. Presented at the 8th Annual Conference of The Wildlife Society. Reno, Nevada.

Rominger, E. M., and E. Goldstein. 2001a. Desert Bighorn sheep annual helicopter census report. Unpublished Report. New Mexico Department of Game and Fish. 19pp.

Rominger, E. M., and E. Goldstein. 2001b. Low-elevation Rocky Mountain bighorn sheep annual helicopter census report. Unpublished Report. New Mexico Department of Game and Fish. 5pp.

Rominger, E. M., and E. Goldstein. 2001c. Wheeler Peak: 2001 Rocky Mountain bighorn sheep census report. Unpublished Report. New Mexico Department of Game and Fish. 4pp.

Rominger, E. M., E. Goldstein, R. Beausoleil, and W. C. Dunn. 2002. Lion surveys in 5 New Mexico bighorn sheep ranges, 1999-2001. Unpublished Report. New Mexico Department of Game and Fish. 10pp.

Rominger, E. M., and E. Goldstein. 2002a. Spring 2002 Desert Bighorn Helicopter Census Report: Peloncillo, Big Hatchet, Little Hatchet, Ladron, and Animas Mountains. Unpublished Report. New Mexico Department of Game and Fish. 8pp.

Rominger, E. M., and E. Goldstein. 2002b. Annual census report for Red Rock Wildlife Area, 2002. Unpublished Report. New Mexico Department of Game and Fish. 3pp.

Ross, P. I., M. G. Jalkotzy, and M. Festa-Bianchet. 1997. Cougar predation on bighorn sheep in south-western Alberta during winter. Canadian Journal of Zoology 75:771-775.

Ruth, R. K., K. A. Logan, L. L. Sweanor, M. G. Hornocker, and L. J. Temple. 1998. Evaluating cougar translocation in New Mexico. Journal of Wildlife Management 62:1264-1275.

Sandoval, A. V. 1979. Preferred habitat of desert bighorn sheep in the San Andres Mountains, New Mexico. M. S. Thesis, Colorado State University, Fort Collins. 314pp.

Sandoval, A. V. 1980. Management of a psoroptic scabies epizootic in bighorn sheep, *Ovis canadensis mexicana*. Desert Bighorn Council Transactions 24:21-28.

Sandoval, A. V. 1981. New Mexico bighorn sheep status report. Desert Bighorn Council Transactions 25:66-68.

Sandoval, A. V, A. S. Elenowitz, and J. R. Deforge. 1987. Pneumonia in a transplanted population of bighorn sheep. Desert Bighorn Council Transactions 31:18-22.

Sawyer, H., and F. Lindzey. 2002. A review of predation on bighorn sheep (Ovis canadensis). Unpublished report. Wyoming Cooperative Fish and Wildlife Research Unit, Laramie. 36pp.

Schaefer, R. J., S. G. Torres, and V. C. Bleich. 2000. Survivorship and cause-specific mortality in sympatric populations of mountain sheep and mule deer. California Department of Fish and Game 86:127-135.

Schmidt, R. H. 1989. Vertebrate Pest Control and Animal Welfare. Pages 63-68 in Kathleen A. Fagerstone and Richard D. Curnow, eds. Vertebrate Pest Control and Management Materials: 6th Volume, ASTM STP 1055. American Society for Testing and Materials, Philadelphia.

Seidensticker IV, J. C., M. G. Hornocker, W. V. Wiles, and J. P. Messick. 1973. Mountain lion social organization in the Idaho Primitive Area. Wildlife Monographs 35:1-60.

Shank, C. C. 1977. Cooperative defense by bighorn sheep. Journal of Mammalogy 58: 243-244.

Sweanor, L. L., K. A. Logan, and M. G. Hornocker. 2000. Cougar dispersal patterns, metapopulation dynamics, and conservation. Conservation Biology 14:798-808.

Thorne, E. T., G. Butler, T. Varcalli, K. Becker, and S. Hayden-Wing. 1979. The status, mortality, and response to management of the bighorn sheep of Whiskey Mountain. Wildl. Tech. Rep. No. 7. Wyoming Game and Fish Department, Cheyenne.

Wakelyn, L. A. 1987. Changing habitat conditions on bighorn sheep ranges in Colorado Journal of Wildlife Management 51:904-912.

Wehausen, J.D. 1996. Effects of mountain lion predation on bighorn sheep in the Sierra Nevada and Granite Mountains of California. Wildlife Society Bulletin 24:471-479.

Wehausen, J.D. 1999. Rapid extinction of mountain sheep populations revisited. Conservation Biology 13:378-384.

Wilson, L. O. 1975. Report and recommendations of the desert and Mexican bighorn sheep workshop group. Pages 110-142 in J. B. Trefethen, ed. The wild sheep of modern North America. The Winchester Press, New York.

Wishart, W. 1975. Report and recommendations of the Rocky Mountain bighorn workshop group. Pages 165-207 in J. B. Trefethen, Ed. The wild sheep in modern North America. Winchester Press, New York.

Wishart, W. 1978. Bighorn sheep. Pages 161-171 in J. L. Schmidt and D. L. Gilbert, eds. Big Game of North America: ecology and management. Stackpole Books, Harrisburg, Pennsylvania.

Wishart, W. 2000. A working hypothesis for Rocky Mountain bighorn sheep management. Pages 47-52 in Thomas, A. E. and H. L. Thomas, eds. Transactions of the 2nd North American Wild Sheep Conference. April 6-9, 1999, Reno, Nevada.

Wright, H.A., and A. W. Bailey. 1982. Fire Ecology. John Wiley & Sons, New York.

U. S. Department of Agriculture. 1995. Final Environmental Impact Statement Animal Damage Control Program.

U. S. Department of Agriculture-Animal and Plant Health Inspection Service-Wildlife Services. 2000. Monitoring report (1999) and decision/finding of no significant impact for Environmental Assessment: Predator Damage Management in the Las Cruces District of the New Mexico Wildlife Services Program. 20pp.

U. S. Fish and Wildlife Service. 1998. Comprehensive conservation plan and environmental assessment: San Andres National Wildlife Refuge. 38pp.

U. S. Fish and Wildlife Service. 1999a. Final Environmental Assessment: Predator damage management to protect the federally endangered Sierra Nevada bighorn sheep.

U. S. Fish and Wildlife Service. 1999b. Endangered and threatened wildlife and plants; emergency rule to list the Sierra Nevada distinct population segment of California bighorn sheep as endangered. Federal Register 64(75):19300-19309.

Woolf, A., and T. O'Shea. 1968. Two bighorn sheep-coyote encounters. Journal of Mammalogy 49:770.

APPENDIX 1. Summary of Public Comments

The following comments were received during the public comment period. The Refuge received many comments that were not pertinent to the EA, and were not considered and addressed in this section.

Concern: Desert bighorn population numbers in the San Andres have declined due to disease.

Response: Section 1.3 of the EA describes the disease history of the San Andres Mountains bighorn population..

Concern: Some commentors stated concerns related to habitat issues.

Response: The San Andres Mountains have the potential to maintain the largest single herd of desert bighorn sheep in New Mexico (New Mexico Department of Game and Fish 1995). Dunn (1994), as described in the New Mexico Long-range Plan for Desert Bighorn Sheep Management, ranked the San Andres as the best desert bighorn sheep habitat in New Mexico. Lack of availability and quality of habitat has not been a limiting factor in the San Andres Mountains bighorn population. Section 1.5.2 (page 10) of this EA discusses habitat restoration efforts.

Concern: Reintroduction of bighorn sheep should be delayed until habitat improvements are complete.

Response: Habitat improvement efforts are discussed in section 1.5.2 (page 10), with primary emphasis on prescribed burning. Reintroduction of fire in the ecosystem is being used to improve forage conditions for native ungulates and reduce hiding cover for mountain lions. Fire, along with other habitat restoration methods are a long-term, dynamic process that do not have an absolute end point.

Concern: Mule deer numbers in the San Andres have declined due to overhunting.

Response: There has been no deer hunting on the Refuge since 1979 or the Range since 1998. Deer numbers declined during the mid-1990s, which corresponded with below normal precipitation. It is hypothesized that mountain lion predation has contributed to the slowed recovery of this mule deer population (Logan et al. 1996). The cooperating agencies have yet to determine the full spectrum of variables associated with the most recent decline of the mule deer herd.

Concern: Deer are the preferred food of mountain lions. Therefore, transplanting desert bighorn sheep should wait until deer numbers have increased, then the lions would have more of their preferred food source and would not predate as heavily on desert bighorn.

Response: With the decline of the San Andres Mountains mule deer population in the mid 1990's, and the subsequent decline in lion sign present throughout the mountain range, we hypothesize that the number of mountain lions is currently low. Furthermore, the desert bighorn population is essentially non-existent, and no domestic livestock are permitted to graze on the Refuge or Range. Therefore, this is an ideal time to transplant bighorn because if mountain lion numbers are low, there are fewer individuals to predate on bighorn sheep.

Concern: Traps are inhumane.

Response: Leg hold traps will not be used. The protocol, as described in Sections 2.1 and 2.2, is to use snares, per recommendations reported in Logan et al. (1999).

Concern: There is opposition to the use of snares as inhumane.

Response: Section 4.1.2 addresses use of snares and Section 4.1.5 discusses humaneness.

Concern: One cause of desert bighorn decline in the San Andres is human encroachment, with development restricting the amount of habitat.

Response: The San Andres National Wildlife Refuge encompasses 57,215 acres and is surrounded by the 2.2 million acre White Sands Missile Range. Both the Refuge and Range are closed to public access, therefore no human encroachment can occur in this bighorn sheep range.

Concern: Mountain lions do not prey on desert bighorn, or only prey on the sick and weak.

Response: There is no available evidence that lions select bighorn sheep that exhibit signs of illness. We do acknowledge that lions will select the young and old, but there is no evidence that mountain lions prefer to prey on the sick over younger or older animals. Since 1992, 172 radiocollars have been deployed on adult desert bighorn sheep in New Mexico. There have been 98 documented mortalities of which 69 were determined to be lion kills and 81% of the known-cause mortality has been due to lion predation. Coursing predators, e.g., wolves, chase prey often over long distances, and are then able to kill those individuals that may be weak or infirm. Mountain lions are "stalking" or "ambush" predators. Thus, mountain lions will get as close as it can to its prey, then wait for an opportunistic moment to kill its prey following a short chase. Lion predation on desert bighorn sheep has been the major cause of mortality in all ranges in New Mexico, despite a variable density of mountain lions among these ranges, i.e., at no density of mountain lions has predation not been the principal cause of mortality on desert bighorn sheep.

Concern: This program is an excuse to provide hunters more opportunities to hunt mountain lions.

Response: No sport hunters will be allowed to hunt mountain lions under this program. Mountain lion removal will be conducted by a Department-contracted snareman.

Concern: The program should concentrate on relocating mountain lions, not on killing them.

Response: Section 2.4 addresses alternatives considered but rejected with rationale.

Concern: When predator control has been conducted for the purpose of enhancing wild ungulate populations, it is generally not met with success.

Response: Section 4.1.2 addresses the effectiveness of predator control for the purpose of enhancing wild ungulate populations.

Concern: Lions are a keystone species and should be preserved.

Response: The cooperating agencies all recognize the importance of top predators within the ecosystem. The recommendations of biologists from these agencies include the temporary reduction of lion numbers to maximize the chances of recovery for the state-endangered species, desert bighorn sheep.

Concern: Lions are self-regulators therefore they will not exceed K. Killing some lions will only result in transient lions taking their place.

Response: The agencies anticipate that transient lions will fill vacated habitat that is open as a result of removed lions. However, it is difficult to predict with definite certainty the age and experience of those mountain lions that fill these vacancies.

Concern: Human intervention in regulating lion populations may inhibit their ability to rebound after a reduction.

Response: A Department study (Logan et al. 1996) documented that mountain lions re-occupied habitat where they had been removed. Thirty one months post-treatment, the adult mountain lion portion of the treatment area had nearly recovered to pre-removal levels.

Concern: The use of dogs is inhumane. If dogs chasing bighorn are a source of stress, why are hounds used to chase lions is not a stressor to bighorn, since both of them involve chasing with dogs.

Response: Section 4.1.2, paragraph six, addresses the potential use of dogs to capture mountain lions.

Concern: The control area is never very well defined.

Response: Control areas have been further defined in EA, Section 2.1, second bullet item.

Concern: Factors such as climate specifically drought, might impact the success of the transplant.

Response: The drought that the western United States is experiencing this year is a concern to all wildlife managers. Based on the expertise of the cooperating agencies and professionals involved, augmentations of bighorn sheep would be delayed if drought conditions were determined to negatively impact the success of the transplant.

Concern: Why is control limited to mature adults when sub-adults are also able to kill bighorn?

Response: Section 2.1, page 17 of the EA has been modified to read ; "Any mountain lion perceived to be a threat to desert bighorn sheep would be killed. Factors that determine a threat might include proximity to bighorn sheep release area, availability of alternative prey, approximate weight of the mountain lion related to age, or overall behavior and movement of the mountain lion".

Concern: There is not enough detail as to what the "monitoring" after the transplant entails.

Response: Refuge staff will continue monitoring bighorn rams that are fitted with satellite radiocollars, and both Refuge and Range staff will be monitoring bighorn sheep on a regular basis. Additionally, a Department bighorn contractor will check for mortality signals a minimum of 5 times per week, and obtain a visual observation of each bighorn as often as possible with a minimum of once per week. In this manner, mortalities would be likely detected within 24 hours after the animal died, enabling the largest amount of information to be collected, and management decisions to be made in a timely fashion. This contractor will be employed for a minimum of 20 months following the release. Section 1.5.4 has been changed to reflect the additional time the Department contract will be employed.

Concern: Why is there is no reference to the Evans 1986 paper that states the Dept stopped the lion removal in the SA because it was not effective?

Response: The Evans (1986) unpublished report, along with additional reports, were considered in the development of this EA and determined not to be included due to conflicting findings. Current environmental conditions have changed significantly since 1986, therefore the cooperating agencies cannot entirely use the Evans (1986) data to evaluate the potential effects of mountain lion control on the success of a bighorn sheep transplant. However, portions of the Evans (1986) report were used in the EA (Section 4.1.2, page 34) but reported as "NMDGF files" as it is an unpublished internal document.

Concern: What has been done to ensure that there will not be another scabies outbreak?

Response: Section 1.5.1 discusses the evaluation of scabies mites in the San Andres Mountains.

Concern: Is there disease risk from domestic sheep and goats in the area?

Response: Section 1.3 describes that no livestock grazing has occurred on the Refuge or Range since 1952. No domestic sheep or goats are grazed on or near the Refuge or Range.

Concern: What is being done to prevent overgrazing on the Refuge?

Response: Section 1.3 describes that no livestock grazing has occurred on the Refuge or Range since 1952. All native ungulate populations are estimated to be substantially below carrying capacity, and therefore not overgrazing the habitat.

Concern: What is the Refuge doing to ensure that there is a healthy ecosystem before they put bighorn back?

Response: Sections 1.5.1, 1.5.2, 1.5.3, and 1.5.4 discuss how the Refuge and cooperating agencies are accomplishing the management efforts with respect to the bighorn sheep restoration program.

Concern: How much has the genetic concerns regarding small populations been incorporated into this plan?

Response: The cooperating agencies have considered the issues related to genetic variability in small populations with respect to the bighorn sheep restoration efforts. An evaluation of genetic variability (Boyce and Ostermann 2002) that specifically looked at the potential source and recipient bighorn populations discussed in the EA demonstrated that the Kofa bighorn population had the greatest genetic variation in desert bighorn populations reported in the literature. For that reason, Arizona bighorn were considered as the primary source stock to augment the San Andres bighorn population in an effort to increase genetic diversity.

Concern: You should let "natural processes'" regulate the cougar population

Response: It is the agencies' position that published data indicates removal of mountain lions during the five month preemptive lion control period or during the offending lion control period, will have no significant long-term effect on population size. Further, we anticipate that removal of mountain lions from the study area at the proposed level likely will result in a short-term reduction in size and/or composition of the local mountain lion population, contributing to assessment of the role of mountain lion predation on desert bighorn in the local population under existing environmental conditions. We recognize in reaching this conclusion that resilience of the local mountain lion population to removal of individuals at the proposed level over time

likely will be dependent on rate of immigration into that population and availability of recruitment-age female progeny.

Concern: Alternative 1 should only be implemented if it is experimental and limited. You need to gather all possible data on the effects of bighorn and lions when we implement any control measures.

Response: Alternative 1 is experimental in that the Department has a implemented a study design for lion control in other New Mexico bighorn sheep ranges (Rominger and Dunn 2000), and this proposed action would also require the collection of all data related to its' efficacy. Alternative 1 is also limited in that it focuses on a small portion of the Refuge and is intended to be a short-term solution until the bighorn sheep population is able to recover.

Concern: Why only a 5% mortality threshold before initiation of control area-wide removal of lions. Why not use an adaptive management approach to decide what threshold to use?

Response: The current level of lion predation has resulted in population declines in all New Mexico bighorn sheep populations except the Fra Cristobal population. The 5% threshold was a result of model work was done relative to extinction probabilities. The objective of the recovery effort in New Mexico is not to avoid extinction but rather to increase new and extant populations as quickly as possible. A rapidly increasing population reduces the need to augment populations and the associated disease risks of mixing bighorn populations; it will also reduce the risk of genetic loss due to the death of founders.

Concern: What is the role of scavenging in comparison to lion predation?

Response: The examination of more than 100 desert bighorn sheep mortalities has documented only a single case of scavenging (<1%). The rate of scavenging on mule deer in the San Andres Mountains (Logan et al. 1996.) was 2% or about twice that documented in desert bighorn sheep.

Concern: To reinstate the preemptive control for 6 months to a year is too long; it should be for 5 months as the original period is set to be.

Response: The objective is to reduce the lion predation after it has exceeded 5% mortality in the bighorn sheep population annually. The flexibility, hence adaptive management, to ensure that this occurs warrants the longer temporal frame.

Concern: What will happen to the mountain lion carcasses?

Response: Mountain lion carcasses will be sent to the Museum of Southwestern Biology at the University of New Mexico for research and educational purposes. If the Museum is no longer able to accept carcasses, an alternative educational institution will be sought.

Concern: How will snaremen minimize take of non-target species?

Response: Section 4.1.3 in the EA directly addresses the impacts on non-target species; all non-target species will be recorded and released and published protocols (Logan et al. 1999) will be followed by the Department-contracted snareman.

Concern: Given the lack of data available as to the number of lions on the Refuge, how can you be certain that the impacts will be small?

Response: The cooperating agencies believe that based on the best available scientific data completed in a Department study (Logan et al. 1996), the effect on the San Andres mountain lion population would be inconsequential.

Concern: Because there are no current, accurate data on lion numbers the level of removals is essentially guess work.

Response: Based on lion distribution and density data presented in the Department's long-term mountain lion study (Logan et al. 1996), the agencies believe these estimates are based on the best available scientific data. Mountain lion nature and behavior is extremely difficult to predict exactly how many mountain lion are in a given area.
Section 4.1.1, page 31 twice states the assumptions that are used to estimate these populations.

Concern: You should use Logan's work for data on lion reproduction.

Response: This citation and related discussion have been added to Section 4.1.1, paragraph 2 of the EA.

Concern: Managers have presented bogus information. Delete the sentence, "As mountain lion population density increases, mortality rates from intra-specific fighting and cannibalism also increase, and/or mountain lions disperse into unoccupied or less densely occupied habitat" in Section 4.1.1, third paragraph.

Response: This sentence has been deleted from Section 4.1.1 of the EA.

Concern: Why conduct the transplant where deer numbers are low because lions will switch to killing bighorn. If deer numbers are high, they will have enough of their preferred prey that they will not eat sheep.

Response: The role of alternative prey is controversial. Most research suggests that high density primary prey is in fact a detriment to small populations of alternative prey rather than a benefit. This becomes exacerbated if the high density primary prey declines due to stochastic processes potentially resulting in a large number of predators prey-switching to rarer alternative prey. High

predator numbers associated with high prey numbers increase the probability of incidentally encountering a rarer prey item as well. The considerable literature on prey-switching includes:

Compton, B. B., P. Zager, and G. Servheen. 1996. Survival and mortality of translocated woodland caribou. Wildlife Society Bulletin 23:490-496.

Harrington, R., N. Owen-Smith, P. C. Viljoen, H. C. Biggs, D. R. Mason, and P. Funston. 1999. Establishing the causes of the roan antelope decline in the Kruger National Park, South Africa. Biological Conservation 90:69-78.

Hurd, T. E., and F. L. Bunnell. 1999. Factors limiting moose numbers and their interaction with elk and wolves in the Central Rocky Mountains, Canada. Presented at the Symposium on Ecology and Management of Ungulates. Nelson, British Columbia.

Patterson, B. R., D. O. Joly, and F. Messier. 2002. Do alternate prey relieve or exacerbate coyote predation on white-tailed deer in eastern Canada? To be presented at the 2002 Annual Meeting of The Wildlife Society, Bismarck, ND.

Seip, D. R. 1992. Wolf predation, wolf control, and the management of ungulate populations. Pages 331-340 in D. R. Mccullough and R. H. Barrett, editors. Wildlife 2001: Populations. Elsevier Applied Science. London and New York.

Concern: What has been the results of lion sign surveys conducted in other bighorn sheep ranges? How has lion removal has affected populations in other parts of the state?

Response: Lion sign surveys may only detect large changes in the presence of lions. Because only 1 survey in 1 mountain range has been conducted following the removal of >5 lions the results to data are inconclusive. The percentage of surveyed transects with lion sign declined from 26% to 15% subsequent to the known removal of 8 mountain lions in the Manzano Mountains. See page 34 of EA for synopsis of the efficacy of lion pretreatment during desert bighorn sheep transplants. In the other ranges, data has been collected for the past 3 years, during which time there is no reason to suspect that the number of lions has changed. NMDGF plans to continue with this annual survey in all desert bighorn ranges in New Mexico.

Concern: The San Andres Mountains used to be considered a lion reserve. If that is no longer the case then should an alternative be considered?

Response: The San Andres mountain range is not an established lion reserve, it was proposed by various entities, but never officially designated.

Concern: 48 hour snare checks are too long, they should be 24 hours page 34, section 4.1.2).

Response: Snares will be checked every 24 hours. The EA has been changed to reflect this modification.

Concern: What factors in addition to lion predation affect desert bighorn?

Response: Section 1.2.1 and Figure 2 describe the causes of mortality for San Andres Mountains bighorn sheep.

Concern: There is no support anywhere that preemptive lion control works.

Response: Section 4.1.2 discusses the effectiveness of preemptive lion control.

Concern: Hunter success on lions in the state has decreased, and this suggests that lion numbers are decreasing.

Response: Harvest success rate is based on the number of animals killed, related to the number of hunters. The number licenses sold may not be correlated with the number of hunters, and the number of mountain lions killed may not be correlated with the number of lions present.

Concern: Lion removal is only successful if you remove lions that are known to have killed sheep.

Response: It is the opinion of the cooperating agencies that this is not an accurate reflection of mountain lion-bighorn sheep dynamics. There is no way to predict which mount ion lions will predate on bighorn sheep.

Concern: Techniques to deter lions from killing bighorn should be employed.

Response: Section 2.4 of the EA addresses this issue.

Concern: Predator control is only a short-term solution.

Response: This wildlife management action is intended to be a short-term measure in conjunction with the longer-term habitat improvement measures as described in Sections 1.0 and 4.1.1, page 32 in the EA.

Concern: The preferred alternative will result in the unnecessary removal of mountain lions that may not pose a predation risk to reintroduced sheep.

Response: As described in Section 2.1 of this EA, the preemptive lion control is limited by time and space.

Concern: The number of sheep proposed for the initial augmentation is too small.

Response: The current population of bighorn sheep in the San Andres Mountains is nine animals (page 6, section 1.3). The initial augmentation of 30 ewes from Arizona and 10 rams from Red Rock Wildlife Area is planned for Fall 2002, providing at least 49 bighorn for initiating restoration efforts. Pages 10-11, section 1.5.3 discuss subsequent augmentations from both Arizona and Red Rock Wildlife Area.

Concern: There is no discussion given as to the method or duration of monitoring (mountain lions) or how the results might affect the proposed action or alternatives as stated on page 32.

Response: Lion track transects will be maintained in the San Andres Mountains throughout the recovery period to monitor large changes in mountain lion densities throughout the mountain range.

Concern: Section 4.1.2, page 34, Ernest et al. (2002) citation was confusing; need to clarify that this study was a basically a modeling exercise.

Response: Language in Section 4.1.2 has been modified to clarify interpretation of study results.

Concern: Lion control will continue even if the bighorn sheep population drops below targets mainly due to other factors, such as disease.

Response: Section 2.1, page 17 of the EA states that the preemptive mountain lion control "would remain in effect as long as lions are killing less than 5% of the San Andres desert bighorn population." If more than 5% of the bighorn population annual mortality was attributed to disease or some other limiting factor, preemptive lion control would not be initiated. Preemptive lion control would cease once the bighorn population reaches a minimum of 100 animals including at least 75 adult ewes (Section 2.1, page 18).

Concern: Need to clarify whether offending lion control will continue if sheep numbers dip below 200 animals, if the decline is unrelated to predation.

Response: Offending lion control may be considered after evaluating all the factors involved at that time, should the situation arise. Section 2.1, page 18 of the EA has been changed to reflect this clarification.

Concern: Regarding Section 4.1.2, page 34, fifth paragraph, you need to state if sheep survival and sheep numbers increased as a result of lion removal

Response: During late 1980 – early 1984, 41 mountain lions were removed from the San Andres Mountains as part of a preventative lion control program. In 1981, the predation rate on

radiocollared bighorn sheep was 35%, in 1982 – 1983, the predation rates were reduced to 14 – 17%, and by 1984 – 1985 the estimated predation rate on bighorn sheep was only 5 – 8% following the lion removal program. During 1980 – 1982, survival rates for bighorn sheep were less than 70%, and mean life expectancies were less than three years. However, during 1984 – 1985, annual survival rates for bighorn sheep exceeded 80%, and mean life expectancies increased to 4.6 – 7.1 years (Evans 1986).

REFERENCES

Boyce, W. and S. Ostermann. 2002. Genetic considerations for reintroducing bighorn sheep to the San Andres Mountains, New Mexico. Final Report. 17pp.

Dunn, W. C. 1994. Evaluation of desert bighorn sheep habitat in New Mexico. A revision of the Final Report, New Mexico Department of Game and Fish, Federal Aid in Wildlife Restoration Project W-127-R-7 Job 4. 43pp.

Ernest, H. B., E. S. Rubin, and W. M. Boyce. 2002. Fecal DNA analysis and risk assessment of mountain lion predation of bighorn sheep. Journal of Wildlife Management 66:75-85.

Evans, W. 1986. Desert Bighorn Survival and mortality parameters in the San Andres Mountains, New Mexico, 1980-85. Unpublished Report. New Mexico Department of Game and Fish, Santa Fe. 35pp.

Logan, K. A., L. L. Sweanor, T. K. Ruth, and M. G. Hornocker. 1996. Cougars of the San Andres Mountains, New Mexico - A Final Report for New Mexico Department of Game and Fish. Hornocker Wildlife Institute, Inc. Santa Fe, New Mexico.

Logan, K. A., L. L. Sweanor, J. Frank Smith, and M. G. Hornocker. 1999. Capturing pumas with foot-hold snares. Wildlife Society Bulletin 27:201-208.

New Mexico Department of Game and Fish. 1995. New Mexico's long-range plan for desert bighorn sheep management, 1995-2002. Final Report Federal Aid in Wildlife Restoration Project W-127-R10, Job 1. New Mexico Department of Game and Fish, Santa Fe. 40pp.

Rominger, E. M., and W. C. Dunn. 2000. Reducing mountain lion predation on bighorn sheep in four New Mexico mountain ranges: A study design. Unpublished Report. New Mexico Department of Game and Fish. 17pp.