BIGHORN SHEEP UNIT MANAGEMENT PLAN
SAN RAFAEL WMU #12
North / South / Dirty Devil
August 2019

BOUNDARY DESCRIPTION

Carbon, Emery, Wayne, Garfield, and Sevier counties –

San Rafael, North - Carbon, Emery and Sevier counties--Boundary begins at SR-10 and US-6 at Price; east and south on US-6 to I-70; west on I-70 to SR-10; north on SR-10 to US-6. Excludes all CWMUs. USGS 1:100,000 Maps: Huntington, Manti, Price, Salina, San Rafael Desert.

San Rafael, South - Emery and Wayne counties—Boundary begins at the junction of I-70 and SR-24; south and west on SR-24 to Caineville and the Caineville Wash road; north along the Caineville Wash road to the Cathedral Valley road; west on the Cathedral Valley road to Rock Springs Bench and the Last Chance Desert road; north on the Last Chance Desert road to the Blue Flats road; north and east on the Blue Flats road to the Willow Springs road; north on the Willow Springs road towards Windy Peak and the Windy Peak road; west on the Windy Peak road to SR-72; north on SR-72 to Fremont Junction and I-70; east on I-70 to SR-24. EXCLUDES ALL NATIONAL PARKS. USGS 1:100,000 Maps: Loa, Hanksville, Salina, San Rafael Desert.

Dirty Devil - Emery, Garfield and Wayne counties—Boundary begins at the junction of I-70 and the Green River; south along the Green River to the Colorado River; south along the Colorado River and the west shore of Lake Powell to SR-95; north on SR-95 to SR-24 in Hanksville; north on SR-24 to I-70; east on I-70 to the Green River. EXCLUDES ALL NATIONAL PARKS. USGS 1:100,000 Maps: Hanksville, Hite Crossing, San Rafael Desert.

LAND OWNERSHIP

Land ownership and approximate area of modeled bighorn sheep habitat for the San Rafael bighorn sheep management sub-units.

San Rafael, North

Ownership	MODELED BIGHORN HABITAT	
	Area (acres)	%
Bureau of Land Management	290,573	86.6%
Utah State Institutional Trust Lands	40,292	12.0%
Private	4,543	1.4%
Utah Division of Wildlife Resources	117	<0.1%
Utah Department of Transportation	107	<0.1%
Totals	**335,631**	**100%**

San Rafael, South

Ownership	MODELED BIGHORN HABITAT	
	Area (acres)	%
Bureau of Land Management	334,521	88.1%
Utah State Institutional Trust Lands	41,501	10.9%
Utah State Parks	1,366	0.4%
Private	1,326	0.3%
National Parks	665	0.2%
Utah Department of Transportation	61	<0.1%
Utah Division of Wildlife Resources	53	<0.1%
Totals	**379,493**	**100%**

San Rafael, Dirty Devil

Ownership	MODELED BIGHORN HABITAT	
	Area (acres)	%
Bureau of Land Management	285,107	52.8%
National Parks	220,718	40.9%
Utah State Institutional Trust Lands	32,938	6.1%
Private	592	0.1%
State Sovereign Land	418	0.1%
Utah Division of Wildlife Resources	100	<0.1%
Totals	**539,872**	**100%**

UNIT MANAGEMENT GOALS

The San Rafael wildlife management unit is in the high desert of southeastern Utah and is part of the Colorado Plateau. The San Rafael Swell anticline was formed by an enormous uplift in the earth's crust where erosion formed deep canyons and mesas providing high quality desert bighorn habitat. Elevation ranges from 4200 to 7900 feet. Specific goals are to:

1) Manage for a healthy population of desert bighorn sheep capable of providing a broad range of recreational opportunities, including hunting and viewing.
2) Balance bighorn sheep impacts with other uses such as authorized grazing and local economies.
3) Maintain a population that is sustainable within the available habitat in the unit boundary.

HISTORY AND CURRENT STATUS

Desert Bighorn sheep are native to this area. They were hunted by indigenous people, and have been noted by early explorers. Early residents of the Dirty Devil area also saw bighorns into the 1900's (BLM, Henry Mountain Desert Bighorn Habitat Management plan). Desert bighorns on the San Rafael were believed to have been extirpated somewhere between the late 1800's and early to mid-1900s. After pioneer settlement thousands of domestic sheep grazed in desert bighorn habitats. Domestic sheep allotment AUM's on the San Rafael were eventually converted to cattle AUM's, however there are some nearby allotments as well as authorized allotments where sheep may trail through.

San Rafael, North- Desert bighorn sheep were reintroduced to the north San Rafael Swell in 1978 and the first hunt was held ten years later on the San Rafael, North unit in 1988 with two hunters afield. Between the years of 2005 and 2011 the bighorn numbers observed on the unit during the aerial surveys declined from 442 bighorns to 86 bighorns. Disease and possibly predation were suspected. Research to determine why the population was declining was initiated in 2012 when the Utah Division of Wildlife Resources (DWR) contracted with BYU to conduct a graduate study which confirmed the population had respiratory disease and that predation particularly by cougars was impacting local bighorn sheep bands.

San Rafael, South- Desert bighorn sheep were reintroduced to the south San Rafael Swell in 1983 and the first hunt was held ten years later on the San Rafael, South unit in 1993 with two hunters afield. During the most recent survey in 2018 population numbers had declined 39% from the 2015 survey. A subsequent survey will be conducted in November of 2019 targeting the most populated areas on the unit to verify the previous year's survey. A disease assessment is scheduled on the unit during the winter of 2019/2020 and will help determine if this decline in part due to respiratory disease.

San Rafael, Dirty Devil- The Dirty Devil River begins near Hanksville where the Muddy and Fremont Rivers join and is where the subunit gets its name. Most hunting and occupied sheep habitat is between the west Canyon Lands National Park boundary and along the Dirty Devil drainage with the associated canyons and mesas. Desert bighorn sheep were reintroduced to the Dirty Devil in 1991 and the first hunt was held ten years later on the unit in 2003 with two hunters afield. The highest count was recorded in 2008 with 115 sheep observed. Numbers declined to 66 in 2012. Hunters have reported coughing sheep on the unit. In 2015 the herd was tested on the unit for disease and it was confirmed that they carry pathogens that can cause respiratory disease.

ISSUES AND CONCERNS

Potential Habitat: We modeled potential bighorn sheep habitat on the San Rafael unit using methodology outlined by O'Brien et al. (2014). Bighorn sheep select habitat based on the proximity of steep-sloped escape terrain, forage availability, ruggedness, and horizontal visibility (Bleich et al. 1997, Valdez and Krausman 1999, Sappington et al. 2007). Bighorn sheep habitat is located throughout the unit in suitable rugged locations (Figure 1).

Livestock Competition: Bighorn sheep annual use of forage classes, when compared to cattle, differ significantly (Dodd and Brady 1988). Likewise, bighorn sheep generally avoid areas where cattle are present (Bissonette and Steinkamp 1996), and also select areas with a much higher degree of slope (Ganskopp and Vavra 1987). For these reasons, competition between cattle and bighorns should not be a significant concern within this unit. Because of the risk of pathogen transmission between bighorns and domestic sheep, the areas where domestic sheep are present are not suitable for bighorn sheep.

Disease: Disease, especially bacterial pneumonia, has been responsible for numerous declines in bighorn populations throughout North America (Cassirer and Sinclair 2007). Pneumonia outbreaks typically affect all age/sex cohorts and are usually followed by several years of annual pneumonia outbreaks in lambs that dramatically reduce population growth (Spraker et al. 1984, Ryder et al. 1992, George et al. 2008). These events are attributed to the transfer of pathogens from domestic sheep (*Ovis aries*) or goats (*Capra aegagrus hircus*) to wild sheep through social contact (Singer et al. 2000, Monello et al. 2001, Cassirer and Sinclair 2007). Disease-induced mortality rates in bighorn sheep vary substantially by population due to multiple processes including contact rates, social substructuring, pathogen virulence, and individual susceptibility (Manlove et al. 2014, 2016). Therefore, spatial separation from domestic sheep and goats is the most important factor in maintaining overall herd health. It is not the intent of this plan or the DWR to force domestic sheep operators off public lands or out of business. Rather, the intent is to look for opportunities that will protect bighorn sheep populations while working with the domestic sheep industry and individual grazers.

Predation: Cougar predation may limit bighorn sheep in locations where predator populations are largely supported by sympatric prey populations (Hayes et al. 2000, Schaefer et al. 2000, Ernest et al. 2002), which, in this case, includes a limited amount of mule deer. It has been hypothesized that declines in sympatric ungulate populations can increase predation on bighorn sheep as cougars switch to bighorns as an alternate prey source (Kamler et al. 2002, Rominger et al. 2004). It is anticipated that cougars will be the main predator of bighorns in the San Rafael unit. If predation becomes a limiting factor, predator control work will be administered within the guidelines of the DWR Predator Management Policy. Predator management is coordinated with USDA Wildlife Services.

POPULATION MANAGEMENT

Population Management Objective:

1) Manage for a population objective of 1200 desert bighorn sheep within suitable habitat across the entire San Rafael unit. Population objectives for each subunit were chosen as a realistic number to achieve and maintain spatial separation between wild and domestic sheep. These objectives are well below the recommended densities of 1.3-1.9 sheep / sq km (Van Dyke 1983). Objectives for each subunit will be:
   - San Rafael, North: 500 bighorn sheep
   - San Rafael, South: 500 bighorn sheep
   - San Rafael, Dirty Devil: 200 bighorn sheep

Population Management Strategies:

1) Monitor the bighorn sheep population using aerial surveys and GPS collar technology in order to assess population trends and health.
2) Augment the population as needed through transplant efforts.
3) Initiate predator management as specified in predator and bighorn sheep unit management plans. Wildlife Services or other contracted personnel may be needed in remote or hard to access areas to help reduce cougar numbers.
4) Document instances of interaction between wild sheep and domestic sheep and goats to allow conflicts to be evaluated and dealt with in a timely manner. Follow established guidelines for dealing with domestic sheep and goats that wander into bighorn sheep units as outlined in UDWR GLN-33.
5) Conduct adequate disease sampling of bighorn sheep on the unit as needed to maintain a current disease profile.
6) Assess results and management recommendations of the recent BYU research and implement useful recommendations when possible.

Population Monitoring Plan:

Continue aerial surveys on the unit on a 2-3 year rotation surveying the San Rafael North and South subunits together, which will likely require 22-24 hours on the North and 20-22 hours on the South to conduct a complete trend count. The Dirty Devil will also be flown on a 2-3 year rotation with the Henry's Unit and will take 20-22 hours to conduct a complete trend count. Conduct ground classification as conditions permit to obtain annual production estimates. Monitor radio-collared bighorns 4-6 times per year to generate annual estimates of survival following DWR guidelines. All population data will be collected and submitted on standardized forms, including all GIS data (waypoints, flight paths, etc.).

Trend Count and Classification Data

San Rafael, North

Year	Pop Est	Total Count	Total Ewes	Total Lambs	Total Rams	Rams > 6 yrs old	Lambs/100 Ewes	Rams/100 Ewes
2008	250	150	82	18	50	19	22	61
2011	132	86	52	15	19	8	29	37
2012	168	101	55	26	20	1	47	36
2013	157	94	51	16	27	1	31	53
2015	207	124	60	25	39	6	42	65
2018	170	102	43	17	42	10	40	98

San Rafael, South

Year	Pop Est	Total Count	Total Ewes	Total Lambs	Total Rams	Rams > 6 yrs old	Lambs/100 Ewes	Rams/100 Ewes
2007	430	258	134	22	103	36	16	77
2009	305	183	82	31	70	28	37	85
2011	367	220	115	33	71	27	29	62
2013	313	188	100	37	51	15	37	51
2015	360	216	110	35	71	19	32	65
2018	222	133	60	15	58	14	25	97

San Rafael, Dirty Devil

Year	Pop Est	Total Count	Total Ewes	Total Lambs	Total Rams	Rams > 6 yrs old	Lambs/100 Ewes	Rams/100 Ewes
2006	127	76	33	18	25	14	54	75
2008	192	115	68	7	40	17	10	59
2010	112	67	40	12	15	7	30	37
2012	110	66	36	14	15	3	39	42
2014	100	60	32	12	16	8	38	50
2016	143	86	44	17	25	3	39	57

Transplant Plan:

These units should be managed to maintain and protect established bighorn sheep numbers and achieve unit population objectives. At this time, there are no transplants to these units scheduled. Augmentations may be warranted in the future to re-establish sheep numbers and achieve unit population management goals. Transplant priorities will be based upon disease profiles, densities, habitat, and overall potential for herd expansion. Initial transplanted sheep will be monitored for general movements and annual survival. The DWR will maintain working relationships with all interested parties and invite them to participate in bighorn sheep related activities, regarding transplant efforts.

Predator Management:

The San Rafael units are managed under a predator management plan. The unit is designated as a bighorn sheep protection area with a liberal cougar harvest quota and a year-round cougar hunting season. Mountain lions are the most significant predators of bighorns in Utah. Coyotes, bobcats, and golden eagles may also take bighorn sheep. Over the last three years, an average of 7 cougars was killed per year on the San Rafael unit. During the 2 year BYU field research project, cougar predation has been shown to adversely impact the North San Rafael sheep population. Fifty percent of collared bighorn sheep mortalities were attributed to cougar predation. The cougar population on this unit should be managed to allow bighorn population to increase if efforts to reach the population objective. Cougar harvest on this unit is difficult because of topography, remoteness, and access. Increased efforts to take or harvest cougars and

protect this bighorn herd are being taken and should continue through established DWR policy and procedures provided in the statewide bighorn sheep and cougar management plans.

Research Needs:

1) Primary objectives for research on the unit should focus on disease issues and low lamb survival.
2) Secondary objectives should focus on dispersal movements of newly transplanted bighorns.
3) Recreationists are attracted to the San Rafael Swell area mainly as a result of social media and tourism marketing. Recreation is increasing substantially particularly on the San Rafael, North unit around Buckhorn Wash and the Wedge areas. At the Wedge there is currently a user created trail which follows along the Goodwater Canyon Rim and has become a destination trail particularly for mountain biking. This trail is of concern because of the local bighorn herd uses this canyon to lamb in. The numbers of recreationist will impact this herd long term if considerations are not made to limit recreation in this area. The BLM is working to designate this trail in order to manage off trail use, designate camping areas, and install restrooms to mitigate crowding use. These efforts will help somewhat but the sheep population in this area may potentially be affected by the increasingly high human impacts. It is an ideal area to begin research and build upon the research performed in the recent past.

DISEASE MANAGEMENT

Disease Management Objective:

1) Maintain a healthy population of desert bighorn sheep on the San Rafael unit.
2) Strive for spatial separation from domestic sheep and goats.

Disease Management Strategies:

Disease Monitoring: The DWR may perform periodic live captures to assess herd health, as well as take advantage of opportunistic sampling of hunter harvested bighorns or bighorns that are found dead. Disease testing should be a priority to guide future transplant efforts in these subunits. The presence of pneumonia pathogens in the population may likely lead to future outbreaks, and recovery is unlikely to be enhanced by translocating native, healthy animals into the population (Plowright et al. 2013). These units are a mid-level priority for statewide disease testing as units with low lamb recruitment and potential transplant sites. A total of 16 bighorn sheep were disease-tested on the North San Rafael unit in 2012, and 19 bighorns were sampled in the Dirty Devil area in 2015. These populations have experienced mortalities due to respiratory disease in the past. Several of the bighorns tested were positive for *Mycoplasma ovipneumoniae* (M.ovi). M.ovi is considered an important pathogen in the bighorn sheep respiratory disease complex. More information on the San Rafael, South sub-unit would help make a more complete health profile and hopefully will help in making management decisions.

Spatial Separation: Work with land management agencies and private landowners to implement agency guidelines for management of domestic sheep and goats in bighorn areas. The following are the primary threats that challenge effective separation

1) Active sheep and trailing allotments - The South Wolf Hollow and the Rock Canyon allotments are the closest to occupied bighorn sheep habitat. There are also active trail allotments which include trailing sheep from Cleveland to Castle Dale through the Cleveland Winter allotment, the Red Seeps Allotment and the Buffalo and Hadden Hills pastures (north and west of Buckhorn Reservoir) of the Buckhorn Allotment.

2) Farm flocks on private lands along the SR-10 corridor - One of the greatest disease risks posed to the San Rafael desert bighorns are from escaped or wandering domestic sheep and goats from the nearby agricultural communities. Correspondingly, the same risk is posed from desert bighorns wandering into domestic sheep and goat areas, being exposed, then returning to a bighorn herd.

Outreach efforts should take place with permittees and BLM employees concerning domestic and wild sheep interactions. Active removal of bighorn sheep within or close to these allotments, trailing areas, and private lands should be a priority.

Risk Management and Response Plan:

High risk areas will be within the domestic allotments and trailing areas. Wild sheep that are in close contact with domestics should be removed immediately. All wandering wild sheep and stray domestic sheep and goat issues will be handled following the UDWR GLN-33. The need to test wandering sheep from this unit will be evaluated on a case by case basis.

HABITAT MANAGEMENT

Habitat Management Objectives:
1) Maintain and improve bighorn sheep habitat to achieve population objectives.
2) Continue to identify crucial bighorn sheep habitats and work with land managers and private landowners to protect these areas.
3) Assist land management agencies in monitoring bighorn habitat to detect changes in habitat quantity or quality.
4) Work with land managers to minimize and mitigate loss of bighorn habitat due to human disturbance and development.

Current and Potential Wild Sheep Distribution:

Bighorn sheep have established throughout bighorn habitat in these subunits. Desert bighorns are primarily associated with canyons, mesas, and slopes of the San Rafael Swell and the Dirty Devil River corridor. Areas where bighorns have declined, there is potential for sheep to reoccupy favorable habitat. Bighorns have generally not been centrally distributed within the Swell. A map of occupied habitat is included in Figure 1.

Potential Threats to Habitat:

1) Human disturbance including vehicular off-road travel, natural resource extraction, organized competitive athletic events, biking trails, and camping near springs and water sources can result in abandonment or degradation of bighorn habitat. Due to the rugged nature and lack of roads in much of sheep habitat, human disturbance from vehicular recreation is lessened. But some areas where desert sheep are accessible, for example Goodwater Canyon, disturbance will be heavier as more people look to recreate in lesser used accessible areas as is happening on the San Rafael Swell. If disturbance becomes an issue, DWR will work with and support federal agencies (e.g. BLM and NPS) on travel management plans and other land use plans and outreach efforts may be made to gain local support to reduce human disturbance to bighorn sheep habitat.
2) Severe and long-term drought may affect bighorn habitat ultimately impacting population trend and distribution on the unit.

Vegetation Management Projects:

1) Initiate vegetative treatment projects to improve bighorn habitat lost to natural succession or human impacts.
2) Cooperate with the BLM and SITLA to utilize controlled burns and/or mechanical treatments to remove pinyon-juniper encroachment and improve bighorn habitat across the subunit.
3) Identify specific habitat restoration projects to benefit bighorn sheep.
    1) Some areas to consider for PJ removal:
    2) NSR- along canyon rims (outside of WSA) between the head of Nates/Spring Canyon and Buckhorn Wash and the Wedge.
    3) SSR: canyons rims along Reds Canyon, Copper Globe area, and the Head Of Sinbad.
    4) Dirty Devil: Canyon rims and flats in areas around Twin Corral Flats, and Twin Corral Box, Sams Mesa Box, and French Spring canyons.

Water Management Projects:

1) Work with the BLM, SITLA, and permitees to locate and improve water sources across bighorn habitat.
2) Cooperatively modify or improve existing water developments and guzzlers for bighorns.
3) Identify areas in otherwise favorable habitat where water developments/guzzlers would benefit desert bighorns by expanding their range, improving production, and possibly decrease drought related stressors. Identify projects on SITLA first then identify areas on BLM.
4) There are some concerns that providing an artificial water source in an otherwise dry environment may negatively impact kit fox populations in the area. Artificial water sources can increase coyote densities and coyotes are a natural predator of kit fox. Prior to establishing an artificial water source, it must be known if kit fox are in the area and if so alternatives may need to be found and/or the project mitigated.

RECREATION MANAGEMENT

Recreation Management Objectives:

1) Provide hunting opportunities on the San Rafael unit that are a quality experience.
2) Increase public awareness and expand viewing opportunities of bighorn sheep.

Recreation Management Strategies:

Hunting: Hunting and permit allocation recommendations will be made in accordance with the Utah Bighorn Sheep Statewide Management Plan. Ewe hunts may be utilized as a tool for maintaining population objective.

Harvest Statistics

San Rafael, North

Year	Permits	Mean Days Hunted	Harvest	Satisfaction
2009	5	7.2	100%	4.8
2010	5	8.8	100%	4.4
2011	5	14.4	80%	4.2
2012	3	9.5	67%	3.5
2013	1	20.0	100%	4.0
2014	1	6.0	100%	5.0
2015	1	4.0	100%	5.0
2016	2	21.5	50%	3.5
2017	3	9.3	100%	4.7
2018	3	6.0	100%	5.0

San Rafael, South

Year	Permits	Mean Days Hunted	Harvest	Satisfaction
2009	8	10.8	75%	3.3
2010	9	10.2	100%	4.8
2011	9	11.1	79%	3.9
2012	8	10.0	100%	4.8
2013	9	10.6	100%	4.4
2014	6	11.0	100%	4.8
2015	6	11.0	100%	4.8
2016	7	8.4	85.7%	4.6
2017	8	13.4	100%	4.5
2018	7	8.3	85.7%	4.9

San Rafael, Dirty Devil

Year	Permits	Mean Days Hunted	Harvest	Satisfaction
2009	5	11.0	80%	3.6
2010	6	8.8	83%	4.3
2011	6	10.2	83%	3.5
2012	3	3.0	67%	4.3
2013	3	12.0	100%	5.0
2014	2	9	100%	5.0
2015	1	20	100%	5.0
2016	1	11.0	100%	3.0
2017	2	4.5	100%	5.0
2018	1	20	100%	5.0

Non-Consumptive Uses: The DWR will look for opportunities to increase public awareness and expand viewing opportunities of bighorn sheep through viewing events and public outreach.

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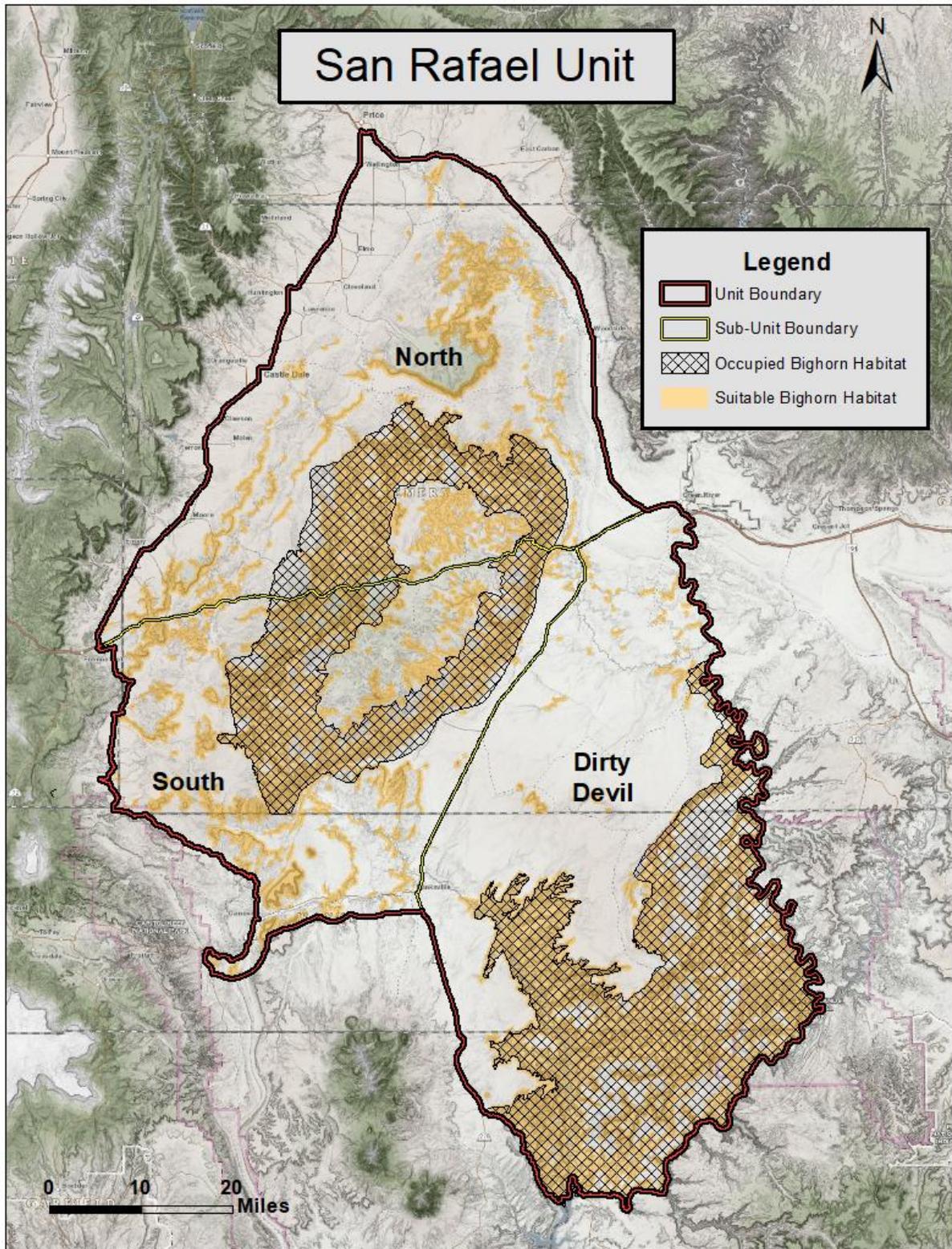
Figure 1. San Rafael unit management boundary, modeled suitable bighorn sheep habitat, and currently occupied bighorn habitat.