

Draft Environmental Assessment

Desert Bighorn Sheep Hunting on San Andres National Wildlife Refuge

Doña Ana County, New Mexico

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Table of Contents

1.0 PURPOSE OF AND NEED FOR PROPOSED ACTION ALTERNATIVE	1
1.1 INTRODUCTION	1
1.2 LOCATION	1
1.3 BACKGROUND	2
1.4 PURPOSE OF ACTION	5
1.5 NEED FOR ACTION	5
THE PROPOSED DESERT BIGHORN SHEEP RAM HUNT FULFILLS THE REFUGE SYSTEM HUNTING GOALS DESCRIBED BELOW: ..	5
THE GUIDING PRINCIPLES OF THE REFUGE SYSTEM’S HUNTING PROGRAMS AS OUTLINED IN THE U.S. FISH & WILDLIFE MANUAL (605 FW 2) ARE TO:	5
1.6 DECISION TO BE MADE	6
1.7 REGULATORY COMPLIANCE	6
1.8 SCOPING/PUBLIC INVOLVEMENT AND ISSUES IDENTIFIED	8
2.0 ALTERNATIVES	9
2.1 ALTERNATIVE A--NO ACTION ALTERNATIVE	9
2.2 ALTERNATIVE B—OPEN BIGHORN SHEEP HUNTING TO GENERAL PUBLIC DURING STATE SEASONS WITH CAMPING (PROPOSED ACTION ALTERNATIVE)	9
2.3 ALTERNATIVE C— OPEN BIGHORN SHEEP HUNTING TO GENERAL PUBLIC DURING STATE SEASONS WITHOUT CAMPING	14
2.4 COMPARISON OF ALTERNATIVES	14
2.5 ALTERNATIVES CONSIDERED BUT DISMISSED FROM DETAILED ANALYSIS	14
3.0 AFFECTED ENVIRONMENT	15
3.1 PHYSICAL ENVIRONMENT	15
3.1.1 <i>Climate</i>	15
3.1.2 <i>Air Quality</i>	16
3.1.3 <i>Water Resources and Quality</i>	16
3.1.4 <i>Soils / Geology</i>	17
3.2 BIOLOGICAL ENVIRONMENT	17
3.2.1 <i>Vegetative Communities</i>	17
3.2.2 <i>Wildlife</i>	18
3.2.3 <i>Threatened and Endangered Species and Other Special Status Species</i>	21
3.3 HUMAN ENVIRONMENT	23
3.3.1 <i>Cultural Resources</i>	23
3.3.2 <i>Socioeconomic Resources</i>	23
3.3.3 <i>Visitor Services/Activities</i>	24
3.4 WILDERNESS	24
4.0 ENVIRONMENTAL CONSEQUENCES	24
4.1 EFFECTS COMMON TO ALL ALTERNATIVES	25
4.1.1 <i>Environmental Justice</i>	25

4.1.2. <i>Climate Change</i>	25
4.1 PHYSICAL ENVIRONMENT	25
4.1.1 <i>Impacts on Air Quality</i>	25
4.1.2 <i>Impacts on Water Quality and Quantity</i>	26
4.1.3 <i>Impacts on Soils</i>	26
4.2 BIOLOGICAL ENVIRONMENT	27
4.2.1 <i>Impacts on Habitat</i>	27
4.2.2 <i>Impacts on Wildlife</i>	28
4.2.3 <i>Impacts on Threatened and Endangered Species and Special Status Species</i>	29
4.3 HUMAN ENVIRONMENT	30
4.3.1 <i>Impacts on Cultural Resources</i>	30
4.3.2 <i>Impacts on Socioeconomics</i>	30
4.3.3. <i>Impacts on Visitor Services/Activities</i>	30
4.3.4 <i>Humaneness and Animal Welfare Concerns</i>	31
4.4 ASSESSMENT OF CUMULATIVE IMPACTS	31
4.4.1 <i>Anticipated Direct and Indirect Impacts of Proposed Hunt on Wildlife Species</i>	32
4.4.2 <i>Anticipated Direct and Indirect Impacts of Proposed Action on Refuge Programs, Facilities, and Cultural Resources</i>	33
4.4.3 <i>Anticipated Impacts of Proposed Hunt on Refuge Environment and Community</i>	34
4.4.4 <i>Other Past, Present, Proposed, and Reasonably Foreseeable Hunts (and Other Activities) and Anticipated Impacts</i>	35
4.4.5 <i>Anticipated Impacts if Individual Hunts are allowed to Accumulate</i>	37
4.5 ENVIRONMENTAL JUSTICE	37
4.6 INDIAN TRUST ASSETS	38
4.7 UNAVOIDABLE ADVERSE EFFECTS	38
4.8 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES	38
4.9 SUMMARY OF ENVIRONMENTAL EFFECTS BY ALTERNATIVE	38
5.0 CONSULTATION, COORDINATION AND DOCUMENT PREPARATION	41
5.1 AGENCIES AND INDIVIDUALS CONSULTED IN THE PREPARATION OF THIS DOCUMENT INCLUDE:	41
6.0 REFERENCES	42
APPENDIX A	49

LIST OF FIGURES:

Figure 1. Locator map for White Sands Missile Range and the San Andres National Wildlife Refuge.....	1
Figure 2. San Andres Mountains desert bighorn sheep population observed and estimated numbers 1941-2011.....	4
Figure 3. Proposed hunt area (in red) for desert bighorn sheep in the San Andres Mountains, New Mexico which included the entire San Andres NWR and most of the San Andres Mountains Range. The San Andres Mountains lie within White Sands Missile Range boundaries.....	12
Figure 4. Proposed camp site on San Andres NWR within proposed bighorn sheep hunt area. Note distance to Small Missile Range gate which is entry and exit access point to entire hunt area.	13

LIST OF TABLES:

Table 1. Desert bighorn sheep transplanted to the San Andres National Wildlife Refuge.	3
Table 2. Summary of San Andres Mountains desert bighorn sheep hunts 1968-1978.....	4
Table 3. Comparison of Alternatives Matrix.	14
Table 4. Population trends for desert bighorn sheep herds in New Mexico, 2000-2011 (taken from http://www.wildlife.state.nm.us/conservation/bighorn/documents/PopulationTrends.htm) (NMDGF 2012).	18
Table 5. San Andres desert bighorn sheep population structure of animals observed during surveys 2002-2011.....	20
Table 6. Ram numbers and age classes from 2008 survey related to potential ram harvest 2013-2014.	21
Table 7. Listed and sensitive species on the San Andres NWR, NM. No federally listed species have been documented on the Refuge proper, but those species with sensitive or State status are included. Species documented on the Refuge are denoted (*).	22
Table 8. Federal species of concern are listed with species documented on the Refuge denoted (*).	23
Table 9. Summary of environmental effects by alternative.	38

1.0 PURPOSE OF AND NEED FOR PROPOSED ACTION ALTERNATIVE

1.1 Introduction

The United States Fish and Wildlife Service (Service), is proposing to initiate a desert bighorn sheep (*Ovis canadensis mexicana*) ram hunt on the San Andres National Wildlife Refuge (Refuge or NWR) in collaboration with White Sands Missile Range (WSMR or Range) and New Mexico Department of Game and Fish (NMDGF). This Environmental Assessment (EA) is being prepared to evaluate the effects associated with this proposal and complies with the National Environmental Policy Act (NEPA) in accordance with Council on Environmental Quality regulations (40 CFR 1500-1509) and Department of the Interior (516 DM 8) and Service (550 FW 3) policies (see Section 1.7 for a list of additional regulations that this EA complies with). Although the scope of the EA applies on to the San Andres NWR, the proposed hunt area exceeds the Refuge lands as part of the cooperation with WSMR and NMDGF.

White Sands Missile Range completed its NEPA requirements through their Integrated Natural Resource Management Plan and associated EA (WSMR 2001). NEPA requires examination of the effects of proposed actions on the natural and human environment. In the following chapters, three alternatives are described and environmental consequences of each alternative are analyzed.

1.2 Location

The Refuge is located approximately 20 miles northeast of Las Cruces, New Mexico, in Dona Ana County, and encompasses 57,215 acres of the southern portion of the San Andres Mountain range (Figure 1). The San Andres Mountains are bordered to the north by the Oscura Mountains and to the south by the Organ Mountains.

The Refuge headquarters are located at 5686 Santa Gertrudis Drive, Las Cruces, New Mexico. The Refuge is completely surrounded by WSMR

Figure 1. Locator map for White Sands Missile Range and the San Andres National Wildlife Refuge.



operated by the Department of Defense and therefore has very limited public access (Figure 1). The Range surrounded Refuge lands in 1952 when Public Land Order 833 permanently established WSMR after World War II. White Sands Missile Range is the largest single Department of Defense (DoD) land holding, with 2.2 million acres, is managed by the U.S. Army, and operated to support DoD readiness programs involving the research, development, testing, and evaluation of weapons and space systems (WSMR 2001).

White Sands National Monument, established in 1933, lies within the Tularosa Basin on the east side of the Refuge. The Jornada Experimental Range (JER) Station, established in 1912, retains certain research rights over the western portion of the Refuge. This land was transferred from the JER to the Service for establishment of the Refuge in 1942. The White Sands Test Facility, a part of the National Aeronautics and Space Administration (NASA) borders the Refuge in the southwest corner. Refuge staff must pass through NASA or WSMR lands to enter the Refuge's main access points; because WSMR and NASA are secured facilities, all access to the Refuge must be coordinated through Refuge staff with these partners to ensure security requirements are met.

1.3 Background

Restoration of the San Andres Mountains desert bighorn sheep population is essential to the recovery of desert bighorn sheep in New Mexico (NMDGF 1998). The Refuge, WSMR, and NMDGF continue to join management efforts to ensure desert bighorn remain a viable component of San Andres Mountains biodiversity. The general approaches the partners have taken to reach this goal over the past several decades 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) continue limited mountain lion control programs necessary to guide recovery efforts.

The San Andres NWR was established in 1941 by Executive Order 8646 for the "conservation and development of natural wildlife resources." In addition to the stated purpose of the refuge, further goals of establishment were to protect desert bighorn sheep habitat. The San Andres Mountains have the potential to maintain the largest single herd of desert bighorn sheep in New Mexico (NMDGF 1995). When the Refuge was established in 1941, there were approximately 31-33 desert bighorn sheep inhabiting the San Andres Mountains (Kennedy 1957). Although the San Andres desert bighorn population has fluctuated over time, there have been two primary declines in the San Andres Mountains documented since 1941 (Hoban 1990). The bighorn population increased to an estimated 140 animals by 1950, but declined to 70 animals by 1955. This 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, NMDGF 2003). Livestock grazing discontinued in 1952 with the establishment of White Sands Missile Range (Hoban 1990). By 1967, the bighorn population increased to approximately 270 animals, the highest number of desert bighorn estimated in the San Andres Mountains. 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).

During a bighorn hunt in 1978, scabies was discovered on all bighorn rams harvested prompting additional aerial and ground surveys. The direct and indirect effects of virulent scabies (*Psoroptes ovis*) outbreak first documented in 1978 caused the San Andres Mountains desert bighorn population to decline to 80 animals by 1979 (Sandoval 1980). Indirect effects of virulent scabies have led to increased susceptibility to predation and accidental falls from loss of equilibrium (Clark and Jessup 1992). This disease event and efforts to treat this bighorn population have been reported in numerous publications (Lange et al. 1980, Sandoval 1980, Kinzer et al. 1983, Hoban 1990, IWVS 1990). Additionally, a thorough review of the San Andres Mountains bighorn

sheep management issues was produced by the Wildlife Management Institute with all members of the review team independent of the three principal agencies (Sparrowe et al. 1992). In addition to disease issues, the bighorn population was impacted by drought, poor reproduction and predation by mountain lions (USFWS 1998).

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). Between 1980 and the early 1990s, the minimum San Andres Mountains desert bighorn sheep population estimate remained less than 40 individuals (Sandoval 1980, Hoban 1990). The population slightly increased during the early 1990s however, in 1995 the minimum population estimate declined to 25 and in 1996 the minimum population estimate declined sharply to 3 individuals. In 1997, the minimum population declined further to a single radio collared ewe, the last indigenous bighorn in New Mexico (Boyce and Weisenberger 2005). Nine of 10 radio collared bighorn sheep died during a 15-month period during 1996-1997. Factors associated with this high mortality rate were drought, predation by mountain lions, accidents, and continued scabies infestation. It is probable that a similar mortality rate also occurred on the uncollared portion of the population because no noncollared bighorn were observed during extensive aerial surveys in 1996 or 1997. Other factors that contributed to the overall population decline were poor reproduction and an aging population. Furthermore, there was no recruitment into the bighorn population from 1995-1997 (USFWS 1998).

Following a two-year disease study (1999-2001) including the lone ewe and several rams transplanted from NMDGF's Red Rock Wildlife Area (RRWA), no scabies were detected in the San Andres bighorn sheep population (Boyce and Weisenberger 2005). Red Rock Wildlife Area is a captive breeding facility for desert bighorn sheep located north of Lordsburg, New Mexico and managed by NMDGF (NMDGF 2003). Established in 1972, the captive herd at RRWA originated from 22 bighorn sheep from the San Andres Mountains and the Loma Prieta Range in Sonora, Mexico.

With negative results for all bighorn tested for scabies during the disease study, the management option to augment the San Andres bighorn population with transplanted animals was examined. Subsequently, 81 bighorn were transplanted from two sources in 2002 and 2005 with the cooperation of Kofa National Wildlife Refuge, Arizona Game and Fish Department (AZGF), Arizona Desert Bighorn Sheep Society, WSMR, New Mexico Chapter of the Wild Sheep Federation, and NMDGF (Table 1).

Table 1. Desert bighorn sheep transplanted to the San Andres National Wildlife Refuge.

Source Stock	2002		2005	
	Ewes	Rams	Ewes	Rams
Kofa NWR, AZ	18	2	25	5
Red Rock Wildlife Area, NM	13	18	0	0

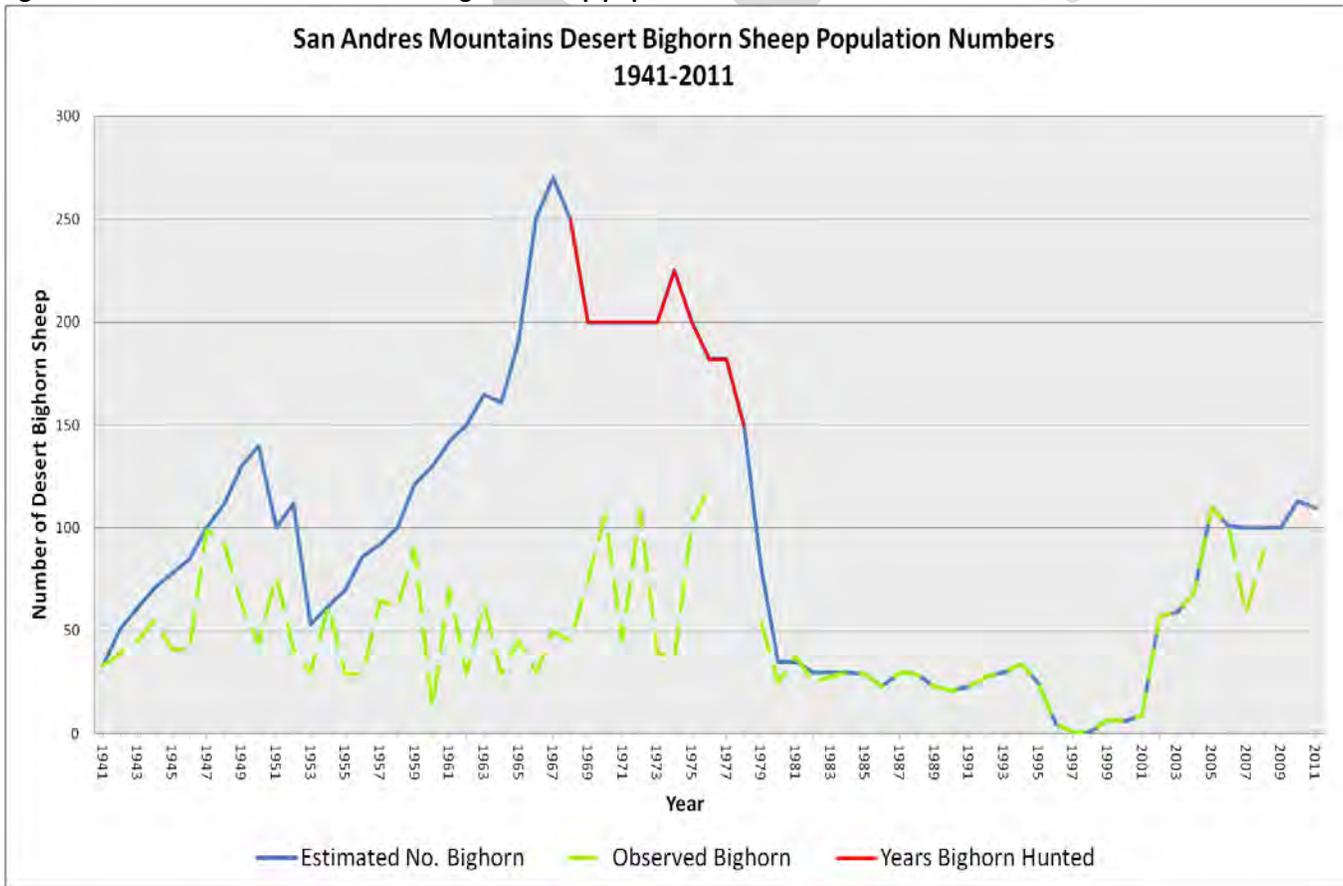
Estimated and observed numbers of bighorn sheep in the San Andres Mountains bighorn population since establishment of the Refuge in 1941 are described in Figure 2 (Hoban 1990, NMDGF 2011a, NMDGF 2012, Refuge files). The most recent complete survey of the bighorn population was conducted by helicopter in 2008. The current desert bighorn population is estimated at 110-130 animals (NMDGF 2012). Desert bighorn sheep were previously hunted on the Refuge from 1968 to 1978 (Table 2 and Figure 2). The estimated San Andres bighorn population is derived from the number of observed animals during ground and aerial surveys. Note should be taken with the San Andres Mountains bighorn sheep population estimated values that were derived using various survey methodologies over time; ground surveys were conducted from

1941 – 1968, and a combination of ground and aerial surveys have been performed sporadically from 1969 to the present.

Table 2. Summary of San Andres Mountains desert bighorn sheep hunts 1968-1978.

Year	No. Hunters	Rams Harvested	Season (days)	Bighorn Population Estimate
1968	4	4	9	250
1969	5	4	8	200
1970	5	5	9	200
1971	6	6	8	200
1972	6	6	9	200
1973	6	6	8	200
1974	5	5	8	225
1975	6	5	9	200
1976	6	6	7	182
1977	5	5	?	182
1978	6	5	9	150

Figure 2. San Andres Mountains desert bighorn sheep population observed and estimated numbers 1941-2011.



Radiocollars were first deployed on bighorn sheep in 1980 and have been used continually since that year. Tracking desert bighorn sheep with the use of radiotelemetry has enabled more intensive monitoring of the San Andres Mountains bighorn population. Determining the number of animals in a population is one of the most challenging responsibilities for wildlife managers (Douglas and Leslie Jr. 1999) because populations such as bighorn sheep are difficult and costly to survey, only a portion of the population will be observed during surveys, and population trends must be evaluated from population composition (age and sex ratios) derived from the surveys. Thus, long-term trend data is essential to address variability in populations and the methodology used to survey them.

1.4 Purpose of Action

The purpose of the proposed action is to provide increased hunting opportunities on the San Andres NWR. The purpose of this Environmental Assessment is to evaluate the feasibility of establishing a public draw hunting program for desert bighorn sheep on the San Andres NWR, Dona Ana County, New Mexico.

1.5 Need for Action

NMDGF is interested in hunting in desert bighorn sheep populations throughout the State. The proposed hunt area falls within NMDGF hunt unit 19, which contains lands managed cooperatively by the Service and the Range. This action is needed to provide consistent bighorn sheep management practices within the same hunt unit. The Service is looking into the feasibility of a desert bighorn sheep hunt in cooperation with WSMR and NMDGF.

This proposed action is also necessary to implement the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd et seq.), which provides authority for the Service to manage the Refuge and its wildlife populations. It mandated that six priority public uses (hunting, fishing, wildlife photography, environmental education, and interpretation) be provided when feasible and compatible with the purpose of the Refuge and the mission of the National Wildlife Refuge System. Hunting has been found to be compatible with the purpose of the Refuge. Desert bighorn sheep hunting would provide the general public an opportunity for a high-quality wildlife-dependent recreational experience on the Refuge. A desert bighorn ram hunt conforms to this objective by offering an uncrowded, highly individualistic experience.

The proposed desert bighorn sheep ram hunt fulfills the Refuge System hunting goals described below:

The guiding principles of the Refuge System's hunting programs as outlined in the U.S. Fish & Wildlife Manual (605 FW 2) are to:

- Manage wildlife populations consistent with Refuge System-specific management plans approved after 1997 and, to the extent practicable, State fish and wildlife conservation plans;
- Promote visitor understanding of and increase visitor appreciation for America's natural resources;
- Provide opportunities for quality recreational and educational experiences consistent with criteria describing quality found in 605 FW 1.6;
- Encourage participation in this deeply-rooted tradition in America's natural heritage and conservation history.

The proposed hunt is also consistent with the San Andres NWR Comprehensive Conservation Plan (CCP). The first of five goals denoted in the 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” (USFWS 1998). To accomplish this goal, the Refuge, in cooperation with NMDGF and WSMR, 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” (USFWS 1998). A desert bighorn ram hunt supports this objective. In 1998 when the CCP was finalized, desert bighorn sheep were listed as State-endangered, but were delisted by NMDGF in 2011 making available the option for hunting this species. Desert bighorn sheep were previously hunted on the Refuge from 1968 to 1978 (Table 2 and Figure 2) and WSMR will begin desert bighorn hunts in fall 2012 on Range lands within the San Andres Mountains in NMDGF Unit 19.

The goals of the Document for the Recovery of Desert Bighorn Sheep in the San Andres Mountains, New Mexico (NMDGF 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.*

1.6 Decision to be Made

This EA is an evaluation of the environmental impacts of the alternatives and provides information to help the Service fully consider these impacts and any proposed mitigation. Using the analysis in this EA, the Service would decide whether there would be major effects associated with the alternatives that would require the preparation of an environmental impact statement or whether the Proposed Action Alternative can proceed. If the selected alternative has no significant impact, a Finding of No Significant Impact (FONSI) will be prepared.

1.7 Regulatory Compliance

National Wildlife Refuges are guided by the mission and goals of the National Wildlife Refuge System (NWRS), the purposes of an individual refuge, Service policy, and laws and international treaties. Relevant guidance includes the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, Refuge Recreation Act of 1962, and selected portions of the Code of Federal Regulations and Fish and Wildlife Service Manual.

The mission of the Refuge System is:

“... to administer a national network of lands and waters for the conservation, management and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans” (National Wildlife Refuge System Improvement Act of 1997, Public Law 105-57).

The goals of the Refuge System are to:

- *Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered;*
- *develop and maintain a network of habitats for migratory birds, anadromous and interjurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges;*
- *conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts;*
- *provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation); and*
- *foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.*

The NWRS Improvement Act of 1997 provides guidelines and directives for the administration and management of all areas in the NWRS. It states that national wildlife refuges must be protected from incompatible or harmful human activities to ensure that Americans can enjoy Refuge System lands and waters. Before activities or uses are allowed on a national wildlife refuge, the uses must be found to be compatible. A compatible use "... will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuges." In addition, "wildlife-dependent recreational uses may be authorized on a refuge when they are compatible and not inconsistent with public safety." The act also recognized that wildlife-dependent recreational uses involving hunting, fishing, wildlife observation, photography, environmental education and interpretation, when determined to be compatible with the mission of the System and purposes of the Refuges, are legitimate and appropriate public uses of the NWRS and they shall receive priority consideration in planning and management.

This EA was prepared by the Service and represents compliance with applicable Federal statutes, regulations, Executive Orders, and other compliance documents, including the following:

- Administrative Procedures Act (5 U.S.C. 551-559, 701-706, and 801-808) as amended
- American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996)
- Antiquities Act of 1906 (16 U.S.C. 431-433)
- Archaeological Resources Protection Act of 1979 (16 U.S.C. 470)
- Bald Eagle Protection Act (16 U.S.C. 668-668d) as amended
- Clean Air Act of 1972, as amended (42 U.S.C. 7401 *et seq.*)
- Clean Water Act of 1972, as amended (33 U.S.C. 1251 *et seq.*)
- Endangered Species Act of 1973, (ESA) as amended (16 U.S.C. 1531 *et seq.*)
- Executive Order 12898, Federal Action Alternatives to Address Environmental Justice in Minority Populations and Low Income Populations, 1994.
- Executive Order 13112, Invasive Species (issued in February 1999)
- Fish and Wildlife Coordination Act of 1958, as amended (16 U.S.C. 661 *et seq.*)
- Fish and Wildlife Improvement Act of 1978 (16 U.S.C. 7421)
- Floodplain Management (Executive Order 11988)
- Migratory Bird Treaty Act (16 U.S.C. 703-712 as amended)
- National Refuge System Administration Act of 1966 (16 U.S.C. 668dd-668ee) as amended
- National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq.*)

- Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 *et seq.*)
- National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 *et seq.*)
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 *et seq.*)
- Protection and Enhancement of the Cultural Environment (Executive Order 11593)
- Protection of Wetlands (Executive Order 11990)
- National Pollutant Discharge Elimination System, as amended (33 U.S.C. 1251 *et seq.*)
- Soil and Water Conservation Act of 1977 (16 U.S.C. 2001-2009) as amended

Further, this EA reflects compliance with applicable State of New Mexico and local regulations, statutes, policies, and standards for conserving the environment and environmental resources such as water and air quality, endangered plants and animals, and cultural resources.

White Sands Missile Range will begin hunting desert bighorn sheep in fall 2012; their NEPA compliance for bighorn hunting was completed through their Integrated Natural Resource Management Plan and associated EA (WSMR 2001).

1.8 Scoping/Public Involvement and Issues Identified

On 28 August 2012, the Service announced its intent to prepare an EA for desert bighorn sheep hunting on the San Andres NWR. A 30-day scoping period from 28 August – 26 September 2012 was established under that notice. The Service provided a news release and also sent it out via 43 letters and emails to potential interested parties announcing the initial scoping period for development of this EA.

During the Scoping period the Service received a total of five comments; three comments received in support of the proposed bighorn hunt on San Andres NWR and two comments were received in opposition to the hunt. The following concerns and comments were identified:

- Two individuals were concerned that the San Andres desert bighorn sheep population is historically fragile and needs to be managed to avoid negatively impacting the herd.
- One individual suggested that income generated from the proposed bighorn hunt would not necessarily benefit the Refuge (financially); another individual suggested that it would help fund raising opportunities for conservation projects on the Refuge.
- One individual was concerned about increased negative impacts that could be generated from additional hunts; one supporter of hunting stated that this population of desert sheep has potential for growth with potential for increased sport hunting.
- One individual stated this hunt would provide additional recreational opportunities on a limited resource.

The draft hunt plan, Compatibility Determination (CD), and EA were released for a 30-day comment period starting on November 7, 2012. The documents were made available at Branigan Public Library in Las Cruces, New Mexico and on the Refuge website (www.fws.gov/southwest/refuges/newmex/sanandres/index.html). A notice was provided to the Las Cruces Sun News, Las Cruces Bulletin, El Paso Times, Alamogordo Daily News, and American Classifieds.

Various personnel from the FWS and partnering agencies reviewed these draft documents and provided comment in their development.

2.0 ALTERNATIVES

The San Andres NWR has included three alternatives for consideration relative to initiating a bighorn ram hunt program on the Refuge.

2.1 Alternative A--No Action Alternative

Under the No Action Alternative, current management direction would continue, and the Refuge would remain closed to bighorn sheep hunting. Desert bighorn sheep hunting would continue on WSMR lands, beginning in fall 2012, in NMDGF Unit 19 and other NMDGF hunt units in New Mexico. The Refuge would continue to allow limited public access for current activities, which are allowed for very specific activities and times. There are only limited oryx hunts currently managed on the Refuge and tour groups are escorted by request on a limited basis, averaging 1-2 times per year. The population reduction hunts for oryx (*Oryx gazella*) would continue on the Refuge, in cooperation with WSMR and the New Mexico Department of Game and Fish (NMDGF). No more than 35 oryx hunters per year are allowed on the Refuge; in addition oryx hunters are permitted to bring up to three guests in their hunting party. Hunters are responsible for their guests and all hunt party members would remain together within reasonable hunting and stalking techniques. Additionally, communication would be maintained by all persons in the hunt party for safety reasons.

The Refuge currently maintains roads on an as-needed basis; all roads on the Refuge are considered two-track and high clearance vehicles with four-wheel drive are required. Road improvements under Alternative A would continue on an as-needed basis.

2.2 Alternative B—Open Bighorn Sheep Hunting to General Public during State Seasons with camping (Proposed Action Alternative)

Under this alternative the Refuge would allow desert bighorn sheep hunting within NMDGF Unit 19 to all qualified hunters during the state-approved bighorn sheep season. The hunt area (approximately 186,000 acres to include 57,215 acres on the San Andres NWR) would consist of bighorn habitat in the San Andres Mountains (NMDGF Unit 19) on both Refuge and WSMR lands (Figure 3). Hunt officials would provide detailed hunt area maps to all hunters prior to or on the day of their assigned hunt. The Refuge is completely surrounded by WSMR operated by the Department of Defense and therefore has very limited public access. Access to the Refuge for hunting would depend on annual evaluations of the hunt program by the Refuge, WSMR, and NMDGF. Those evaluations would include assessment of fall aerial survey results, access logistics related to testing and training on WSMR, and any other issues that arise. Bighorn ram hunts would occur in the entire Refuge and portions of WSMR as defined by mutual agreement, addressed annually, between WSMR and Refuge. The hunt area may change depending on bighorn sheep distribution throughout the San Andres Mountains and/or WSMR testing and training activities. Additional fall desert bighorn sheep hunts in southern New Mexico that do not have access restrictions can be found on public lands in NMDGF Units 13, 20, 26, and 27 and in NMDGF Unit 20 on private land.

Seasons, licenses, safety courses, species, and bag limits are within the guidelines established by NMDGF, but hunting on the Refuge would be more restrictive to assure compatibility with other Refuge purposes. Law enforcement would consist of random hunting license and bag limit checks by Refuge Officers, WSMR Game Wardens, and NMDGF Game Wardens. To obtain data on hunter success and biological data on species harvested, all hunters would be required to check harvested rams at the Refuge headquarters or with Refuge, WSMR, or NMDGF staff. Three to four ram tags would be made available initially based on desert bighorn

sheep population numbers and demographics based on data collected during fall aerial surveys. For example, the first hunt season (2013-2014) may include three NMDGF lottery draw general public hunters; two adult and a possible Auction or Raffle hunter. If fall aerial survey data report a sufficient number of rams in the San Andres bighorn population, then a fourth tag for a youth-only hunt may be considered. The season, method of take, licensing requirements, and bag limits would be consistent with the NMDGF desert bighorn sheep hunting regulations. Additional Refuge-specific and WSMR regulations would also apply. Under this alternative, camping would be allowed on the Refuge; however implementation of this option to camp is contingent upon WSMR determining whether camping meets their mission and safety considerations. On the Refuge, camping would be restricted to Little San Nicholas Camp which is already used by Service staff and researchers conducting studies.

Access to WSMR and the Refuge for desert bighorn sheep hunts would only be through the Small Missile Range gate (Figure 4). Due to safety and security requirements specific to the areas targeted for these hunts, bighorn sheep hunters may be escorted while on the Refuge or WSMR. Official escorts can only be on-duty WSMR hunt program personnel, and include Department of the Army Civilian Police, identified Range civilian and contractor personnel, Refuge staff, and NMDGF employees with authorized WSMR security access. Prior to each hunt, WSMR, Refuge, or NMDGF staff (or their agents) would provide hunters and guests with a Range safety and security briefing, and would conduct a vehicle, licensing, and registration inspection. If available, escorts would lead hunters to the hunt area, assist with locating sheep, and ensure location and shot safety. The need for escorts is determined on the number of hunters and escort availability. Depending on the number of hunters and available escort personnel, check stations located on WSMR may be established in lieu of the escort requisite. No Refuge-specific permit would be required for hunters, although they would be required to check harvested rams to the Refuge headquarters or with Refuge or WSMR staff.

Bighorn hunts would be scheduled according to access availability from WSMR and NMDGF hunt seasons; the permitted hunt dates each year shall occur during late December and early January based on mutual agreement between the Refuge, WSMR, and NMDGF. Scouting prior to the hunt shall occur only after coordination with WSMR and the Refuge. Bighorn sheep hunting on San Andres NWR would have important differences from hunting on other public lands in New Mexico due to security and safety restrictions associated with WSMR testing and training activities. Some of the major contrasts from other New Mexico bighorn hunts would include some limitations of camping and use of all-terrain vehicles (ATV), except to retrieve harvested game on WSMR lands; ATV use would not be permitted on the Refuge for bighorn sheep hunting.

White Sands Missile Range, NMDGF, or Refuge staff or their agent(s) may require hunters be escorted and hunters may also be required to report to a check station depending on the number of hunters and escort availability. The need for escorts would be determined by the number of hunters and escort availability. Federal and State laws and regulations are enforced by Refuge and WSMR law enforcement personnel and NMDGF game wardens, respectively (i.e., hunters must possess a valid hunting license from NMDGF and official tags, etc).

Desert bighorn sheep would be taken by hunters in accordance with WSMR, NMDGF, and Refuge specific regulations. The number of licenses and authorizations issued for the entire San Andres Mountains (NMDGF Unit 19) would be dependent on the bighorn sheep population size and demographics as determined by annual or biennial fall aerial surveys conducted by the Refuge, WSMR, and/or NMDGF. Bighorn sheep populations are susceptible to over-exploitation because of their low population growth rate and low population size, thus, determining the status of the San Andres Mountains bighorn population through bi-

annual aerial surveys is necessary to ensure sustainability. Adjustments to the number of hunt tags issued may occur to reflect surveys and in cooperation with WSMR and NMDGF. For example, the first hunt season (2013-2014) may include three NMDGF lottery draw general public hunters; two adult and a possible Auction or Raffle hunter. If NMDGF Unit 19 is not selected by an Auction or Raffle hunter during any year then we would be below potential harvest level for that year. Radiocollared and unmarked rams would be permitted for take per NMDGF regulations. If fall aerial survey data report a sufficient number of rams in the San Andres bighorn population, then a fourth tag for a youth-only hunt may be considered.

The hunting program would be reviewed by the cooperating agencies on an annual basis and necessary changes would be incorporated accordingly. If desert bighorn sheep population demographics, habitat, or hunter success rates considerably change or affect other wildlife populations, necessary modifications to the hunt would be incorporated accordingly. State biologists with NMDGF have reported that desert bighorn sheep populations in New Mexico are stable to slightly increasing (NMDGF 2012).

Approximately 130-170 additional hunt visits are expected if the Refuge is opened to bighorn sheep hunting; this estimate includes 5 days of scouting prior to the hunt and 10 hunt days. Hunt parties would consist of a hunter and up to three companions and we estimate three or four ram tags would be available initially per hunt season. Hunters are responsible for their guests and all hunt party members would remain together within reasonable hunting and stalking techniques. Additionally, communication would be maintained by all persons in the hunt party for safety reasons. As mentioned previously, the specific number of days to access the San Andres Mountains for scouting and hunting would depend on WSMR testing and training schedules and the number of ram tags would be determined based on bighorn sheep population numbers and demographics derived from fall aerial surveys.

Funding for fall aerial surveys would be provided by one or more of the cooperating agencies and/or proceeds from Auction or Raffle hunters who choose to hunt in NMDGF Unit 19. Proceeds from the auction and raffle are used for bighorn sheep research, management, and propagation in New Mexico. Should auction or raffle hunters choose to hunt in the San Andres Mountain Range, 25-50% of the proceeds from those tags would be used for fall aerial surveys of the San Andres desert bighorn sheep population.

While WSMR would administer bighorn hunts on San Andres NWR, the Refuge would provide funding and staffing to implement and maintain the program to ensure compatibility with Refuge purposes, perform appropriate law enforcement compliance checks, and ensure appropriate facility's maintenance. Additional detail on costs of implementing the proposed action are provided in the CD.

Additional road maintenance to support access for bighorn sheep hunters may be required along existing roads. No additional roads would be constructed for Alternative B.

Figure 3. Proposed hunt area (in red) for desert bighorn sheep in the San Andres Mountains, New Mexico which included the entire San Andres NWR and most of the San Andres Mountains Range. The San Andres Mountains lie within White Sands Missile Range boundaries.

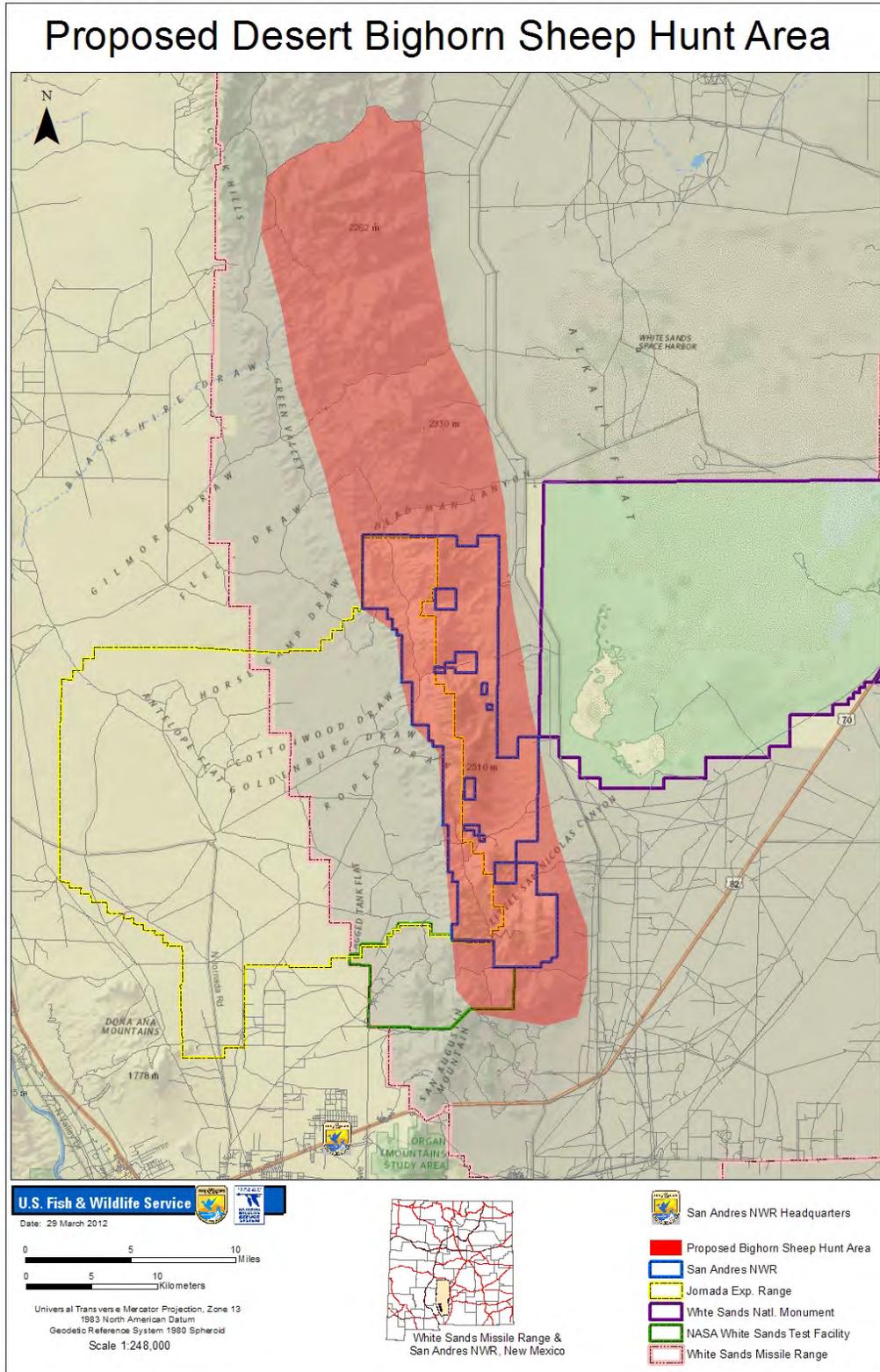
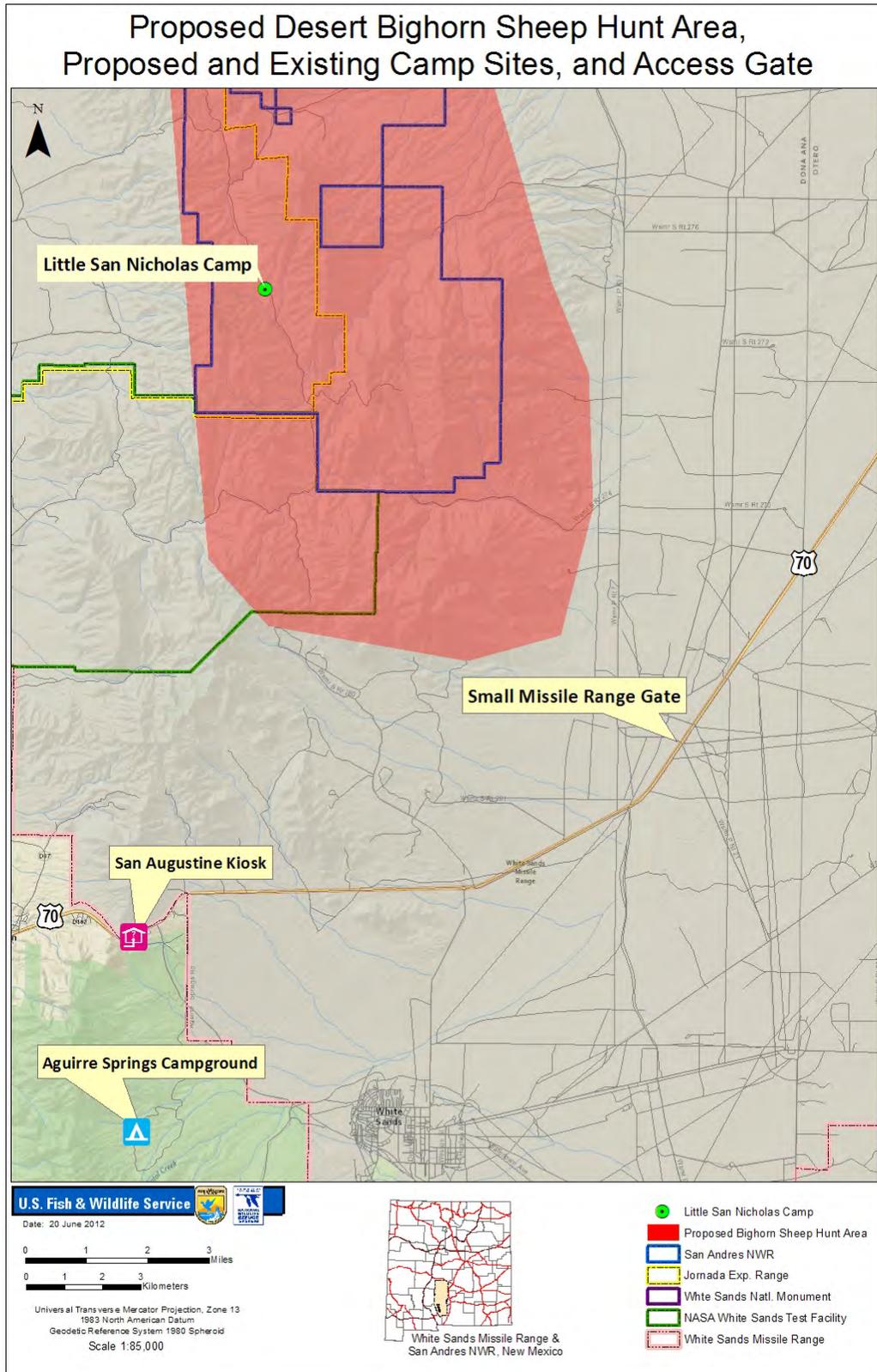


Figure 4. Proposed camp site on San Andres NWR within proposed bighorn sheep hunt area. Note distance to Small Missile Range gate which is entry and exit access point to entire hunt area.



2.3 Alternative C— Open Bighorn Sheep Hunting to General Public during State Seasons without camping

This alternative is the same as Alternative B with the exception of no camping allowed on the San Andres NWR, although camping could become available on WSMR in the future. Hunters would have to exit the Refuge via the Small Missile Range Gate each day and re-enter the following morning for each visit. Camping sites are available year-round at Aguirre Springs Campground, managed by the Bureau of Land Management (Figure 4). Aguirre Springs Campground, located on the northeast portion of the Organ Mountains, is approximately 30 – 45 minutes' drive from the southern tip of the proposed bighorn sheep hunt area in the San Andres Mountains. It takes at least 40 – 60 minutes to drive from Small Missile Range Gate to the nearest hotel in Las Cruces or Alamogordo, New Mexico.

Additional road maintenance to support access for bighorn sheep hunters may be required along existing roads. No additional roads would be constructed for Alternative C.

2.4 Comparison of Alternatives

Table 3 describes a matrix to compare the alternatives for this Environmental Assessment.

Table 3. Comparison of Alternatives Matrix.

Alternative A: No Action- No Bighorn Sheep Hunts on the Refuge	Alternative B: (Preferred) Open Bighorn Sheep Hunting on the Refuge to General Public during State Seasons with camping	Alternative C— Open Bighorn Sheep Hunting on the Refuge to General Public during State Seasons without camping
No harvesting of bighorn on the Refuge would occur. Population would be allowed to grow as large as habitat would support. Bighorn hunts would continue on WSMR lands surrounding the Refuge.	Refuge would allow desert bighorn sheep hunting within NMDGF Unit 19 to all qualified hunters during the state-approved bighorn sheep season. The number of licenses and authorizations issued for the entire San Andres Mountains would be dependent on the bighorn sheep population size and demographics as determined by the Refuge, WSMR, and NMDGF. Hunters would be permitted to camp on the Refuge at Little San Nicholas Camp. Bighorn hunts would continue on WSMR lands surrounding the Refuge.	Same as Alternative B, except no camping would be permitted on the Refuge. Camping may be permitted on WSMR.

2.5 Alternatives Considered But Dismissed From Detailed Analysis

Issues identified in this EA, Section 1.8 were considered, however they did not generate additional alternatives.

3.0 AFFECTED ENVIRONMENT

3.1 Physical Environment

The San Andres mountain range is approximately 75 miles long, forming an arc six to 12 miles wide that concaves to the east. The mountain range is bordered by the Jornada del Muerto plains to the west and the Tularosa Basin to the east. The Organ Mountains, located directly south of and virtually contiguous with the San Andres Mountains, rise nearly a mile above the floor of the Tularosa Basin (Seager 1981).

The southern San Andres and Organ Mountains represent a west-tilted fault block, uplifted vertically along an east bounding fault zone. The mountain range has a relatively gentle slope on the west side, breaking into a series of precipitous cliffs and benches on the east side. Elevation of the Refuge ranges from 4,200 to 8,235 feet. Major east-west canyons delineate five mountain subunits within the Refuge, which are known (from south to north) as: Bennett, Black Brushy, San Andres, Oñate, and Block. Major east-west canyons (from south to north) are known as: Bear, Little San Nicholas, Ash-Salt, San Andres and Mayberry.

3.1.1 Climate

The climate of the San Andres NWR and surrounding region is semi-arid. Annual precipitation averages 14.03 inches on the Refuge to approximately 11 inches in the Las Cruces area. The fall and spring are relatively dry with winter and late summer being the wettest seasons. Although winter precipitation includes snowfall, snowpack rarely develops. Temperatures range from subfreezing in the winter to over 100 degrees Fahrenheit in the summer.

Climate Change

Long-term climate change generated by vast quantities of heat-storing (greenhouse) gasses in the earth's atmosphere may have the most profound impact on ecological systems of any other human-induced stressors. San Andres NWR is located in southern New Mexico which is in the northern portion of the Chihuahuan desert.

Two climate-related meteorological conditions that have shown profound influence on Chihuahuan Desert systems are the intensity and persistence of rainfall, and the frequency and duration of prolonged periods of drought (Davey et al. 2007). Desert ecosystems are sensitive indicators of climate change because small changes in precipitation and temperature can have significant effect on physical resources and biological communities. Changing patterns in precipitation and temperature have the potential to shift the latitudinal and elevational distribution of some plant communities and threaten the persistence of others.

Water and water dependent ecosystems are scarce resources in the arid southwest, and are generally regarded as bio-diverse areas. Seeps and springs are critical surface water sources and are among the most restricted habitats for plant and animal species. Precipitation is critical to the existence of seeps and springs. The size, frequency, and duration of precipitation events are key factors influencing spring-water availability. Climate change is expected to alter surface water quantity, as well as seasonal patterns of flooding and drought. Springs are an indicator of these changes. Intense rainfall affects the transport and distribution of energy and materials through arid and semi-arid systems (Whitford 2002).

Run-off also affects the hydrology and quality of aquatic systems such as the Rio Grande and Amistad International Reservoir. Prolonged drought often leads to diminished productivity in many species of plants and animals. Loss of vegetation cover, in turn, leads to greater vulnerability of soil erosion (Okin et al. 2006).

Precipitation is projected to drop by 5 percent by century's end (relative to average precipitation over the last three decades of the 20th century) for much of Arizona and New Mexico, based on results from an ensemble of 18 global climate models (Reichler and Kim 2008). Such a decrease could have a more serious impact than the numbers suggest. The decrease of water draining from the landscape into rivers and reservoirs typically can be double or triple the proportional reductions in rainfall amounts, especially when combined with higher temperatures (Bader et al. 2008).

Temperatures

Desert scrub communities now comprise nearly one half of the total vegetation in the Chihuahuan Desert, and may have grown to their present extent through invasion of eroded grasslands (Chihuahuan Desert Research Institute 2009). Climate change could result in upslope biome shifts, with significant impacts to upland systems. (Breshears et al. 2008).

The average annual temperature in the U.S. Southwest is projected to rise by 5 to 8 degrees Fahrenheit by the end of this century, based on the "collective" results from numerous climate models used by the IPCC. (IPCC 2007, Lenart 2007, Meehl et al. 2007, Bader et al. 2008, Diffenbaugh et al. 2005) What's more, summer is projected to warm even more than winters in the Southwest. Of major concern in the Chihuahuan Desert region is the on-going transformation of semi desert grassland into shrublands and a more desert-like ecosystem. Much of the ecoregion was once covered by healthy semi desert grasslands, but heavy livestock grazing coupled with frequent droughts during the 20th century transformed thousands of acres to desert shrublands, a process that continues today (Hoyt 2002).

Invasive Exotic Plants

Climatic changes are predicted to provide exotic plant species with new opportunities for invasion. Because they fragment native ecosystems, displace native plants and animals, and alter ecosystem function, invasive exotics represent one of the greatest threats to natural ecosystem integrity. Several climate models predict that climate change will result in more frequent and extreme droughts that could episodically reduce water availability and soil moisture.

3.1.2 Air Quality

The project area has excellent air quality due to the rural land uses in most of the surrounding area. Some of the testing activities on WSMR release airborne pollutants that may temporarily affect air quality in the Tularosa airshed (east of the San Andres Mountains) and regionally (WSMR 2001).

3.1.3 Water Resources and Quality

Rainfall averages 12.0 – 14.0 inches annually with most moisture coming in the form of short intense rainfall from thunderstorms in the late summer. The San Andres Mountains are relatively well watered with springs, seeps and permanent streams in major east-west canyons. Most of these waters are located deep within canyons or higher up the escarpment with no road access.

The San Andres escarpment is responsible for the recharge of the aquifer in the Jornada del Muerto Basin to the west and a primary source of water for Lake Lucero to the east. Precipitation in the highland areas of the mountain range is absorbed by porous alluvium as runoff percolates into the water table. The aquifer under the San Andres contains water of poor quality, with high amounts of dissolved solids and heavy salt concentrations. Extensive water drainage in canyon bottoms can occur immediately following heavy rainfall in the form of thunderstorms (USFWS 2007).

Limited quantitative data has been published on the hydrogeology of the Refuge because of its remoteness, rarity of wells, and restricted access. Boykin et al. (1996) conducted a range wide survey of natural springs in the San Andres Mountains and Oscura Mountains, located immediately north of the San Andres Mountains. They described 276 montane seeps and springs including several parameters associated with the springs to include vegetation, invasive plant species, surface water, recent human evidence (within the past 125 years), and vertebrate species detected at the springs (Boykin et al. 1996, Thompson et al. 2002).

Rawling (2005) evaluated the hydrogeology and geology of five major springs on the San Andres NWR. Included in his report are a description of the geologic setting and hydrologic framework of five springs including geologic maps and cross sections, interpretation of the hydrologic setting and water sources, and an assessment of the possible threats or potential enhancements for these locations (Rawling 2005).

3.1.4 Soils / Geology

Soils are typically very shallow and intermixed with exposures of bedrock. Soils are generally well drained and are composed of gravels, sands, sandy and loamy silts and some clays. Organic matter in these soils is low. The rock formations include limestone, sandstone, basalt and shale. The outcrops of limestone commonly occur as vertical or nearly vertical exposures and ledges, giving a “stair-step” appearance to the landscape of the east escarpment. A thin mantle of stoney, loamy soil occurs between the outcrops of bedrock on very steep slopes, below rock ledges, and in small, narrow valleys (USFWS 2007).

Rawling (2005) evaluated the hydrogeology and geology of five major springs on the San Andres NWR. Included in his report are a description of the geologic setting and hydrologic framework of five springs including geologic maps and cross sections, interpretation of the hydrologic setting and water sources, and an assessment of the possible threats or potential enhancements for these locations (Rawling 2005).

3.2 Biological Environment

3.2.1 Vegetative Communities

According to Larson (1970), five plant communities described by Merriam are found on the San Andre NWR. These include desert shrub (14,305 acres), desert riparian (2,860 acres), grass-shrub (28,610 acres), mountain shrub (5,720 acres) and pinyon-juniper (5,720 acres). Merriam Life Zones represented include both the Upper (above 7,000 feet) and Lower (below 6,500 feet) Sonoran of the Chihuahuan Desert.

In general, the lowlands, foothills and alluvial fans are dominated principally by creosote bush (*Larrea tridentate*), acacia (*Acacia constricta*), honey mesquite (*Prosopis glandulosa*), tarbush (*Flourenzia cernua*), and mimosa (*Mimosa aculeraticarpa*). Grasslands which occupy the lower slopes and piedmonts of the refuge are dominated by plants such as New Mexico needlegrass (*Stipa neomexicana*), fluffgrass (*Dasyochloa pulchella*), bush muhly *Muhlenbergia porteri*, and various grama grasses (*Bouteloua spp.*). Yuccas (*Yucca bacata* and *Y.*

elata), ocotillo (*Fouquieria splendens*) and sotol (*Dasyliirion wheeleri*) are also common in these areas, often times mixed or in transition to shrublands dominated by fourwing saltbush (*Atriplex canescens*), sand sage (*Artemisia filifolia*), mesa dropseed (*Sporobolus flexulosus*), tobosa grass (*Hilaria mutica*) and alkali sacaton (*Sporobolus airoides*).

The middle and higher elevations within the Refuge support a combination of piñon pine (*Pinus edulis*), juniper (*Juniperus monosperma*), oak (*Quercus grisea*, *Q. turbinella*, *Q. pauciloba*), and mountain mahogany (*Cercocarpus breviflorus*). Riparian vegetation occurs around springs and in the major drainages and include Fremont cottonwood (*Populus fremontii*), black willow (*Salix goodingii*), Apache plume (*Fallugia paradoxa*), velvet ash (*Fraxinus velutina*), and desert willow (*Chilopsis linearis*).

3.2.2 Wildlife

Thirty eight species of mammals have been documented on the Refuge, including desert bighorn sheep, desert mule deer, mountain lion (*Felis concolor*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), desert cottontail (*Sylvilagus audubonii*), and a wide variety of rodents that are typical of western mountains and deserts (USFWS 1998). More than 150 bird species inhabit the Refuge for all or part of the year; 38 new species have been documented for the Refuge since 1993 (Refuge files). More than 45 species of reptiles occur on the Refuge (USFWS 1998), and Refuge staff and collaborating researchers have been documenting preliminary baseline data for invertebrate species to include 40 species of butterflies, 24 species of damselflies, and 18 species of dragonflies (Refuge files). Several of the damselflies and dragonflies are new county records for Dona Ana County.

Primary emphasis since establishment of the Refuge has been the restoration and management of desert bighorn sheep (also see section 1.3). The San Andres Mountains desert bighorn sheep population has been considered paramount to the recovery and delisting of desert bighorn in New Mexico because it has the largest and most contiguous desert bighorn habitat in New Mexico (NMDGF 1995, NMDGF 2003). Desert bighorn sheep were initially listed as State-endangered in 1980 by NMDGF, were downlisted to State-threatened in 2009, and were completely delisted in 2011 after meeting the biological requirements specified in the NMDGF Recovery Plan for delisting (NMDGF 2011b). With an estimated state population of 610-705 desert bighorn sheep in New Mexico (Table 4, NMDGF 2012), the opportunity for hunting desert bighorn sheep in the San Andres Mountains is being explored.

Table 4. Population trends for desert bighorn sheep herds in New Mexico, 2000-2011 (taken from <http://www.wildlife.state.nm.us/conservation/bighorn/documents/PopulationTrends.htm>) (NMDGF 2012).

Herd	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ladrones	21	26	27	30	25-30	25-35	25-35	25-40	25-40	30-45	30-45	35-45
Peloncillos	48	30	25	55	65-75	60-70	70-75	75-85	75-85	80-90	70-75	95-110
Hatchets	43	40	50	35	38-47	60-75	100-110	120-130	125-135	130-140	130-140	135-155
Fra Cristobal	55	66	75	58	55-65	55-80	70-80	80-90	95-105	120-130	150-160	180-200
Caballos	0	0	0	?	?	?	12-20	20-30	25-30	47-50	55-60	55-65
San Andres	5	4	60	60	65-70	105-115	85-105	80-90	80-90	90-100	110-115	110-130
TOTAL	172	166	237	238	248-287	305-375	362-425	400-465	425-485	497-555	535-595	610-705

Desert bighorn sheep occur in the San Andres, Fra Cristobal, Caballo, Sierra Ladrones, Peloncillo, and Hatchet Mountains in New Mexico. They are distributed throughout the southern half of the San Andres Mountains, including the Refuge and south toward Highway 70. Necessary elements of bighorn habitat include food, water, escape terrain, and open space (Krausman et al. 1999). All components are critical as sites with open habitat and high-quality forage, but deficient of escape terrain, are rarely used by bighorn. Escape terrain is described as having a slope $\geq 60\%$ (Holl 1982, McCarty and Bailey 1994). The entire Refuge, with the exception of the headquarters site location which is separated from the Refuge proper by approximately 11.0 straight-line miles, is desert bighorn sheep habitat because it provides all the necessary elements required for sustaining bighorn populations.

New Mexico Department of Game and Fish receives funding annually from the Service's Division of Wildlife and Sport Fish Restoration Program for the purpose of implementing endangered species and other wildlife conservation programs. Over the past three decades Federal Aid resources have been used extensively toward desert bighorn sheep recovery in New Mexico. White Sands Missile Range has also contributed substantial initiatives for habitat conservation and species management for the recovery of desert bighorn sheep in the San Andres Mountains. State biologists with NMDGF have reported that desert bighorn sheep populations in New Mexico are stable to slightly increasing (NMDGF 2012). Wildlife populations are dynamic with respect to age structure and total numbers of individuals in the population. Sex and age ratios in desert bighorn sheep vary markedly and are related to survey techniques and seasonality. The bighorn sheep lambing season occurs primarily during late January through early June with peak lambing February-April, although they can lamb at any time of the year. Unbiased lamb:ewe ratios can only be collected near or post weaning (i.e., late September to mid November; lambs wean at 4-6 months of age) because prior to that time period lambs do not consistently accompany adults. Bighorn rams and ewes are freely intermixed in the fall breeding period but not in the spring, consequently unbiased adult sex ratios and ram age structure data can only be collected during the fall. Therefore, aerial surveys will only be conducted in the fall to get the most accurate population estimate. Additionally, aerial surveys reduce duplicate observations of individuals compared to ground surveys which take place over a longer time period.

Sex ratios are the proportion of male to females in a population where ram:ewe ratios in bighorn sheep populations indicate reproduction potential. The age structure of a population is a distribution of numbers of individuals of various ages where lamb:ewe ratios produced from fall surveys provide an index of recruitment into the population and can evaluate population growth rates. Recruitment is defined as lamb survival past weaning. During bouts of drought, lamb survival can decrease, subsequently reducing the lamb:ewe ratios, whereas, lamb survival and recruitment into the population often increases with favorable weather and forage conditions. These ratios are meaningful as long-term trend data which means one year's data is not a good indicator of population status. The last complete survey of the San Andres bighorn sheep herd was conducted in 2008. An attempt was made in fall 2010 to conduct another aerial survey, but both days were cut short by high winds and another survey was not rescheduled due to funding.

The population structure of the San Andres Mountains desert bighorn sheep herd between 2002-2011 has increased from a minimum estimate of 57 total animals to 110, with an average of ram:ewe:lamb ratio of 91:100:44 (Table 5). Population composition data described in Table 4 are derived from ground counts, with the exception of 2007-2008 whereby aerial surveys were conducted; all survey data was reported from the late breeding season. Sandoval (1979) reported an average ram:ewe:lamb ratio of 41:100:19 during breeding season aerial surveys in the San Andres Mountains between 1975-1976. Between 1941-1976, Sandoval (1979) also reported a long-term average ram:ewe:lamb ratio of 72:100:51 and Hoban (1990) reported an average ram:ewe:lamb ratio of 64:100:47 between 1985-1989. A viable bighorn sheep population is dependent on the

number of adult ewes; therefore ram tags would be issued on the Refuge. Bighorn ewe tags may be issued in populations as a management tool to reduce a herd that has become too large for an area.

Age classes of rams are described by Geist (1971) whereby yearlings are 1-2 years old, Class I (CI) rams are 2-3 years old, Class II (CII) rams are 3-6 years old, Class III (CIII) rams are 5-8 years old, and Class IV (CIV) rams are 8+ years old. Lambs are classified as 12 months old and younger.

Table 5. San Andres desert bighorn sheep population structure of animals observed during surveys 2002-2011.

Year	Obs.	Est.	Ram:Ewe	Lamb:Ewe	Ewes			lambs	Rams					
					Adults	Yearlings	unk		CI	CII	CIII	CIV	unk	UNK
2002	57	57	79:100	.03:100	31	2	0	1	10	8	4	3	1	0
2003	59	59	83:100	63:100	24	0	0	15	0	0	0	0	0	20
2004	68	68	127:100	82:100	22	0	0	18	0	0	0	0	0	28
2005	110	110												
2006	101	101												
2007	58	100	77:100	46:100	26	0	0	12	4	4	8	4	0	0
2008	89	100	91:100	30:100	33	5	0	10	6	9	12	3	0	11
2009		100												
2010		113												
2011		110												
Ave.			91:100	44:100										

The criteria to determine the number of available ram tags in western states varies ranging between 15% - 30% of mature rams identified as Class III and IV rams which are 6+ years of age (Utah Division of Wildlife Resources 2008, Washington Department of Fish and Wildlife 2008, AZGF 2011), 4% - 12% of the total ram numbers in the bighorn population (Nevada Division of Wildlife 2001, Utah Division of Wildlife Resources 2008, Colorado Division of Wildlife 2009), or a percentage of the statewide hunter success (Colorado Division of Wildlife 2009). Although the NMDGF Long-range Management Plan for Desert Bighorn Sheep (NMDGF 2003) does not specify a formula for the number of bighorn sheep ram tags issued, an action plan published in 2010 (NMDGF 2010) indicates that “none of the proposed herds have ever been hunted, therefore we should not have to err on the conservative side for several years.” That document also suggests 12% of the ram population is an acceptable number of permits to be issued initially (NMDGF 2010). Desert National Wildlife Refuge, Nevada, issues desert bighorn sheep ram permits each season equal to 8% of the total ram population estimate (Nevada Division of Wildlife 2001, USFWS 2009) and Kofa National Wildlife Refuge, Arizona, issues permits equal to 15-25% of the Class III and IV rams (AZGF 2011). If we consider the most recent year of complete data available for the San Andres Mountains in 2008, 20% of the Class III and IV rams equates to three tags and 25% equates to four tags (Table 6). Conversely, 8% of all rams documented in 2008 equates to two tags and 12% equates to 4 tags.

Table 6. Ram numbers and age classes from 2008 survey related to potential ram harvest 2013-2014.

CI Rams	CII Rams	CIII Rams	CIV Rams	Unk. Rams	Total
6	9	12	3	0	30
8% of all rams (n=30) = 2.4 ~ 2 tags			15% of CIII & CIV rams (n=15) = 2.25 ~2 tags		
10% of all rams (n=30) = 3.0 tags			20% of CIII & CIV rams (n=15) = 3.00 ~3 tags		
12% of all rams (n=30) = 3.6 ~4 tags			25% of CIII & CIV rams (n=15) = 3.75 ~4 tags		
			30% of CIII & CIV rams (n=15) = 4.50 ~5 tags		

High mule deer densities in the San Andres Mountains were previously considered detrimental to desert bighorn sheep resulting in desert mule deer buck and doe hunts from 1942–1977 (Halloran 1944, Leopold et al. 1947, Halloran and Kennedy 1949). Habitat competition between the target species and other wildlife is primarily limited to mule deer and oryx. Mule deer and bighorn diets have some overlap, though mule deer are primarily browsers. According to Krausman et al. (1999) bighorn prefer browse to other available forage, however, bighorn will opportunistically browse and graze forage species depending on range condition and time of year (Halloran and Kennedy 1949, Boeker et al. 1972, Sandoval 1979, Miller and Gaud 1989, Krausman et al. 1997, Hoenes and Bender 2010). Oryx diet studies on WSMR have found that oryx are primarily grazers, but will also browse depending on forage availability (Saiz 1975, Smith 1994, Dye 1998, Burkett 1999). Competition between species targeted by the hunting program and other wildlife or their habitats is not considered a limiting factor.

3.2.3 Threatened and Endangered Species and Other Special Status Species

No federally listed threatened or endangered species or their critical habitats are found on the San Andres NWR. A list of federal and state listed species and sensitive species found on or near the San Andres NWR are described in Table 7, where sensitive flora and fauna species documented on the Refuge are denoted. Federal species of concern are listed in Table 8 for planning purposes only.

Federal Species of Concern found on the Refuge are Bell’s vireo and Townsend’s big-eared bat. Bell’s vireo is a Neotropical migrant that is only present during the summer breeding season. Townsend’s big-eared bats are generally resident species that inhabit abandoned mines or caves where they would hibernate during winter.

New Mexico state-threatened species documented on the Refuge are Costa’s hummingbird, gray vireo, Bell’s vireo, and varied bunting. Two flora species found on the Refuge and classified as Species of Concern by the state of New Mexico are New Mexico rock daisy and Castetter’s milkvetch. Costa’s hummingbirds are considered rare on the Refuge and along with gray vireos and varied buntings, are only present during the summer breeding season. New Mexico rock daisy was collected by Von Loh (1977) in Ash Canyon on the San Andres NWR, but subsequent attempts to determine the exact location or locate the specimen collected have been unsuccessful. Castetter’s milkvetch is scattered throughout the Refuge, also found in other locations in Dona Ana and Sierra counties, and occupies areas with soil disturbance such as roads and mine spoils (New Mexico Rare Plant Technical Council 2012).

Table 7. Listed and sensitive species on the San Andres NWR, NM. No federally listed species have been documented on the Refuge proper, but those species with sensitive or State status are included. Species documented on the Refuge are denoted (*).

Family	Taxon	Common Name	Federal Status	New Mexico Status	General Location
FALCONIDAE	Falco femoralis septentrionalis	Northern Aplomado Falcon	Experimental Population, Non-Essential	Endangered	Rare occurrence in lower elevations surrounding Refuge
TROCHILIDAE	*Calypte costae	Costa's Hummingbird	NONE	Threatened	Mayberry Canyon, Cedar Site
VIREONIDAE	*Vireo vicinior	Gray Vireo	NONE	Threatened	Scattered throughout Refuge
VIREOINDAE	*Vireo bellii	Bell's Vireo	NONE	Threatened	San Andres Canyon
CARDINALIDAE	*Passerina versicolor	Varied Bunting	NONE	Threatened	San Andres Canyon
ASTERACEAE	Hymenoxys vaseyi	Vasey's Bitterweed	NONE	Species of Concern	Expected on Refuge; found at Rock House Spring and Rhodes Canyon
ASTERACEAE	*Perityle staurophylla var. staurophylla	New Mexico Rock Daisy	NONE	Species of Concern	Collected by Von Loh in Ash Canyon in 1975 (5800' elev.)
CACTACEAE	Coryphantha sandbergii (<i>Escobaria sandbergii</i>)	Sandberg Pincushion Cactus	NONE	Species of Concern	Expected on Refuge with two plants at Upper Ash Spring; grows in limestone
CACTACEAE	Coryphantha sneedii (<i>Escobaria sneedii</i>)	Sneed Pincushion Cactus	Endangered	Endangered	Expected on Refuge; grows in limestone
CACTACEAE	Peniocereus greggii var. greggii	Night-blooming Cereus	NONE	Endangered	Expected on Refuge; documented southwest of Refuge on WSMR/NASA lands
FABACEAE	*Astragalus castetteri	Castetter's Milkvetch	NONE	Species of Concern	Scattered throughout Refuge
LAMIACEAE	Salvia summa	Supreme sage	NONE	Species of Concern	Expected on Refuge; documented on Black Mountain
POLYGALACEAE	Polygala rimulicola var. mescalerorum	Mescalero Milkwort	NONE	Endangered	Expected on Refuge; found on north facing slopes of Black Mountain in Bear Canyon
SCROPHULARIACEAE	Penstemon alamosensis	Alamo Beardtongue	NONE	Species of Concern	Expected on Refuge; found on north facing slopes in Bear Canyon

Table 8. Federal species of concern are listed with species documented on the Refuge denoted (*).

Family	Taxon	Common Name	Federal Status	New Mexico Status	General Location
STRIGIDAE	Athene cunicularia hypugaea	Western Burrowing Owl	Species of Concern	NONE	Rare occurrence in lower elevations surrounding Refuge
VIREOINDAE	*Vireo bellii	Bell's Vireo	Species of Concern	Threatened	San Andres Canyon
CHIROPTERA	*Corynorhinus townsendii	Townsend's big-eared bat	Species of Concern	NONE	Scattered throughout Refuge
CACTACEAE	Peniocereus greggii var. greggii	Night-blooming Cereus	Species of Concern	Endangered	Expected on Refuge; documented southwest of Refuge on WSMR/NASA lands
POLYGALACEAE	Polygala rimulicola var. mescalerorum	Mecalero Milkwort	Species of Concern	Endangered	Expected on Refuge; found on north facing slopes of Black Mountain in Bear Canyon
SCROPHULARIACEAE	Penstemon alamosensis	Alamo Beardtongue	Species of Concern	Species of Concern	Expected on Refuge; found on north facing slopes in Bear Canyon

3.3 Human Environment

3.3.1 Cultural Resources

The history of the San Andres Mountains is rich with legends of lost gold mines and outlaws. The area was occupied as early as 900 A.D. by ancestors of the North American Indians. Remnants of rock houses and mines throughout the range are evidence of heavy mining activity in the area during the late 1800's and early 1900's. Twenty-seven cultural sites have been documented within the confines of the San Andres National Wildlife Refuge. Temporal components documented on the refuge include Middle Archaic, Late Archaic, early and late Formative (ceramic), Protohistoric, and Historic. Less than one percent of the Refuge has been surveyed for cultural resources (Gibbs 2003).

3.3.2 Socioeconomic Resources

The Refuge is located approximately 20 miles from the city of Las Cruces, New Mexico with a population of 97,618 in 2010 (<http://www.city-data.com/city/Las-Cruces-New-Mexico.html>). Several other small towns are also within thirty to ninety miles away. The predominate land uses in the vicinity of the Refuge are military testing and training, grazing and recreation on nearby lands administered by the Bureau of Land Management, research studies on the JER and New Mexico State University College Ranch, rural residential areas, and irrigated farming along the Rio Grande River. The presence and operation of the Refuge has limited socio-economic impact on the surrounding communities, particularly with regard to recreational activities. This is due largely to the fact that San Andres NWR is surrounded by WSMR and has limited forms of public use such as guided tours and oryx hunting. The primary socioeconomic influence on Las Cruces is the recycling of refuge budget money due to refuge personnel living in the area, purchasing of all equipment and supplies, and in contracting local labor to accomplish refuge projects. The Dona Ana County population is comprised of 65%

Hispanic descent, 31% Anglo decent, 2% African-American, and 2% American Indian, Asian-American, or other descent. Approximately 80% of the county lives in an urban setting and 20% is rural; the estimated median household income in 2009 was \$35,717 (http://www.city-data.com/county/Dona_Ana_County-NM.html).

3.3.3 Visitor Services/Activities

The Refuge averages approximately 150 visits per year to include oryx hunting parties and special interest groups volunteering for work projects or participating on Refuge tours. Special interest groups that have visited the refuge most often are the Wilderness Society, Audubon Society, and Native Plant Society. Of the 96 visitors in FY2012, 38 of those visits were attributed to oryx hunt groups.

Little San Nicholas Camp is used by Service staff and researchers conducting studies on the Refuge. It takes at least 40-60 minutes to drive from the Small Missile Range Gate to the nearest hotel in Las Cruces or Alamogordo, New Mexico. Camping sites are available year-round at Aguirre Springs Campground, managed by the Bureau of Land management (Figure 4). Aguirre Springs Campground, located on northeast portion of the Organ Mountains, is approximately 30-45 minutes drive from the southern tip of the proposed bighorn sheep hunt area in the San Andres Mountains.

3.4 Wilderness

There are no lands with Wilderness designation on the San Andres NWR or in the San Andres Mountain range.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter provides an analysis of the effects of each of the alternatives on physical, biological, and human resources on the San Andres NWR. Potential impacts are described in terms of type, duration, intensity, and context (scale). Please refer to Appendix A for definitions of terms used during analysis.

Included is analysis for a No Action Alternative, Alternative A, which would continue current management practices with the continued closure to desert bighorn sheep hunting. Also included are two action alternatives and analysis of the anticipated effects.

This chapter is organized by resource, following the same order as Chapter 3 (Affected Environment). Impacts of the alternatives on each resource topic are compared to show the similarities and differences between alternatives and the range of impacts. Summary tables of the impacts are provided at the end of each the chapter.

4.1 Effects Common to All Alternatives

4.1.1. Environmental Justice

Executive Order 12898 “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” was signed by President Bill Clinton on February 11, 1994, to focus federal attention on the environmental and human health conditions of minority and low-income populations with the goal of achieving environmental protection for all communities. The Order directed federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. The Order is also intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority- and low-income residents access to public information and participation in matters relating to human health or the environment. This EA has not identified any adverse or beneficial effects for any alternative unique to minority or low-income populations in the affected area. Additionally, none of the alternatives will disproportionately place any adverse environmental, economic, social, or health impacts on minority or low-income populations.

4.1.2. Climate Change

Climate change is already affecting fish, wildlife, plants and their habitats around the globe. The Service's Southwest Region has been working with the U.S. Geological Survey (USGS), the academic community, and other natural resource management agencies and interest groups to translate available and emerging science into concrete actions that reduce the impacts of a changing climate on the broadly diverse ecosystems in Arizona, New Mexico, Oklahoma and Texas

The Refuge believes that its hunt program will have negligible impacts on Climate Change; however, much is unknown about this subject. The Service has recently addressed the subject of Climate Change with the issuance of the publication “*Rising to the Urgent Challenge: Strategic Plan for Responding to Accelerating Climate Change.*” This five year plan calls for developing long-term processes and protocols for biological planning and conservation at broad, landscape scales. This five year action plan calls for baseline data to be established. Refuges to date have no information or data regarding their carbon footprint. This subject will be further addressed as future direction is developed and provided on how to step this Strategic Plan down to the field level.

4.1 Physical Environment

4.1.1 Impacts on Air Quality

Alternative A--No Action Alternative:

No additional impacts are expected from continuation of current management; existing emissions from motor vehicles are well within background levels of normal operations in the region (WSMR 2001).

Alternative B--Proposed Action:

Camping would not produce adverse effects on air quality. Approximately 130-170 hunt visits are expected if the Refuge is opened to bighorn sheep hunting; this estimate includes 5 days of scouting prior to the hunt and dust. Increased traffic and road maintenance activities on the Refuge would result in a minor increase in traffic-related emissions. These emissions would not result in violations of the ambient air quality standards

because the amount of Refuge traffic at any one time is expected to be small, and traffic would be limited to existing roads and parking areas. Therefore, traffic-related impacts to ambient air quality would be minor and short-term.

Alternative C:

Under Alternative C, the same amount of hunting would be allowed as described under Alternative B, so the same types of impacts to air quality would occur. However, since no camping would be allowed, hunters would have to drive in and out of the refuge on a daily basis during the 5 days of scouting and the 10-day hunting period. This would result in increased traffic in and around the Refuge, with a corresponding increase in vehicle emission and dust. Impacts to ambient air quality would be greater than Alternative B, but would still be expected to be minor and short-term.

4.1.2 Impacts on Water Quality and Quantity

Alternative A--No Action Alternative:

Alternative A would not affect hydrology on the San Andres NWR. Water resources on the Refuge are currently not utilized for road maintenance or other management activities. Water is available at the Refuge headquarters as part of the infrastructure of the office building, shop, and temporary quarters for visiting researchers.

Alternative B--Proposed Action:

Alternative B would not affect hydrology on the San Andres NWR. Water sources on the Refuge are not made available for use to visitors or staff members when on the Refuge, therefore an increase in Refuge visits by bighorn sheep hunters would not impact water quality and quantity. Members of bighorn sheep hunting parties would be required to bring their own source of potable water, whether or not they choose to camp. Road maintenance under Alternative B would have minimal direct impacts on surface water quality on the Refuge because of the lack of surface waters in the vicinity.

Alternative C:

Same as Alternative B.

4.1.3 Impacts on Soils

Alternative A--No Action Alternative:

The Refuge currently maintains roads on an as-needed basis; all roads on the Refuge are considered two-track and high clearance vehicles with four-wheel drive are required. Road maintenance under Alternative A would continue on an as-needed basis. Currently, roads are repaired whenever possible with heavy equipment following wash-outs as a result of localized heavy rains.

Alternative B--Proposed Action:

Impacts to soils from the Proposed Action are expected as a result of increased road use and the potential need for increased road maintenance. Additional disturbances to soils would include increased traffic by bighorn sheep hunt parties and increased use by heavy equipment such as road graders to maintain roads. We have estimated that up to 170 hunt visits may occur on the Refuge as a result of allowing bighorn sheep hunting; however, those hunt visits would be distributed across the Refuge, so it is unlikely that all Refuge roads would be impacted. It is expected that a limited amount of additional road maintenance will be necessary to support access for bighorn sheep hunters. Potential impacts to soils from the proposed action

are expected to be minor, due to the limited number of potential hunters, the distribution of those hunters over a large area, and the short duration of the proposed hunt. No additional roads would be constructed for Alternative B.

Additional soil disturbance by hunters at the proposed camp site would be temporary and minor. Service staff and researchers already utilize Little San Nicholas Camp, and parking and cleared areas already exist at this site.

Alternative C:

Under Alternative C, there could potentially be increased traffic, since hunters would have to drive in and out of the Refuge on a daily basis. The same types of Impacts on soils would occur as described under Alternative B; however, the increased traffic could result in increased impacts to refuge roads and an increased need for road maintenance.

4.2 Biological Environment

4.2.1 Impacts on Habitat

Alternative A--No Action Alternative:

Maintaining or improving roads would protect habitats from unnecessary disturbance. No impacts to habitat are expected from continuation of current management.

Alternative B--Proposed Action:

The proposed action would result in negligible disturbance to habitat/vegetation due to hunter foot traffic during hunts, scouting, and camping. There is a small potential of spreading invasive species by vehicle and hunter foot traffic. These impacts are expected to be negligible due to low hunter density across the Refuge on scouting and hunting days. Refuge regulations would not permit the use of off-highway vehicles and passenger vehicles would be confined to existing roads. ATVs would not be permitted for retrieval of harvested rams and increased foot traffic by bighorn hunters would result in minor impacts on habitats due to the small areas being affected. When available, camping would occur only at Little San Nicholas Camp in an already established camp site used by researchers and Service personnel. We do not anticipate other parties using Little San Nicholas Camp at the same time as bighorn hunters. Bighorn hunters are permitted to bring up to three visitors as part of their hunting party; as an example, with four hunting parties and four escorts, the potential number of people camping at Little San Nicholas Camp during bighorn hunts could be up to 20 individuals. This is equivalent to when the Service uses this camp site as a base camp for prescribed fires on the Refuge. Bighorn sheep hunt parties would be required to bring in their own potable water and food, pack out their trash, and no camp fires would be permitted. They would be permitted to set up tents during scouting or hunt visits; vehicles must stay on existing roads and established parking areas.

Maintaining or improving roads would protect habitats from unnecessary disturbance. Road maintenance would result in minimal impacts to habitat. Only existing roads would be maintained for bighorn hunt parties to access the Refuge, resulting in minor losses of vegetation in the small affected areas. These activities would result in minor impacts on habitats due to the small areas being affected.

Alternative C:

Impacts would be similar to Alternative B; however, there would be fewer disturbances to vegetation around Little San Nicholas Camp, since no camping would be allowed.

4.2.2 Impacts on Wildlife

Alternative A--No Action Alternative:

Under the No Action Alternative, the existing habitat conditions would be maintained. There would be no change in diversity or abundance of wildlife in the hunt area. This alternative has the least direct impacts of physical and biological resources and it does not fulfill our mandates under the National Wildlife Refuge System Improvement Act of 1997.

Alternative B--Proposed Action:

There would be some short-term impacts on small mammals, birds, and other wildlife due to disturbance in areas where human access for hunting activities occurs. Non-hunted resident wildlife would include resident birds, small mammals such as voles, moles, mice, shrews, and bats; reptiles and amphibians such as snakes, turtles, and toads; and invertebrates such as butterflies, moths, insects and spiders. These species have very limited home ranges and hunting could not possibly affect their populations regionally; thus, only local effects will be discussed. Disturbance by hunting to non-hunted wildlife would be the most likely concern. Displacement of resident birds is usually brief, infrequent, and short distance. Disturbance would be unlikely for many small mammals, such as bats, which are inactive during fall and winter when hunting season occurs, and/or are nocturnal. Hibernation or torpor by cold-blood reptiles and amphibians also limits their activity during the hunting season when temperatures are low, making encounters with reptiles and amphibians infrequent and negligible to local populations.

Immediate responses by wildlife to recreational activity can range from behavioral changes including nest abandonment or change in food habits, physiological changes such as elevated heart rates due to flight, or even death (Knight and Cole 1995). The long term effects are more difficult to assess but may include altered behavior, vigor, productivity or death of individuals; altered population abundance, distribution, or demographics; and altered community species composition and interactions. According to Knight and Cole (1991), there are three wildlife responses to human disturbance: 1) avoidance; 2) habituation; and 3) attraction. The magnitude of the avoidance response may depend on a number of factors including the type, distance, movement pattern, speed, and duration of the disturbance, as well as the time of day, time of year, weather; and the animal's access to food and cover, energy demands, and reproductive status (Knight and Cole 1991; Gabrielsen and Smith 1995).

Invertebrates are also not active during cold weather and will have few interactions with hunters during the hunting season.

Short-term disturbance would occur to bighorn sheep would occur during scouting and hunting, but bighorn sheep would be able to return to the affected areas following the disturbance. Camping at Little San Nicholas Camp would also cause temporary disturbance to wildlife in the general vicinity. All members of the hunt party would be required to bring their own food and potable water, remove trash, and no camp fires would be permitted. Because this site is already used by Service personnel and researchers, minor impacts are expected by allowing bighorn hunt parties to also camp at Little San Nicholas Camp.

In otherwise suitable habitat, desert bighorn sheep have been observed to abandon an area, either temporarily or permanently, when their tolerance to disturbance is exceeded (Welles and Welles 1961, Light 1971, Wehausen 1980, Papouchis et al. 2001, Thompson et al. 2007). If the resulting loss of habitat is considerable, the population's carrying capacity could be reduced (Light and Weaver 1973). Furthermore, when disturbance elicits a flight response in sheep, resulting energetic losses and loss of foraging time could

negatively affect the physiology of individuals, potentially reduce their survival and reproductive success (MacArthur et al. 1979). Papouchis et al. (2001) found that response of female bighorn sheep to disturbance was greater during the spring lambing period and the response of male sheep was greatest during the fall rut.

In some circumstances, sheep may habituate to predictable human activity (Wehausen et al. 1977, Kovach 1979), including highway traffic (Horesji 1976), hiking (Hicks and Elder 1979, Hamilton et al. 1982, Holl and Bleich 1987), and aircraft (Weisenberger al. 1996, Krausman et al. 1998). Habituation is defined as a form of learning in which individuals stop responding to stimuli that carry no reinforcing consequences for the individuals that are exposed to them (Alcock 1993). A key factor for predicting how wildlife would respond to disturbance is predictability. Gabrielsen and Smith (1995) suggest that most animals seem to have a greater defense response to humans moving unpredictably in the terrain than to humans following a distinct path.

A controlled number of bighorn sheep would be harvested by sport hunting annually, except for years when no season is held. In the period of 1968-1978, eleven bighorn hunting seasons were conducted and an average of five rams was harvested each season (Table 2) with a San Andres bighorn population estimate of 150-250 animals. The hunting harvest would cause a temporary reduction in the bighorn population. Hunters would temporarily disrupt the activities of individual bighorns such as feeding and resting patterns. This impact is minor and would not result in any long-term changes in bighorn use patterns throughout the San Andres Mountains.

Hunters tend to target the oldest rams with the biggest horns in a given population. This can have a variety of indirect effects on the remaining sheep population (See Section 3.2.2). Singer and Zeigenfuss (2002) found that that young rams in trophy-hunted populations of mountain sheep were more involved in breeding activities and harassed ewes more frequently. However, the same study found no compelling evidence for any deleterious effects on ewe energetics or ewe reproductive success. Singer and Zeigenfuss (2002) also found that trophy hunting decreased competition between rams for obtaining copulations because rut groups in hunted populations had fewer rams than groups in unhunted populations. Additionally, they found compelling evidence for depressed survivorship of young rams in heavily hunted populations, but not in lightly trophy-hunted populations (<3 percent of the total population or <10 percent of standing ram population). By this standard, San Andres NWR's sheep population would be considered lightly hunted if the number of tags issued is based on 10 percent of the total ram population or 20% of the mature rams.

Alternative C:

Alternative C would have similar short-term impacts on the bighorn sheep herd and other wildlife species as Alternative B. Disturbance patterns could be different with hunters passing by Little San Nicholas Camp enroute to other locations in the proposed hunt area versus camping overnight.

4.2.3 Impacts on Threatened and Endangered Species and Special Status Species

Alternative A--No Action Alternative:

Under the No Action Alternative, the existing habitat conditions would be maintained. Under current management activities, no impacts to Sensitive Species have been documented.

Alternative B--Proposed Action:

Under Alternative B, hunter visits are not likely to impact sensitive species (i.e., Bell's vireo and Townsend's big-eared bat) due to the timing and duration of the proposed hunt. No federally listed species currently occupy the proposed hunt area on the San Andres NWR.

Alternative C:

Same as Alternative B.

4.3 Human Environment

4.3.1 Impacts on Cultural Resources

Alternative A--No Action Alternative:

Under this alternative, there are no anticipated direct or indirect impacts to the cultural environment, as current conditions would be maintained, and no additional ground disturbance would occur.

Alternative B--Proposed Action:

Under the Proposed Action Alternative, there are no anticipated direct or indirect impacts to the cultural environment, as current conditions would be maintained and minimal disturbance would occur outside existing roads from hiking during desert bighorn sheep hunts. Other than two-track driving routes, no hiking trails exist in the San Andres Mountains.

Alternative C:

Same as Alternative B.

4.3.2 Impacts on Socioeconomics

Alternative A--No Action Alternative:

The economic and social condition of the area would remain the same. Much of the Refuge's annual budget is recycled into local businesses through Refuge staff, purchases of equipment and supplies, as well as contracts for local labor to accomplish refuge projects. The Refuge provides full-time employment for four individuals that live in nearby communities.

Alternative B--Proposed Action:

Opening of the refuge to desert bighorn sheep hunting under Alternative B may contribute to further financial support for wildlife conservation, through purchases of hunting licenses and taxes levied on purchases of hunting equipment (USFWS 2000). Alternative B would expand public use of the Refuge. This action could potentially result in the temporary hiring of individuals to assist Refuge staff in implementing the hunt. The impact of this Alternative is expected to be negligible on the local economy.

Alternative C:

Same as Alternative B, except this alternative could potentially produce increases in lodging for the cities of Las Cruces or Alamogordo if hunters did not choose to camp at Aguirre Springs Campground. This impact is expected to be negligible on the economy of these cities.

4.3.3. Impacts on Visitor Services/Activities

Alternative A--No Action Alternative:

Under this alternative, the Refuge would not open to desert bighorn sheep hunting. Implementation of this alternative would not further enhance the hunting opportunities on the Refuge. There would be no additional cost to the Refuge under this alternative. There would be no change to current public use and wildlife management programs on the Refuge under this alternative.

Alternative B--Proposed Action:

The proposed alternative would have a negligible effect on recreation. While some additional hunting opportunities would be opened up by desert bighorn sheep hunts on the Refuge, they would be limited by time and number of hunters and so would have a minor impact to the overall visitor activities. This alternative would allow camping, as it relates to bighorn sheep hunting, on the Refuge at Little San Nicholas Camp.

Considering the very limited and controlled public uses at San Andres NWR, no foreseeable public use conflicts are expected. Alternative B would expand the hunting program which could result in increased staff time to implement the program..

Alternative C:

The hunting opportunities provided would be the same as Alternative B, but no camping would be allowed on the Refuge .

4.3.4 Humaneness and Animal Welfare Concerns

Alternative A--No Action Alternative:

There would be no changes in impacts on humaneness and animal welfare concerns under this alternative.

Alternative B--Proposed Action:

Under this alternative, mortality of desert bighorn rams would occur. Hunter safety and license requirements would be in accordance with State regulations. All hunters under the age of 18 are required to complete a hunter safety course before they will be issued a hunting license. During this course, established hunter ethics and responsibilities to help ensure hunters are using good judgment related to humaneness and animal welfare are addressed. Accurate, clean shots are expected. The target should be within the effective range of the firearm and ammunition and the skills of the hunter; and a humane kill is likely.

Alternative C:

Same as Alternative B.

4.4 Assessment of Cumulative Impacts

The Council on Environmental Quality (CEQ) regulations, which implement the National Environmental Quality Act (NEPA), requires assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are determined by combining the impacts of each alternative with other past, present, and reasonable foreseeable future actions. Therefore it was necessary to identify other ongoing or reasonable foreseeable future actions within San Andres NWR and, if applicable, the surrounding region.

Cumulative impacts are the overall, net effects on a resource that arise from multiple actions. Impacts can "accumulate" spatially, when different actions affect different areas of the same resource. They can also accumulate over the course of time, from actions in the past, the present, and the future. Sometimes different actions counterbalance one another, partially canceling out each other's effects on a resource. But more

typically, multiple effects add up, with each additional action contributing an incremental impact on the resource.

Other State, Federal and other Service activities considered in this analysis include WSMR military weapons testing, hunting on other State and Federal lands, and other Service activities such as salt cedar control and prescribed burning. These actions are further discussed in section 4.4.4.

4.4.1 Anticipated Direct and Indirect Impacts of Proposed Hunt on Wildlife Species

Resident (Hunted) Wildlife

Currently, hunting for oryx is allowed on the Refuge. The Refuge is proposing a new hunt for desert bighorn sheep rams.

Desert Bighorn Sheep - Regional and Local Analysis

Desert bighorn sheep are not migratory species, although limited inter- and intra-mountain range movements occur throughout the west. Movements and home range size of desert bighorn sheep are influenced by the individual animal's response to various stimuli (Leslie 1977) such as age, sex, heredity, population density, topography, season, food and water availability, cover, and reproductive activities (Krausman et al. 1999). Desert bighorn sheep in the San Andres Mountains do not move seasonally in elevation as some bighorn do in colder climates, although ram movements increase throughout the Mountain Range during the breeding season. There are not documented movements of desert bighorn sheep in the San Andres Mountains and the Fra Cristobal or Caballo Mountain Ranges in southern New Mexico. In the past decade, a single ram moved more than 60 miles north from the San Andres Mountains to the Oscura Mountains, remained alone for several months, and then moved back south to the San Andres Mountains. Also during the last decade, two rams moved south to Antelope Hill along Highway 70, directly south of the San Andres Mountains and northeast of the Organ Mountains. These two rams remained on Antelope Hill with the exception of a few, short trips to the Organ Mountains before returning to Antelope Hill. No other bighorn sheep have been observed in the Oscura Mountains, on Antelope Hill, or in the Organ Mountains during the past decade with any of these three rams (Refuge files). There are no other records of bighorn sheep from the San Andres Mountains moving between other mountain ranges in New Mexico or the western United States. Hunting is not expected to cause a change in home range or local distribution of desert bighorn sheep in the San Andres Mountains.

The Service anticipates no measurable negative cumulative impacts to the desert bighorn sheep population locally, regionally, or globally due to this alternative.

Other (Non-hunted) Resident Wildlife

Other resident wildlife on the Refuge includes birds; small mammals such as voles, moles, mice, shrews, and bats; reptiles and amphibians such as snakes, turtles, and toads; and invertebrates such as butterflies, moths, insects and spiders. Most of these species are common and widespread. In general, these species are broadly distributed throughout the San Andres Mountains. These species have very limited home ranges and hunting could not possibly affect their populations regionally. Some wildlife disturbance (increased human presence and sounds of gunshots) will occur locally during the hunting season; however, these impacts are expected to be negligible due to the limited number of hunters and the short duration of the hunting season.

Disturbance would be unlikely for many small mammals, such as bats, which are inactive during fall and winter when hunting season occurs, and/or are nocturnal. Hibernation or torpor by cold-blood reptiles and amphibians also limits their activity during the hunting season when temperatures low, making encounters with reptiles and amphibians infrequent and inconsequential to local populations. Invertebrates are also not active during cold weather and would have few interactions with hunters during the hunting season. The Service anticipates no measurable negative cumulative impacts to resident non-hunted wildlife populations locally, regionally, or globally due to this alternative.

Migratory Species

Neotropical migratory avian species would not be present during the bighorn hunting season; resident and wintering species may experience temporary disturbance when bighorn hunting parties are hiking. Displacement of resident birds is usually brief, infrequent, and short distance. Impacts to the overall avian community are expected to be negligible.

Endangered Species

There are no federally listed endangered or threatened species documented on the San Andres NWR, so there would be no impacts.

4.4.2 Anticipated Direct and Indirect Impacts of Proposed Action on Refuge Programs, Facilities, and Cultural Resources

Other Refuge Wildlife-Dependent Recreation

The Refuge is completely surrounded by WSMR, operated by the Department of Defense, and therefore has very limited public access (Figure 1). The only regularly occurring source of wildlife-dependent recreation on the San Andres NWR is oryx hunting, which would continue except during bighorn hunts (see Section 3.3.3 Visitor Services/Activities). Infrequent visits by special interest groups volunteering for work projects or participating on Refuge tours would continue whenever possible, as requested.

A permanent interagency information kiosk is located at San Augustine Pass pullout. Service and Refuge staff coordinated with area partners to provide information about their respective natural resources and management activities in the San Andres Mountains and Tularosa Basin to the east (Figure 4). This pullout area is most often used as a road block for testing activities by WSMR where traffic eastbound on State Highway 70 is stopped for approximate one-hour intervals as needed. This pullout area also has public restrooms available.

San Andres NWR, in addition to hunting, provides visitors with several of the remaining opportunities, despite considerable access issues. Historically hunting has had no impacts on those opportunities that occur during the hunting season. The Refuge does not anticipate any impacts to other forms of wildlife dependent activities (i.e., volunteer activities and special interest tours) on San Andres NWR. Parking, public restrooms and a welcome center are provided at the San Andres NWR headquarters; for Refuge staff and visitors that utilize Little San Nicholas Camp, a small parking area already exists.

The proposed action would add a negligible amount to other Refuge wildlife dependent recreation on the Refuge; no cumulative effects are anticipated.

Refuge Facilities

The Service defines facilities as: “Real property that serves a particular function(s) such as buildings, roads, utilities, water control structures, raceways, etc.”

Limited accessibility affects all public uses found on the Refuge. Much of the 57,215 acres of San Andres NWR are only accessible by foot.

Under the proposed action, the facilities that would be most utilized by hunters are the roads and Little San Nicholas Camp. Most facilities serve multiple use purposes throughout the year, primarily for Refuge staff and researchers due to limited access. A small building at Little San Nicholas Camp remains locked and would not be made available for public hunters, should camping become available on the San Andres NWR. These facilities pose little to no effect on wildlife due to their location adjacent to primary thoroughfares. Facilities associated with wildlife dependent activities require low to minimal maintenance. The proposed action would have no measurable cumulative effect on Refuge facilities.

Cultural Resources

Hunting, regardless of method or species targeted, is a consumptive activity that does not pose any threat to historic properties on and/or near the Refuge. In fact, hunting meets only one of the two criteria used to identify an “undertaking” that triggers a federal agency’s need to comply with Section 106 of the National Historic Preservation Act. These criteria, which are delineated in 36 CFR Part 800, state:

1. An undertaking is any project, activity, or program that can alter the character or use of an archaeological or historic site located within the “area of potential effect;” and
2. The project, activity, or program must also be either funded, sponsored, performed, licenses, or have received assistance from the agency.
3. Consultation with the pertinent State Historic Preservation Office and federally recognized Tribes is, therefore, not required.

4.4.3 Anticipated Impacts of Proposed Hunt on Refuge Environment and Community

Negative impacts to the Refuge environment (soils, vegetation, air quality, water quality and solitude) associated with the proposed bighorn sheep ram hunt will be minor. Some disturbance to surface soils and vegetation would occur in areas selected for hunting; however this impact would be minimal and short-term. The Refuge would also control access to minimize habitat degradation. The Refuge expects impacts to air and water quality to be minimal and only due to bighorn sheep hunters' automobile vehicle emissions and run-off. The effect of these Refuge-related activities, as well as other management activities, on overall air and water quality in the region are anticipated to be minor. Existing State water quality criteria and use classifications are adequate to achieve desired on refuge conditions; thus, implementation of the proposed action would not impact adjacent landowners or users beyond the constraints already implemented under existing State standards and laws. Impacts associated with solitude are expected to be minimal given time and space zone management techniques, such as seasonal access and area closures, used to avoid conflicts among user groups. Therefore, cumulative impacts to the Refuge environment would occur. The Service does anticipate

future positive economic effects in the community resulting from the proposed alternative, resulting from increased use of traditional services (e.g. fuel, lodging, guiding, and supplies) if hunters were visiting the area just to hunt on the Refuge. Also, allowing hunting on the Refuge would have a positive effect on community relations with the Service. Hunting is a very strong tradition in New Mexico, and a limited number of local residents have questioned the Refuge about allowing hunting on Refuge lands.

Opening of the Refuge to desert bighorn sheep hunting may contribute to further financial support cumulatively among communities for wildlife conservation, as hunters have provided, through purchases of hunting licenses and migratory bird conservation stamps, and taxes levied on purchases of hunting equipment, a steady stream of revenue to build the National Wildlife Refuge System, and to restore upland and wetland habitats on millions of acres of public and private lands across the country (USFWS 2000). These habitat projects also benefit migratory songbirds and other wildlife. The top two reasons given for hunter dissatisfaction and desertion in a national survey (Duda et al. 1995) were 1) not enough access to places to hunt (46%), and 2) not having enough places to hunt (44%). Opening the San Andres NWR to bighorn sheep hunting would provide dependable access and opportunity for hunters from the local community and out of state to pursue this traditional wildlife-dependent activity, and would provide access and opportunity for new participants from the local community and out-of-state individuals to become initiated into hunting.

Camping at Little San Nicholas Camp on the Refuge is expected to have minor, adverse impacts on the Refuge environment. Some disturbance to surface soils and vegetation would occur in areas selected for camping; however minimal. Furthermore, Little San Nicholas Camp is already used for camping by Service staff and researchers on the Refuge. This site has been an established camp site for more than 50 years and the cumulative impacts from a maximum total of 12 individuals for bighorn sheep hunt parties is expected to be minimal.

The WSMR, which surrounds the refuge, is sparsely unpopulated. Historically hunting has been a common activity in the area, so the brief increase in activity on the Refuge would have little effect on the public and nearby communities.

Summary - Anticipated Effects of Alternatives on Refuge Environment and Community

It is the best professional judgment of the Refuge Manager that the action alternatives (Alternatives B and C) would have no measurable adverse cumulative effects to the Refuge environment, and would likely have negligible positive local and cumulative effects on communities. The proposed action would enhance the Refuge's ability to garner support for conservation from communities, and to minimize the risk of adverse effects of over-abundant species on habitats, priority wildlife species, and human health and safety. Furthermore, the proposed action is in the best interests of the natural resources of the refuge and vicinity and the region, and it is consistent with Service policy and the National Wildlife Refuge Improvement Act.

4.4.4 Other Past, Present, Proposed, and Reasonably Foreseeable Hunts (and Other Activities) and Anticipated Impacts

Past

Past land use practices in the San Andres Mountains include mining and ranching. White Sands National Monument, established in 1933, lies within the Tularosa Basin on the east side of the Refuge. The Jornada Experimental Range (JER) Station, established in 1912, retains certain research rights over the western portion

of the Refuge. This land was transferred from the JER to the Service for establishment of the Refuge in 1941. The White Sands Test Facility, managed by NASA, borders the Refuge in the southwest corner. White Sands Missile Range surrounded Refuge lands in 1952 when Public Land Order 833 permanently established WSMR after World War II. White Sands Missile Range was established to support DoD readiness programs involving the research, development, testing, and evaluation of weapons and space systems (WSMR 2001).

Desert bighorn sheep hunting previously occurred on the San Andres NWR from 1968-1978. San Andres NWR opened the Refuge oryx hunt program in 2000 to control the population which was over browsing the Refuge and to provide a wildlife-dependent recreational use.

Present

Oryx hunting is the only form of hunting currently allowed on the Refuge. Oryx hunting also occurs on adjacent WSMR and JER lands. WSMR also allows hunting of quail, desert bighorn sheep and mountain lion (on a limited basis). Other hunts within unit 19 include mule deer hunting south of Hwy 70 on Bureau of Land Management property.

Additional fall desert bighorn sheep hunts in southern New Mexico that do not have access restrictions can be found in NMDGF Units 13, 20, 26, and 27 on public lands and in NMDGF Unit 20 on private land. The Refuge is closed to public access due to the proximity of WSMR which surrounds the Refuge. White Sands Missile Range is a large area primarily used for military weapons testing and visitors are not allowed on the Refuge unescorted.

There are approximately 1100 hunting permits on WSMR for trophy and population reduction oryx hunts, and an additional 500-800 permits for off-range oryx hunting. Security Badge hunts issued by NMDGF for oryx are currently permitted during several months throughout the year. For the 2013-2014 hunt season, there are a total of 688 tags (i.e., Youth-only, broken-horn, security badge, and returning Iraq/Afghanistan Resident Veterans-only hunts) available for oryx hunting on WSMR, 780 oryx tags available Off-Range, 100 oryx tags available on McGregor Range, and additional private land hunts in New Mexico. Less than 35 oryx hunters access the Refuge annually. No conflict with oryx hunters is expected in the proposed bighorn sheep hunt area because oryx hunt seasons on WSMR and the Refuge will not occur at the same time as bighorn sheep hunts; oryx hunting will continue during the bighorn sheep hunt season in WSMR locations not included in the bighorn sheep hunt area. Additionally, oryx hunters generally hunt habitat in the foothills and lower elevations, where bighorn sheep hunters generally hunt in rocky, steep terrain uninhabited by oryx. Other activities that occur in and around the Refuge are WSMR military weapons testing and prescribed burning .

Some of the testing activities on WSMR release airborne pollutants that may temporarily affect air quality in the Tularosa airshed (east of the San Andres Mountains) and regionally (WSMR 2001). When combined with increased vehicular traffic on the Refuge by hunters, the impacts to ambient air quality is still expected to be minor and short-term. This applies to all of the alternatives in this EA.

Other management activities that occur on the Refuge include salt cedar control and prescribed burning. The only past and present project or management action conducted on the Refuge that would directly affect resources analyzed in this environmental assessment is the prescribed burning program conducted on the Refuge since 1999. Indications are that there is a benefit for resource values of the Refuge by conducting prescribed burns. Prescribed burns are conducted primarily during historical burning periods and are designed

to mimic natural fires. Habitats located on the San Andres NWR are adapted to fire with many plant species dependent on regular burning to maintain a healthy ecosystem.

Future

San Andres NWR does not anticipate major hunting harvest to occur immediately on Refuge lands as a result of opening these areas to desert bighorn sheep hunting due to the availability of public and private land open to hunting outside the Refuge. The Refuge would only be open to bighorn hunting approximately 15-20 days per year. Refuge-specific hunting regulations may be altered to achieve species-specific harvest objectives in the future. There are no other reasonably foreseeable hunts and anticipated impacts. Consequently, no direct or indirect unanticipated cumulative impacts would occur.

The Refuge would work closely with State, Federal, and private partners to minimize unwanted impacts to adjacent lands and associated natural resources; however, no indirect or direct impacts are anticipated. The newly opened hunt would result in a net gain of public hunting opportunities positively affecting the general public, nearby residents, and Refuge visitors. The Refuge expects increased visitation and tourism to bring additional revenues to local communities but a minor increase in overall revenue in any area.

4.4.5 Anticipated Impacts if Individual Hunts are allowed to Accumulate

The Service has concluded that cumulative impacts on the Refuge's wildlife populations, either hunted or non-hunted species will be negligible. The Service has also concluded that the proposed action will not cumulatively impact the Refuge environment or Refuge programs. This determination was based upon a careful analysis of potential environmental impacts of hunting on the Refuge together with other projects and/or actions. Hunting is an appropriate wildlife management tool that can be used to manage wildlife populations. Some wildlife disturbance will occur during the limited hunting seasons.

San Andres NWR does not anticipate major hunting harvest to occur immediately on Refuge lands as a result of opening this area to desert bighorn sheep hunts, and anticipates that hunting harvests would be sustainable. The Refuge would be adaptive in the harvest management under the hunt program. Refuge-specific hunting regulations may be altered to achieve species-specific harvest objectives in the future. Most game species populations are monitored through field surveys, and game harvests are monitored through a mandatory hunter survey, which provides an additional means for monitoring populations. There are no other reasonably foreseeable hunts, so there would be no anticipated impacts over time. Consequently, no cumulative impacts would occur.

4.5 Environmental Justice

Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority and Low-Income Populations; February 11, 1994) was designed to focus the attention of Federal Agencies on the environmental and human health conditions of minority and low-income populations, with the goal of achieving environmental protection for all communities. The order directed federal agencies to develop environmental justice strategies to aid in identifying and addressing disproportionately high and adverse human health and environmental effects of their programs, policies, and activities on minority and low-income populations. The order is intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority and low income communities with access to public information and opportunities for participation in matters related to human health and the environment.

None of the alternatives described in this EA would disproportionately place any adverse environmental, economic, social or health impacts on minority and low income populations. Implementation of the proposed action is anticipated to benefit the environment and people in the surrounding communities.

4.6 Indian Trust Assets

No Impact - No Indian Trust Assets have been identified in the San Andres NWR. There are no reservations or ceded lands present. Because resources are not believed to be present, no impacts are anticipated to result from implementation of either alternative described in the EA.

4.7 Unavoidable Adverse Effects

As proposed under Alternatives B and C, implementation of desert bighorn sheep hunting on the San Andres NWR may result in some unavoidable adverse impacts. Some rams would be killed; however, bighorn sheep are a renewable resource and there would be no discernable effect on the general bighorn sheep population in the San Andres Mountains of New Mexico. There would also be some short-term disturbance to other resident wildlife, but these impacts are expected to be minor.

4.8 Irreversible and Irretrievable Commitment of Resources

None of the alternatives would result in a large commitment of nonrenewable resources. Project implementation would require the irretrievable commitment of fossil fuels (diesel and gasoline), oils, and lubricants used by heavy equipment and vehicles. The Proposed Action would result in unavoidable harm or harassment to some wildlife. The Service would implement best management practices to minimize potential impacts.

4.9 Summary of Environmental Effects by Alternative

Table 9. Summary of environmental effects by alternative.

<u>Environmental Resource</u>	<u>Alternative A: No Action Alternative</u>	<u>Alternative B: Proposed Action Alternative</u>	<u>Alternative C:</u>
Impacts to Air Quality	There would be no effect by proposed actions as existing emissions from motor vehicles are well within background levels of normal operations in the region.	Camping would not produce adverse effects on air quality. Increased traffic on the Refuge would result in a minor increase in traffic-related emissions. Therefore, traffic-related impacts to ambient air quality would be minor.	Increased traffic on the Refuge would result in a minor increase in traffic-related emissions. Therefore, traffic-related impacts to ambient air quality would be more than Alternative B, but are still expected to be minor.
Impacts to Water Quality and Quantity	Alternative A would not affect hydrology on the San Andres NWR. Water resources on the Refuge are currently not utilized for road maintenance or other management activities.	Alternative B would not affect hydrology on the San Andres NWR. Members of bighorn sheep hunting parties would be required to bring their own source of potable water, whether or not they choose to camp. Road maintenance under Alternative B would have minimal direct impacts on	Same as Alternative B.

		surface water quality on the Refuge because of the lack of surface waters in the vicinity.	
Impacts to Soils	The Refuge currently maintains roads on an as-needed basis; all roads on the Refuge are considered two-track and high clearance vehicles with four-wheel drive are required. Road maintenance under Alternative A would continue on an as-needed basis.	Road maintenance under Alternative B would have minimal direct impacts on soils. Additional disturbances to soils would include increased use by heavy equipment such as road graders to maintain roads and increased traffic by bighorn sheep hunt parties. These activities would result in minor impacts on soils due to the small areas being affected. No additional roads would be constructed for Alternative B.	Road maintenance under Alternative C would have minimal direct impacts on soils. Additional road maintenance to support access for bighorn sheep hunters would result in some disturbance to soil along existing roads, potentially causing erosion in the small affected areas. No additional roads would be constructed for Alternative C.
Impacts on Habitat	Maintaining or improving roads would protect habitats from unnecessary disturbance. No impacts to habitat are expected from continuation of current management.	Minimal impacts to the habitat are expected under Alternative B with increased foot traffic by bighorn sheep hunting parties. When available, camping would occur only at Little San Nicholas Camp in an already established camp site used by researchers and Service personnel. Maintaining or improving roads would protect habitats from unnecessary disturbance. Only existing roads would be maintained for bighorn hunt parties to access the Refuge, resulting in minor losses of vegetation in the small affected areas. These activities would result in minor impacts on habitats due to the small areas being affected.	Minimal impacts to the habitat are expected under Alternative C with increased foot traffic by bighorn sheep hunting parties. Maintaining or improving roads would protect habitats from unnecessary disturbance. Only existing roads would be maintained for bighorn hunt parties to access the Refuge, resulting in minor losses of vegetation in the small affected areas. These activities would result in minor impacts on habitats due to the small areas being affected.
Impacts of Wildlife	Under the No Action Alternative, the existing habitat conditions would be maintained. There would be no change in diversity or abundance of wildlife in the hunt area.	A controlled number of bighorn sheep would be harvested by sport hunting annually, except for years when no season is held. Hunters would temporarily disrupt the activities of individual bighorns such as feeding and resting patterns. This impact is minor and would not result in any long-term changes in bighorn use patterns. The number of licenses and authorizations issued for the	Alternative C would have the same impacts on the bighorn sheep herd and other wildlife species as Alternative B. Although no camping would be permitted on the Refuge under this alternative, camping may be permitted on WSMR in the future for bighorn sheep hunts. Potentially less vehicle traffic would go past Little San Nicholas Camp

		entire San Andres Mountains (NMDGF Unit 19) would be dependent on the bighorn sheep population size and demographics as determined by annual or biennial fall aerial surveys conducted by the Refuge, WSMR, and/or NMDGF. The first hunt season (2013-2014) may include three NMDGF lottery draw general public hunters; two adult and a possible Auction or Raffle hunter. If fall aerial survey data report a sufficient number of rams in the San Andres bighorn population, then a fourth tag for a youth-only hunt may be considered.	with no camping permitted at that site, although road access by this site would still be open during bighorn sheep hunts.
Impacts on Threatened and Endangered Species	Under the No Action Alternative, the existing habitat conditions would be maintained. There would be no impact to Sensitive Species.	Under Alternative B, temporary disturbance to sites inhabited by sensitive species, however impacts to the overall habitat availability are expected to be negligible. No federally listed species currently occupy the proposed hunt area on the San Andres NWR.	Same as Alternative B
Impacts on Cultural Resources	Under this alternative, there are no anticipated direct or indirect impacts to the cultural environment, as current conditions would be maintained, and no additional ground disturbance would occur.	Under the Proposed Action Alternative, there are no anticipated direct or indirect impacts to the cultural environment, as current conditions would be maintained and minimal disturbance would occur outside existing roads from hiking during desert bighorn sheep hunts. Other than two-track driving routes, no hiking trails exist in the San Andres Mountains.	Under Alternative C, there are no anticipated direct or indirect impacts to the cultural environment, as current conditions would be maintained and no ground disturbance would occur outside existing roads from hiking during desert bighorn sheep hunts. Other than two-track driving routes, no hiking trails exist in the San Andres Mountains.
Impacts on Socioeconomic Resources	The economic and social condition of the area would remain the same. Much of the Refuge's annual budget is recycled into local businesses through Refuge staff, purchases of equipment and supplies, as well as contracts for local labor	Opening of the refuge to desert bighorn sheep hunting under Alternative B may contribute to further financial support for wildlife conservation, as hunters have provided, through purchases of hunting licenses and migratory bird conservation	Same as Alternative B, except that this alternative could produce higher increases in lodging than Alternative B for the cities of Las Cruces or Alamogordo if hunters did not choose to camp at Aguirre Springs

	to accomplish refuge projects. The Refuge provides full-time employment for four individuals that live in nearby communities.	stamps, and taxes levied on purchases of hunting equipment, a steady stream of revenue to build the National Wildlife Refuge System, and to restore upland and wetland habitats on millions of acres of public and private lands across the country (USFWS 2000). These actions would result in increased staff time at the Refuge in order to accommodate visitor needs.	Campground.
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5.0 CONSULTATION, COORDINATION AND DOCUMENT PREPARATION

Document prepared by Refuge Staff, San Andres National Wildlife Refuge, U.S. Fish and Wildlife Service, Las Cruces, New Mexico.

5.1 Agencies and individuals consulted in the preparation of this document include:

During the preparation of this Environmental Assessment, Refuge staff consulted Service, WSMR, and NMDGF biologists with expertise and experience in the research and management of the wildlife species discussed in this document. Refuge staff consulted with staff from USFWS Divisions of Biological Science and Visitor Services regarding the cumulative effects on resident wildlife, migratory birds, and non-hunted wildlife of hunting on all refuges. Because desert bighorn sheep are not migratory species, we anticipate no direct or indirect cumulative effects on resident wildlife, migratory birds, and non-hunted wildlife of hunting on all refuges.

The Hunt Plan, Compatibility Determination and this Environmental Assessment were made available for public review and comment. News Releases were sent to local newspapers, posted on the Refuge website, and hard copies were made available at the Refuge headquarters and the local library.

In addition copies of the documents were sent to the Southwest Consolidated Sportsmen in New Mexico, Mesilla Valley Audubon, Animal Protection of New Mexico, New Mexico Chapter of Foundation for Wild Sheep, New Mexico Chapter of the Nature Conservancy, New Mexico Department of Game and Fish (both Regional and State Offices), National Park Service, Bureau of Land Management, White Sands Missile Range, Jornada Experimental Range, National Aeronautics and Space Administration, and local private land owners.

6.0 REFERENCES

- Alcock, J. 1993. *Animal behavior: an evolutionary approach*. Fifth ed. Sinauer Assoc., Sunderland, MA. 625pp.
- [AZGF] Arizona Game and Fish Department. 2011. *Guidelines for the 2012-2013 and 2013-2014 Hunting Seasons*. 23 pp.
- Bader, D.C., C. Covey, W. Gutowski, I. Held, K. Kunkel, R. Miller, R. Tokmakian, and M. Zhang. 2008. *Climate models: An assessment of strengths and limitations*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Department of Energy, Office of Biological and Environmental Research, Washington, D.C.
- Boeker, E. L., V. E. Scott, H. G. Reynolds, and B.A. Donaldson. 1972. Seasonal food habits of mule deer in southwestern New Mexico. *J. Wildl. Management* 36:56–63.
- Boyce, W.M. and M.E. Weisenberger. 2005. The rise and fall of Psoroptic scabies in bighorn sheep in the San Andres Mountains, New Mexico. *J. Wildl. Diseases* 41(3):525-531.
- Boykin, K. G. Matusik, P. L. Thompson, B. C. 1996. *Comparative Biotic and Physical Attributes of Natural Water Sites on White Sands Missile Range, New Mexico* Cooperative Fish and Wildlife Research Unit, Las Cruces. 87 pp.
- Breshears, D., T. Huxman, H. Adams, C. Zou, and J. Davison. 2008. Vegetation synchronously leans upslope as climate warms. *PNAS*, 105(33): 11591-11592.
- Burkett, D. W. 1999. *Comprehensive Oryx Management Plan*. MEVATEC Report no. 400A2/99/002F, March. Prepared by MEVATEC Corporation for White Sands Missile Range and the New Mexico Department of Game and Fish. WSMR, N.Mex.: U.S. Department of the Army, CSTE-DTC-WS-ES-ES. 34 pp.
- Chihuahuan Desert Research Institute, 2009, *The Chihuahuan Desert Region*, [<https://cdri.org/Desert/index.html>], accessed 10/30/06].
- 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.
- Colorado Division of Wildlife. 2009. *Colorado bighorn sheep plan 2009-2019*. Special Report Number 81 (DOW-R-S-81-09). 88 pp.
- Diffenbaugh, N., J. Pal, R. Trapp, and F. Giorgi. 2005. Fine scale processes regulate the response of extreme events to global climate change. *Proceedings of the National Academy of Sciences*, 102:1574–1578.
- Davey, C. A., K. T. Redmond, and D. B. Simeral. 2007. *Weather and Climate Inventory*, National Park Service, Chihuahuan Desert Network. Natural Resource Technical Report NPS/CHDN/NRTR—2007/034. National Park Service, Fort Collins, Colorado, USA.
- Dye, J. L. 1998. *Gemsbok and mule deer diets in southern New Mexico*. Master's thesis. Las Cruces: New Mexico State University. 68 pp.

- Douglas, C.L. and D.M. Leslie Jr. 1999. Management of bighorn sheep. Pages 238-262 in R. Valdez and P. R. Krausman, editors. Mountain sheep of North America. University of Arizona Press, Tucson.
- Duda, M. D., S. J. Bissell and K. C. Young. 1995. Factors related to hunting and fishing participation in the United States. Phase V: Final Report. Federal Aid in Sport Fish and Wildlife Restoration Grant 14-48-0009-1252. Washington, DC: U.S. Fish and Wildlife Service.
- Gabrielson , G. W. and E. N. Smith. 1995. Physiological responses of wildlife to disturbance. Pages 95-107 in R. L. Knight and K. J. Gutzwiller, ed. Wildlife and Recreationists: coexistence through management and research. Island Press, Washington, D. C. 372pp.
- Geist, V. 1971. Mountain sheep: a study in behavior and evolution. University of Chicago Press, Chicago, IL.
- Gibbs, V. 2003. A Cultural Resources Overview of the San Andres National Wildlife Refuge, New Mexico. Report of Investigations for U.S. Fish & Wildlife Service. 111 pp.
- Halloran, A.F. 1944. History and present status of bighorn in south-central New Mexico. J. Mammalogy 25(4):364-367.
- Halloran, A.F. and C.A. Kennedy. 1949. Bighorn:Deer food relationships in Southern New Mexico. J. Wildl. Management 13(4):417-419.
- Hamilton, K. M., S. Holl and C. L. Douglas. 1982. An evaluation of the effects of recreational activities on bighorn sheep in the San Gabriel Mountains, California. Desert Bighorn Council Transactions 26:50-55.
- 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.
- Hoenes, B.D. and L.C. Bender. 2010. Relative habitat- and browse-use of native desert mule deer and exotic oryx in the greater San Andres Mountains, New Mexico. Human-Wildlife Interactions 4(1):12-24.
- Holl, S.A. 1982. Evaluation of bighorn sheep habitat. Desert Bighorn Council Transactions 26:47-49.
- Holl, S.A. and V. C. Bleich. 1987. Mineral Lick use by mountain sheep in the San Gabriel Mountains, California. Journal of Wildlife Management 51:383-385.
- Horesji, B. 1976. Some thoughts and observations on harassment and bighorn sheep. Pages 149-155 in T. Thorne, chairman. Proceedings of the Biennial Symposium of North American Bighorn Sheep Council. Jackson, Wyoming, USA.
- Hoyt, Cathryn A., 2002, The Chihuahuan Desert: Diversity at Risk: Endangered Species Bulletin, March/June 2002, Volume XXVII No. 2. [<http://www.fws.gov/Endangered/bulletin/2002/03-06/16-17.pdf>, accessed 11/2/06]

- [IPCC] Intergovernmental Panel on Climate Change, 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- [IWVS] International Wildlife Veterinary Services, Inc. 1990. Status of Psoroptic scabies in and health of bighorn sheep in the San Andres Mountains of New Mexico. Research Project Final Report. 196 pp.
- Kennedy, C.A. 1957. Status of bighorn sheep on the San Andres National Wildlife Refuge, Las Cruces, New Mexico. Desert Bighorn Council Transactions 1:31-33.
- Kinzer, H.G., W.E. Houghton, and J.M. Reeves. 1983. *Psoroptes ovis* research with bighorn sheep in New Mexico. Desert Bighorn Council Transactions 27:6-8.
- Knight, R. L. and D. N. Cole. 1991. Effects of recreational activity on wildlife in wildlands in Transactions of the North American Wildlife and Natural Resources Conference. 56:238-247.
- Knight, R. L. and D. N. Cole. 1995. Wildlife responses to recreationists. Pages 71-79 in R. L. Knight and K. J. Gutzwiller, ed. Wildlife and Recreationists: coexistence through management and research. Island Press, Washington, DC.
- Kovach, S. D. 1979. An ecological survey of the White Mountain bighorn. Desert Bighorn Council Transactions 23:57-61.
- Krausman, P. R., A. J. Kuenzi, R. C. Etchberger, K. R. Rautenstrauch, L. L. Ordway, and J. J. Hervert. 1997. Diets of desert mule deer. J. of Range Management 50:513-522.
- Krausman, P. R., Wallace, C. L. Hayes, and D.W. DeYoung. 1998. Effects of jet aircraft on mountain sheep. Journal of Wildlife Management 62:1246-1254.
- Krausman, P. R., A. V. Sandoval, and R. C. Etchberger. 1999. Natural history of desert bighorn sheep. In: R. Valdez and P. R. Krausman, editors. Mountain sheep of North America. University of Arizona Press, Tucson. Pages 139-191.
- 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. 29 pp.
- Lange, R.E., A.V. Sandoval, and W.P. Meleney. 1980. Psoroptic scabies in bighorn sheep (*Ovis canadensis mexicana*) in New Mexico. J. Wildl. Diseases 16(1):77-82.
- Larson, P. 1970. Deserts of America. Prentice-Hall, Englewood Cliffs, New Jersey. 340 pp.
- Lenart, M. 2007. Is global warming creeping into Southwest forests? In Lenart, M. (ed.), *Global warming in the Southwest: Projection, observations, and impacts*. University of Arizona, Climate Assessment of the Southwest, Tucson, Arizona.

- Leslie, D. M., Jr. 1977. Home range, group size, and group integrity of desert bighorn sheep in the River Mountains, Nevada. *Desert Bighorn Council Transactions* 21:25-28.
- Leopold, A. L.K. Sowls, and D.L. Spencer. 1947. A survey of over-populated deer ranges in the United States. *J. Wildl. Management* 11(2):162-177.
- Light, J.T. 1971. An ecological view of bighorn habitat on Mt. San Antonio. *Transactions of the North American Wild Sheep Conference* 1:150-157. U.S. Forest Service, San Bernardino National Forest, California, USA.
- Light, J.T. and R. Weaver. 1973. Report on bighorn sheep habitat study in the area for which an application was made to expand the Mt. Baldy winter sports facility.
- MacArthur, R. A., R. H. Johnson, 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.
- McCarty, C. W, and J.A. Bailey. 1994. Habitat requirements of desert bighorn sheep. Special Report 69. Colorado Division of Wildlife, Denver, USA. MCGARIGAL, K., ANDW C. MCCOMB.19 95.
- Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver and Z.-C. Zhao. 2007. Global Climate Projections. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*[Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Miller, G.D. and W.S. Gaud. 1989. Composition and variability of desert bighorn sheep diets. *J. Wildl. Management* 53(3):597-606.
- Nevada Division of Wildlife. 2001. Bighorn Sheep Management Plan. 44 pp.
- [NMDGF] 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.
- [NMDGF] New Mexico Department of Game and Fish. 1998. Document for the Recovery of desert bighorn sheep in the San Andres Mountains, New Mexico. 23 pp.
- [NMDGF] New Mexico Department of Game and Fish. 2003. Plan for the recovery of desert bighorn sheep in New Mexico 2003-2013. 63 pp.
- [NMDGF] New Mexico Department of Game and Fish. 2010. Desert bighorn sheep status, population projections, and proposed management actions 2010-2014. 4 pp.
<<http://www.wildlife.state.nm.us/conservation/bighorn/documents/documents/ActionPlanJan2010.pdf>>

- [NMDGF] New Mexico Department of Game and Fish. 2011a. New Mexico's Bighorn Sheep. 14 Feb. 2012 <<http://www.wildlife.state.nm.us/conservation/bighorn/index.htm>>
- [NMDGF] New Mexico Department of Game and Fish. 2011b. Desert Bighorn Sheep (*Ovis canadensis mexicana*) Delisting Investigation Report. 15 pp.
- [NMDGF] New Mexico Department of Game and Fish. 2012. Population trends for individual desert bighorn sheep herds in New Mexico, 2000-2011. 22 Feb. 2012
<<http://www.wildlife.state.nm.us/conservation/bighorn/documents/PopulationTrends.htm>>
- New Mexico Rare Plant Technical Council. 2012. *Astragalus castetteri* (Castetter's milkvetch). 21 June 2012 <http://nmrareplants.unm.edu/rarelist_single.php?SpeciesID=19>
- Okin, G. S., D. A. Gillette, and J. E. Herrick. 2006. Multi-scale controls on and consequences of Aeolian processes in landscape change in arid and semi-arid environments. *Journal of Arid Environments* 65:253–275.
- 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(3):573-582.
- Rawling, G.C. 2005. Geology and hydrologic setting of selected springs on the San Andres National Wildlife Refuge. New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech, Socorro. Open-file Report 493. 54 pp.
- Reichler, T. and J. Kim. 2008. How well do coupled models simulate today's climate? *Bulletin for the American Meteorological Society*, 89(3): 303-311.
- Saiz, R. S. 1975. Ecology and behavior of gemsbok on White Sands Missile Range, New Mexico. Master's thesis. Las Cruces: New Mexico State University.
- 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. 314 pp.
- Sandoval, A. V. 1980. Management of a Psoroptic scabies epizootic in bighorn sheep, *Ovis canadensis mexicana*. *Desert Bighorn Council Transactions* 24:21-28.
- Seager, W.R. 1981. Geology of Organ Mountains and southern San Andres Mountains, New Mexico. New Mexico Bureau of Mines and Mineral Resources, Memoir 36, Socorro, New Mexico. 97 pp.
- Singer, F.J. and L.C. Zeigenfuss. 2002. Influence of trophy hunting and horn size on mating behavior and survivorship of mountain sheep. *J of Mammalogy*, 83(3):682–698.
- Smith, J. C. 1994. Microhistological analysis of diets of exotic and native ungulates in south-central New Mexico. Master's thesis. Las Cruces: New Mexico State University.

- Sparrowe, R.D., J.A. Bissonette, W.M. Boyce, K.L. Risenhoover, and P.R. Krausman. 1992. A review of desert bighorn sheep in the San Andres Mountains, New Mexico. The Wildlife Management Institute final report. 18 pp.
- Thompson B. C., P. L. Matusik-Rowan, K. G. Boykin. 2002. Prioritizing conservation potential of arid-land montane natural springs and associated riparian areas. *Journal of Arid Environments* 50:527–547.
- Thompson, D., K. Longshore and C. Lowery. 2007. The impact of human disturbance on desert bighorn sheep (*Ovis canadensis nelsoni*) in the Wonderland of Rocks / Queen Mountain region of Joshua Tree National Park, California. A final report prepared for Joshua Tree National Park, CA.
- [USFWS] U. S. Fish and Wildlife Service. 1998. Comprehensive conservation plan and environmental assessment: San Andres National Wildlife Refuge. 38 pp.
- [USFWS] U.S. Fish and Wildlife Service. 2000. Hunting and migratory birds: how hunters benefit many migratory bird species. Office of Migratory Bird Management, U. S. Fish and Wildlife Service. 2pp. www.fws.gov/r9mbmo/homepg.html
- [USFWS] U.S. Fish and Wildlife Service. 2007. Environmental Assessment: Opening of hunting for San Andre National Wildlife Refuge. 26 pp.
- [USFWS] U.S. Fish and Wildlife Service. 2009. Appendix G – Compatibility Determination *in* Desert National Wildlife Refuge Complex Final Comprehensive Conservation Plan and Environmental Impact Statement. 841 pp.
- Utah Division of Wildlife Resources. 2008. Utah Bighorn Sheep Statewide Management Plan. Department of Natural Resources. 25 pp.
- Von Loh, James D. 1977. A flora of the San Andres National Wildlife Refuge, Dona Ana County, New Mexico. M.S. Thesis, University of New Mexico, Albuquerque. 171 pp.
- Washington Department of Fish and Wildlife. 2008. 2009-2015 Game Management Plan. Wildlife Program, Washington Department of Fish and Wildlife, Olympia, Washington, USA. 154 pp.
- Wehausen, J. D., L. L. Hicks, D. P. Gardner, and J. Elder. 1977. Bighorn sheep management in the Sierra Nevada. *Desert Bighorn Council Transactions* 21:30-32.
- Wehausen, J. D. 1980. Sierra Nevada bighorn sheep: history and population ecology. Ph.D Dissertation, University of Michigan, Ann Arbor, 240 pp.
- Weisenberger , M.E Weisenberger, P.R Krausman, M.C Wallace, D.W De Young, O.E Maughan. 1996. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. *Journal of Wildlife Management*, 60 (1996), pp. 52–61.
- Welles, R.E. and F.B. Welles. 1961. The bighorn of Death Valley. U.S. Govt. Printing Office, Washington D.C. Fauna Series No. 6. 242 pp.
- Whitford, W. G. 2002. Ecology of desert systems. Academic Press, San Diego, California, USA.

[WSMR] White Sands Missile Range. 2001. Integrated Natural Resource Management Plan. 490 pp.

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Appendix A

DEFINITION OF TERMS

Carrying capacity is the maximum population of a particular organism that a given environment can support without detrimental effects.

Effects

Direct effects are the impacts that would be caused by the alternative at the same time and place as the action.

Indirect effects are impacts that occur later in time or distance from the triggering action.

Cumulative effects (definition provided in section 4.6)

Impact Type

Beneficial impacts are those resulting from management actions that maintain or enhance the quality and/or quantity of identified refuge resources or recreational opportunities.

Adverse impacts are those resulting from management actions that degrade the quality and/or quantity of identified refuge resources or recreational opportunities.

Duration of Impacts

Short-term impacts affect identified refuge resources or recreational opportunities; they occur during implementation of the management action but last no longer.

Medium-term impacts affect identified refuge resources or recreational opportunities that occur during implementation of the management action; they are expected to persist for some time into the future though not throughout the life of the Plan.

Long-term impacts affect identified refuge resources or recreation opportunities; they occur during implementation of the management action and are expected to persist throughout the life of the Plan and possible longer.

Intensity of Impact

Negligible impacts result from management actions that cannot be reasonably expected to affect identified refuge resources or recreational opportunities at the identified scale; impacts are so small that they would not be measurable.

Minor impacts result from a specified management action that can be reasonably expected to have detectable though limited effect on identified refuge resources or recreation opportunities at the identified scale; impacts are detectable but would affect a small area

Moderate impacts result from a specified management action that can be reasonably expected to have apparent and detectable effects on identified refuge resources or recreation opportunities at the identified scale; readily apparent and would occur over a relatively large area but are not extreme or excessive

Major impacts result from a specified management action that can be reasonably expected to have readily apparent and substantial effects on identified refuge resources and recreation opportunities at the identified scale; effects would be readily apparent and would substantially change the characteristics of the resource

Scale of Impact

Site-specific effects are those impacts that occur solely within the project area (the 3 new units).

Local effects are those impacts that can be reasonably expected to have detectable effects within and immediately surrounding the project area (all 7 units).

Refuge-wide effects are those impacts that can be reasonably expected to have noticeable effects across the entire Refuge landscape.

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