# North Dakota Bighorn Sheep Management Plan (2013 – 2023)

**North Dakota Game & Fish Department**
**Wildlife Division**
Report A-213
November 2013

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## ACKNOWLEGEMENTS

This report was funded by the North Dakota Game & Fish Department, Wild Sheep Foundation – Midwest Chapter, and the Bureau of Land Management – North Dakota Field Office. Regardless of jurisdiction, bighorn sheep cannot be managed effectively without the full support of agency leadership. Therefore, gratitude is owed to Terry Steinwand (Director), Randy Kreil (Wildlife Chief), Jeb Williams (Assistant Wildlife Chief), Mike Johnson (Wildlife Section Supervisor), and Bruce Stillings (Big Game Management Supervisor) for their dedication to the management of bighorn sheep in North Dakota. Bill Jensen (Big Game Management Biologist) has also made significant contributions to North Dakota's bighorn sheep for over 20 years, and Jeff Faught (NDGF pilot) has flown hundreds of hours over rugged terrain while collecting telemetry data. In the true spirit of hunter-conservationists, members of the Wild Sheep Foundation – Midwest Chapter have never ceased to be trusted partners and advocates for the management of bighorn sheep in North Dakota and elsewhere. Although there are far too many Game and Fish personnel to list, recognition is owed to A. Duxbury, S. Dyke, J. Gulke, D. Grove, D. Hildebrand (former Director – deceased), R. Johnson (Big Game Management Supervisor - retired), J. F. Kolar, B. Kreft, G. Link, J. McKenzie (Big Game Management Supervisor – deceased), R. Parsons, D. Repnow, J. Schumacher, and J. Smith. We also thank our colleagues from the Bureau of Land Management – North Dakota Field Office, National Park Service – Theodore Roosevelt National Park, North Dakota Department of Trust Lands, and U.S. Forest Service – Dakota Prairie Grasslands.

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*Suggested Citation:* Wiedmann, B. P., and B. M. Hosek. 2013. North Dakota Bighorn Sheep Management Plan (2013 – 2023): Report A-213. Federal Aid in Wildlife Restoration Project. North Dakota Game and Fish Department, Bismarck, USA.

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# HISTORY AND BIOLOGY

## History

Prior to European settlement of North America, bighorn sheep (*Ovis canadensis*) ranged from Canada to Mexico, and eastward to the Dakotas and Nebraska. Seton (1929) estimated their numbers at 1.5 – 2 million; however, many now believe that estimate to be greatly exaggerated because bighorn sheep occupy a narrow habitat niche and are widely distributed across their range. Notwithstanding, bighorn sheep were extirpated throughout much of their historical range and numbered only 15,000 – 20,000 by the early twentieth century (Fig. 1).

Audubon's bighorn sheep (formerly *O. c. auduboni*) were native to North Dakota, where small, fragmented subpopulations likely comprised a metapopulation structure along the Little Missouri, Missouri, and Yellowstone Rivers. The Lewis and Clark expedition observed their first "anamale with circular horns" near the confluence of the Yellowstone and Missouri Rivers in present-day North Dakota. Despite the expedition's poor luck hunting the "big horned animal" in North Dakota, they managed to kill two along the Missouri River in Montana. John James Audubon and Theodore Roosevelt also wrote about their difficulties and frustrations hunting bighorn sheep in North Dakota. It is impossible to know with certainty how many bighorn sheep inhabited the state historically, but they likely were never abundant as North Dakota lies on the eastern fringe of their range.

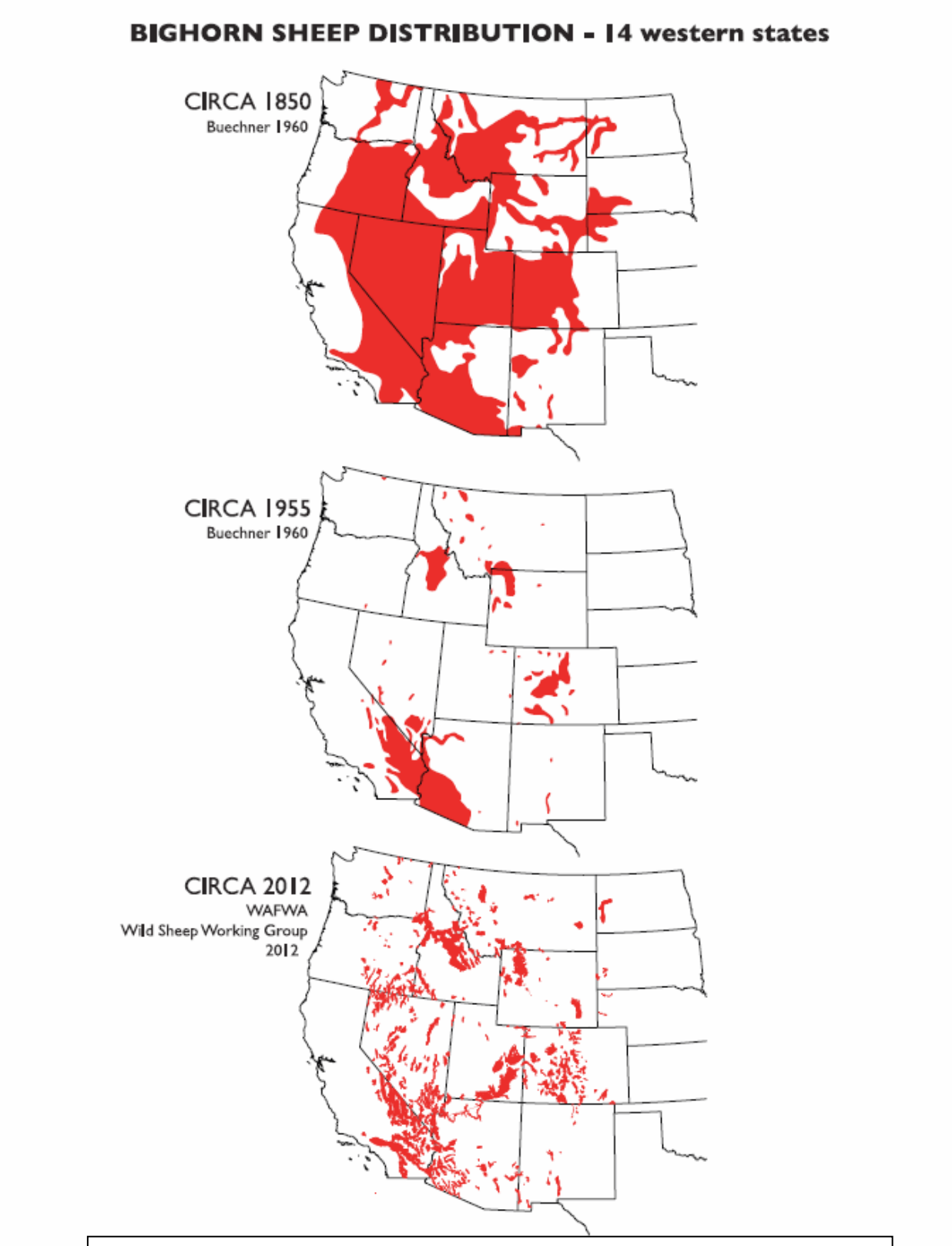


Figure 1. Historical and current distribution of bighorn sheep in the U.S. (courtesy WAFWA Wild Sheep Working Group).

Although Audubon's bighorn sheep were recently synonymized with Rocky Mountain bighorn sheep (*O. c. canadensis*), the last known native bighorn sheep in North Dakota was killed near the Little Missouri River in 1905. Unregulated hunting certainly contributed to the extirpation of native bighorn sheep in North Dakota, but diseases introduced from domestic sheep likely played a more significant role in their demise (Fig. 2 and 3).

The North Dakota Game and Fish Department (NDGF) became interested in reintroducing bighorn sheep to western North Dakota during the mid-1940s, but it was not until 1955 that a source population was found that was both available and thought to be suitable to the region's badlands habitat. California bighorn sheep (formerly *O. c. californiana*) – also recently reclassified as Rocky Mountain bighorn sheep – of southern British Colombia occupied low elevation, canyon habitats that were somewhat similar to the badlands of North Dakota. In 1956, bighorn sheep were translocated from British Columbia to an enclosure located at Magpie Creek, North Dakota where they served as source-stock to reestablish bighorn sheep throughout the badlands (Fig. 4 and 5).

## Biology

Indigenous populations of bighorn sheep exhibit clinal and ecotypic variation throughout North America, but three distinct subspecies are generally recognized: Rocky Mountain bighorn sheep, Desert bighorn sheep (*O. c. nelsoni*), and Sierra Nevada bighorn sheep (*O. c. sierrae*). Bighorn sheep are widely distributed throughout their range, where they can be found from the highest mountains to the deepest canyons; and from the hottest deserts to the coldest regions of North America.

Rocky Mountain bighorn sheep are the largest subspecies and include those found in North Dakota. Males can reach body weights of over 300 lbs. The most prominent feature of bighorn sheep is the large, sweeping horns of mature males – the head of a mature male can account for up to 12 percent of its total weight. Females are noticeably smaller than males and have much smaller, sickle-shaped horns. Pelage coloration ranges from blond to dark brown. Bighorn sheep have characteristic white markings on their rump, muzzle, and backside of legs.

Bighorn females are characterized as paedogenic: sexually mature "juveniles" throughout their lives. Female offspring are generally reluctant to disperse from natal ranges, and they typically adopt the home range of their maternal band. Male offspring, however, frequently disperse from maternal ranges when 2 years old and eventually locate and adopt home ranges of nearby bachelor groups of older males. Thereafter, young males either return to maternal ranges during the rut or follow mature males to bands of unrelated females. Geist (1970) classified bighorn males according to age and dominance structure (Fig. 6 – 9).

Figure 2. Diseases introduced from domestic sheep likely caused catastrophic losses of indigenous populations of bighorn sheep throughout North America.

Figure 3. Because of their low reproductive rates, bighorn sheep were vulnerable to market hunters in North Dakota and elsewhere.

Figure 4. A corral trap was used to capture bighorn sheep in British Columbia, 1956.

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Figure 6. Class I rams (2 years old) often disperse from maternal ranges in search of older males.

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Figure 9. Class IV rams (≥8 years old) are more likely to be solitary and are the last males to arrive at rutting grounds.

Male and female bighorn are typically segregated until the breeding season, which occurs during late-fall through early-winter. Dominance behaviors by males are highly ritualized and include the *low-stretch, head twist, leg kick, head butt, clash*, and *present*. Shortly after the rut, males form bachelor groups on separate and often less rugged ranges where quality forage is more abundant. The largest bachelor group ever recorded in North Dakota totaled 22 individuals; however, they usually number between 5 and 10.

Bighorn sheep are long-lived ungulates – the oldest male and female documented in North Dakota were 14 and 19 years old, respectively. However, they rarely achieve irruptive population growth due to low recruitment rates. Females usually give birth for the first time when 3 years old, but parous 2-year-olds have been documented in North Dakota. Females isolate themselves prior to parturition after a gestation period of 175 days. Timing of parturition is discontinuous as neonates have been observed in North Dakota as early as April 8 to as late as mid-September; however, the peak birthing period occurs during May. Females almost exclusively give birth to a single offspring. Newborn lambs are precocial and, unlike most ungulates that hide neonates in dense cover, they remain at heel of their dams when just a few days old. Females and young usually form nursery bands within 7 to 10 days after parturition, and occupy historic lambing areas thereafter until late summer when lambs become less dependent on escape terrain for predator avoidance.

In North Dakota, nursery bands use one to three patches of lambing habitat during the lambing season. However, they do not migrate to winter ranges following the lambing season, but instead use areas within their annual home ranges that provide quality winter forage. Conversely, males roam throughout a larger, annual home range during most of the year until they migrate to rutting areas during fall. Some males in North Dakota migrate >15 miles to rutting grounds, which are commonly located within the home ranges of females.

In North Dakota, most lamb mortality occurs during the first month of life; however, "summer pneumonia" events are not uncommon as lambs reach 3 – 4 months old. Except during those winters with extreme conditions, winter lamb survival is typically high in North Dakota, as 75% (60 – 98%) of lambs observed during summer surveys survived their first winter (2003 – 2012).

Bighorn sheep inhabit a wide range of landscapes but prefer drier environments. Consequently, they forage opportunistically on the most nutritious forage that is available seasonally. Bighorn sheep tend to be grazers, with forbs being their preferred forage followed by grasses, sedges, and shrubs. Because they are well-adapted to xeric landscapes, bighorn sheep can readily digest desiccated forage unpalatable to other ungulates. Males generally select those areas providing higher quality forage over those with rugged escape terrain, whereas parous females typically select areas with higher

quality escape terrain over those with high quality forage.

Unlike most ungulates in North Dakota, bighorn sheep appear to prefer native forage to agricultural fields; however, females will use agricultural fields that buttress lambing habitat. Surprisingly, although males generally select the most nutritious sources of forage within their home range, they occupy the most remote areas in the badlands of North Dakota and are rarely found near agricultural fields. Juniper encroachment and competition with livestock, especially near lambing areas, can significantly degrade the quality and quantity of forage preferred by bighorn sheep.

In North Dakota, bighorn sheep are found in Billings, Dunn, Golden Valley, McKenzie, and Slope counties where they exhibit a metapopulation structure: subpopulations of females are naturally fragmented and rarely associate with adjacent subpopulations of unrelated females. Genetic interchange among subpopulations of females is achieved via movements of males. Bighorn sheep occur primarily on lands managed by the U.S. Forest Service (USFS), but also inhabit lands managed by the Bureau of Land Management (BLM), National Park Service (NPS), state agency lands, and private lands within and adjacent to the Little Missouri National Grassland.

Bighorn sheep are found primarily in areas of steep, rugged terrain along the Little Missouri River that are separated from similar areas by plains or rolling hills. Elevations range from 2,090 to 3,445 ft, and substrates consist of highly erosive silts and clays, sandstone, and scoria. The climate is semi-arid, continental and windy, with cold winters and warm summers: annual temperatures can range potentially from -60° to 121° F. Highly variable rates of precipitation are common, but most precipitation occurs during April – September.

The distribution of vegetation is consistent throughout the badlands. Rolling hills, ridges, and moderate (15–40%) slopes are dominated by mixed-grass prairie. Vegetation on steeper north-facing slopes is composed primarily of Rocky Mountain juniper (*Juniperus scopulorum*), green ash (*Fraxinus pennsylanica*), and an assortment of shrubs. South-facing slopes are sparsely vegetated with big sage (*Artemisia tridentata*), shadscale (*Artiplex confertifolia*), Nuttall's saltbrush (*Artriplex nuttallii*), rubber rabbitbrush (*Chrysothamnus nauseosus*), and greasewood (*Sarcobatus vermiculatus*). Big sage (*Artemisia tridentate*), silver sage (*Artemisia cana*), and wheatgrass (*Agropyron smithii*) dominate creek beds where high levels of erosion during spring and summer are common.

Primary land uses include livestock grazing, agriculture, and energy production. Recreational activities (hunting, biking, hiking, horseback riding, camping) are also common. Bighorn range is also occupied by cattle and horses, mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), pronghorn (*Antilocapra*

*americana*), and elk (*Cervus elaphus*). Potential predators of bighorn sheep include mountain lions (*Puma concolor*), coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and golden eagles (*Aquila chrysaetos*).

Suitable bighorn sheep habitat generally consists of open areas containing rugged escape terrain (40 – 80% slopes) that is adjacent to grassland foraging areas – they are rarely found >300 yards from escape terrain. Visibility is of the utmost importance to bighorn sheep for predator detection and avoidance, especially near those areas where females bear and rear their young. Females typically arrive at lambing areas during late March, give birth, and then occupy those lambing areas from April through July. Parous females begin foraging farther from lambing habitat by late summer when their lambs are older and less dependent on the security of escape terrain.

Females have high fidelity to traditional lambing areas, which are the most critically important habitats used by bighorn sheep and, because such areas are very limited in North Dakota, they are the most apt to be negatively impacted by forest succession, residential development, road construction, industrial development, noxious weeds, competition with livestock, and recreational disturbances. Abandonment of critically important areas required by bighorn sheep is therefore of the utmost concern in regions like North Dakota, where a very limited quantity of suitable habitat is available. Maintaining the integrity of historic lambing habitat is essential to the persistence of these specialized ungulates, as lambing habitat is the primary limiting factor for abundance of most populations of bighorn sheep.

Human disturbance near lambing habitat can force females and young to flee from these critically important areas and those movements can make lambs more vulnerable to predation, poor body condition, and disease, thereby impacting the viability of a particular subpopulation. Humans on foot elicit the most severe flight responses by bighorn sheep in North Dakota, especially parturient females, which have routinely been observed fleeing from the security of escape terrain when approached to within 660 yards by humans on foot. Consequently, the NDGF's GIS Line-of-Sight model (Fig. 10) should be used to ensure that:

- Sources of human disturbance, particularly pedestrian traffic, do not occur within 660 yards of lambing habitat;
- Permanent human actives (e.g., recreational trails, campgrounds, oil pads) where humans on foot are a common occurrence are not constructed within 660 yards of lambing habitat;
- Construction activities and other sources of disturbance that are temporary (e.g., pipelines, water developments, road construction) do not occur within 660 yards of lambing habitat from April 1 to July 15 – a period when lambs are most dependent on escape terrain but also most likely to flee.

Bighorn sheep can acclimate to sources of disturbance that are consistent, predictable, and non-threatening (e.g., roads). For example, nursery bands that consistently flee from pedestrians that approach within 660 yards have been regularly located within 220 yards of roads, where traffic flow is consistent and predictable. Sensitivity of bighorn females to perturbations declines substantially after the lambing season (i.e., late summer), when female/lamb bonds begin to break and nursery bands depart lambing habitat in search of higher quality forage.

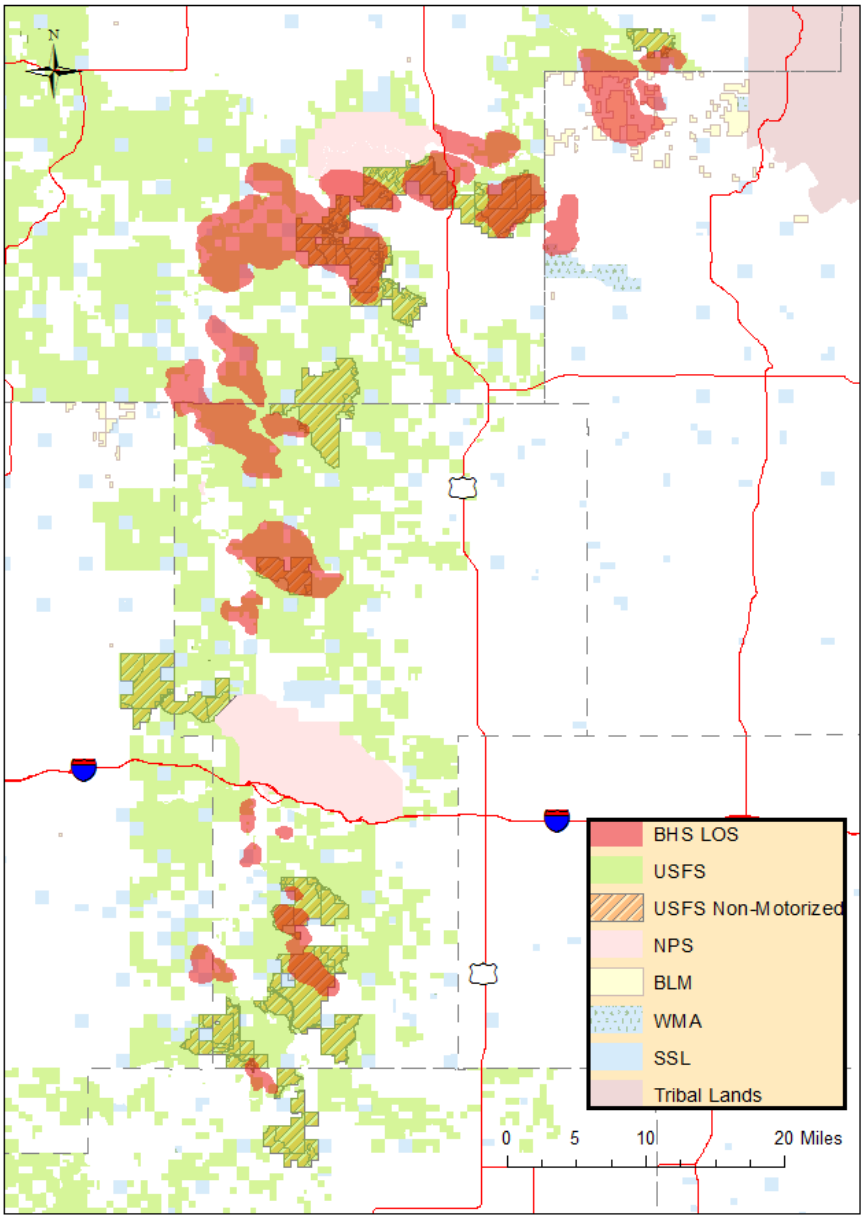


Figure 10. GIS Line-of-Sight model developed by the NDGF to minimize human disturbance near lambing areas.

# POPULATION MANAGEMENT

## Survey Methodology

Survey data of wildlife populations is useful only when it is repetitive, standardized, transferable, and understandable to staff and public in making valid management decisions. Not surprisingly, therefore, survey methods for bighorn sheep are notoriously difficult due to the species' naturally fragmented distribution and low population densities. Moreover, use of fixed-wing aircraft for surveying bighorn sheep is largely ineffective due to the rugged landscapes in which they live and poor sightability at minimum speeds required by fixed-wing aircraft. Consequently, most jurisdictions use helicopters for aerial surveys of bighorn sheep because they are more maneuverable and can fly at much slower speeds.

The NDGF has historically recorded incidental observations of bighorn sheep during annual mule deer surveys using fixed-wing aircraft, but reliable survey data specifically for bighorn sheep was lacking for decades. The widely distributed and low-density characteristics of North Dakota's population of bighorn sheep only compounded the difficulties in formulating a standardized survey methodology. Further, the NDGF does not own a helicopter, which

is essential to a standardized aerial count, and contracting helicopters specifically for bighorn sheep would be cost-prohibitive. For example, it would cost ~$60,000 annually to effectively survey bighorn sheep in North Dakota.

In 2000, therefore, the NDGF deployed radio-collars on bighorn sheep throughout the badlands to collect baseline data on population abundance, demographics, distribution, and to develop a standardized survey methodology. A survey method was subsequently developed from that initial project that is uniquely adapted to North Dakota. Not only does the method provide accurate survey data that is standardized and repetitive, but it is much less expensive than contracting helicopters for aerial surveys. The survey method is summarized:

1. Deploy VHF radio-collars on 2 – 3 males and females in each herd via helicopter net-gun techniques. Approximately 10 collars must be deployed annually using a helicopter capture-crew to replace collars lost to mortalities or battery failures;
2. During late summer (mid-July – August), census individual herds by locating marked animals with telemetry equipment, and then use a spotting scope to count and classifying individuals in each herd as adult male (≥ 2 years old), yearling male, adult female (≥ 2 years old), or lamb. Males that are ≥¾-curl should also be recorded. The NDGF's airplane is often required to locate marked animals that cannot be found using ground telemetry equipment (Fig. 11);
3. Radio-tracking indicates that young males (i.e., 1 – 3-year-olds) frequently move among male and female groups. Therefore, to achieve an accurate count, censuses of males and females from distinct herds should be completed sequentially. For example, the census of Ice Box Canyon males and females should be completed before commencing the census at Magpie Creek;
4. Repeat the same procedure the following March to recount females and lambs, as they approach 1-year-old, to determine recruitment.

Although this survey method is more laborious and time-consuming than aerial surveys, it costs much less than contracting helicopters. It is also a less intrusive technique that lessens disturbance to livestock on the numerous private ranches intermingled throughout the badlands, where low flying helicopters could cause significant disruptions to ranching activities. The method also causes fewer disturbances to bighorn sheep, as counts can usually be made with a spotting scope at distances where bighorn sheep are unaware of the biologist's presence. Radio-marked animals also provide supplemental data including cause-specific mortality, health monitoring, home range analyses, empirical data for land-use management by federal and state agencies, and more precise demographic data.

The cost-effectiveness of this survey method will only improve as battery life of radio-collars continues to increase; for example, battery-life of collars has increased from 3 – 4 years to 8 – 10 years in just the last few years.

Figure 11. Highly skilled pilots capable of using temporary runways are essential to completing surveys of bighorn sheep in North Dakota.

## Population Model

A census of bighorn sheep should be completed annually. However, during those years that:

1. A census could not be completed:
    a. A correction factor of 1.024 can be applied to the previous year's count ($N_t$) of males to estimate $N_{t+1}$ for males;
    b. A correction factor of 1.035 can be applied to the previous year's count ($N_t$) of females to estimate $N_{t+1}$ for females;
    c. A correction factor of 0.268 can then be applied to the estimated number of females ($N_{t+1}$) to estimate recruitment for $N_{t+1}$;
    d. For example:
        i. Where, $N_t$ = 60 males and 100 females;
        ii. Then, $N_{t+1}$ = 60(1.024) + 100(1.035) + 103.5(0.268);
        iii. Therefore, the estimate for $N_{t+1}$ = 61 males + 104 females + 28 lambs = 193.

2. A summer count was completed, but a March count of recruited lambs was not:
    a. A correction factor of 0.747 can be applied to the summer count of lambs ($N_t$) to determine lamb recruitment for $N_t$;
    b. For example:
        i. Where, the summer count ($N_t$) = 60 males, 100 females, 50 lambs;
        ii. Then, lamb recruitment ($N_t$) = 50(0.747);
        iii. Therefore, the estimate for $N_t$ = 60 males + 100 females + 37 lambs = 197.

## Current Status and Distribution

For the purposes of distinguishing population demographics and setting goals for this report, we categorized bighorn demography as metapopulation, subpopulation, and herd (Demarchi et al. 2000; Table 1). In 2012 there were two metapopulations that totaled approximately 330 individuals distributed among 15 herds (Fig. 12 – 14). There were ~280 individuals in the northern metapopulation and a ~50 individuals in the southern metapopulation (Tables 2 and 3). The state's total population increased 140% from 1999 to 2012; 131% in the northern metapopulation (excluding TRNP) and 200% in the southern metapopulation.

From 2000 to 2012, 2 – 3 females ($n$ = 167) and 2 – 3 males ($n$ = 76) were fitted with radio-collars in each herd ($N$ = 15) and located every 10 – 21 days using a fixed-wing aircraft. We collected 3,191 male locations and 7,718 female locations and used appropriate GIS models (Rogers and Carr 1998) to identify home ranges (HR), core-use areas (i.e., lambing areas), and to obtain distributional information to facilitate population surveys. We used a Fixed Kernel (95% isopleth) with a least-squares cross-

validation bandwidth to determine the sizes of HRs for males and females in each herd ($N$ = 15). To control for the influence of nonpartuient females, we used a 75% probability of locations obtained during April – July (2001 – 2012) to indentify lambing HRs for each herd. The sensitivity of the precise locations of lambing areas precluded inclusion in this report; however, they are saved on the NDGF's GIS geo-database.

During 2000 – 2012, the mean HR for females ($N$ = 15 herds) was 18.7 $mi^2$ (SE = 3.5) and the mean HR for males ($N$ = 13 herds) was 56.8 $mi^2$ (SE = 11.6). The mean female HR in the northern metapopulation was 18.9 $mi^2$ (SE = 3.7), and 18.1 $mi^2$ (SE = 9.6) in the southern metapopulation. The mean HR for males in the northern metapopulation was 52.2 $mi^2$ (SE = 10.5), and 67.3 $mi^2$ (SE = 32.0) in the southern metapopulation. The mean size of lambing HRs ($N$ = 15 herds) was 6.7 $mi^2$ (SE = 1.8); 6.5 $mi^2$ (SE = 2.1) in the northern metapopulation and 7.3 $mi^2$ (SE = 3.7) in the southern metapopulation (Fig. 15 – 29; Tables 4 and 5).

Table 1. Population divisions of bighorn sheep based on a metapopulation structure (Demarchi et al. 2000).

| **Population Divisions** | **Definition** |
|---|---|
| Metapopulation | Two or more distinct subpopulations where barriers to connectivity do not exist |
| Subpopulation | Two or more distinct herds where connectivity exists via movements of males |
| Herd | A self-sustaining group of males or females that use a particular home range |
| Band | A group of males or females that are a temporary subgroup of a herd |

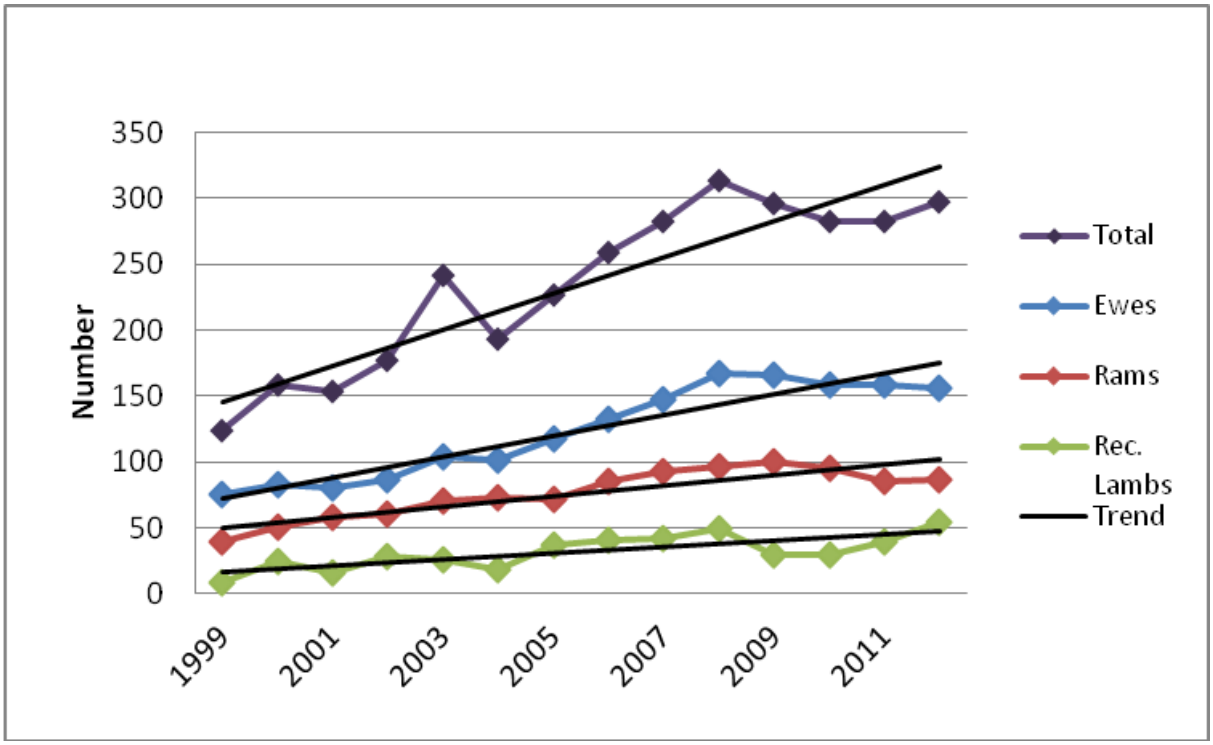


Figure 12. Population and demography of bighorn sheep (excluding TRNP), 1999 – 2012.

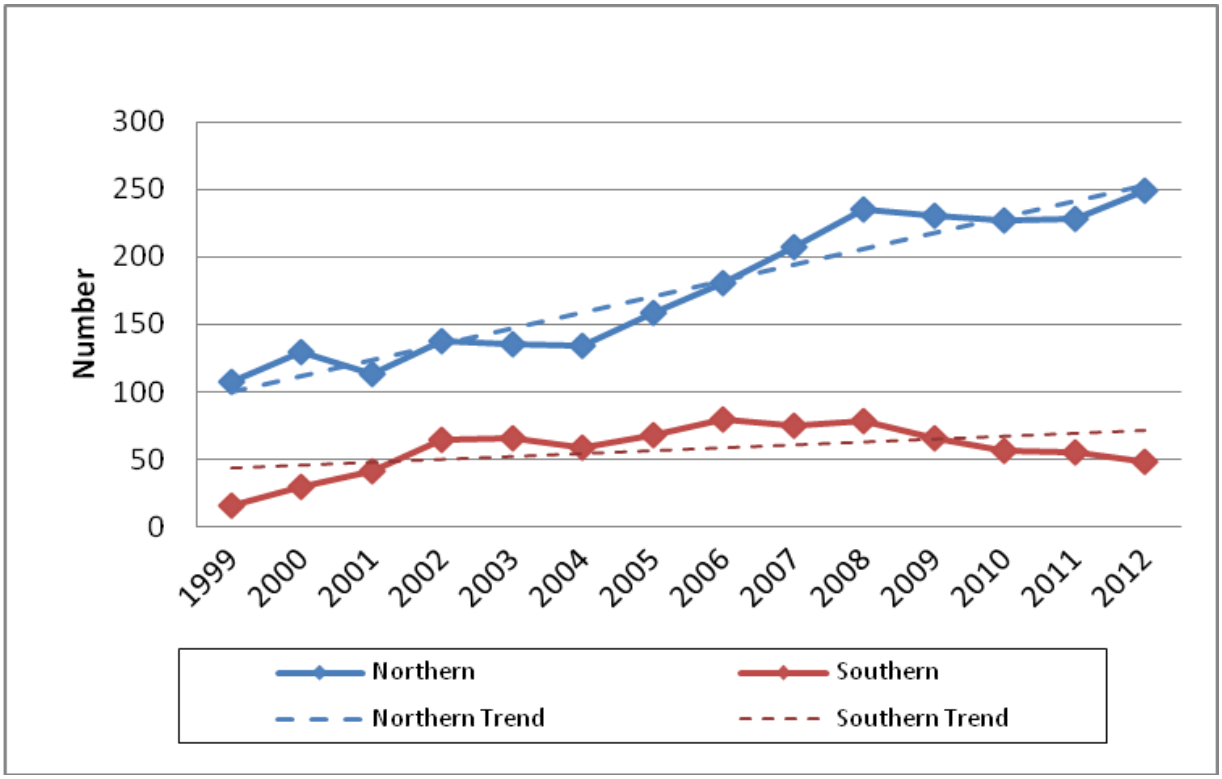


Figure 13. Minimum population of bighorn sheep in the northern and southern metapopulations (excluding TRNP), 1999 – 2012.

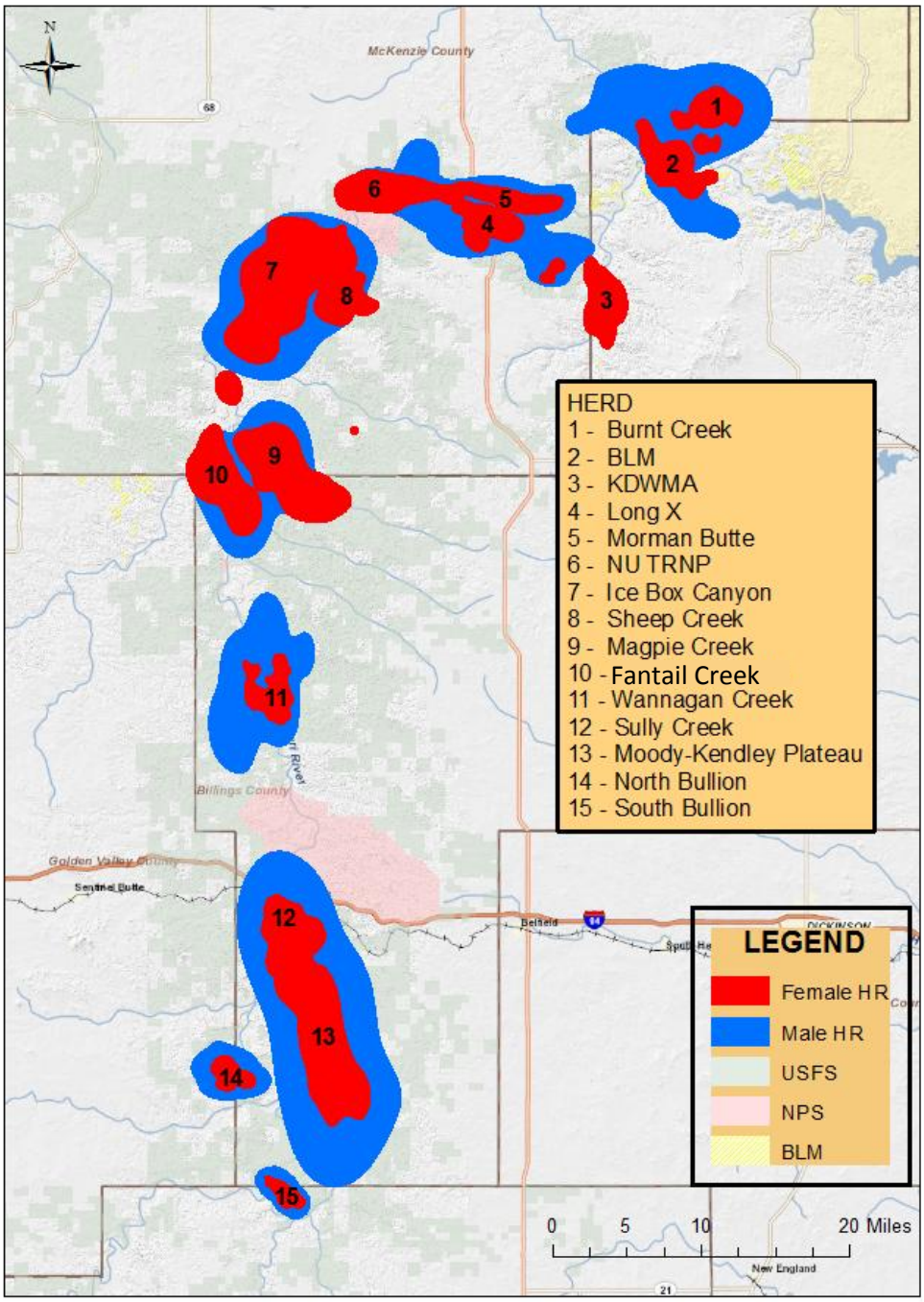


Figure 14. Herd distribution of bighorn sheep in North Dakota, 2012.

Table 2. Herd demography of bighorn sheep in the northern metapopulation (north of Interstate 94), 2012.

| Herd[1] | 2012 Males | 2012 Females | 2012 Lambs | 2012 Total | Status |
|---|---|---|---|---|---|
| Burnt Creek | 4 | 8 | 4 | 16 | Stable |
| BLM | 6 | 12 | 3 | 21 | Declining |
| Killdeer WMA[2] | 1 | 6 | 4 | 11 | Stable |
| NU TRNP | UN | UN | UN | ~30 | Stable |
| Morman Butte | 6 | 7 | 3 | 16 | Relocated |
| Long X[3] | 1 | 16 | 11 | 28 | Increasing |
| Sheep Creek[4] | 4 | 4 | 2 | 10 | Declining |
| Ice Box Canyon[5] | 21 | 42 | 10 | 73 | Increasing |
| Magpie Creek[6] | 20 | 19 | 7 | 46 | Increasing |
| Fantail Creek | 2 | 10 | 4 | 16 | Increasing |
| Wannagan Creek | 5 | 5 | 2 | 12 | Declining |
| **TOTAL** | **70** | **129** | **50** | **~279** | |

[1] Color denotes connectivity among herds via movements of males.
[2] Includes Killdeer WMA, Crosby Creek, and Dry Creek.
[3]Includes Long X and Summit Creek.
[4]Includes Bennett Creek, Cottonwood Creek (unoccupied), Corral Creek, and Sheep Creek.
[5]ncludes Bummer Creek, Ice Box Canyon, and Red Wing Creek.
[6] Includes Cedar Top Butte and Magpie Creek.

Table 3. Herd demography of bighorn sheep in the southern metapopulation (south of Interstate 94), 2012.

| Herd[1] | 2012 Males | 2012 Females | 2012 Lambs | 2012 Total | Status |
|---|---|---|---|---|---|
| Sully Creek[2] | 4 | 5 | 0 | 9 | Declining |
| Moody-Kendley[3] | 5 | 3 | 1 | 9 | Declining |
| North Bullion | 1 | 10 | 1 | 12 | Stable |
| South Bullion | 7 | 9 | 2 | 18 | Stable |
| **TOTAL** | **17** | **27** | **4** | **48** | |

[1] Color denotes connectivity among herds via movements of males.
[2] Includes Merrifield Creek, Kendley Plateau, and Moody Plateau.
[3] Includes Cliffs Plateau and Kendley Plateau.

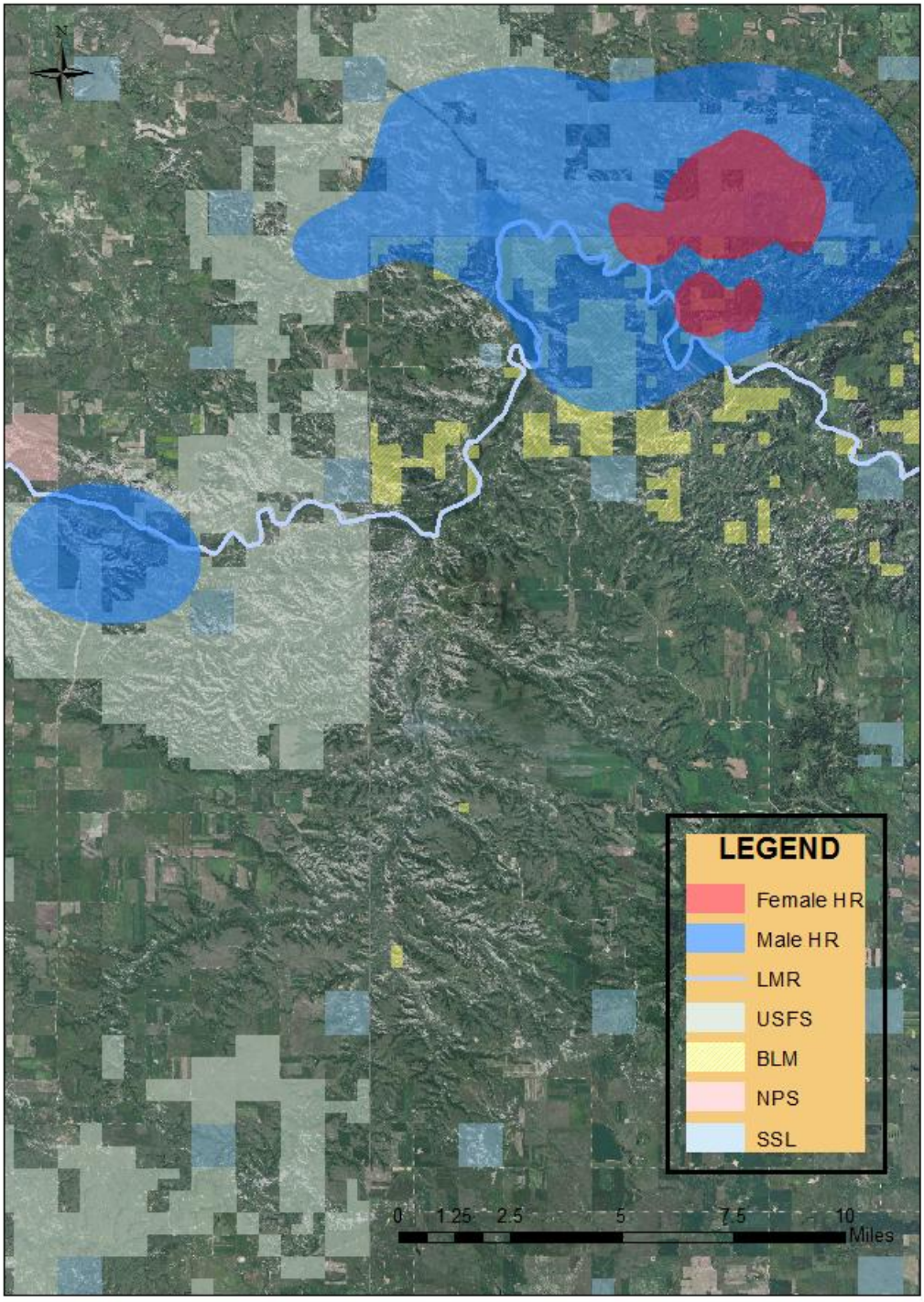


Figure 15. Burnt Creek herd: Established in 1995.

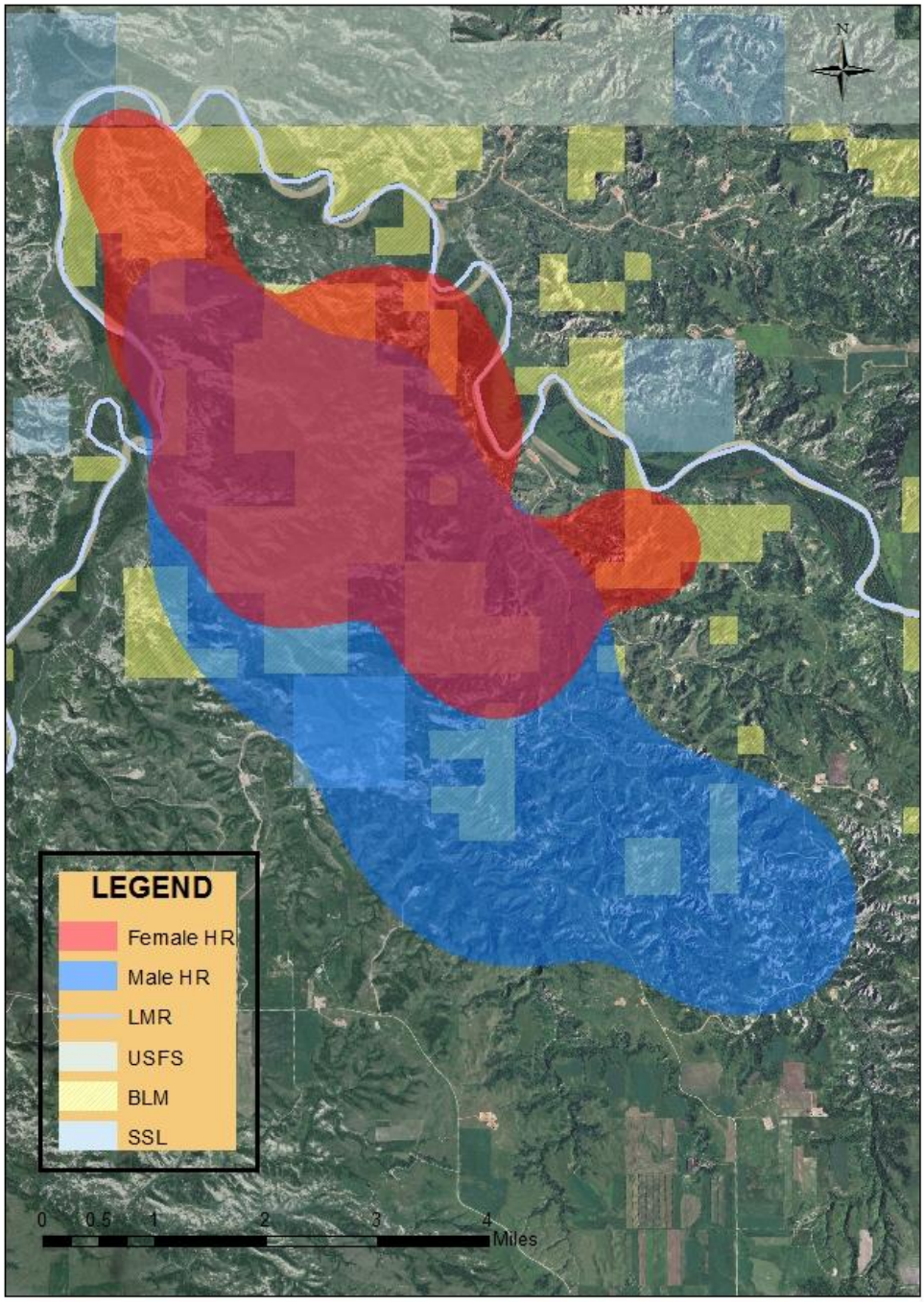


Figure 16. BLM herd: Established in 1991.

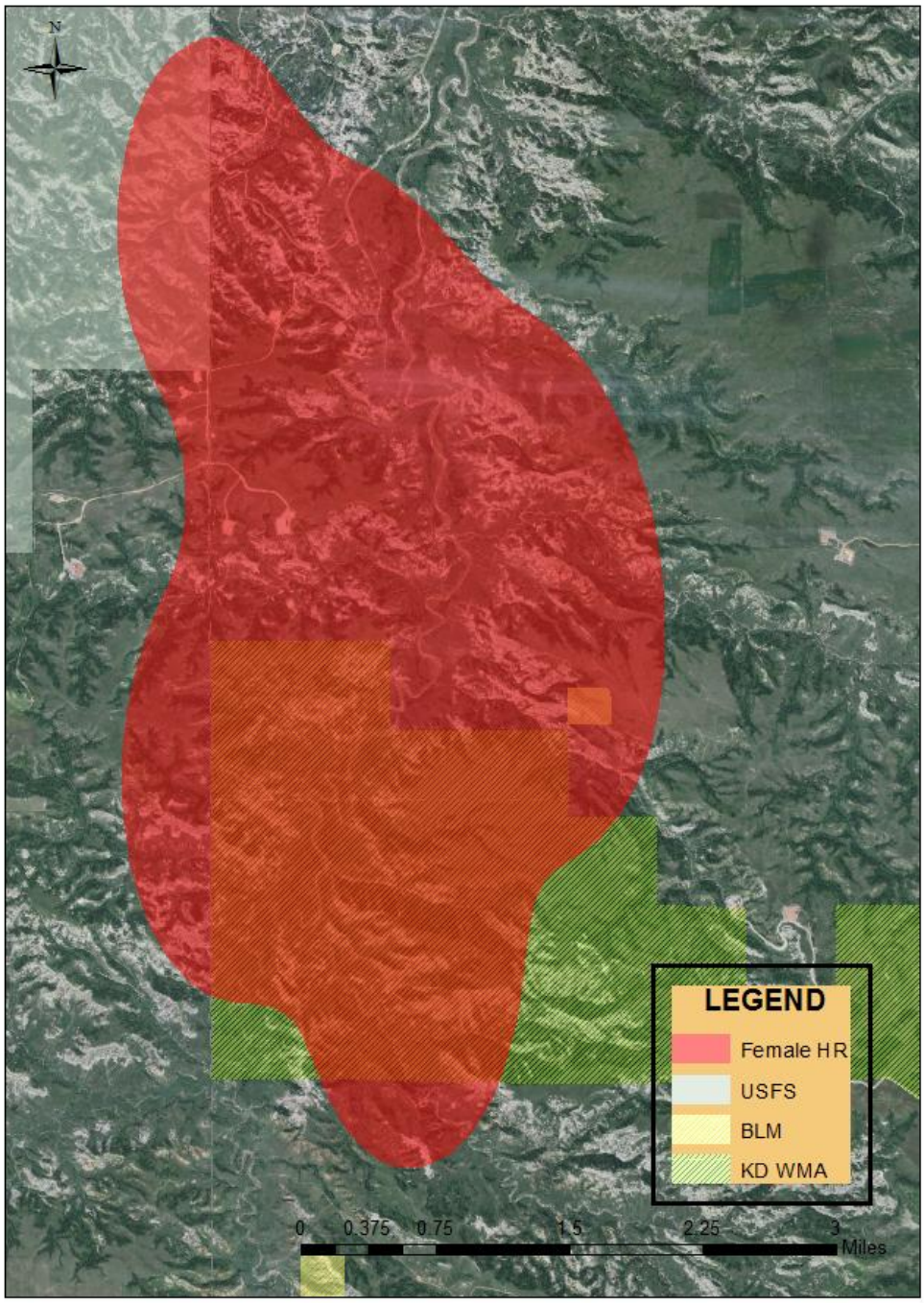


Figure 17. Killdeer WMA herd: Established circa 1983.

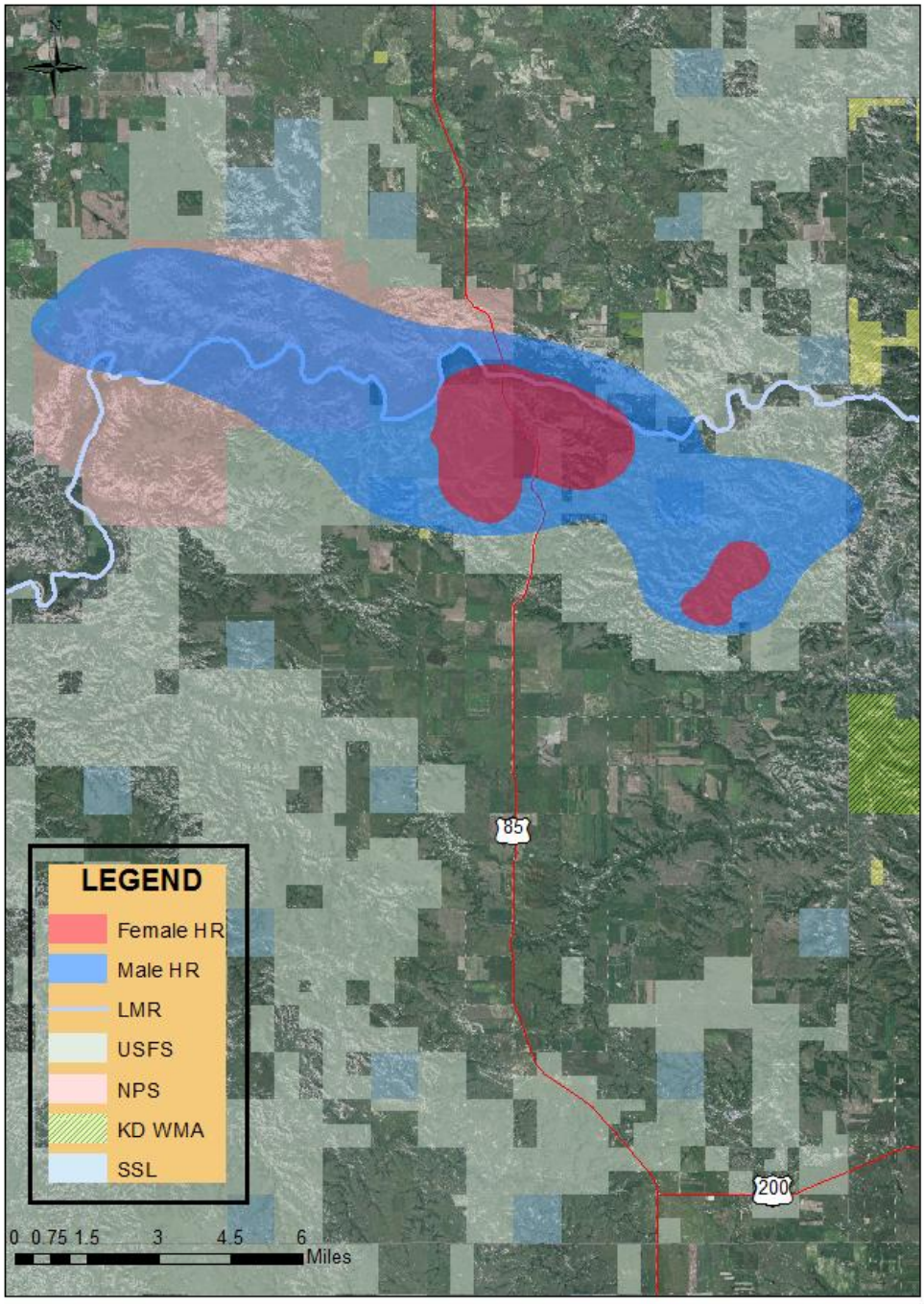


Figure 18. Long X herd: Established in 1990.

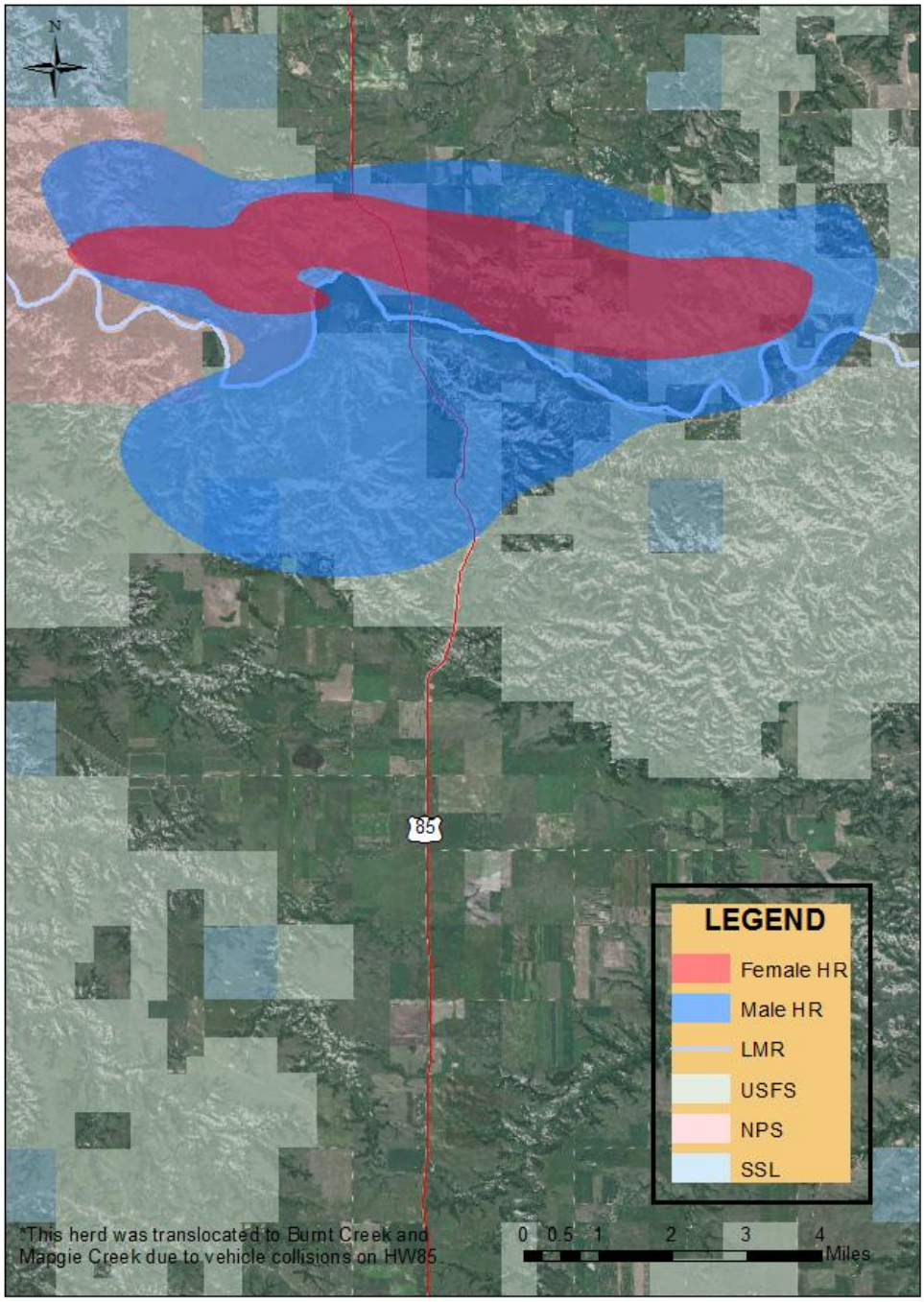


Figure 19. Morman Butte herd*: Established in 2006.

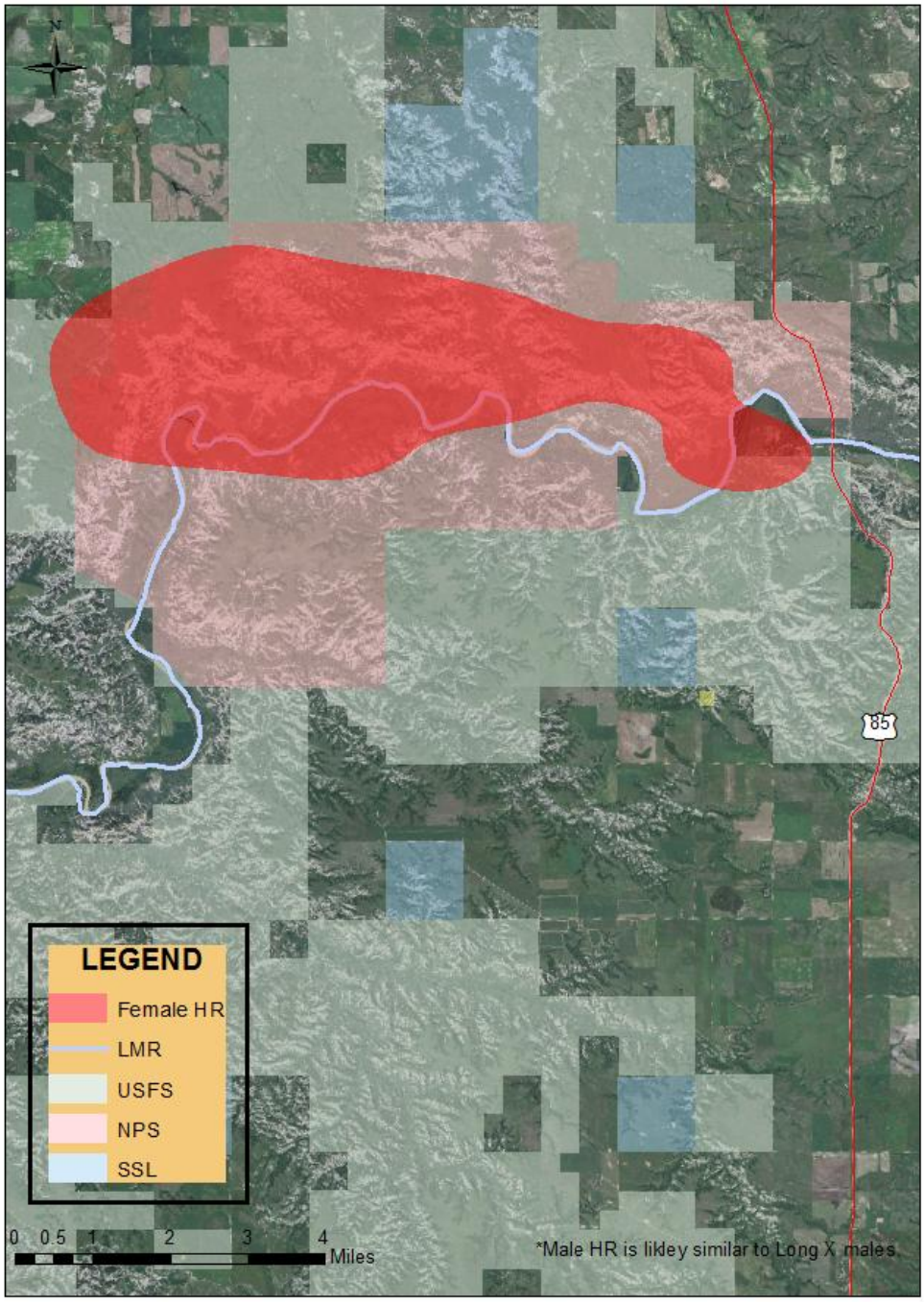


Figure 20. NU TRNP herd*: Established in 1996.

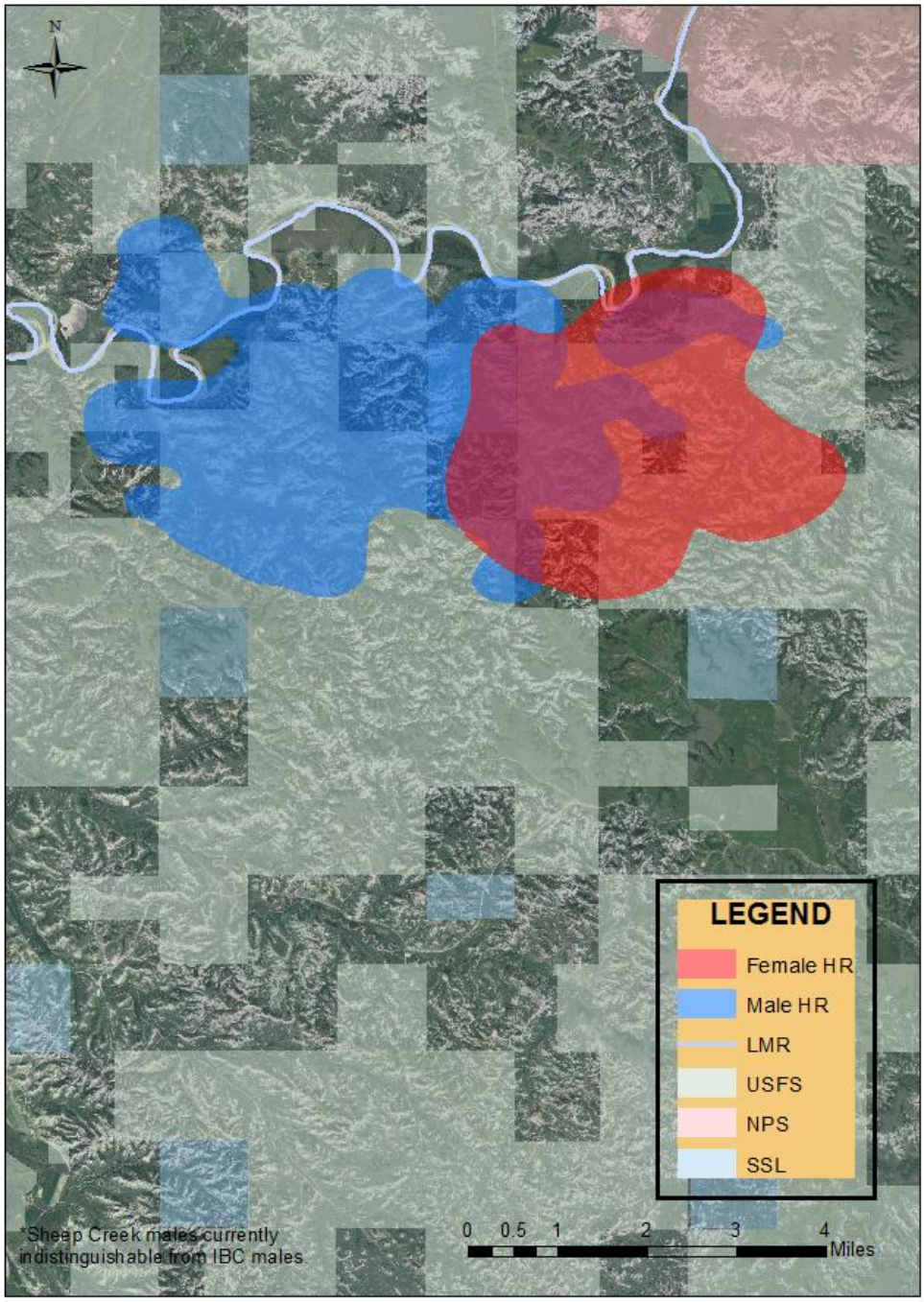


Figure 21. Sheep Creek herd*: Established in 1987.

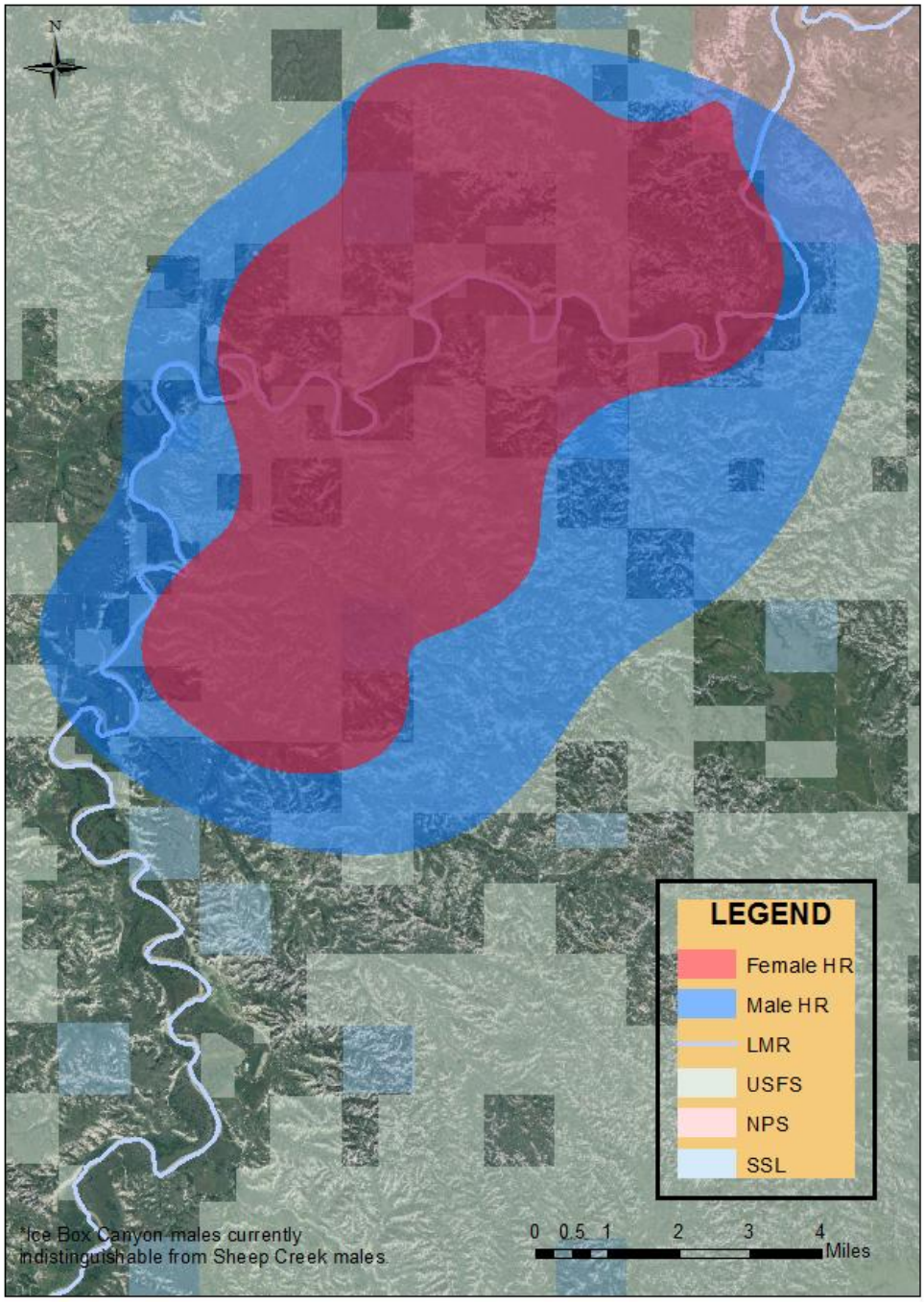


Figure 22. Ice Box Canyon herd*: Established circa 1996.

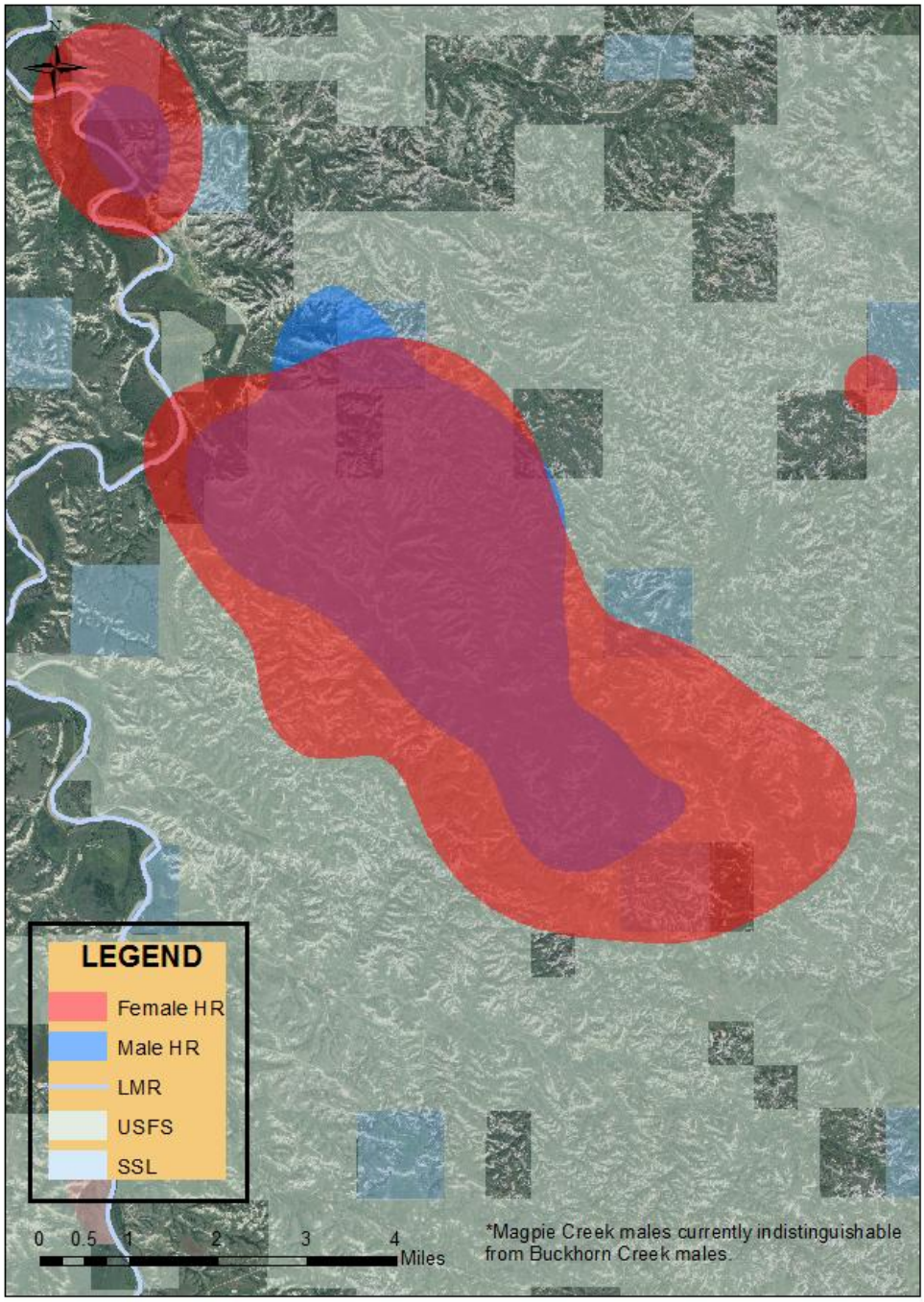


Figure 23. Magpie Creek herd*: Established in 1956.

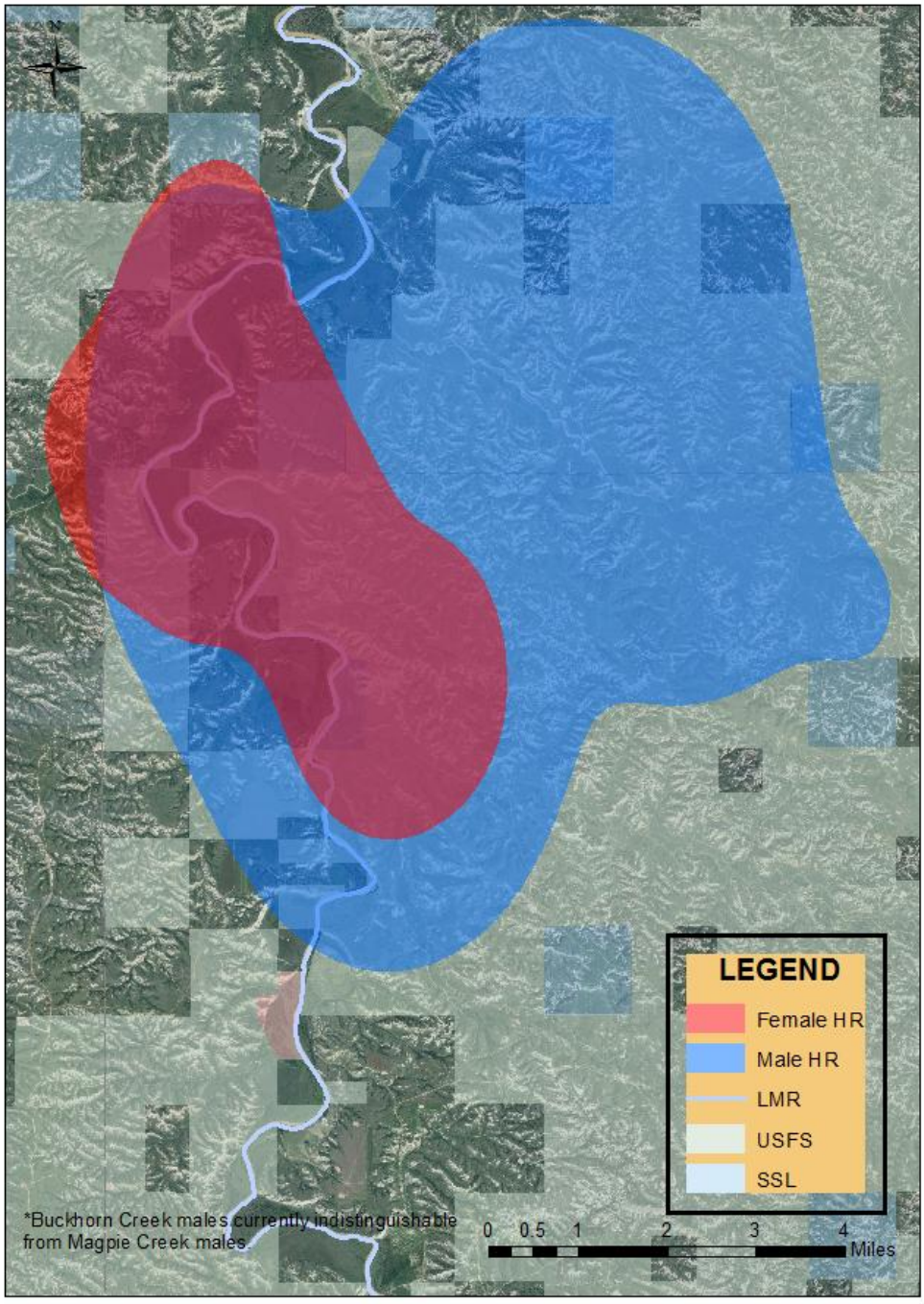


Figure 24. Fantail Creek herd*: Established in 2003.

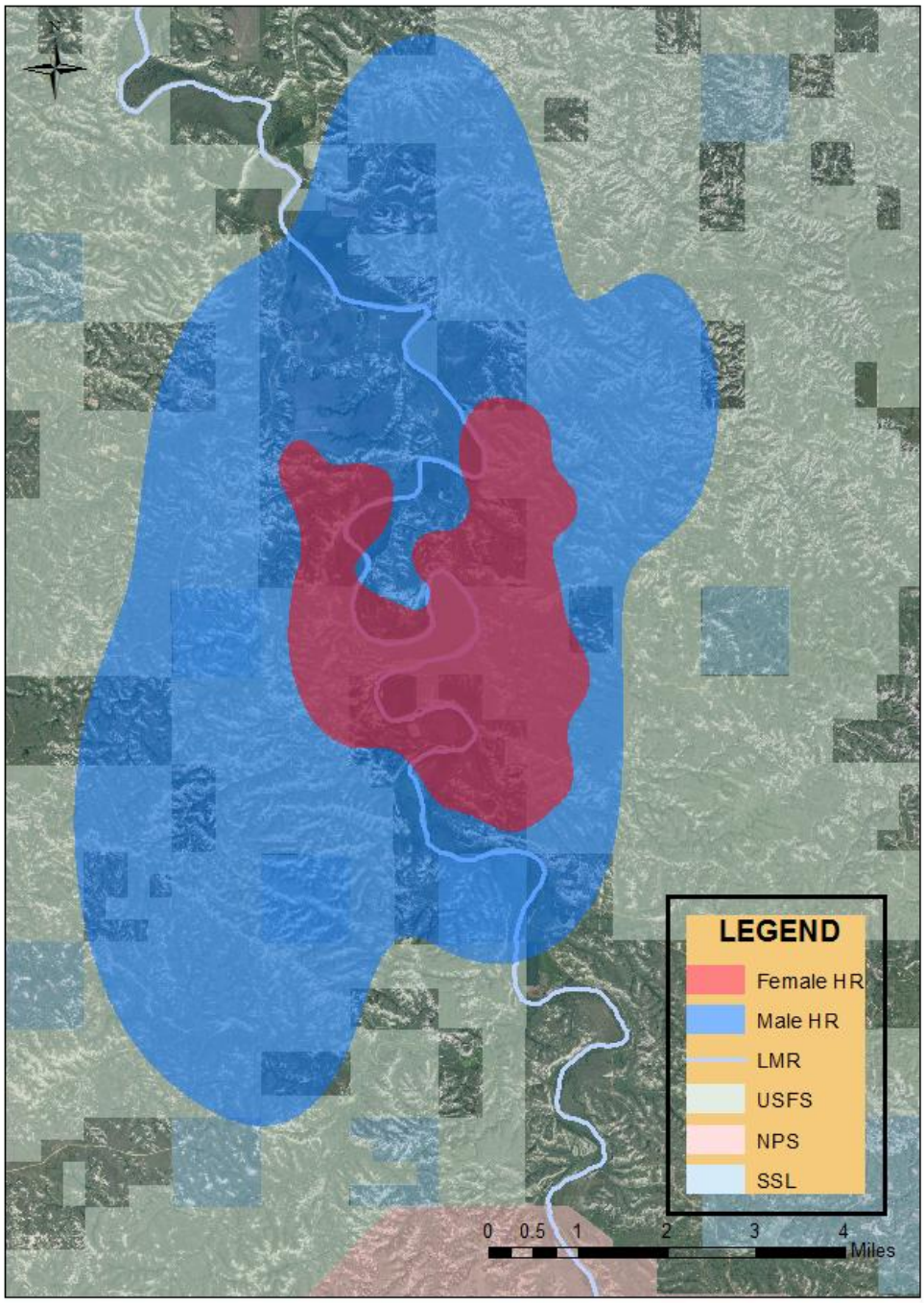


Figure 25. Wannagan Creek herd: Established in 1991.

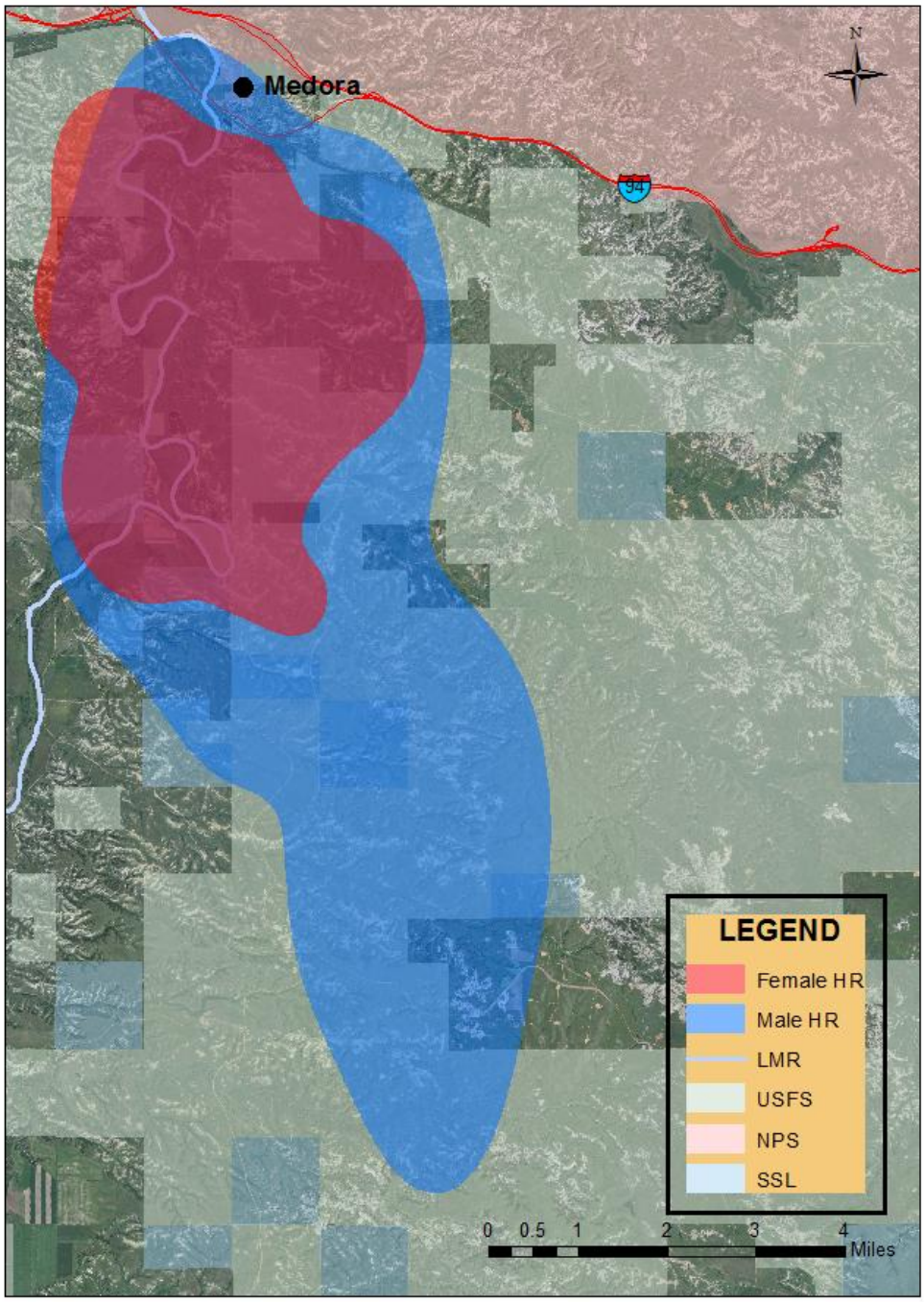


Figure 26. Sully Creek herd: Established circa 1962.

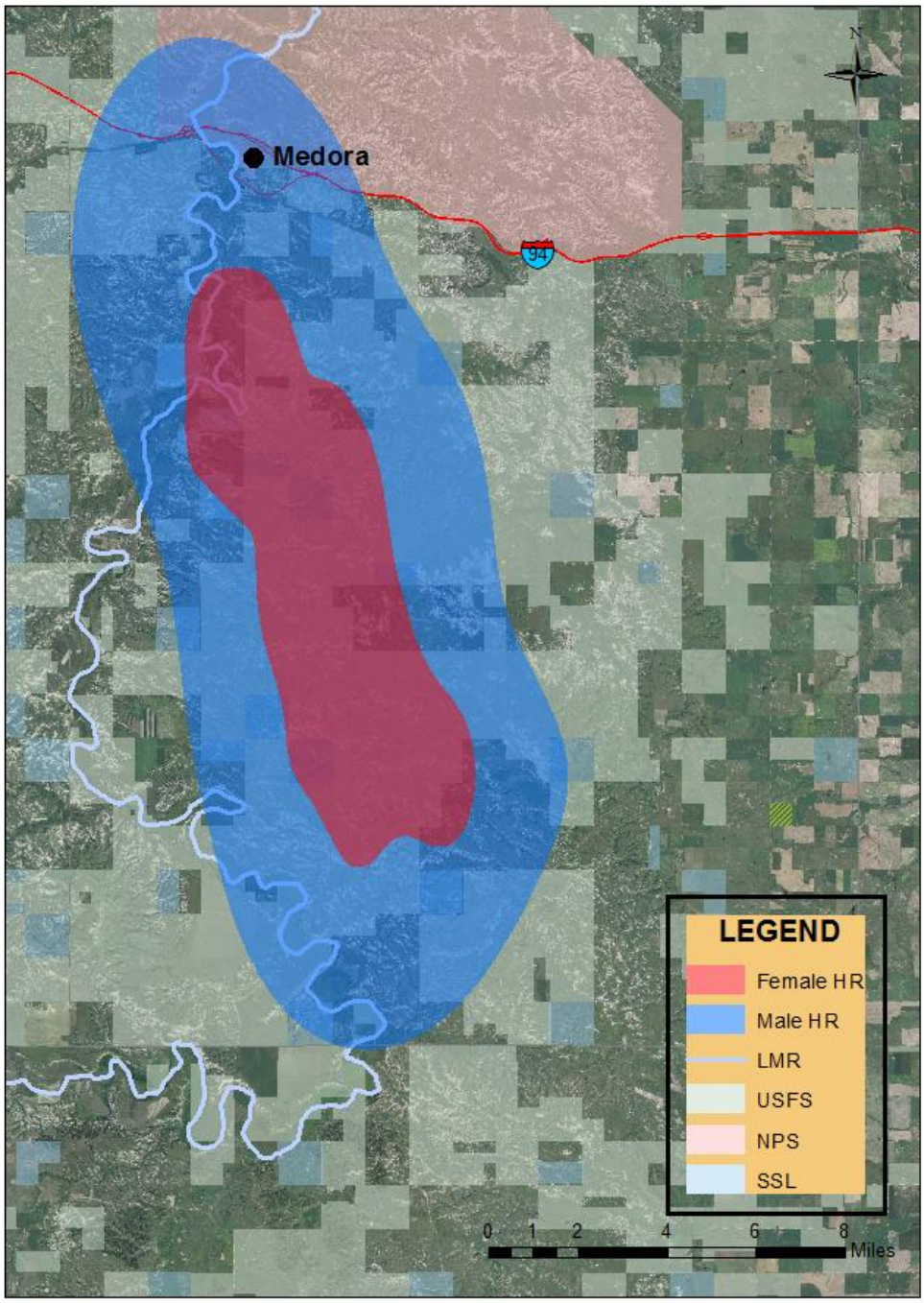


Figure 27. Moody-Kendley Plateau herd: Established in 1962.

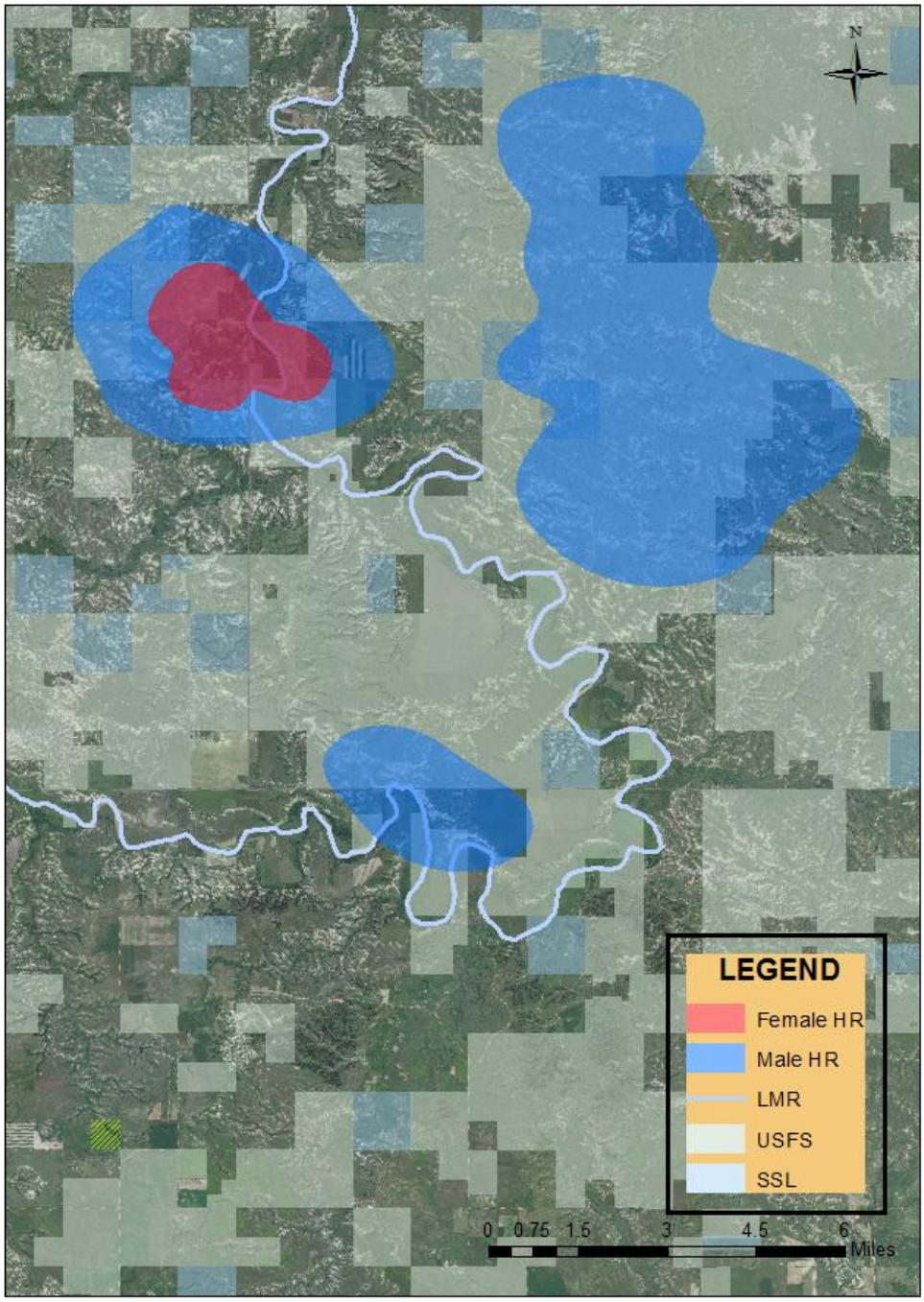


Figure 28. North Bullion herd: Established in 1989.

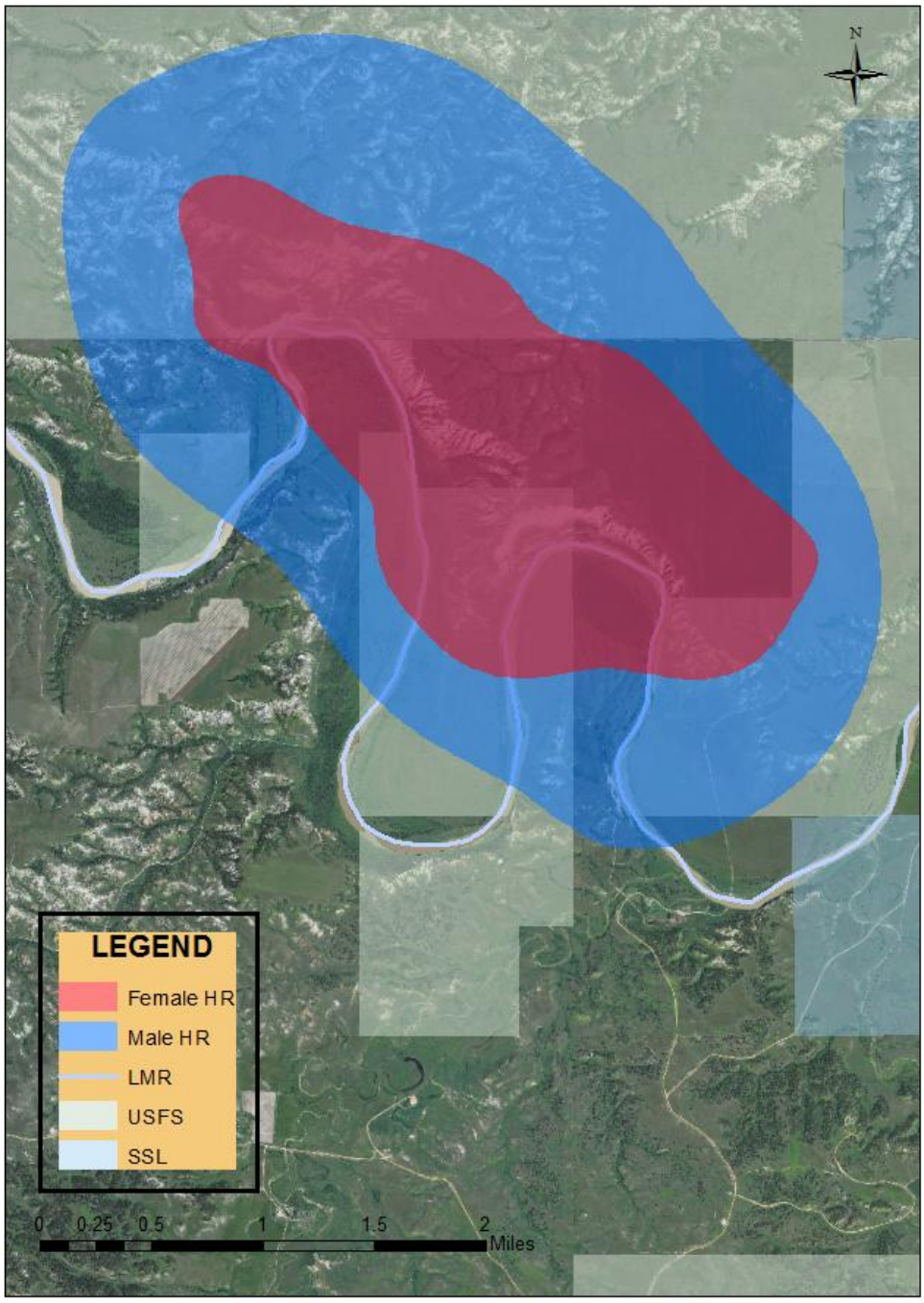


Figure 29. South Bullion herd: Established in 1990.

Table 4. Home ranges of bighorn sheep in the northern metapopulation (north of Interstate 94).

| **Herd**[1] | **Females (mi$^2$)** | **Lambing (mi$^2$)** | **Males (mi$^2$)** |
|---|---|---|---|
| Burnt Creek | 11.6 | 2.5 | 82.5 |
| BLM | 14.3 | 2.7 | 21.9 |
| Killdeer WMA[3] | 13.0 | 3.3 | NA |
| NU TRNP | 19.1 | 2.3 | NA |
| Morman Butte | 11.8 | 3.5 | 41.5 |
| Long X[4] | 11.6 | 3.2 | 58.0 |
| Sheep Creek[5] | 11.1 | 3.9 | 17.8 |
| Ice Box Canyon[6] | 49.8 | 24.8 | 110.6 |
| Magpie Creek[7] | 33.5 | 9.4 | 17.2 |
| Fantail Creek | 21.0 | 12.9 | 63.5 |
| Wannagan Creek | 10.9 | 2.5 | 56.4 |
| **Mean** | 18.9 | 6.5 | 52.2 |

[1] Color denotes connectivity among herds via movements of males.

Table 5. Home ranges of bighorn sheep in the southern metapopulation (south of Interstate 94).

| **Herd**[1] | **Females (mi$^2$)** | **Lambing (mi$^2$)** | **Males (mi$^2$)** |
|---|---|---|---|
| Sully Creek | 18.7 | 9.1 | 44.5 |
| Moody-Kendley | 44.9 | 17.1 | 158.1 |
| North Bullion | 5.2 | 1.9 | 57.9 |
| South Bullion | 3.6 | 1.0 | 8.8 |
| **Mean** | 18.1 | 7.3 | 67.3 |

[1] Color denotes connectivity among herds via movements of males.

## Population Goals

A commonly recognized goal for a minimum viable population (MVP) of bighorn sheep, where connectivity exists among fragmented subpopulations of females via movements of males, is 125 individuals (Geist 1975, Berger 1990). However, this number should be regarded as a *minimum* population objective, as most jurisdictions attempt to manage metapopulations at >125 individuals.

Smith et al. (1991) estimated that bighorn sheep in Utah realized densities of 19.9 individuals/mi$^2$ throughout their entire potential range, and Zeigenfuss et al. (2000) estimated that suitable prairie-badlands habitat, similar to that found in North Dakota, could support a density of 10.0 individuals/mi$^2$, or 12.5 mi$^2$ of total potential habitat to support a MVP of 125 bighorn sheep. Holl (1982) and McKinney et al. (2003) reported that the quantity of escape terrain (i.e., lambing habitat) is a more significant determinant of carry capacity than forage. Therefore, because the quantity of lambing habitat (Fig. 30) is the primary limiting factor in North Dakota, we used lambing HRs of females from extant herds (75% isopleth, April – July) to determine population goals for those herds according to Zeigenfuss et al. (2000), and also estimated goals for areas that are currently unoccupied but where future introductions are planned (Fig. 31 – 34).

We calculated 10 females/mi$^2$ for lambing HRs to estimate carrying capacity for females in each herd, and then applied a correction factor of 0.5 (i.e., half of carrying capacity) to determine goals for females in each herd. We modified the correction factor for some herds because HR values likely over- or underestimated the quantity of lambing habitat, or because range expansions are planned in those areas. We then applied a ratio of 50 males per 100 females to determine goals for males. Based on these criteria, the goal for the state's population is 765 individuals (260 males and 505 females; Tables 6 and 7).

Figure 30. The quantity of lambing habitat is the primary limiting factor for abundance of bighorn sheep in North Dakota.

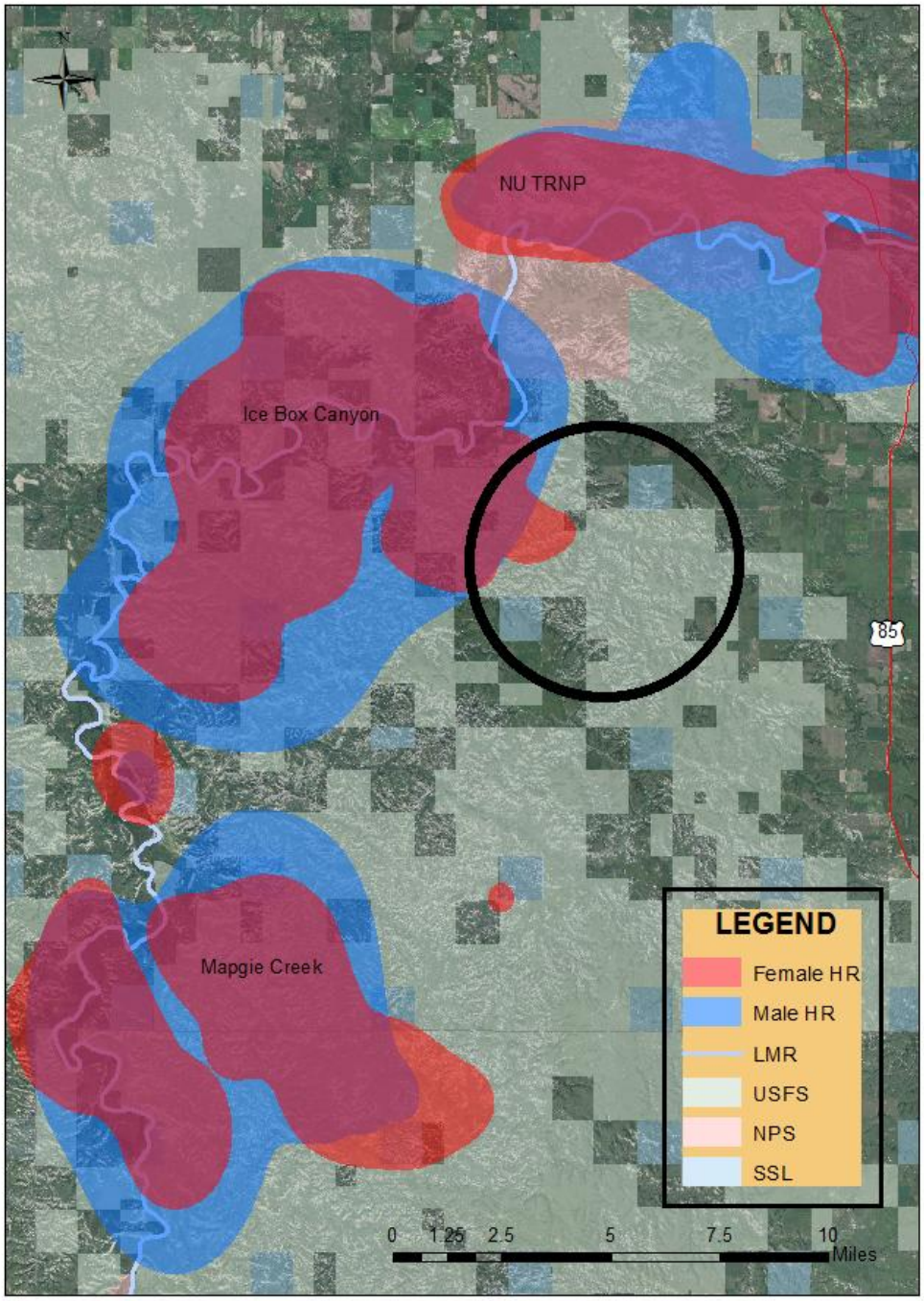


Figure 31. Potential introduction area at Cottonwood Creek.

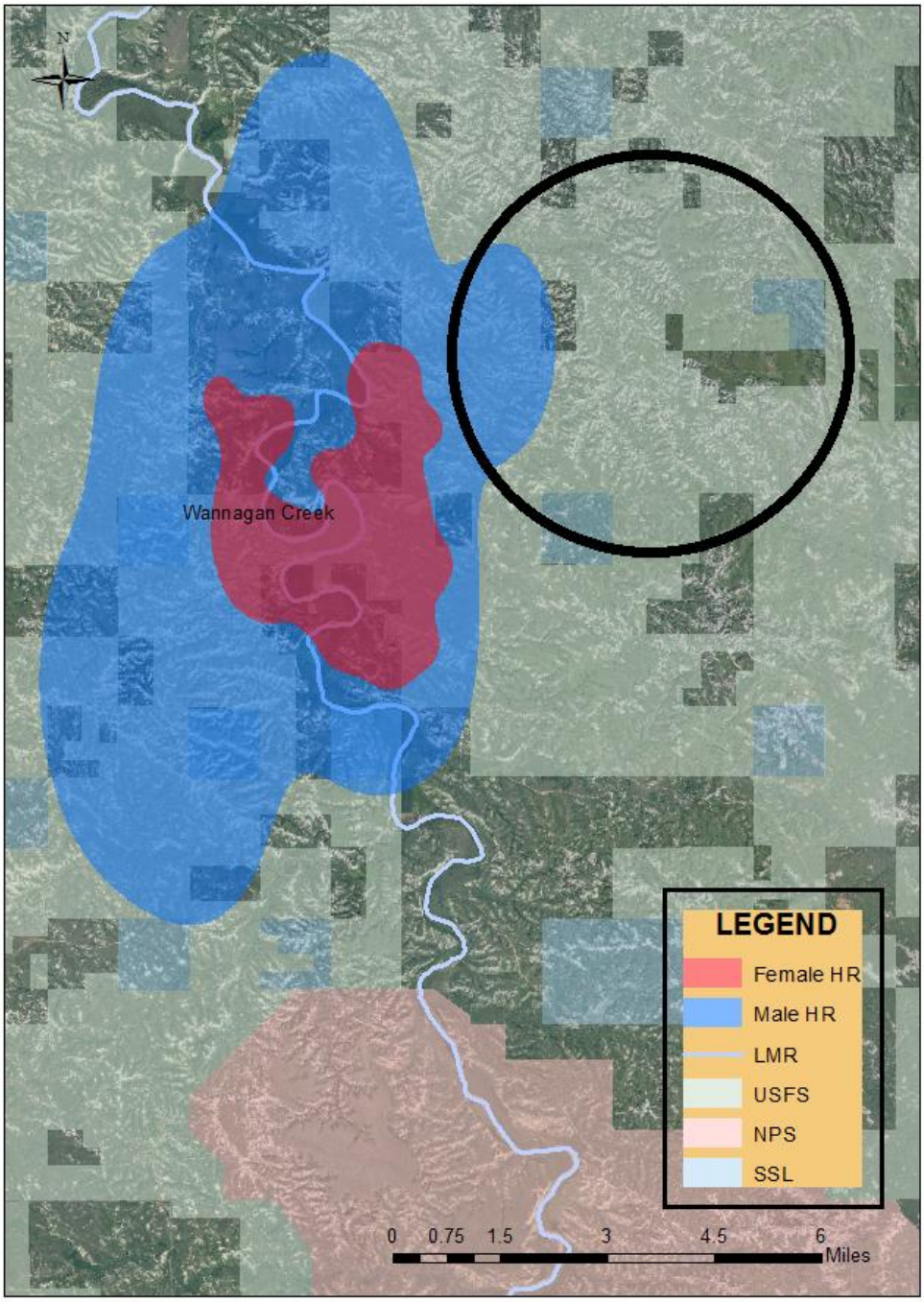


Figure 32. Potential introduction area at Mikes Creek.

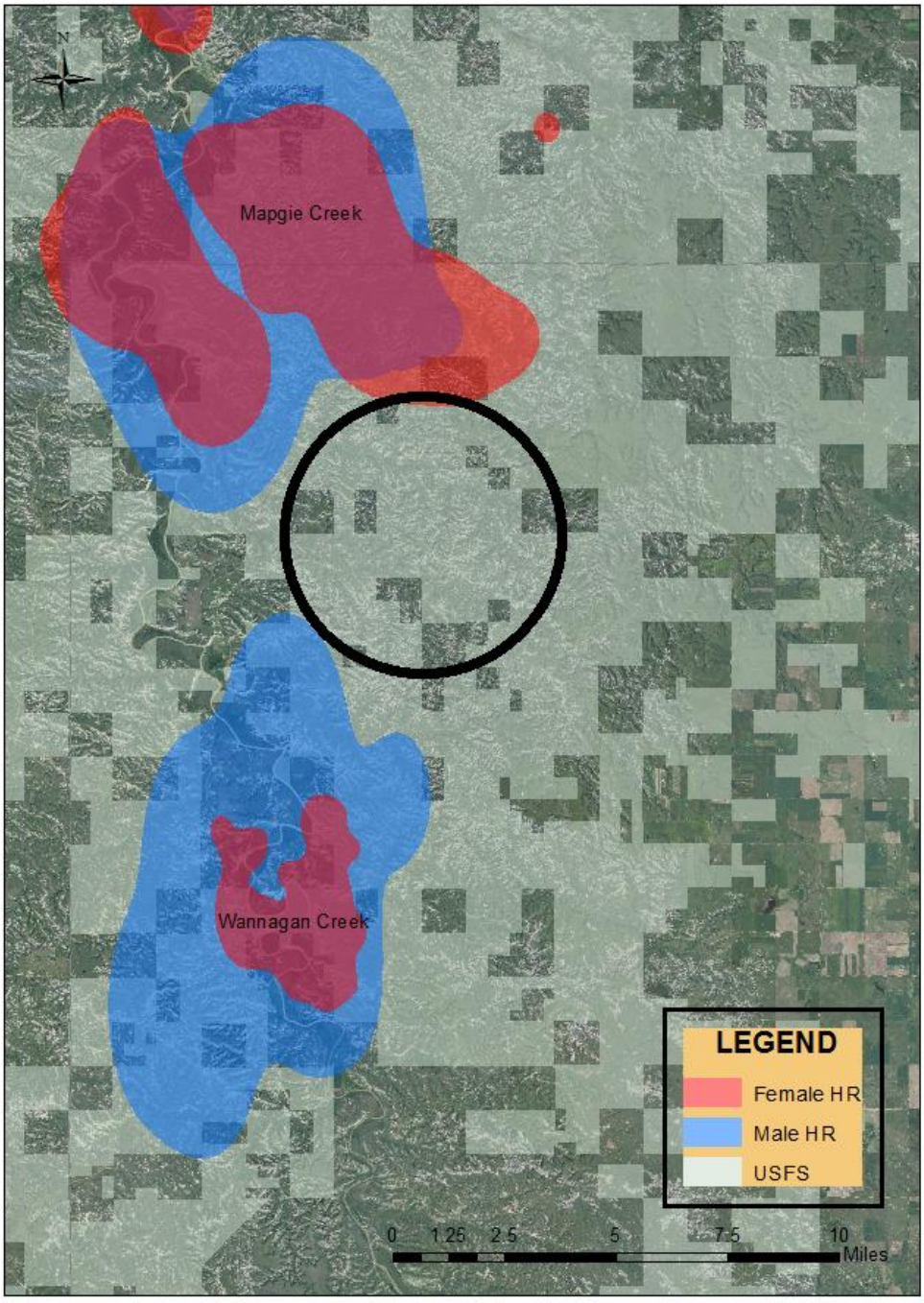


Figure 33. Potential introduction area at Whitetail Creek.

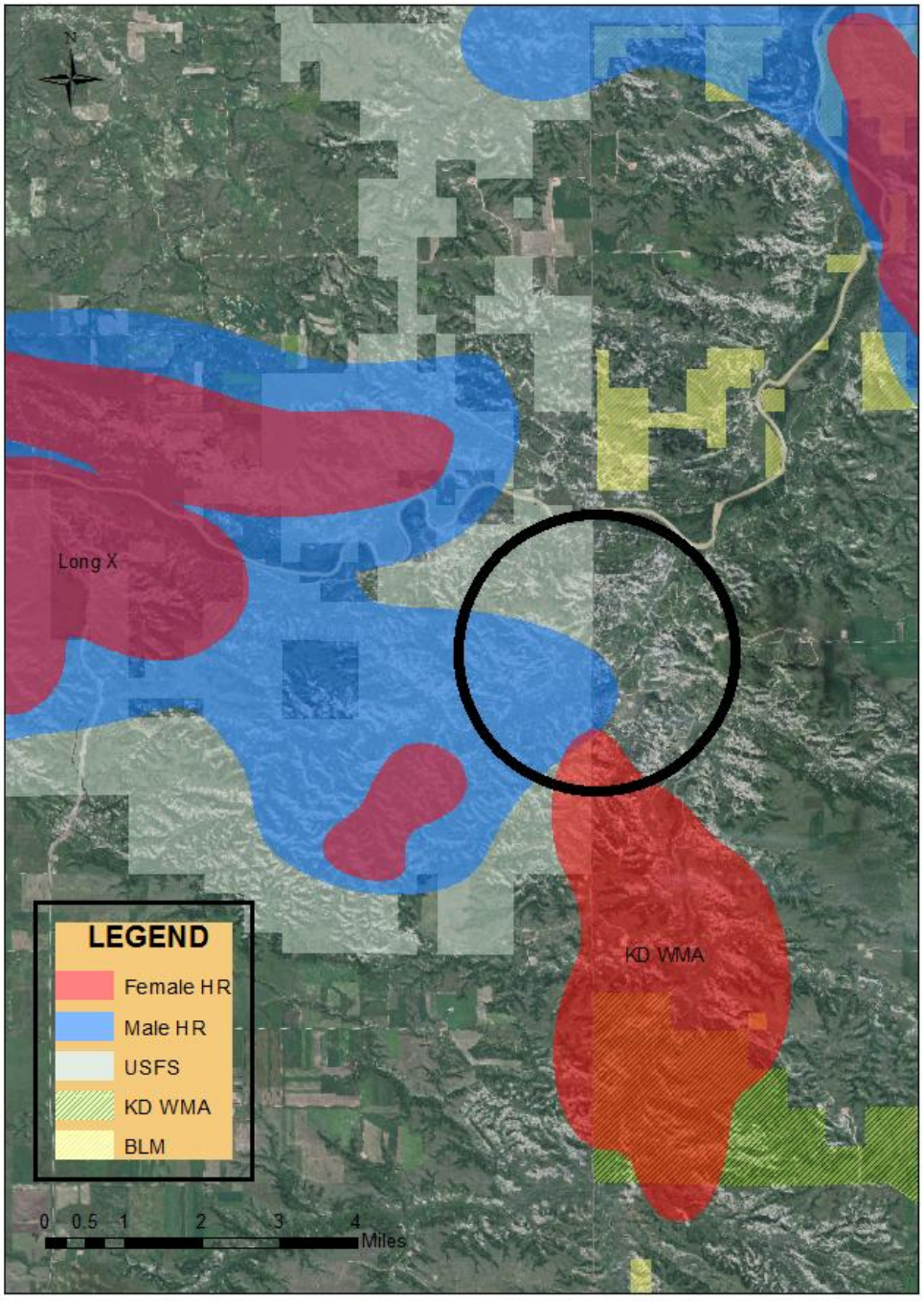


Figure 34. Potential introduction area at Dry Creek.

Table 6. Population goals for bighorn sheep in the northern metapopulation (north of Interstate 94).

| Herd[1] | 2012 Males | 2012 Females | 2012 Lambs | 2012 Total | Goal: Males | Goal: Females | Goal: Total |
|---|---|---|---|---|---|---|---|
| Burnt Creek | 4 | 8 | 4 | 16 | 10 | 20 | 30 |
| BLM | 6 | 12 | 3 | 21 | 10 | 20 | 30 |
| Killdeer WMA[2] | 1 | 6 | 4 | 11 | 10 | 20 | 30 |
| NU TRNP | UN | UN | UN | ~30 | 10 | 20 | 30 |
| Morman Butte[3] | 6 | 7 | 3 | 16 | 10 | 20 | 30 |
| Long X[4] | 1 | 16 | 11 | 28 | 10 | 20 | 30 |
| Sheep Creek[5] | 4 | 4 | 2 | 10 | 10 | 20 | 30 |
| Ice Box Canyon[6] | 21 | 42 | 10 | 73 | 60 | 120 | 180 |
| Magpie Creek[7] | 20 | 19 | 7 | 46 | 24 | 46 | 70 |
| Fantail Creek[8] | 2 | 10 | 4 | 16 | 25 | 50 | 75 |
| Wannagan Creek | 5 | 5 | 2 | 12 | 7 | 13 | 20 |
| Cottonwood Creek[9] | 0 | 0 | 0 | 0 | 10 | 20 | 30 |
| Mikes Creek[9] | 0 | 0 | 0 | 0 | 10 | 20 | 30 |
| **TOTAL** | **70** | **129** | **50** | **279** | **206** | **409** | **615** |

[1] Color denotes connectivity among herds via movements of males.
[2] Includes Killdeer WMA, Crosby Creek, and Dry Creek (unoccupied).
[3] One male, seven females, and three lambs were translocated from this herd in February 2013 due to vehicles collisions on HW85. Morman Butte is currently unoccupied.
[4] Includes Long X and Summit Creek.
[5] Includes Bennett Creek, Cottonwood Creek (unoccupied), Corral Creek (unoccupied), and Sheep Creek.
[6] Includes Bowline Creek, Bummer Creek, Ice Box Canyon, and Red Wing Creek.
[7] Includes Cedar Top Butte and Magpie Creek.
[8] Includes Blacktail Creek, Fantail Creek, and Whitetail Creek (unoccupied).
[9] Proposed area for introduction via translocation.

Table 7. Population goals for bighorn sheep in the southern metapopulation (south of Interstate 94).

| Herd[1] | 2012 Males | 2012 Females | 2012 Lambs | 2012 Total | Goal: Males | Goal: Females | Goal: Total |
|---|---|---|---|---|---|---|---|
| Sully Creek[2] | 4 | 5 | 0 | 9 | 12 | 23 | 35 |
| Moody-Kendley[3] | 5 | 3 | 1 | 9 | 22 | 43 | 65 |
| North Bullion | 1 | 10 | 1 | 12 | 10 | 15 | 25 |
| South Bullion | 7 | 9 | 2 | 18 | 10 | 15 | 25 |
| **TOTAL** | **17** | **27** | **4** | **48** | **54** | **96** | **150** |

[1] Color denotes connectivity among herds via movements of males.
[2] Due to significant human development, this goal is likely unachievable.
[3] Includes Cliffs Plateau, Kendley Plateau, Merrifield Creek, and Moody Plateau.

## Translocation Strategy

Translocations of wildlife are the purposeful movements of individuals from one part of their range to another to reestablish or augment populations. Translocations have been instrumental in the U.S. to restore populations of bighorn sheep that were extirpated during the early twentieth century. However, translocations are expensive – costing ~$1,100 per animal – and have often failed or not met objectives (Fig. 35). Therefore, a translocation program that is not defined by clear objectives that meet specific criteria is likely to be ineffective, a poor use of funding, and may stress source populations unnecessarily.

The NDGF translocated 18 bighorn sheep (9 males, 9 females) from the Williams Lake region of British Columbia to an enclosure located at Magpie Creek, North Dakota in 1956. Since that time, management of bighorn sheep in North Dakota has emphasized a trap and transplant program to establish or augment subpopulations throughout the western region of the state (Appendix A). Funding from the sale of the state's bighorn sheep auction license, donations from the Wild Sheep Foundation – Midwest Chapter, and funds from Pittman-Robertson have been instrumental in accomplishing most translocation projects that have occurred in North Dakota.

Since 1956 the NDGF has conducted nine additional inter-state translocations totaling 169 individuals (43 males, 126 females) from sources in British Columbia, Idaho, Montana, and Oregon (Fig. 36). The National Park Service also translocated 20 bighorn sheep (5 males, 15 females) from British Colombia to the North Unit of Theodore Roosevelt National Park in 1996. Eight of 10 inter-state translocations (36 males, 125 females) were hard-released, and two (12 males, 16 females) were released into enclosures.

The NDGF has conducted a total of 47 intra-state translocations from 1959 to 2013 (Fig. 37) totaling 260 individuals (89 males, 171 females). Twenty-two of those translocations (30 males, 59 females) included moving animals among four captive sources; 12 included hard-releases (34 males, 30 females) from captive sources, and 13 included capturing free-range stock (25 males, 82 females) from intra-state sources and hard-releasing them elsewhere in the state. Using stock from captive sources was abandoned in 1992 in favor of free-range stock from inter- and intra-state sources.

Much of the state's bighorn range is currently occupied; however, most herds are below population objectives. Further, introductions to unoccupied habitats at Cottonwood Creek (Fig. 31), Mikes Creek (Fig. 32), Whitetail Creek (Fig. 33), Dry Creek (Fig. 34), and Morman Butte (Fig. 19) are planned. Therefore, similar to most wildlife agencies, translocations will remain a fundamental part of the NDGF's management strategy for bighorn sheep.

Figure 35. Capturing bighorn sheep using net-guns fired from helicopters is expensive, but it is usually the most effective technique.

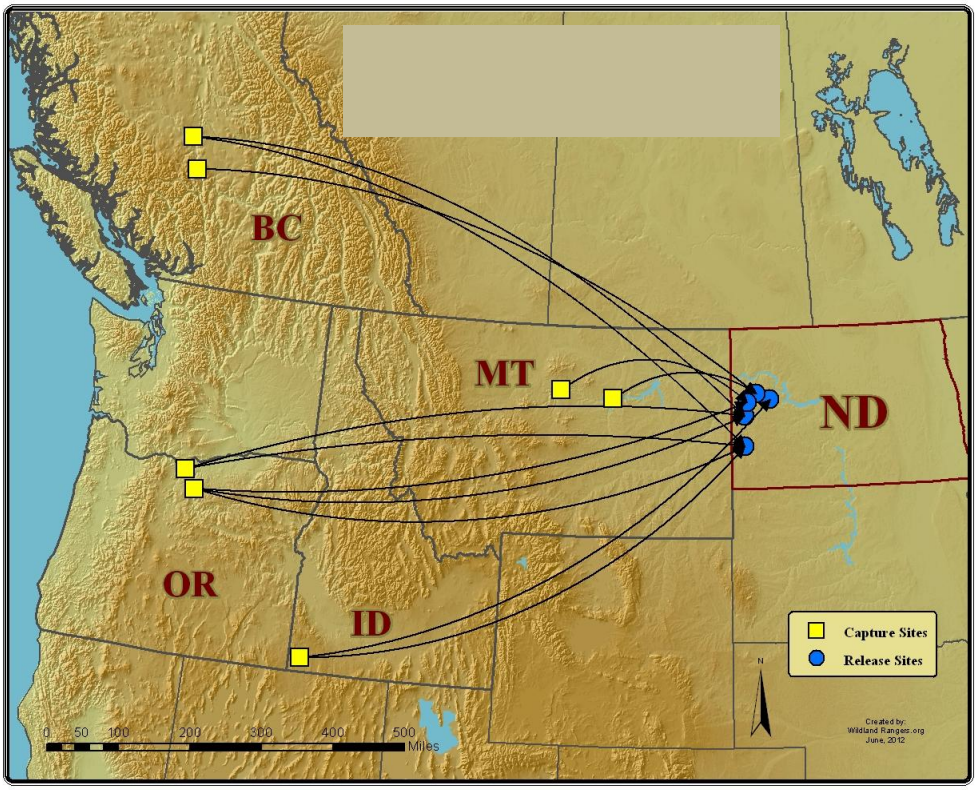


Figure 36. Inter-state translocations of bighorn sheep to North Dakota, 1956 – 2007 (courtesy WAFWA Wild Sheep Working Group).

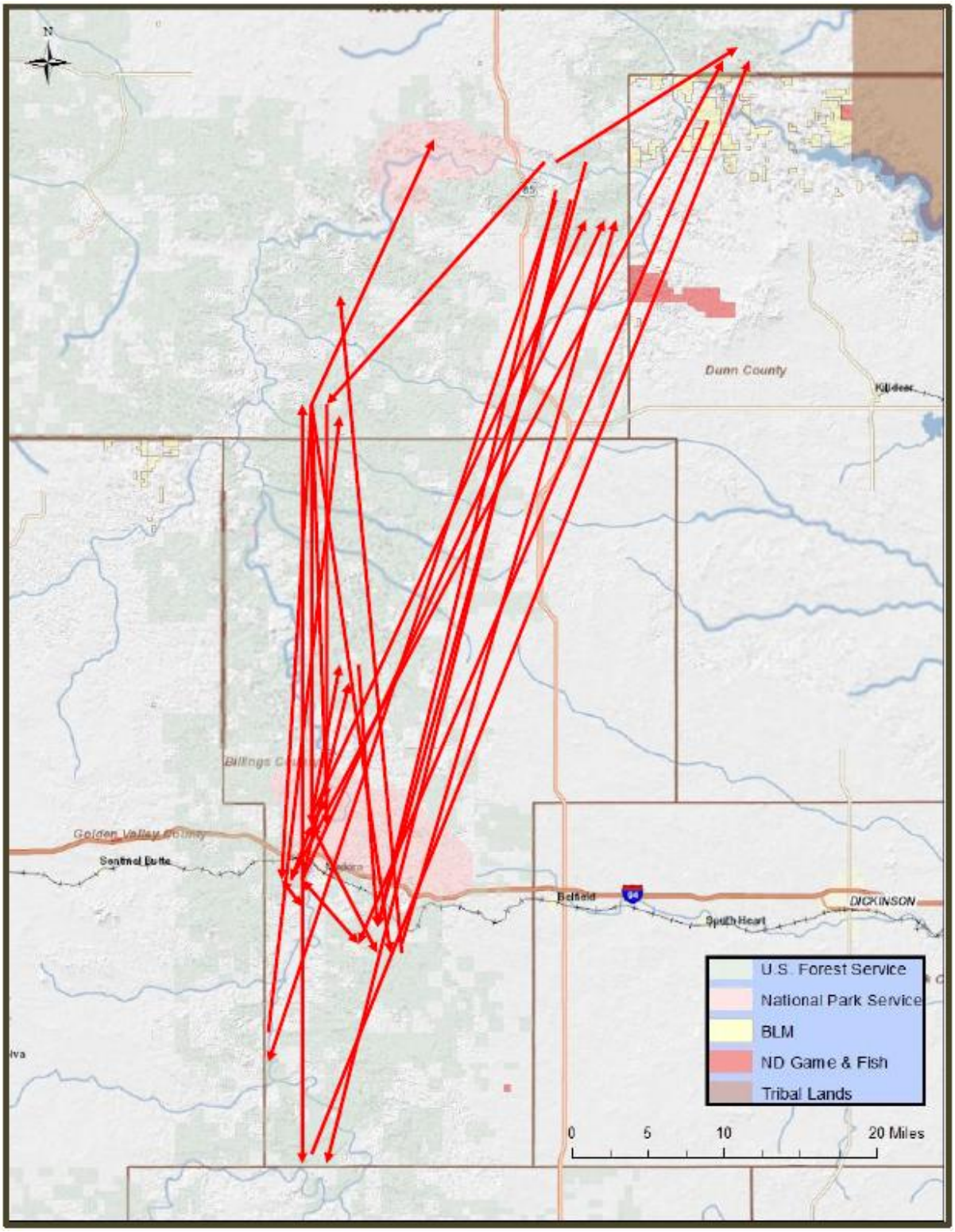


Figure 37. Intra-state translocations of bighorn sheep in North Dakota, 1959 – 2012.

## Translocation Guidelines

General guidelines for translocations of wild sheep were established at the 2nd North American Wild Sheep Conference in 1999 and describe further by Foster (2005):

1. Wild sheep should be re-established throughout historic ranges that provide suitable habitat;
2. Translocations should be accomplished within a metapopulation structure that can support >100 individuals;
3. Release sites should be evaluated, including quality and quantity of habitat, predator abundance, and competition and disease transmission with other wildlife and domestic livestock;
4. Source-stock should be similar to native populations and have forage and habitat-use patterns compatible with release locations;
5. Initial introductions should include ≥30 individuals; however, smaller groups may be used for augmentations. Multiple release locations may be used;
6. Caution should be taken to prevent translocating too many individuals from particular source populations.
7. Source populations should have an acceptable health history and stock from populations with recent episodes of disease should not be used as translocation stock;
8. Translocated stock should be closely monitored for at least one year by deploying radio-collars to provide location and mortality data;
9. A translocation database should be maintained, including histories of disease.

## Source Populations

1. Sources of funding should be secured prior to initiating a translocation project and at least three months should be committed to pre-capture planning;
2. Source stock that is well-adapted to North Dakota's severe winters should be used. For example, larger-bodied stock from the Missouri River Breaks of Montana have fared much better in North Dakota's continental climate than smaller-bodied stock indigenous to a milder region near Williams Lake, British Columbia;
3. To lessen the effects of genetic drift, stock should be acquired from native populations, which typically have greater heterozygosity, rather than previously reintroduced populations. However, using stock more compatible to North Dakota's climate and habitat should take precedence over stock from native sources;
4. High-quality populations (i.e., robust and highly productive) that do not have a recent history of disease should be preferred as source-stock because they are often more resilient to post-release losses and are less likely to transfer pathogens to extant populations;
5. Intra-state sources should not be used unless losses do not jeopardize long-term viability of those populations. Few populations in North Dakota are large enough to exploit for translocation stock; therefore, using intra-state sources should be done cautiously.

## Establishing New Populations

1. The persistence and health of extant populations should take precedence over establishing new populations;
2. Preference should be given to those areas that provide the highest quality habitat, where bighorn sheep are most likely to thrive, rather than arbitrary "management areas" (e.g., USFS MA 3.51s);
3. A minimum of 20 individuals (5 males, 15 females) should be introduced when establishing a new population adjacent to extant populations; 30 - 40 individuals should be used if new populations are liley to be isolated from other populations;
4. Younger animals should be translocated, preferably ≤5 years old for females and ≤2 years old for males. This minimizes losses of older animals that have a greater penchant for dispersing from release sites, and allows for greater fecundity of translocated stock. Males that are ≥3 years old should be separated from females while in-transit;
5. Translocating lambs should be avoided. Assessments of translocations in North Dakota have revealed higher mortality rates of translocated lambs compared to adults. Further, female/lamb pair-bonds are broken much earlier than other ungulates. Therefore, a lamb is more likely to survive if it remains with its source population rather than being translocated to a new environment with its dam;
6. Translocated stock should be released ≤330 yards from escape terrain and should preferably travel uphill;
7. Animals should be allowed to leave trailers unharrassed, but measures should be taken that encourage animals to leave the trailer in a single group. For example, once animals begin exiting the trailer, personnel should enter the front of the trailer to ensure that all animals stay with the group. This may lessen the likelihood of lone animals dispersing from release sites;
8. Translocated stock that disperse from release sites and have not associated with domestic sheep should be re-captured and returned to the original release site. All such actions in North Dakota have resulted in animals remaining at the original release site after being re-captured;
9. Regardless of habitat quality, females should not be introduced to summer ranges of extant males. Males are naturally segregated from females during most of the year, so the integrity of summer ranges of males should be maintained to reduce competition for forage with introduced females;
10. All translocated stock from inter-state sources should be fitted with radio-collars and monitored closely post-release;
11. At least half of translocated stock from intra-state sources should be fitted with radio-collars and monitored closely post-release;
12. Domestic sheep should be ≥12 miles from release sites where barriers to

separation are not present (Singer et al. 2000);

13. Stock should not be introduced ≤12 miles from extant populations of bighorn sheep that:
    - Have experienced a recent disease episode;
    - Have experienced recent dramatic declines in abundance for which the causes are unknown;
    - Have experienced chronically low lamb recruitment;

14. Because bighorn males travel significant distances between subpopulations of females within a metapopulation distribution, stock should not be introduced to those areas where domestic sheep occur between release sites and extant herds of bighorn sheep. Translocated males could subsequently act as disease vectors to healthy populations of bighorn sheep. Bighorn males should be able to travel among subpopulations of bighorn females without encountering domestic sheep;
15. Precedence should be given to those areas where most bighorn sheep habitat occurs on public land (e.g., USFS Non-Motorized Areas; Fig. 10). However, because all extant populations in North Dakota currently occupy intermingled private lands to some degree, NDGF personnel should meet with surrounding landowners prior to translocations to:
    - Explain why the translocation is occurring and the rationale for releasing the stock at that particular site;
    - Ensure that domestic sheep are not grazed on nearby private lands and that nearby landowners do not have intentions of acquiring domestic sheep in the future;
    - Ensure that nearby landowners will not be opposed to introduced bighorn sheep on their property;
    - Ensure that nearby landowners will allow hunting of bighorn sheep when the NDGF determines that introduced populations can be hunted;
    - Ensure that NDGF personnel can access private property during annual surveys and to investigate mortalities;

16. The NDGF should assume all risks with the failure of translocations. If translocated bighorn sheep interact with nearby flocks of domestic sheep on private property, those landowners should not be held responsible. If translocated bighorn sheep interact with domestic sheep, NDGF personnel will dispatch those bighorn sheep (Appendix B; Fig. 38);
17. Introduced populations should not be hunted for a minimum of five years to allow introduced stock adequate time to establish seasonal ranges without harassment, to increase abundance and age structure of males, and to allow translocated males several years to tend females.

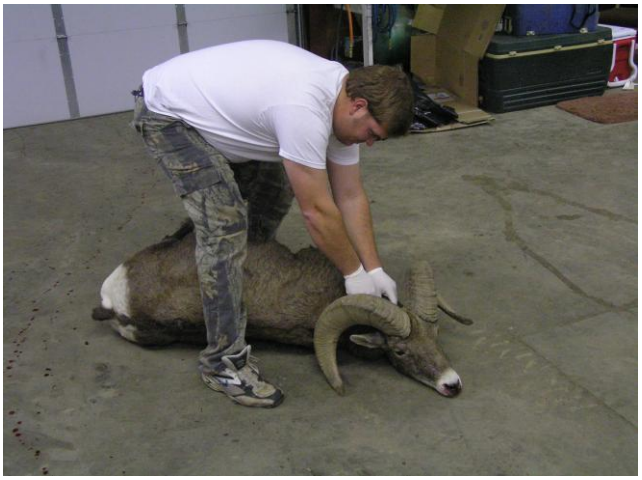

Figure 38. Biological samples were collected from this ram that was euthanized after it associated with domestic sheep during the rut. Euthanizing such rams is necessary to ensure the health of nearby bighorn herds.

## Augmenting Populations

1. Adhere to criterion for establishing new populations;
2. Determine why there is a need to augment a particular population:
    a. Disease – do not augment populations that have experienced a disease event as the extant population will likely transfer pathogens to the introduced stock. Populations that have experienced a disease event should not be augmented until adult survival is ≥85% for three consecutive years, recruitment rates are ≥25% for three consecutive years, pathogens have not been detected during routine sampling for three consecutive years, and there are no clinical signs of disease;
    b. Predators – reduce predators (e.g., cougars) from areas where there are significant losses of bighorn sheep via predation (Fig. 39). Cougars can be effectively targeted by directing licensed hunters to those areas. However, where cougar predation threatens the viability of a subpopulation of bighorn sheep, NDGF personnel or APSIS Wildlife Services may be used to remove cougar(s) from those areas;
    c. Vehicle mortality – Do not augment populations that have experienced significant losses to vehicle collisions until structures are in place that reduce the likelihood that introduced stock will wander onto roads;
    d. Habitat – Do not augment populations where juniper encroachment has eliminated high-visibility areas and access to quality forage cannot support higher numbers of bighorn sheep.

Figure 39. Bighorn sheep are vulnerable to cougar predation, especially small, fragmented populations like those found in North Dakota.

## Federal Agencies

1. U.S. Forest Service (USFS)
    a. According to the Organic Administration Act, Multiple Use-Sustained Yield Act, Federal Land Policy Act, Sikes Act, Wilderness Act, and U.S. Department of Agriculture – USFS policies, the USFS shares in responsibility with state wildlife agencies for managing wildlife species occupying USFS lands. However, state wildlife agencies have jurisdictional authority over managing wildlife populations on those lands, while the USFS has jurisdictional authority over managing habitats on those lands.
    b. Bighorn sheep occupying the Little Missouri National Grassland (Grassland) are managed in accordance with the USFS's Land and Resource Management Plan (Plan). The Plan assigns special Management Areas (3.51, 3.51A, 3.51B) specifically for bighorn sheep. However, management directives and stipulations within most MA 3.51s are limited; for example, MA 3.51Bs are managed for greater levels of oil and gas leasing within bighorn range. Moreover, many bighorn sheep within the Grassland occupy habitats outside MA 3.51s, thereby falling under a variety of the Plan's management directives.
    c. The USFS has determined that bighorn sheep do not exact a significant impact on habitat throughout the Grassland and that translocations within the Grassland are necessary for the viability of the species in the state (Blunt 1983). Moreover, because translocations are a state action, the USFS has concluded the following regarding the National Environmental Policy Act (NEPA) (File Code 1950/2640 1996):
        i. *Application of NEPA: The NEPA process is triggered by Federal actions…. In general, wildlife transplants…by a State agency do not require FS approval of decisions, are not Federal actions, and thus are not subject to NEPA…. Thus, State transplants…on NFS lands do not require NEPA unless there is a connected Federal Action – a) FS approval is required to carry out the project; or b) the implementation of the project is substantially dependent upon FS funds, personnel, or equipment for which the FS has control.*

d. Although NEPA is not required for translocations of bighorn sheep within the Grassland, the NDGF should inform USFS personnel of such actions, collaborate on such projects, and adhere to current management directives set forth by the Plan, especially regarding release sites outside MA 3.51s.

2. Bureau of Land Management (BLM):
    a. Management of bighorn sheep on BLM lands is similar to that of the USFS: NEPA is not required to translocate established species. All BLM lands in North Dakota that contain suitable habitat are currently occupied by bighorn sheep.
3. National Park Service (NPS):
    a. Approximately 30 bighorn sheep occupy the North Unit of Theodore Roosevelt National Park (TRNP).
    b. The NPS has jurisdiction over the management of bighorn sheep within TRNP; however, the NDGF routinely collaborates with the NPS in management efforts in and around TRNP as bighorn sheep frequently travel between both jurisdictions (Fig. 40).
4. U.S. Fish and Wildlife Service (FWS):
    a. There are currently no bighorn sheep occupying lands managed by the FWS; however, the FWS routinely comments on NEPA solicitations that may affect bighorn sheep on federal lands.

Figure 40. Bighorn sheep in the North Unit of Theodore Roosevelt National Park. The NDGF and NPS have collaborated on management projects since the 1960s.

# HARVEST STRATEGY

## History

The first recreational hunting season for bighorn sheep in North Dakota was proclaimed in 1975 and, except for four years (1980-1983), seasons have been held annually since. Hunting licenses are once-in-a-lifetime and issued via a lottery. The NDGF began offering one license to be auctioned to the highest bidder through the Wild Sheep Foundation in 1986 to generate more funding for bighorn sheep management in the state (Fig. 41). The NDGF subsequently signed a management partnership with the Wild Sheep Foundation – Midwest Chapter in 1999, and that group has auctioned North Dakota's license annually since. From 1986 to 2013, the auction license has raised $1,008,500 (17,000 – 75,000) for management projects in the state (Fig. 42). One hundred percent of the purchase price of the auction license is remunerated to the NDGF for management of bighorn sheep; and a 5% buyer's fee is remunerated to WSF – Midwest Chapter. Since 1986, 27 of 28 (96.4%) auction hunters have been successful harvesting a ram.

Hunting bighorn sheep has been restricted to male-only since the inaugural season. A *¾-curl* restriction designating legal rams was abandoned during the 1990s, however, in favor of the current *any-ram* regulation

because it is less ambiguous and easier to enforce. The NDGF issued 228 bighorn sheep licenses from 1975 to 2013, and 223 (98%) of those hunters were successful harvesting a ram. Although hunters were required to hunt with NDGF personnel the first few seasons, hunters now attend an orientation meeting and all hunts are *Do-it-yourself*. Guiding and outfitting are prohibited on public lands in North Dakota.

Interest by sportsman in hunting bighorn sheep in North Dakota is apparent from the marked increase in applications submitted for lottery licenses (Fig. 43). Residents and non-residents pay a $5 and $100 non-refundable application fee, respectively, and are then entered into a random drawing. No more than one non-resident may draw a bighorn sheep license in the lottery annually.

The NDGF does not offer preference points for bighorn sheep. In 2012 there were four hunting units (Fig. 44).

All hunters must register harvested rams with the NDGF: biological samples are collected, age is determined, horn size is recorded, and a plug with a unique number is permanently embedded into one horn. All heads of wild sheep in North Dakota, regardless of where they were harvested, must be plugged. Possession of bighorn skulls without a valid hunting license is prohibited in North Dakota. To discourage poaching, the NDGF does not issue permits to individuals who find bighorn skulls; such skulls must be surrendered to the NDGF and most are then donated for educational purposes.

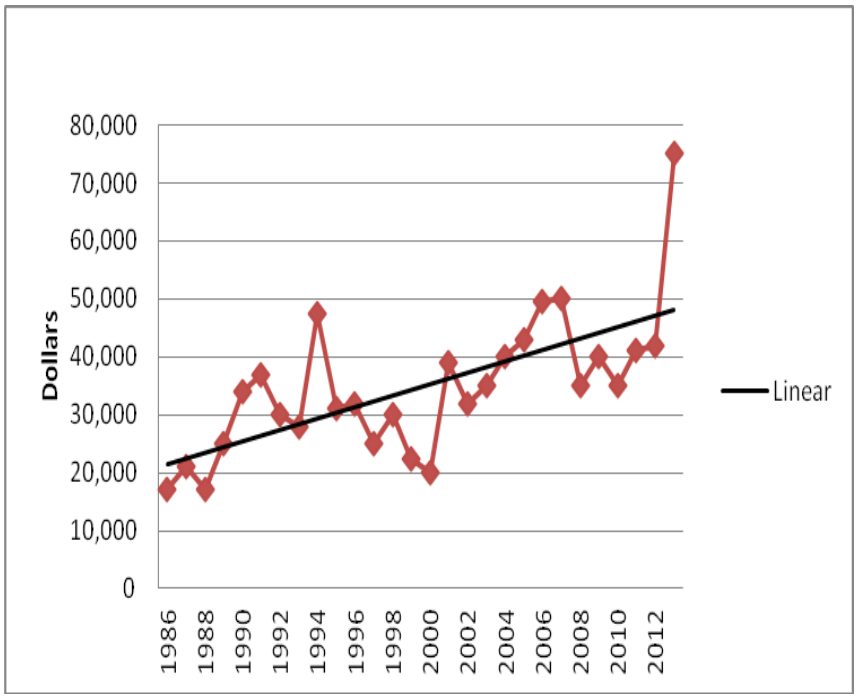


Figure 41. North Dakota's auction license has raised over one million dollars for management of bighorn sheep, 1986 – 2013.

Figure 42. Since 1986, revenue from the state's auction license has been the primary source of funding for North Dakota's bighorn sheep management program.

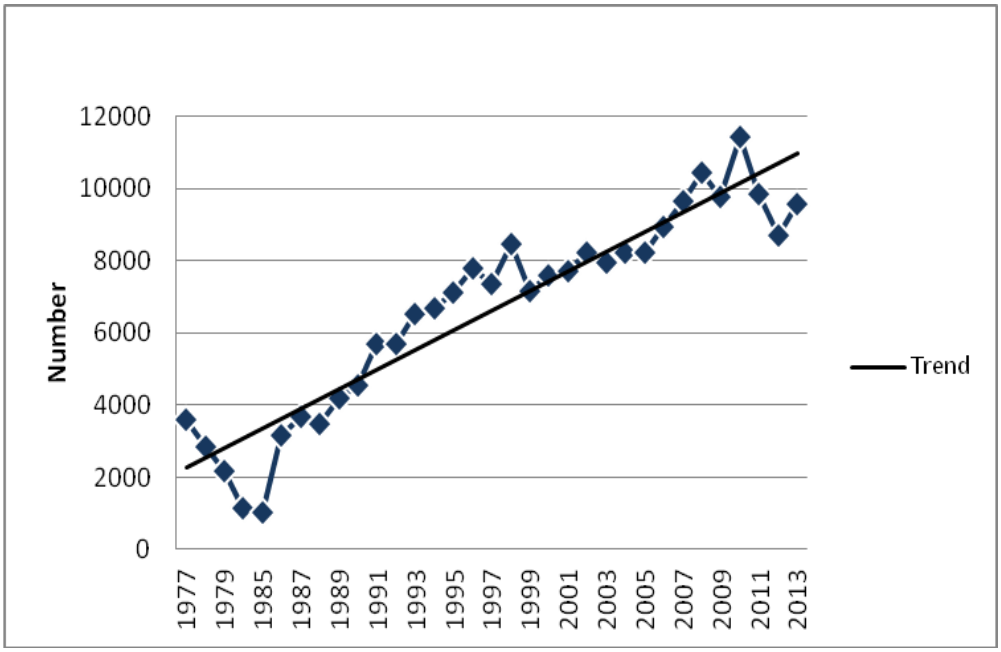


Figure 43. Interest in hunting bighorn sheep in North Dakota is evident by the number of applicants for lottery licenses, 1975 – 2013.

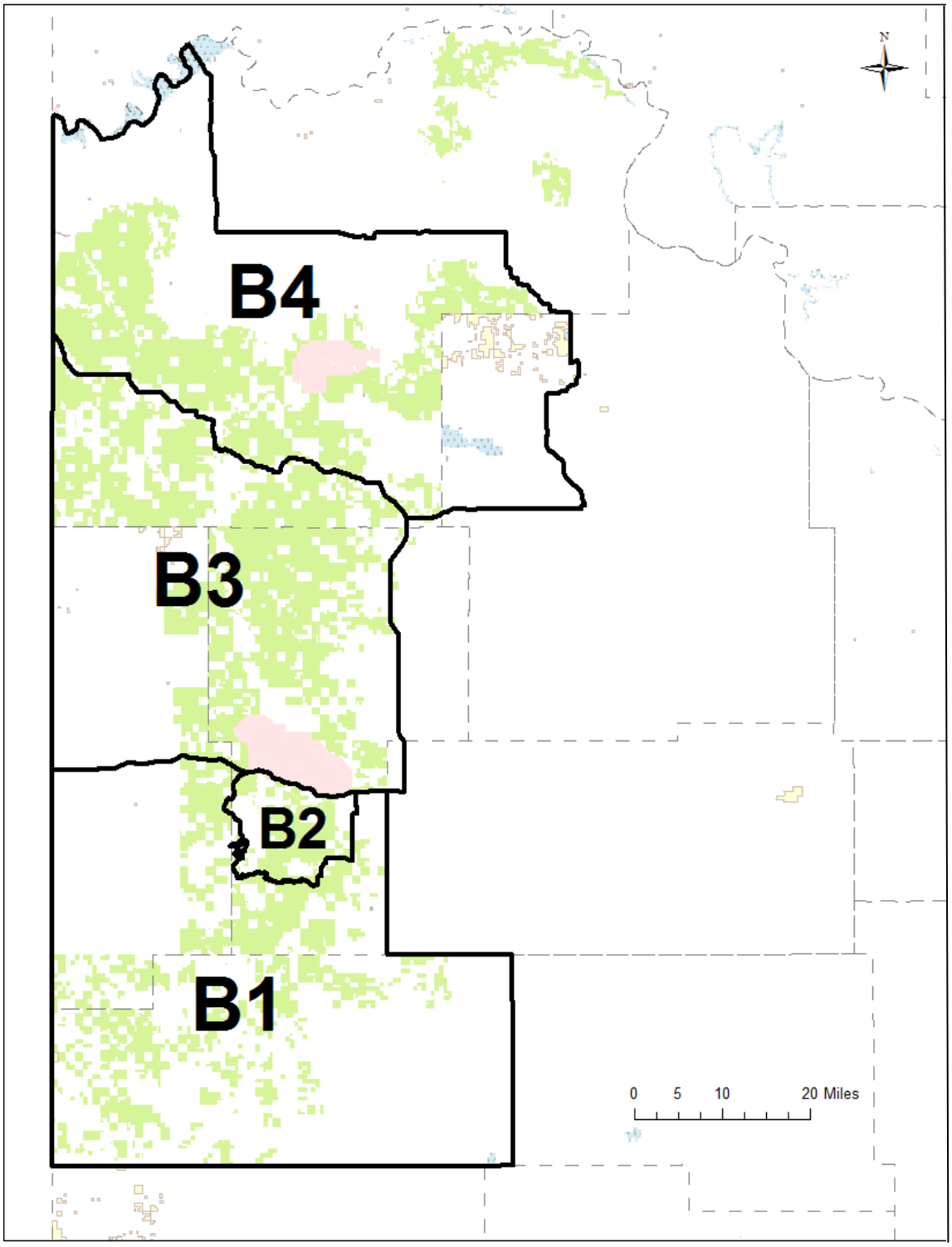


Figure 44. Bighorn sheep hunting units, 2012.

## Harvest Methodology

Bighorn sheep generally persist at low densities so they will never be abundant in North Dakota and, consequently, neither will hunting licenses. Bighorn sheep are long-lived ungulates with low recruitment rates, so populations can be vulnerable to over-harvest. Although most jurisdictions in North America have unique goals and objectives for issuing hunting licenses, all are characterized by conservative harvest rates compared to other ungulates. For example, only Alberta, Colorado, Montana, and Wyoming allow a limited harvest of females, and most jurisdictions harvest males at only 1 – 5% of the total population. Recently, 4 – 6 licenses have been issued in North Dakota, with a goal of 10 by 2023 (Table 8).

Historically, the bighorn hunting season in North Dakota occurred during September, but that timeframe resulted in a disproportionate harvest of Class II and III males. Consequently, in 2010, the season was changed to coincide with the rut to increase the harvest of Class IV males.

Three primary considerations are made when determining the number of hunting licenses issued annually: abundance of males, age structure of males, and the male:female ratio. These data are collected during the annual census and are then used to determine the number of licenses to be issued. There is no *one size fits all* method for setting the number of bighorn licenses, but the following criteria is generally followed in North Dakota, where bighorn sheep persist at low densities and are widely distributed across their range:

1. Based on a 100% success rate, total harvest should be ≤15% of ¾-curl males (i.e., 4.5-year-olds), but not to exceed 8% of total males. Males occupying areas that are closed to hunting should not be included when determining the number of hunting licenses. These parameters maximize hunter opportunity, ensure a sustainable harvest of mature males, and protect cohorts with few males from overharvest. Three scenarios are summarized:
    - If the annual census revealed 100 total males, of which 50 were ≥¾-curl, then 7 licenses would be issued (i.e., ≤15% of ¾-curl males *and* ≤8% of total males);
    - If the annual census revealed 75 total males, of which 50 were ≥¾-curl, then 6 licenses would be issued (i.e., ≤15% of ¾-curl males *and* ≤8% of total males);
    - If the annual census revealed 100 total males, of which 25 were ≥¾-curl, then 3 license would be issued (i.e., ≤15% of ¾-curl males *and* ≤8% of total males);
2. The goal for male:female ratio is ≥0.50:1.0 (Figure 45);
3. The goal for mean age of harvested rams is ≥7 years old;
4. Although there is no goal for horn size, the long-term trend using the Boone & Crockett scoring system is evaluated.

Table 8. History and goal for bighorn sheep hunting licenses by 2023.

| Year | Total Males[1] | Hunters | Hunter Days | Days/hunter | Harvest | Hunter Success % |
|---|---|---|---|---|---|---|
| 2000 | 51 | 4 | 7 | 1.8 | 4 | 100 |
| 2001 | 58 | 4 | 12 | 3.0 | 4 | 100 |
| 2002 | 61 | 4 | 11 | 2.8 | 4 | 100 |
| 2003 | 71 | 4 | 16 | 4.0 | 4 | 100 |
| 2004 | 73 | 4 | 21 | 5.3 | 4 | 100 |
| 2005 | 72 | 4 | 9 | 1.8 | 4 | 100 |
| 2006 | 85 | 6 | 30 | 5.0 | 6 | 100 |
| 2007 | 93 | 6 | 20 | 3.3 | 6 | 100 |
| 2008 | 96 | 6 | 24 | 4.0 | 6 | 100 |
| 2009 | 100 | 5 | 13 | 2.6 | 5 | 100 |
| 2010 | 95 | 6 | 14 | 2.3 | 6 | 100 |
| 2011 | 86 | 6 | 12 | 2.0 | 6 | 100 |
| 2012 | 87 | 4 | 10 | 2.5 | 4 | 100 |
| **2023[2]** | **130** | **10** | **32** | **3.2** | **10** | **100** |

[1] Based on annual ground surveys of known herds.

[2] 2023 projection based on population growth of extant populations, and potential introductions at Cottonwood Creek, Mikes Creek, and Morman Butte.

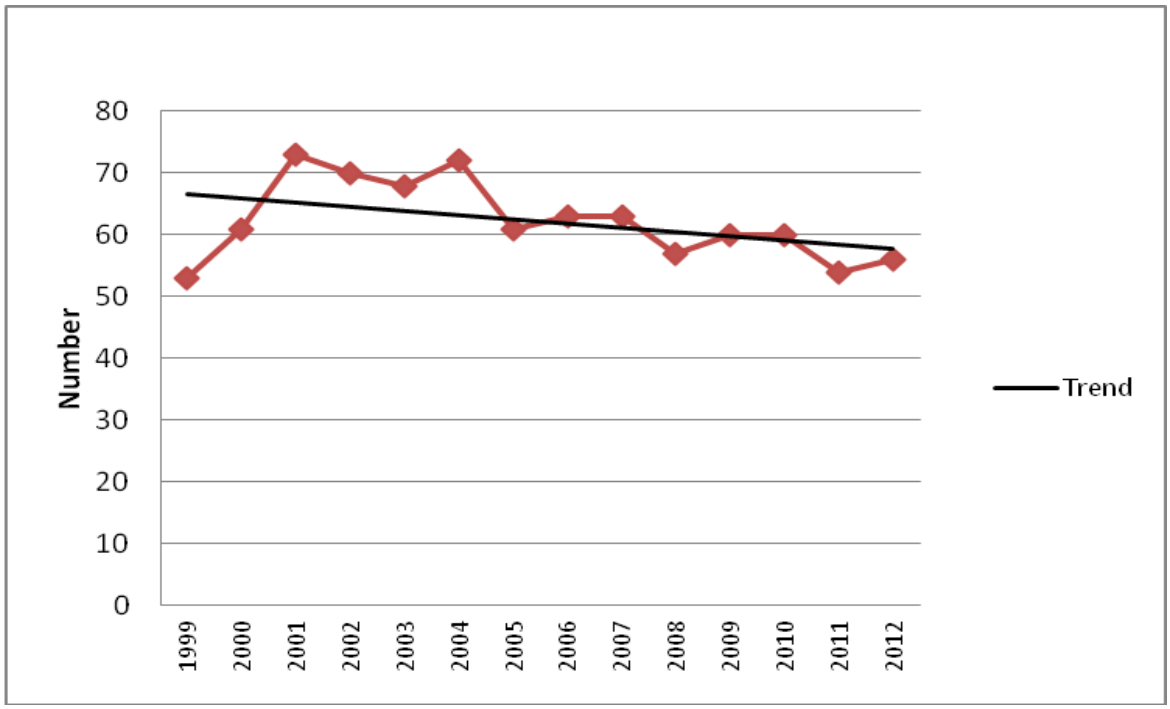


Figure 45. Male:female ratios in North Dakota, 1999 – 2012.

# HEALTH MONITORING

Unregulated hunting, competition with domestic livestock, and habitat degradation certainly contributed to the precipitous decline in indigenous populations of bighorn sheep in the U.S. during the twentieth century, but diseases introduced by domestic sheep were unquestionably the most significant factor that led to wide-scale extirpations. Epizootics continue to be the most significant threat to wild sheep and the greatest hindrance to viable populations. Bunch et al. (1999) summarized diseases affecting North American wild sheep:

**Pasteurellosis** – Although much remains unknown about the precise mechanisms that cause acute bronchopneumonia in populations of bighorn sheep following association with domestic sheep or goats, recent research has clearly demonstrated that a virulent strain of bacteria, *Mannheimia haemolytica*, was transmitted from domestic sheep to bighorn sheep that caused the subsequent deaths of those bighorn sheep (Lawrence et al. 2010). Ongoing research is also exploring what role *Mycoplasma ovipneumoniae* may play in epizootics of bighorn sheep, and whether *M.*

*ovipneumoniae* works in concert with *M. haemolytica* in intensifying epizootics of wild sheep. *Pasteurella multocida* has also been suspected in some disease events. Regardless of the exact pathogen and mechanism that causes epizootics in bighorn sheep, pasteurellosis is widely regarded as the most significant factor threatening populations of wild sheep in North America due to the extensive area affected, the swiftness with which the disease can spread, and the inability to stop such epizootics once they begin. Separation between wild sheep and domestic sheep or goats is the most effective strategy to prevent catastrophic die-offs of bighorns sheep.

Pasteurellosis may also be triggered or exacerbated by environmental stressors such as elevated population densities, poor nutrition, habitat degradation, elevated lungworm loads, harassment, human encroachment, heavy snowfall, noise, and atmospheric dust (e.g., dust from gravel roads). Minimizing such stressors may result in healthier bighorn sheep that are less vulnerable to disease events.

Because many populations of bighorn sheep are presently at risk of association with domestic sheep or goats, the Western Association of Fish and Wildlife Agencies' Wild Sheep Working Group (2012) developed the following recommendations to prevent disease transmission from domestic sheep or goats to wild sheep:

1. Wildlife agencies should:
    - Assess wild sheep conservation value/status and complete risk assessments of interspecies contact in a metapopulation context;
    - Remove wild sheep that have likely associated with domestic sheep or goats and develop a policy to promptly respond to wild sheep wandering from occupied wild sheep ranges (Appendix B);
    - Thoroughly explore demographic consequences of translocations and conduct appropriate analyses of habitat suitability and risk of disease transfer prior to implementing translocations;
    - Coordinate with other agencies, land owners and stakeholders regarding management of domestic sheep and goats on or near ranges occupied by wild sheep;
    - Fully consider the risk of disease transmission when issuing or commenting on permits/regulations associated with private and public lands used for production of domestic sheep and goats;
    - Develop educational materials and outreach programs to interpret the risk of association between wild sheep and domestic sheep or goats.
2. Land management agencies should:
    - Reduce risk of association by eliminating overlap of domestic sheep or goat allotments or grazing permits/tenures within wild sheep habitat. For example,

domestic sheep and goats may not graze on USFS, BLM, or state lands within 10 miles of bighorn sheep range in North Dakota;
    - Ensure that annual operating instructions or their equivalent include measures to minimize domestic association with wild sheep and confirm appropriate methods to remove stray domestic sheep or goats;
    - Manage wild sheep habitat to promote healthy populations in areas without domestic sheep or goats.
3. Wild sheep conservation organizations should:
    - Assist with educational/extension efforts to all parties;
    - Negotiate alternatives and incentives for domestic sheep or goat grazers on private and public land to find alternatives to doing so in wild sheep habitat;
    - Advocate for and support research concerning disease and risk associated with domestic sheep and goats in proximity to wild sheep.
4. Domestic sheep and goat permittees/owners should:
    - Implement best management practices (BMPs) to prevent straying by domestic sheep or goats;
    - Establish protocols to respond to straying.
5. Private landowners should:
    - Educate themselves and work with wild sheep managers and advocates to support effective separation through a variety of site-specific mitigation measures;
    - Promptly report the potential or actual association between domestic sheep or goats and wild sheep to local wildlife agencies.

Pasteurellosis was the likely cause of an all-age die-off of bighorn sheep in the southern badlands of North Dakota when several hundred domestic goats were intentionally grazed to control leafy spurge within core bighorn range. The NDGF has subsequently collected biological samples from all harvested males and mortalities of radio-marked animals (Fig. 46). Swab samples from the nasal and tonsil region of the throat are collected and sent to diagnostic labs for the detection of virulent pathogens. Translocated stock from inter-state sources are also tested for pathogens.

Figure 46. Disease sampling is collected opportunistically from transplant stock, harvested rams, and mortalities of radio-marked animals.

**Verminous Pneumonia** – Verminous pneumonia is a parasitic disease caused by lungworm: *Protostrongylus rushi* and *P. stilesi*. Although lungworm is a naturally occurring parasite, demographic consequences to populations of bighorn sheep can occur when individuals become burdened with high lungworm loads. *P. stilesi* can be especially troublesome because transplacental transmission of larvae occurs that may lead to acute pneumonia of neonates. *P. stilesi* can also lead to what is commonly referred to as "summer pneumonia," where 2 – 3 month-old lambs are lethargic, have low body weights, and show symptoms of pneumonia such as coughing and nasal discharge. Adult bighorn sheep may be more susceptible to pasteurellosis when they have high lungworm loads.

Overpopulation, seasonal or artificial concentrations of animals, poor nutrition, severe weather, or harassment by humans or predators are thought to exacerbate the effects of verminous pneumonia. Ingestion of gastropods serves as the vector for lungworm; therefore, proper management that keeps populations of bighorn sheep below carrying capacity can greatly minimize the impacts of lungworm. Although bighorn sheep can be treated for lungworm via ingestion of medicated feed, such methods in North Dakota actually increased lungworm loads due to artificially concentrating animals (W. Jensen, NDGF, per. comm.). Therefore, reducing population densities via translocations or hunting are likely more effective at reducing the effects of lungworm.

Biopsies of lung tissue have demonstrated that most bighorn sheep in North Dakota carry lungworm, but it does not appear to be a limiting factor. However, sporadic episodes of "summer pneumonia" of lambs may be the result of *P. stilesi*.

**Psoroptic Scabies** – Mites (*Psoroptes* spp.) that cause scabies are thought by many to have been introduced to bighorn sheep from domestic sheep. Scabies primarily affects the ears but can also be found on the body. Scabies is widespread among populations of wild sheep in North America and can cause die-offs under extreme conditions. Ivermectin can kill scabies but administration on a large-scale basis is impractical. No clinical signs of psoroptic scabies have been found in North Dakota.

**Chronic Sinusitis** – Sinusitis is an infectious disease believed to be caused by bacterial invasions of nasal botfly larvae. The disease is most prevalent in xeric habitats and can be fatal to bighorn sheep. There is no effective treatment for sinusitis in free-ranging populations. Sinusitis has been found in sympatric mule deer populations in North Dakota (J. Kolar, University of Missouri, per. comm.), and bighorn sheep have been observed with behaviors consistent with animals suffering from sinusitis; however, it has not been documented in bighorn sheep in North Dakota.

**Bluetongue** – Similar to Epizootic Hemorrhagic Disease (EHD) in cervids, bluetongue is caused by a biting gnat (*Culicoides variipennis*) that is most

prevalent during years with wet springs followed by hot, dry summers. Bluetongue can be fatal to bighorn sheep but is apparently rare, as only few cases have been confirmed in three states. Bluetongue has not been documented in North Dakota's population of bighorn sheep.

**Johne's Disease** – Paratuberculosis is caused by a *Mycobacterium paratuberculosis* and is apparently rare in bighorn sheep. Clinical signs included emaciation, diarrhea, and submandibular edema (i.e., bottle jaw). Treatment is ineffective in free-ranging animals as infected individuals may shed bacteria in their feces for years. Johne's Disease has not been documented in North Dakota's population of bighorn sheep.

**Contagious Ecthyma** – Sore mouth is evidently a recent viral disease affecting bighorn sheep but is now ubiquitous across the West. Little is known about the transmission of sore mouth, but artificial concentrations of bighorn sheep at contaminated sites (e.g., feeding sites, salt licks) apparently contribute to its spread. Clinical signs include large, painful lesions over the muzzle, mouth, nose, and genitalia. The disease is not usually fatal to healthy adults but may be fatal secondarily to nursing lambs that are not permitted to suckle due to the discomfort it causes their dam. Contagious ecthyma may also cause otherwise healthy adults to be more susceptible to other diseases. Contagious ecthyma has not been documented in North Dakota's population of bighorn sheep.

**Scrapie** – Scrapie is a transmissible spongiform encephalopothie (TSE) that affects domestic sheep. The only TSE that has been found in free-ranging ungulates, however, is Chronic Wasting Disease (CWD), and has been found exclusively in cervids. Scrapie has not been found in bighorn sheep.

**Brucellosis –** Brucellosis is a highly contagious bacterial disease that is typically spread via after-birth. Brucellosis is especially concerning to cattle producers because it causes premature abortions of calves. Although brucellosis has not been documented in free-ranging bighorn sheep, it was confirmed in captive bighorn sheep that were exposed to an infected elk fetus (Kreeger et al. 2004).

**Bovine Tuberculosis -** *Mycobacterium bovis* is a bacterium that affects the respiratory system. It has been found in numerous domesticated and wildlife species, but is apparently rare in sheep and has not been confirmed in wild sheep. Bovine tuberculosis can be spread through the air or bodily fluids. Several bighorn sheep in North Dakota were tested for Tb after a nearby herd of cattle tested positive; all bighorn sheep tested negative for the disease.

# ISSUES AND STRATEGIES

## Goal

Maximize bighorn sheep populations in areas that are feasible and compatible with habitat and people; and to provide unique hunting and viewing opportunities.

## Objectives

1. Manage bighorn sheep to achieve goals set forth in this plan within the northern and southern metapopulations;
2. Manage bighorn sheep to issue 10 licenses by 2023;

## Issues and Strategies

**Issue one**

Lack of suitable habitat within bighorn range is a limiting factor.

**Strategies**

1. Work with federal and state agencies to initiate controlled burns &/or mechanical removal of juniper, especially near identified lambing areas (Fig. 47 and 48);
2. Work with private landowners to initiate controlled burns &/or

Figure 47. Decades of fire suppression has led to significant encroachment of Rocky Mountain juniper throughout most of the badlands, and has severely degraded wildlife habitat.

Figure 48. Prescribed fire can transform the badlands from an unproductive landscape dominated by juniper to high-quality habitat preferred by wildlife and livestock.

mechanical removal of juniper, especially near identified lambing areas;
3. Work with private landowners to permit bighorn sheep to be released into areas on private lands that contain suitable bighorn habitat;
4. Work in conjunction with federal and state agencies, along with conservation groups such as the Wild Sheep Foundation and Wild Sheep Foundation – Midwest Chapter, to contribute to habitat improvement projects on federal, state, and private lands that contain bighorn habitat;
5. Work with WSF and WSF – Midwest Chapter to contribute to easements and hunter access programs on private lands;
6. Continue research into habitat characteristics preferred by bighorn sheep. For example, use Maxent program to estimate carrying capacity of females (Holl 1982) by more accurately identifying the amount of escape terrain suitable as lambing habitat;
7. Continue to work with federal agencies regarding the development and implementation of policies and practices relating to habitat-management;
8. Work with the USFS to more accurately align Bighorn Sheep MA 3.51s with the current distribution of bighorn sheep, and eliminate MA 3.51s that are not occupied by bighorn sheep and where introductions are not planned.

**Issue two**

Oil and gas development within bighorn sheep range.

**Strategies**

1. Work with federal and state agencies and oil companies regarding the placement of oil wells and roads (Fig. 49);
2. Use the NDGF's Line-of-sight model (Fig. 10) and lambing HR analyses to provide information about critical bighorn areas that are most sensitive to disturbance;
3. Work with federal and state agencies to ensure that existing bighorn distribution and future range expansions are considered when proposing future oil and gas leases, rather than focusing solely on arbitrary "management areas" (e.g., USFS MA 3.51s);
4. Provide input for proposed energy development during the beginning stages of the planning process;
5. Place wells ≥660 yards from lambing habitat;
6. Place roads ≥220 yards from lambing habitat;
7. Gate roads and pads near lambing habitat to minimize traffic not related to oil and gas;

8. Place tank batteries ≥660 yards from pads that are ≤660 yards from lambing habitat to reduce activity at those sites;
9. Avoid drilling, construction, seismic exploration, surveying and similar activities during the lambing season (April 1 – July 15).

Figure 49. Construction of roads and oil wells can displace bighorn sheep from critical habitats.

**Issue three**

Development of tourism and residential home construction within bighorn habitat including trails, roads, golf courses, homes, etc.

**Strategies**

1. Use the NDGF's Line-of-sight model (Fig. 10) and lambing HR analyses to provide information about critical bighorn areas that are most sensitive to disturbance;
2. Work with federal, state and local agencies, along with private tourism organizations, when constructing trails, campgrounds, housing, etc.;
3. Place trails, campgrounds, structures, etc., ≥660 yards from lambing habitat.

**Issue four**

Disease transmission from domestic sheep and goats within bighorn range.

**Strategies**

1. Work with federal and state agencies and private landowners to eliminate possible association between domestic sheep and goats and bighorn sheep;
2. Provide information (e.g., Recommendations for Domestic Sheep and Goat Management in Wild Sheep Habitat 2012) and public outreach regarding the seriousness of disease transfer from domestic sheep and goats to bighorn sheep;
3. Provide information regarding adequate separation parameters between domestic sheep and goats and bighorn sheep;
4. Encourage private landowners to exchange domestic sheep and goats with cattle within bighorn range.

**Issue five**

Survival rates of bighorn sheep.

**Strategies**

1. Monitor distribution and proximity of domestic sheep and goats to bighorn range, and work with private landowners to remove domestic sheep ≤12 miles from bighorn range;
2. Euthanize any bighorn sheep that has likely associated with domestic sheep or goats;
3. Continue to gather data pertaining to cause-specific causes of adult and lamb mortality;
4. Direct licensed hunters to harvest mountain lions from areas where significant predation on bighorn sheep exists.

**Issue six**

Reliable and accurate census information.

**Strategies**

1. Continue to census and classify bighorn sheep via ground counts during late summer annually;
2. Continue to censes recruited lambs via ground counts during March annually;
3. Continue to monitor the health of bighorn sheep during annual counts.

**Issue seven:**

Trap and transplant within the two metapopulations.

**Strategies:**

1. Continue to identify areas where new bighorn herds can be established.
2. Continue to identify extant herds that may require augmentation.
3. Continue to monitor feasibility of inter- and intra-state translocation sources.

**Issue eight:**

Dietary requirements specific to North Dakota's bighorn sheep habitat.

**Strategies:**

1. Complete analysis of fecal samples collected in 1992 in order to determine preferred forage.
2. Work with federal and state agencies to improve quantity and quality of forage near lambing habitat (e.g., seasonal reduction in livestock grazing near lambing areas from April – July 15). Work with NDGF's PLI program to plant high-quality forage (e.g., alfalfa) near lambing habitat when feasible.

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**Appendix A. History of Bighorn Sheep Translocations in North Dakota (1956 – 2013). W. Jensen and B. Wiedmann.**

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 11/5/56 | British Columbia | Magpie Enclosure | 3 | 3 | 3 | 7 | 0 | 2 | 18 | Trapped on 11/03/56 Riske Creek area, 27 miles west of Williams Lake. |
| 1/15/59 | Magpie Enclosure | SUTRNP (Free ranging) | 3 | 2 | 0 | 0 | 0 | 0 | 5 | Three adult males from B.C. One adult male later found dead. |
| 2/17/60 | Magpie Enclosure | SUTRNP Enclosure #1 | 1 | 0 | 1 | 2 | 0 | 0 | 4 | Included 2 adult females and 1 adult male from B.C. |
| 2/25/60 | Magpie Enclosure | SUTRNP Enclosure #1 | 1 | 0 | 1 | 3 | 0 | 0 | 5 | Included 2 adult females from B.C. |
| 1/15/62 | SUTRNP Enclosure #1 | SUTRNP Enclosure #1 | 5 | 1 | 0 | 4 | 0 | 0 | 10 | One adult male had apparently jumped into enclosure. Animals handled and released back into enclosure. |
| 1/16/62 | SUTRNP Enclosure #1 | Dutchman's Barn Encl. | 2 | 0 | 0 | 0 | 0 | 0 | 2 | Both males born in North Dakota. |
| 1/16/62 | Magpie Enclosure | Dutchman's Barn Encl. | 0 | 0 | 0 | 2 | 0 | 1 | 3 | One adult female from B.C. |
| 1/16/62 | Magpie Enclosure | Magpie Enclosure | 3 | 0 | 0 | 0 | 0 | 0 | 3 | Handled and released back into enclosures. Included two males from B.C. |
| 1/17/62 | Magpie Enclosure | NUTRNP (Free ranging) | 2 | 0 | 0 | 0 | 0 | 0 | 2 | Both males born in North Dakota. |
| 12/04/62 | Magpie Enclosure | Magpie Enclosure | 0 | 0 | 0 | 1 | 0 | 1 | 2 | Handled and released back into enclosure. |
| 12/05/62 | Magpie Enclosure | Moody Plateau Area | 5 | 1 | 0 | 3 | 0 | 1 | 10 | Included one adult from B.C. |
| 12/05/62 | SUTRNP Enclosure #1 | Dutchman's Barn Encl. | 0 | 0 | 0 | 0 | 1 | 1 | 2 | |
| 12/05/02 | SUTRNP Enclosure #1 | Moody Plateau Area | 1 | 1 | 0 | 0 | 0 | 0 | 2 | |
| 12/05/02 | SUTRNP Enclosure #1 | SUTRNP (Free ranging) | 3 | 0 | 0 | 0 | 0 | 0 | 3 | Included 1 male from B.C. |
| 12/05/02 | SUTRNP Enclosure #1 | SUTRNP Enclosure | 0 | 0 | 1 | 6 | 1 | 2 | 10 | Released back into enclosure. Included give females from B.C. |
| 1/5/65 | Magpie Enclosure | Magpie Enclosure | 0 | 2 | 0 | 2 | 0 | 3 | 7 | Included one female from B.C. |
| 1/25/66 | SUTRNP Enclosure #1 | Moody Plateau | 0 | 0 | 0 | 3 | 0 | 0 | 3 | Enclosures at Magpie & SUTRNP removed during the summer of 1966. |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| | | | | | | | | | | Included one female from B.C. |
| 1978-1981 | Chateau De Mores | Dutchman's Barn Encl. | 1 | 0 | 0 | 4 | 0 | 0 | 5 | Sheep got inside enclosed pasture. |
| 3/16/83 | Chateau De Mores | Lone Butte | 0 | 0 | 1 | 6 | 0 | 2 | 9 | Use drop net. |
| 3/25/86 | Dutchman's Barn Encl. | Dutchman's Barn Enclosure | 2 | 0 | 0 | 0 | 4 | 0 | 6 | Released back into enclosure. Used drop net. |
| 3/25/86 | Dutchman's Barn Encl. | SUTRNP Enclosure #2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | Used drop net. |
| 3/225/86 | Dutchman's Barn Encl. | Moody Plateau Area | 4 | 0 | 0 | 0 | 0 | 0 | 4 | Used drop net. |
| 3/9/87 | Magpie (Free range) | SUTRNP Enclosure #2 | 0 | 0 | 0 | 2 | 0 | 0 | *2 | Used helicopter and drive net. *Two females died in nets, two transported to SUTRNP. Both dead by 12 March 1987 |
| 3/10/87 | Moody Plateau | Sheep Creek | 1 | 0 | 1 | 6 | 2 | 0 | 10 | Used net gun. |
| 3/10/87 | Moody Plateau | Dutchman's Barn Encl. | 0 | 0 | 0 | 3 | 0 | 0 | 3 | Used net gun. One female a freemartin, probably infertile. |
| 3/11/87 | Chateau De Mores | Dutchman's Barn Encl. | 0 | 0 | 0 | 0 | 2 | 0 | 2 | Used net gun. |
| 3/12/87 | Dutchman's Barn Encl. | SUTRNP Enclosure #2 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | Used net gun. |
| 3/15/88 | Lone Butte | Lone Butte | 0 | 0 | 0 | 7 | 0 | 0 | 7 | Released back in same area. |
| 3/15/88 | Lone Butte | Hettinger Sheep Barn | 1 | 0 | 0 | 0 | 0 | 0 | 1 | Adult male died shortly after reached Hettinger. |
| 3/21/88 | Dutchman's Barn Encl. | Wannagan Creek | 0 | 2 | 0 | 5 | 3 | 0 | 10 | Drop net used. |
| 3/15/89 | British Columbia | North Bullion Butte | 1 | 0 | 1 | 7 | 0 | 1 | 10 | Another adult female sent to zoo; later died. |
| 3/19/90 | SUTRNP Enclosure #2 | SUTRNP Enclosure #2 | 1 | 1 | 0 | 4 | 0 | 0 | 6 | In addition, one adult male died during capture. (Used drop net.) |
| 3/19/90 | SUTRNP Enclosure #2 | Lone Butte | 2 | 0 | 0 | 0 | 0 | 0 | 2 | Used drop net. |
| 3/19/90 | SUTRNP Enclosure #2 | Dutchman's Barn Encl. | 1 | 0 | 0 | 0 | 0 | 0 | 1 | Used drop net. |
| 3/20/90 | Chateau De Mores | SUTRNP Enclosure #2 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | Used helicopter and net gun. |

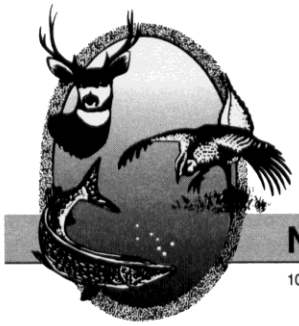
| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 3/20/90 | Chateau De Mores | Dutchman's Barn Encl. | 0 | 0 | 0 | 6 | 0 | 0 | 6 | Used helicopter and net gun. |
| 3/21/90 | Moody Plateau | SUTRNP Enclosure #2 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | Used helicopter and net gun. |
| 3/21/90 | Moody plateau | Lone Butte | 1 | 0 | 0 | 8 | 1 | 0 | 10 | Used helicopter and net gun. |
| 3/23/90 | Magpie Creek | South Bullion Butte | 0 | 3 | 0 | 8 | 0 | 0 | 11 | Used helicopter and net gun. |
| 11/28/90 | East Fork Owyhee River, Idaho | Killdeer WMA | 2 | 3 | 1 | 13 | 3 | 1 | 23 | Dispersed widely; estimated 70% mortality. |
| 11/13/91 | Dutchman's Barn Encl. | Wannagan Creek | 1 | 1 | 0 | 4 | 0 | 0 | 6 | One additional female died. Drop net used. |
| 12/06/91 | Owyhee River, Idaho | BLM | 1 | 2 | 1 | 15 | 6 | 3 | 28 | Some animals dispersed; estimated 20 to 40% mortality. |
| 12/06/91 | Owyhee River, Idaho | Dutchman's Barn Encl. | 0 | 2 | 1 | 7 | 0 | 0 | 10 | |
| 2/6/92 | SUTRNP Enclosure #2 | Moody Plateau Area | 2 | 0 | 0 | 0 | 0 | 0 | 2 | Clover trapped. |
| 3/92 | Magpie Enclosure | Magpie Enclosure | 0 | 0 | 0 | 10 | 0 | 0 | 10 | As part of a research project, 10 females were captured and radio collared. (Two females died of capture myopathy.) One young male ear tagged and released. |
| 3/92 | Moody Plateau | Moody Plateau | 0 | 0 | 2 | 10 | 0 | 0 | 12 | As part of a research project, 10 females were captured and radio collared. (Two females died of capture myopathy.) One young male ear tagged and released. |
| 7/93 | Dutchman's Barn Encl. | Chateau De Mores | 0 | 0 | 0 | 5 | 0 | 0 | 5 | Fence fell down. Five adult females from Idaho escaped from enclosure. |
| 1/19/95 | Dutchman's Barn Encl. | Burnt Creek | 6 | 0 | 0 | 5 | 0 | 0 | 11 | One female bleeding from vagina (condition unknown). Group included three males and two ewes from Idaho. |
| 1/25/95<br>2/1/95<br>2/17/95 | SUTRNP Enclosure | Wannagan Creek | 3 | 0 | 1 | 1 | 0 | 0 | 5 | Clover trapped. One adult male died within a week of release. |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 3/8/95 | | | | | | | | | | |
| 1/26/96 | British Columbia | NUTRNP | 5 | 0 | 0 | 15 | 0 | 0 | 20 | Good condition when released. |
| 1/22/98 | South Bullion Butte | Burnt Creek | 1 | 0 | 0 | 8 | 0 | 0 | 9 | Used drop net. All animals in good condition when released. |
| 2/7/01 | Long X | South Bullion Butte | 3 | 0 | 0 | 6 | 0 | 0 | 9 | Used helicopter and net gun. All animals radio-collared and in good condition when released. |
| 2/1/02 | Long X | North Bullion Butte | 2 | 0 | 0 | 3 | 0 | 0 | 5 | Used helicopter and net gun. All animals radio-collared and in good condition when released. |
| 1/9/03 | Deschutes River, OR | Fantail Creek | 1 | 2 | 0 | 7 | 0 | 0 | 10 | Used helicopter and net gun. All animals radio-collared. Most animals in poor condition when released (two females died of capture myopathy). |
| 1/9/03 | John Day River, OR | Fantail Creek | 0 | 1 | 0 | 2 | 0 | 0 | 3 | Used helicopter and net gun. All animals radio-collared and in good condition when released. |
| 1/9/03 | Deschutes River, OR | Kendley Plateau | 0 | 2 | 1 | 6 | 1 | 0 | 10 | Used helicopter and net gun. Two males and six females radio-collared. Most animals in poor condition when released (three females died of capture myopathy). All but three animals dispersed from release site. |
| 1/9/03 | John Day River, OR | Kendley Plateau | 0 | 1 | 0 | 1 | 0 | 1 | 3 | Used helicopter and net gun. One male and one female radio-collared. All animals in good condition when released. |
| 12/5/04 | John Day River, OR | Red Wing Creek | 0 | 2 | 0 | 5 | 3 | 0 | 10 | Used helicopter and net gun. All animals were radio collared. Nine animals in good condition when released (one female died of capture myopathy). |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 12/5/04 | John Day River, OR | Fantail Creek | 0 | 0 | 1 | 3 | 1 | 0 | 5 | Used helicopter and net gun. All animals radio collared and in good condition when released. All females dispersed to Beaver Creek and were recaptured and translocated to Red Wing Creek on 19 January 2006. |
| 1/17/06 | Charles M. Russell National Wildlife Refuge, MT | Morman Butte | 0 | 3 | 2 | 10 | 4 | 0 | 19 | Used helicopter and net gun. All females radio-collared; all males received ear transmitters. One female euthanized at capture site due to spinal cord trauma. 19 sheep in good condition when released. |
| 1/20/07 | Upper Missouri River Breaks National Monument, MT | Ice Box Canyon | 2 | 1 | 0 | 17 | 0 | 0 | 20 | Used helicopter and net gun. All animals were radio collared and in good condition when released. |
| 1/19/06 | Beaver Creek | Red Wing Creek | 0 | 0 | 1 | 3 | 0 | 0 | 4 | Used helicopter and net gun. Females were already collared; lamb received ear transmitter. All animals in good condition when released. |
| 1/19/06 | Wannagan Creek | Moody Plateau | 0 | 0 | 0 | 2 | 1 | 0 | 3 | Used helicopter and net gun. All animals were radio collared and in good condition when released. |
| 1/26/08 | BLM | Moody Plateau | 0 | 0 | 1 | 4 | 0 | 0 | 5 | Used helicopter and net gun. All females were radio collared and in good condition when released. |
| 1/26/08 | Morman Butte | Moody Plateau | 0 | 0 | 0 | 0 | 1 | 0 | 1 | Used helicopter and net gun. Female was radio collared and in good condition when released. |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 1/26/08 | Long X | Moody Plateau | 0 | 1 | 0 | 0 | 0 | 0 | 1 | Used helicopter and net gun. Male was radio collared and in good condition when released. |
| 1/26/08 | North Bullion | Magpie Creek | 0 | 0 | 0 | 1 | 1 | 0 | 2 | Used helicopter and net gun. Females were radio collared and in good condition when released. |
| 1/26/2008 | South Bullion | Magpie Creek | 0 | 0 | 0 | 2 | 0 | 0 | 2 | Used helicopter and net gun. Females were radio collared and in good condition when released. |
| 2/15/10 | Morman Butte | Burnt Creek | 1 | 1 | 0 | 3 | 1 | 0 | 6 | Used helicopter and net gun. All but yearling male were radio collared and in good condition when released. |
| 2/15/10 | Morman Butte | Magpie Creek | 0 | 2 | 1 | 3 | 2 | 0 | 8 | Used helicopter and net gun. All but male lamb were radio collared and in good condition when released. |
| 2/22/13 | Morman Butte | Magpie Creek | 0 | 1 | 3 | 7 | 0 | 1 | 12 | Used helicopter and net gun. All adults were radio collared and in good condition when released. Lambs had blue tag in ear. |

**Appendix B. North Dakota Game and Fish Department Policy Regarding Bighorn Sheep Interactions with Domestic Sheep or Goats.**



"VARIETY IN HUNTING AND FISHING"

NORTH DAKOTA GAME AND FISH DEPARTMENT

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**POLICY STATEMENT** 16 May 2005

**DEPARTMENT PROCEDURE WHEN ASSOCIATION BETWEEN BIGHORN SHEEP AND DOMESTIC SHEEP, EXOTIC SHEEP, OR GOATS OCCURS.**

**JUSTIFICATION**

Domestic sheep (*Ovis aries*) are known carriers of several pathogenic strains of bacteria spp. that cause severe pneumonia-induced die-offs of wild sheep populations, even when interactions between the two species is minimal. A summary of over 30 documented cases in which contact between wild and domestic sheep occurred resulted in the demise of 75-100 percent of the bighorn sheep immediately following each incident, whereas domestic sheep always remained healthy (Martin 1996). Most recently, in 2005, approximately 75 percent of the bighorn sheep population in Custer State Park, South Dakota was lost following association with domestic sheep. Foreyt (1994) found that mouflon sheep (*Ovis orientalis*) are also incompatible with wild sheep. Because wild sheep have low reproductive rates, bighorn die-offs can have lasting effects and take many years to recover if at all. Therefore, association between the wild and domestic sheep should be prevented.

Research conducted at the Caine Veterinary Teaching Center, University of Idaho, has confirmed that goat species are also carriers of the same pathogenic *Pasteurella* strains found in domestic and exotic sheep (Ward et al. 2002). Therefore, contact between bighorn sheep and *Capra* spp. (goats, ibex, tur and markor), *Ammotragus lervia* (barbary sheep) and *Hemitragus* (tahr) also pose a serious threat to North Dakota's wild sheep population. Domestic goats are believed to have been the disease vectors resulting in two die-offs of bighorn sheep in Hells Canyon in which 260 animals from six herds succumbed to pneumonia in ID, WA and OR in 1995 (Rudolph 1998). Evidence also points to domestic goats as the cause of a major epizootic of bighorn sheep in North Dakota in 1998.

Although domestic sheep and goats cannot be grazed on federal lands within 10 miles of bighorn sheep habitat in North Dakota, there exists no method by which bighorn sheep, especially young rams, can be prevented from wandering near domestics. As evidenced recently in South Dakota, if bighorn sheep that have had associated with domestic sheep return to healthy bighorn herds, the effects can be devastating. Therefore, the North Dakota Game & Fish

Department has adopted a similar policy held by most western states and provinces regarding incidents in which bighorn sheep associate with domestic sheep or goats.

## POLICY

1. Any bighorn sheep that has likely associated with domestic sheep, exotic sheep, or goats will be immediately destroyed and biological samples will be collected in conjunction with a comprehensive necropsy.
2. Any NDGF employee who observes a bighorn sheep near domestics will immediately contact the Director, Deputy Director, Wildlife Chief, Assistant Wildlife Chief or a member of the Big Game staff.
3. Before any bighorn sheep is destroyed, the Director, Deputy Director, Wildlife Chief or Assistant Wildlife Chief will be contacted and apprised of the situation.
4. If the Director, Deputy Director, Wildlife Chief or Assistant Wildlife Chief cannot be contacted, a member of the Big Game staff may authorize the destruction of the animal if he or she deems it necessary. However, the Director, Deputy Director, Wildlife Chief or Assistant Wildlife Chief will be promptly notified following the destruction of the animal.
5. Any bighorn sheep destroyed will be done so as discreetly as possible.
6. No bighorn sheep will be destroyed on private property without first notifying the landowner and the landowner will be given an educational brochure explaining the seriousness of the situation.
7. A supplemental Bighorn Sheep P-R Report will be submitted explaining the circumstances under which the culling incident was deemed necessary.

## Literature Cited

Foreyt, W.J. 1994. Effects of controlled contact exposure between healthy bighorn sheep and llamas, domestic goats, mountain goats, cattle, domestic sheep, or mouflon sheep. *Biennial Symposium of the Northern Wild Sheep and Goat Council.* 9:7-14.

Martin, Kevin, et al. 1996. Literature review regarding the compatibility between bighorn and domestic sheep. *Biennial Symposium of the Northern Wild Sheep and Goat Council.* 10:72-77.

Rudolph, K.M. et al. 1998. (In draft) Sharing of *Pasteurella spp.* between free-ranging bighorn sheep and feral goats.

Ward, Alton, et al. 2002. Characterization of *Pasteurella* spp isolated from healthy domestic pack goats and evaluation of the effects of a commercial *Pasteurella* vaccine. *American Journal of Veterinary Research.* 63:119-123.

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