# North Dakota Bighorn Sheep Management Plan (2024 – 2034)

**North Dakota Game & Fish Department**
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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, but that estimate likely is greatly exaggerated (Valdez 1988). Bighorn sheep occupy a narrow habitat niche and are widely distributed across western North America. 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 occurred as a metapopulation along the Little Missouri, Missouri, and Yellowstone rivers (Table 1). 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 anamale" 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 historical distribution.

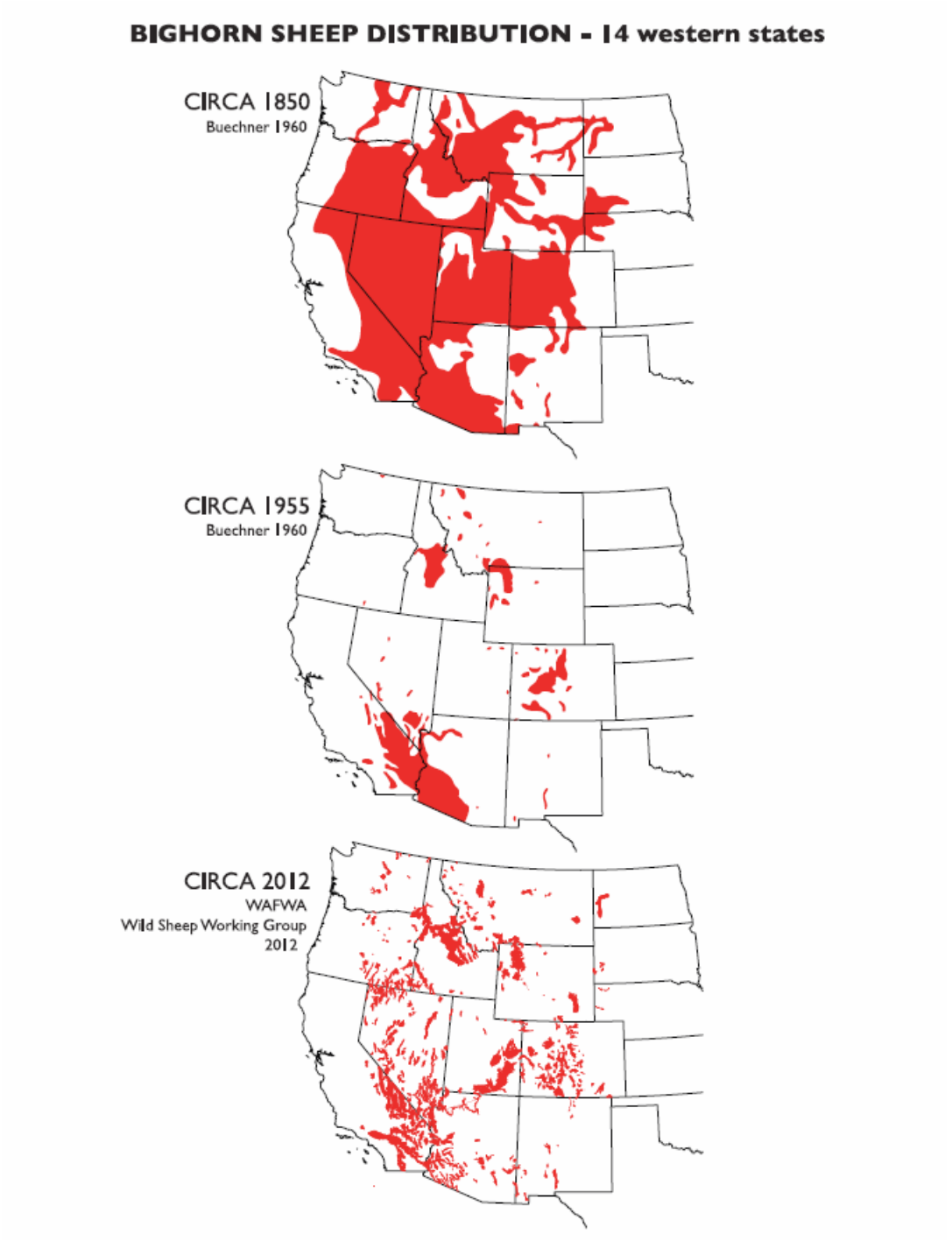


Figure 1. Historical and current distribution of bighorn sheep in the U.S. (courtesy WAFWA Wild Sheep Working Group).

Table 1. For the purposes of distinguishing population hierarchies and setting goals for this report, we categorized bighorn sheep demography as metapopulation, subpopulation, and herd (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. |

Although Audubon's bighorn sheep were recently synonymized with Rocky Mountain bighorn sheep (*O. c. canadensis*), the last 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 important role in their demise (Figs. 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 suitable for translocation to the region's badlands habitat. At that time, California bighorn sheep (formerly *O. c. californiana*; currently classified as *O. c. canadensis*) in southern British Colombia occupied low-elevation canyon habitats thought to be like the badlands of North Dakota. In 1956, bighorn sheep were translocated from British Columbia to an enclosure located at Magpie Creek, McKenzie County, North Dakota where they would serve as source-stock to reestablish bighorn sheep throughout the badlands (Figs. 4 and 5).

## Biology

Indigenous populations of bighorn sheep exhibit clinal and ecotypic variation throughout North America, but three distinct subspecies generally are recognized: Rocky Mountain bighorn sheep, desert bighorn sheep (*O. c. nelsoni*), and Sierra Nevada bighorn sheep (*O. c. sierrae*). These specialized ungulates are widely distributed throughout their range, where they occur 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 of the three subspecies and include those found in North Dakota, with males

achieving weights greater than 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 possess much smaller, sickle-shaped horns. Pelage color ranges from blond to dark brown. Bighorn sheep have characteristic white markings on their rump, muzzle, and backside of legs.

Bighorn sheep 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 (1971) classified bighorn sheep males according to age and dominance hierarchy (Figs. 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. In 1956, a corral trap was used to capture bighorn sheep in British Columbia.

Figure 5. Eighteen bighorn sheep were translocated from British Columbia to North Dakota in 1956.

Figure 6. Class I rams (2 years old) often disperse from maternal ranges to join bands of older males.

Figure 7. Class II rams (3–5 years old) often wander more than other rams and are usually the first to arrive at rutting grounds.

Figure 8. Class III rams (6–7 years old) are eager to participate in the rut and are the most likely to engage in dominance behaviors.

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

Male and female bighorn sheep are typically segregated until the breeding season, which occurs during late-fall through early-winter. Dominance behaviors by males are highly ritualized and include what have been described as a *low-stretch, head twist, leg kick, head butt, clash,* or *present*; such behaviors likely minimize the amount of 'combat' between males competing for breeding opportunities. However, intense battles among males vying for the opportunity to tend estrous females are not uncommon. Shortly after the rut, males again form bachelor groups on separate and often less rugged ranges than those used by females. The largest bachelor group ever recorded in North Dakota totaled 22 individuals; however, they usually number between 5 and 10.

Like many large mammals, bighorn sheep exhibit numerous traits consistent with a slow-paced life history. These attributes include long lives (the oldest male and female documented in North Dakota were 16 and 22 years old, respectively), a Type I Survivorship Curve (i.e., survival of young initially declines but then quickly asymptotes with survivorship remaining high throughout mid-life, and then again declining), slow development, iteroparity, a delay in age at first reproduction, small litters (almost always a singleton in bighorn sheep) of large-bodied progeny, high maternal investment in young, and a low intrinsic rate of increase ($r$).

As a result, populations of bighorn sheep rarely achieve irruptive 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 about 175 days. Timing of parturition is protracted with neonates having been observed in North Dakota from April 8 to mid-September, but 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 10 days after parturition and occupy historic lambing areas (i.e., areas where ewes birth and rear their young) until late summer when lambs become more mobile and somewhat less dependent on escape terrain to evade predators.

In North Dakota, nursery bands use multiple patches of habitat during the birthing and rearing seasons. However, they do not migrate to winter ranges following parturition, but instead use areas within their annual home ranges that provide winter forage. Conversely, mature males (i.e., ≥3 years old) occupy larger annual home ranges during most of the year, until they move to areas occupied by females during fall. Some males in North Dakota move >24 km 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, but "summer pneumonia" events are not uncommon and manifest when lambs are 3

to 4 months old. Except during those winters characterized by extreme conditions, winter lamb survival typically is high, and an average of 74% (range 54%–98%) of lambs observed during summer surveys survived their first winter from 2013 to 2023.

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 that may be unpalatable to other ungulates. Segregation between males and females is best explained by a combination of nutrient intake and predator evasion strategies. Males generally select areas providing higher quality forage over those with rugged escape terrain, albeit at greater risk to predators. Females, and especially parous females, prioritize safety and typically select areas providing forage adequate to meet their energetic demands but in which they are more apt to detect or evade predators (i.e., rugged escape terrain) in lieu of those with higher quality forage.

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

In North Dakota, bighorn sheep are found in Billings, Dunn, Golden Valley, McKenzie, and Slope counties where they comprise two disjunct metapopulations (Table 1). Subpopulations of females are naturally fragmented into distinct herds and rarely associate with adjacent herds of unrelated females. Each herd has the potential to represent a single matriline, but with the possibility of multiple female demes within the subpopulation. Genetic interchange (i.e., movement of nuclear genes) among subpopulations of females is achieved primarily via dispersals 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 or adjacent to the Little Missouri National Grassland (an area collectively referred to as Grassland in this report).

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 640 to 1050 m, and substrates consist of highly erosive silts and clays, sandstone, and scoria. The climate is semi-arid and windy, with cold winters and warm summers producing annual temperatures ranging from -60° to 115° F. Precipitation is highly variable, both within and among seasons, but most occurs during April–September.

The majority of the vegetation in the Grassland of western North Dakota is comprised of native species (Jensen 2020). Rolling hills, ridges, and moderate (15–40%) slopes are dominated by mixed-grass prairie comprised largely of western wheat grass (*Pascopyrum smithii)*, prairie junegrass (*Koeleria macrantha)*, green needlegrass (*Nassella viridula)*, blue grama (*Bouteloua gracilis)*, little bluestem (*Schizachyrium scoparium)*, and needleleaf sedge (*Carex duriuscula)*. Vegetation on steeper north-facing slopes is composed primarily of Rocky Mountain juniper (*Juniperus scopulorum*), green ash (*Fraxinus pennsylvanica*), 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 (*Ericameria nauseosa*), and greasewood (*Sarcobatus vermiculatus*). Big sage, silver sage (*A. 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) also are common. Bighorn sheep 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 – females are rarely found >300 m from escape terrain. Visibility is of the utmost importance to bighorn sheep for predator detection or evasion, especially near those areas where females bear and rear offspring. Females typically arrive at these birthing areas during late March, give birth, and then occupy those areas from April through July. Parous females begin foraging farther from these areas 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 important habitats used by bighorn sheep. These areas are limited in North Dakota, and such lands are most apt to be affected by anthropogenic activities. Among these are forest succession, energy, industrial, and residential development, road construction, noxious weeds, competition with livestock, or recreational disturbance. 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 exists. Maintaining the integrity of historic lambing habitat is essential to the persistence of these specialized ungulates, as availability of suitable terrain is the primary factor limiting the abundance of most populations of bighorn sheep in North Dakota and elsewhere.

Human disturbance near lambing habitat can force females and young to leave—or even abandon—these critically important areas, and has occurred in North Dakota. Such movements can make lambs and their dams more vulnerable to predation, poor body condition, or disease, and thereby impact the viability of a particular subpopulation. Humans on foot elicit the most severe flight responses by bighorn sheep in North Dakota, especially among parturient females, which have routinely been observed fleeing from the security of escape terrain when approached to within 600 m. Consequently, 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 600 m of lambing habitat;
- Permanent human activities (e.g., recreational trails, campgrounds, oil pads) where humans on foot are a common occurrence are not constructed within 600 m of lambing habitat;
- Construction activities and other sources of disturbance that are temporary (e.g., pipelines, water developments, road construction) do not occur within 600 m of lambing habitat from April 1 to July 15, when lambs are most dependent on escape terrain but also most apt to take flight.

Bighorn sheep can acclimate to sources of disturbance that are consistent, predictable, and non-threatening (e.g., regular vehicle traffic on a roadway; aircraft following a consistent flight path on a regular basis). For example, nursery bands that consistently flee from pedestrians approaching within 600 m have been regularly located within 200 m of roads, where traffic flow is consistent and predictable. Sensitivity of bighorn sheep females to perturbation declines substantially during late summer, when female-lamb bonds begin to break, and nursery bands depart lambing areas in search of better-quality forage.

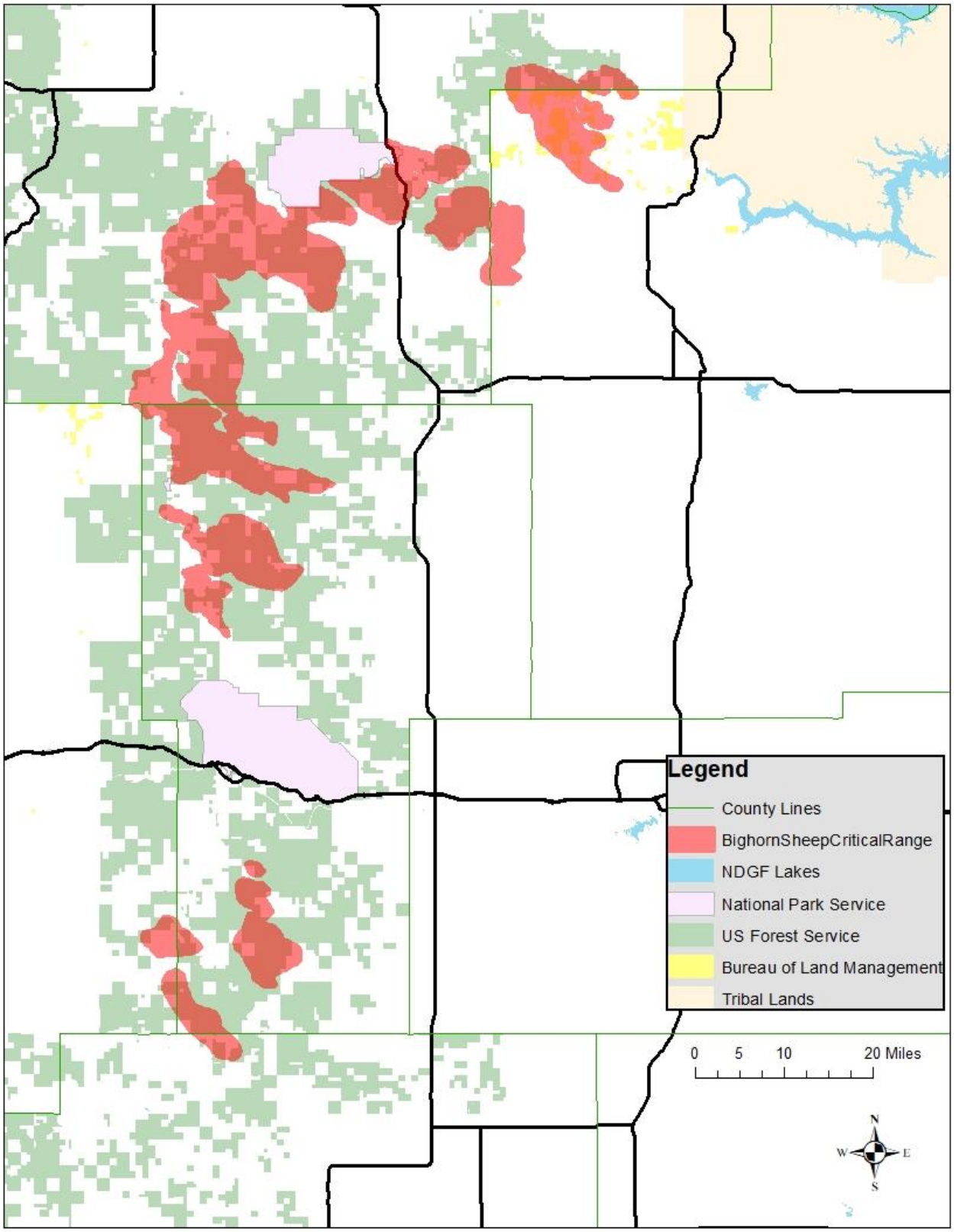


Figure 10. GIS Critical Bighorn Sheep Range model developed by NDGF to minimize human disturbance near lambing areas.

# POPULATION MANAGEMENT

## Survey Methodology

Data obtained during population surveys are useful only when the methods used are repetitive, standardized, transferable, and understandable to staff and public in guiding management decisions. Survey methods for bighorn sheep are notoriously difficult due to the species' naturally fragmented distribution and low population densities. The use of fixed-wing aircraft to survey bighorn sheep is largely ineffective because of the rugged landscapes in which they live and poor sightability at the minimum speeds required by fixed-wing aircraft to remain airborne. Consequently, most jurisdictions use helicopters for aerial surveys of bighorn sheep because they are more maneuverable and can fly at much slower speeds.

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 were lacking for decades. The wide distribution and low density of bighorn sheep compounded the difficulties in formulating a standardized survey methodology. Further, NDGF does not own a helicopter, which is essential to ensure aerial counts are standardized, and contracting helicopters specifically to survey bighorn sheep would be cost-prohibitive. For example, at current rates it would cost

~$60,000 annually to effectively survey bighorn sheep in North Dakota.

During 2000, NDGF personnel deployed VHF radio-collars on bighorn sheep throughout the Grassland to facilitate collection of baseline data on abundance, demography, and distribution, and to develop a standardized survey methodology. A survey protocol subsequently was developed from that initial project, and the method is uniquely adapted to North Dakota. The method not only provides accurate data that is standardized and repeatable, but it is much less expensive than contracting helicopters for aerial surveys. The survey methodology is summarized below.

1. Deploy GPS radio-collars on 20% of males and females in each herd via helicopter net-gun techniques (Figure 11). Approximately 15 collars must be deployed annually by a helicopter capture-crew to replace collars lost to mortalities or battery failures, and to maintain an adequate number of telemetered animals in each herd to ensure survey continuity;
2. Program GPS collars to record locations of marked animals at 0600, and immediately to transmit those coordinates to NDGF personnel;
3. During late summer (July–August), census individual herds from the ground by locating marked animals via *real time* GPS locations, and then use a spotting scope to count and classify individuals in each herd as adult male (≥ 2 years old), yearling male, adult female (≥ 2 years old), yearling female, or lamb. Males that are ≥¾-curl should also be recorded;
4. Young males (i.e., 1–3 years old), frequently move between or 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;
5. Repeat the same procedure the following March to recount females and lambs as they approach 1 year old to estimate recruitment.

Although this survey method is more laborious and time-consuming than aerial methods, it is of lesser risk to investigators and costs much less than contracting helicopters. It is also a less intrusive method that decreases disturbance to livestock on the numerous private ranches intermingled throughout the Grassland and on which low flying helicopters could cause substantial disruptions to ranching activities.

The method also creates 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 information, such as cause-specific mortality, health status, home range information, finely detailed demographic data, foray movements, habitat selection, and other data useful to planners, state or federal land management agencies, and conservationists in general.

The cost-effectiveness of this survey method will only improve as battery life of GPS collars continues to increase; for example, GPS collars powered by solar technology are currently in use in some jurisdictions. Such collars are much lighter in weight and could function throughout the life of each marked animal, and then be re-deployed.


Figure 11. Highly skilled helicopter capture crews are essential to effectively and safely capturing bighorn sheep in the rugged badlands of North Dakota.

## Population Models

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

1. A census could not be completed (correction factors were calculated using survey data, 2013–2023):
    a. A correction factor of 1.006 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 1.022 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 0.256 can be applied to the estimate of females ($N_{t+1}$) to estimate $N_{t+1}$ for recruited lambs;
    d. For example:
        i. Where, $N_t$ = 100 males and 200 females;
        ii. Then, $N_{t+1}$ = 100(1.006) + 200(1.022) + 204.4(0.256);
        iii. Therefore, the estimate for $N_{t+1}$ = 101 males + 204 females + 52 lambs = 357.

2. A summer count was completed, but a March count of recruited lambs was not:
    a. A correction factor of 0.748 can be applied to the summer count of lambs ($N_t$) to determine lamb recruitment for $N_t$;
        i. For example: Where, the summer count ($N_t$) = 100 males, 200 females, 50 lambs;
        ii. Then, lamb recruitment ($N_t$) = 50(0.748);
        iii. Therefore, the estimate for $N_t$ = 100 males + 200 females + 37 lambs = 337.

## Current Status and Distribution

In 2023 there were two metapopulations that totaled approximately 400 individuals distributed among 15 herds (Figs. 12–14). There were ~395 individuals in the northern metapopulation and about 10 individuals remaining in the southern metapopulation (Tables 2 and 3). From 2013 to 2023, the total number of bighorn sheep in North Dakota increased by 23%. The northern metapopulation (excluding bighorn sheep in Theodore Roosevelt National Park [TRNP]) increased by 39%, and the southern metapopulation declined to 24% (i.e., -76%) of its former value.

Each year from 2021 to 2023, approximately 20% of females ($n$ = 65) and 20% of males ($n$ = 37) were fitted with GPS radio-collars in each of the 14 herds outside the North Unit of TRNP (NU TRNP). Locations were collected daily from each animal. We collected 18,790 male locations and 7,718 female locations and used appropriate GIS models to identify annual home ranges (HR), special use areas (i.e., the core areas used during birthing and rearing of lambs), and to obtain distributional information to facilitate population surveys. We used a

Fixed Kernel (99% isopleth) with a least-squares cross-validation bandwidth to determine the sizes of HRs for males and females in each herd. We used a 99% probability of locations obtained during April–August (2021–2023) to identify lambing HRs for each herd. The sensitivity of the precise locations of lambing areas precluded inclusion in this report; however, they have been saved on NDGF's GIS geo-database.

During 2021–2023, the mean HR (±SD) for females in the northern metapopulation (*N* = 12 herds) was 7.0 $mi^2$ (±3.6 $mi^2$) and the mean HR for males in the northern metapopulation (*N* = 5 subpopulations) was 34.1 $mi^2$ (±8.6 $mi^2$). The mean HR for females in the southern metapopulation (*N*=2 herds) was 12.9 $mi^2$ (±2.7 $mi^2$), and the mean HR for males in the southern metapopulation (*N*=1 subpopulation) was 28.3$mi^2$.

The mean size of lambing HRs in the northern metapopulation (*N*=12 herds) was 5.6 $mi^2$ (±2.4); and the mean size of HRs in the southern metapopulation (*N*=2 herds) was 10.7 $mi^2$ (±1.4 $mi^2$) (Figs. 15–29; Tables 4 and 5).

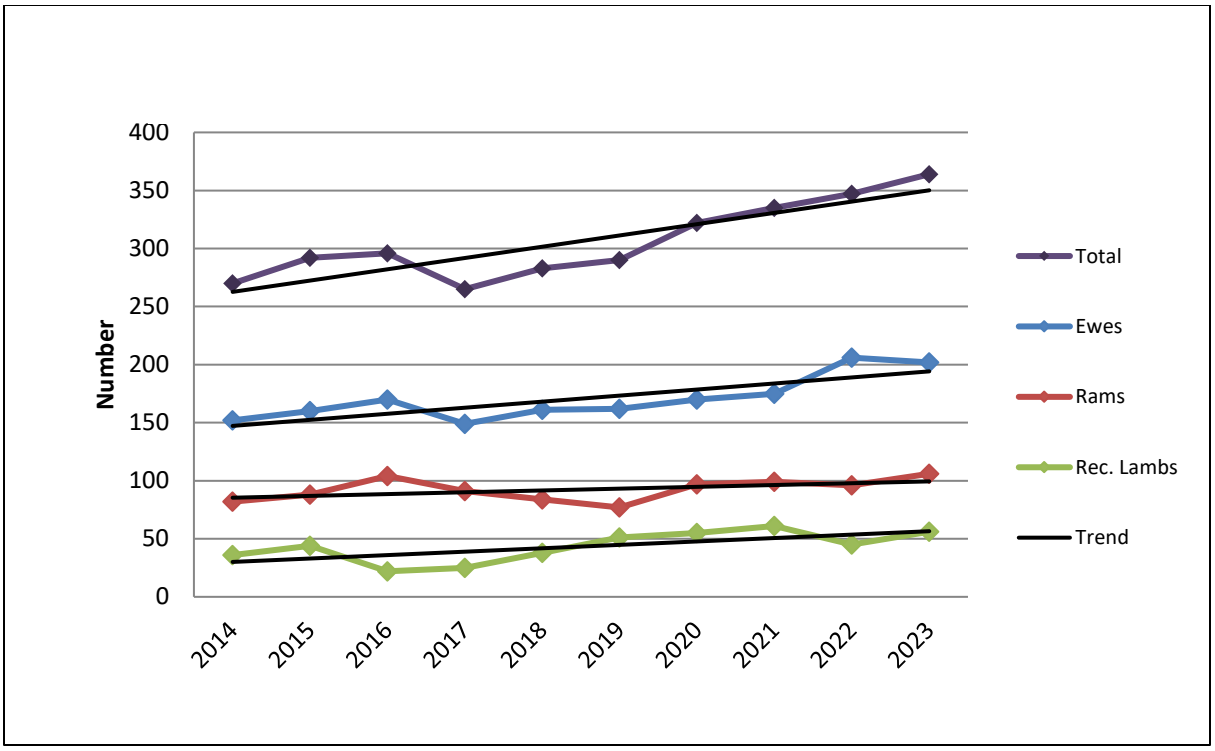


Figure 12. Size and demographic structure of bighorn sheep (excluding TRNP) among 14 herds in North Dakota, 2014–2023.

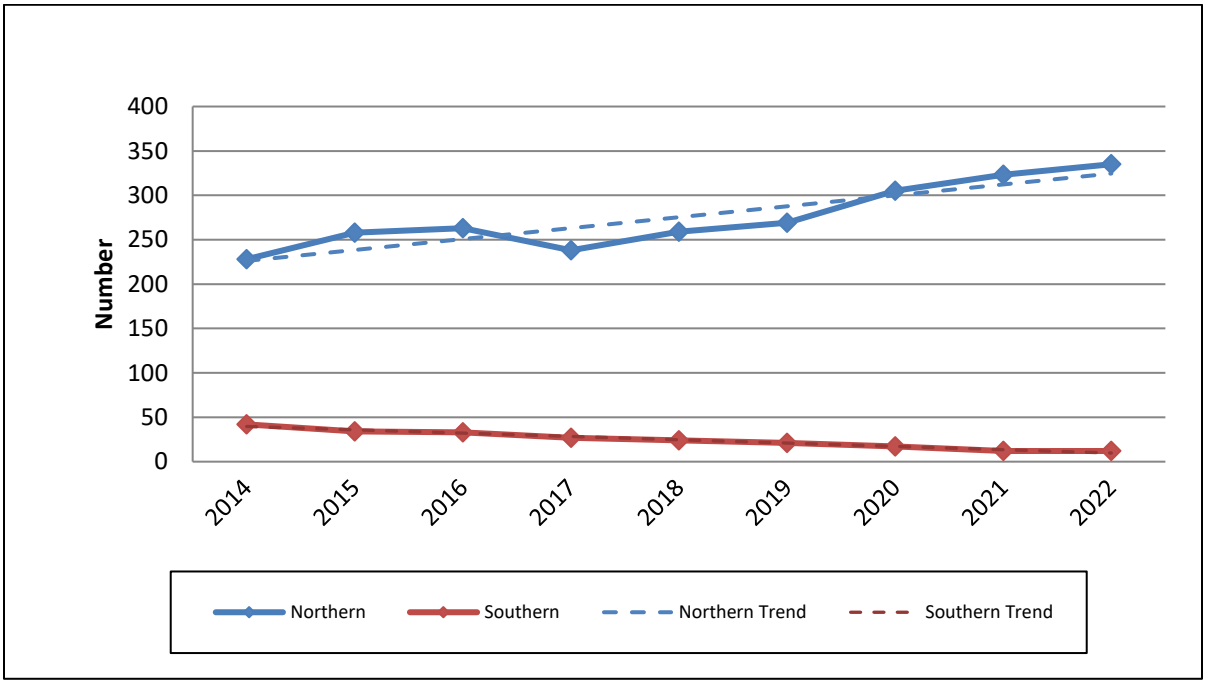


Figure 13. Minimum annual populations of bighorn sheep in the northern and southern metapopulations in North Dakota (excluding TRNP), 2014–2023.

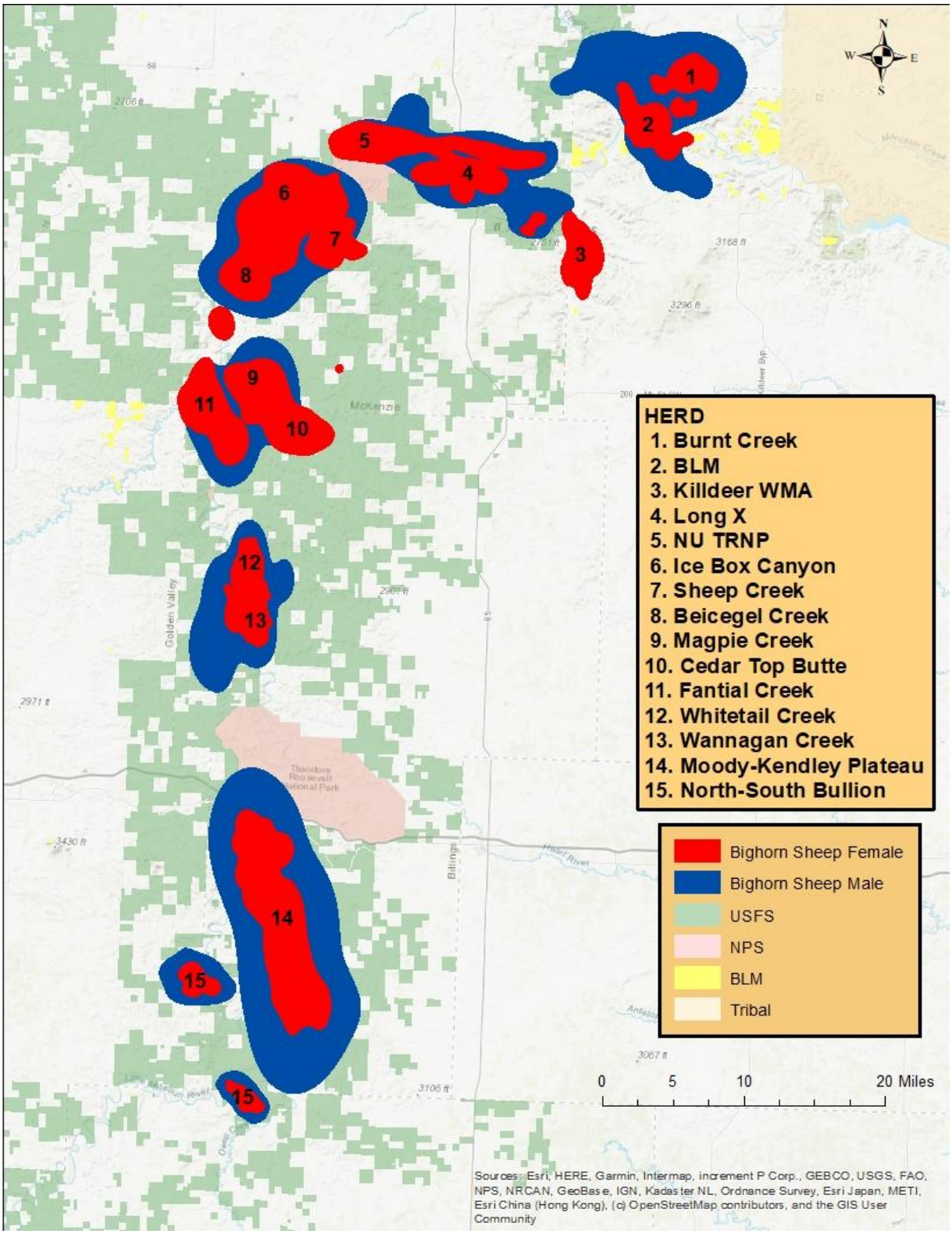


Figure 14. Annual distribution of adult male and female bighorn sheep within the 15 herds in North Dakota during 2023.

Table 2. Demography of bighorn sheep occupying the 13 herds that comprise the northern metapopulation (north of Interstate 94) in North Dakota, 2023.

| Herd[1] | 2023 Males | 2023 Females | 2023 Lambs | 2023 Total | Status |
|---|---|---|---|---|---|
| Burnt Creek | 12 | 15 | 6 | 33 | Increasing |
| BLM | 13 | 28 | 9 | 50 | Increasing |
| Killdeer WMA[2] | 1 | 9 | 0 | 10 | Stable |
| NU TRNP | UN | UN | UN | ~40 | Stable |
| Long X[3] | 17 | 30 | 10 | 57 | Increasing |
| Sheep Creek[4] | 2 | 21 | 5 | 28 | Increasing |
| Ice Box Canyon[5] | 19 | 28 | 5 | 52 | Stable |
| Beicegel Creek | 4 | 18 | 9 | 31 | Increasing |
| Magpie Creek | 22 | 15 | 0 | 37 | Stable |
| Cedar Top Butte | 1 | 13 | 4 | 18 | Stable |
| Fantail Creek | 1 | 4 | 3 | 8 | Declining |
| Whitetail Creek | 1 | 10 | 3 | 14 | Stable |
| Wannagan Creek | 9 | 3 | 1 | 13 | Declining |
| **TOTAL** | **102** | **195** | **55** | **~392** | **Increasing** |

[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 and Sheep Creek.
[5]Includes Bowline Creek, Bummer Creek, Ice Box Canyon, and Red Wing Creek.

Table 3. Demography of bighorn sheep occupying the 2 herds that comprise the southern metapopulation (south of Interstate 94) in North Dakota, 2023.

| Herd[1] | 2023 Males | 2023 Females | 2023 Lambs | 2023 Total | Status |
|---|---|---|---|---|---|
| Moody-Kendley[2] | 0 | 2 | 0 | 2 | Declining |
| North-South Bullion[3] | 4 | 3 | 1 | 8 | Declining |
| **TOTAL** | **4** | **5** | **1** | **10** | **Declining** |

[1]Color denotes connectivity among herds via movements of males.
[2]Includes Cliffs Plateau, Kendley Plateau, and Moody Plateau.
[3]Includes North and South Bullion Butte.

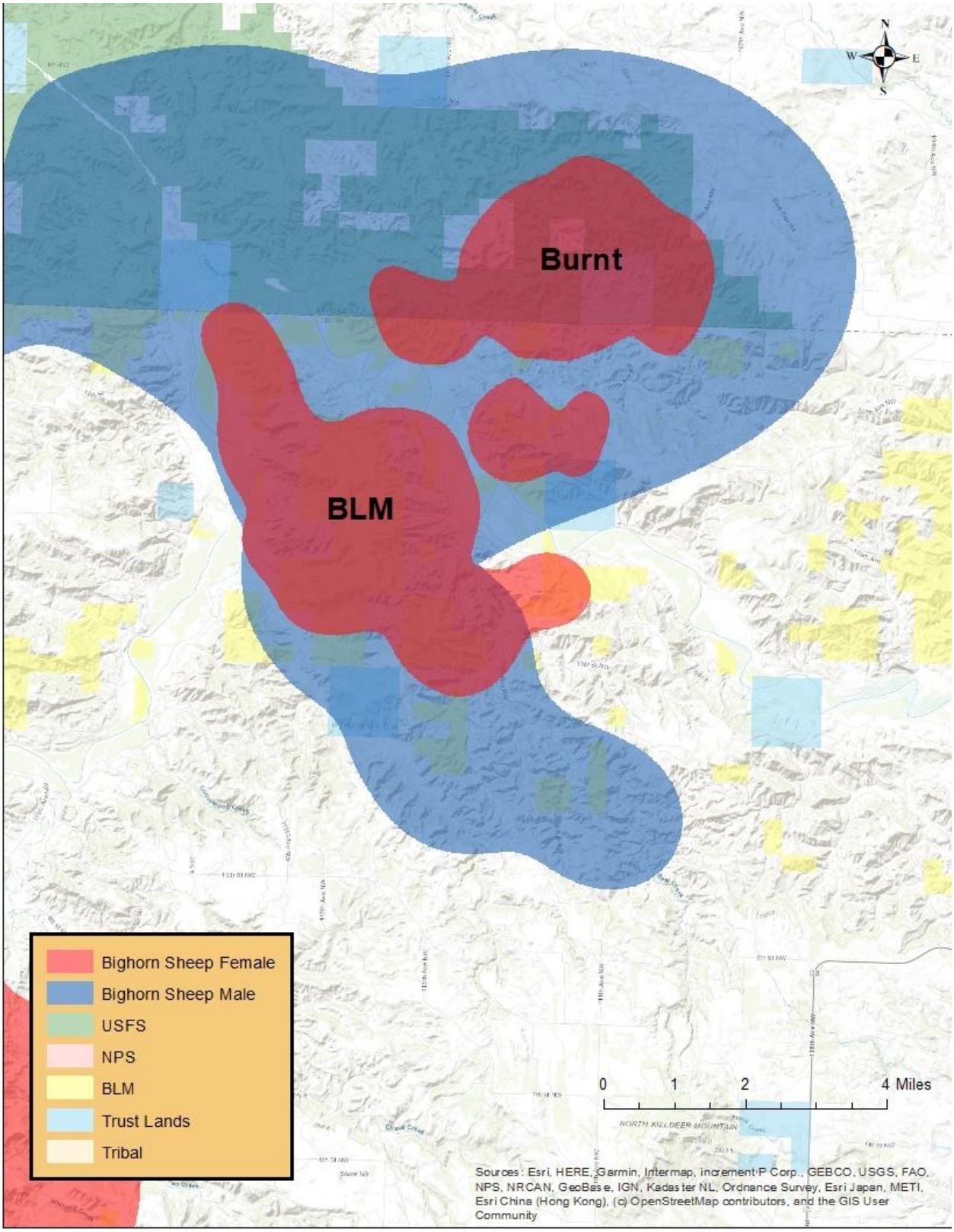


Figure 15. Distributions of male and female bighorn sheep comprising the BLM Herd (established in 1991) and the Burnt Creek Herd (established in 1995) from dates of founding to 2023.

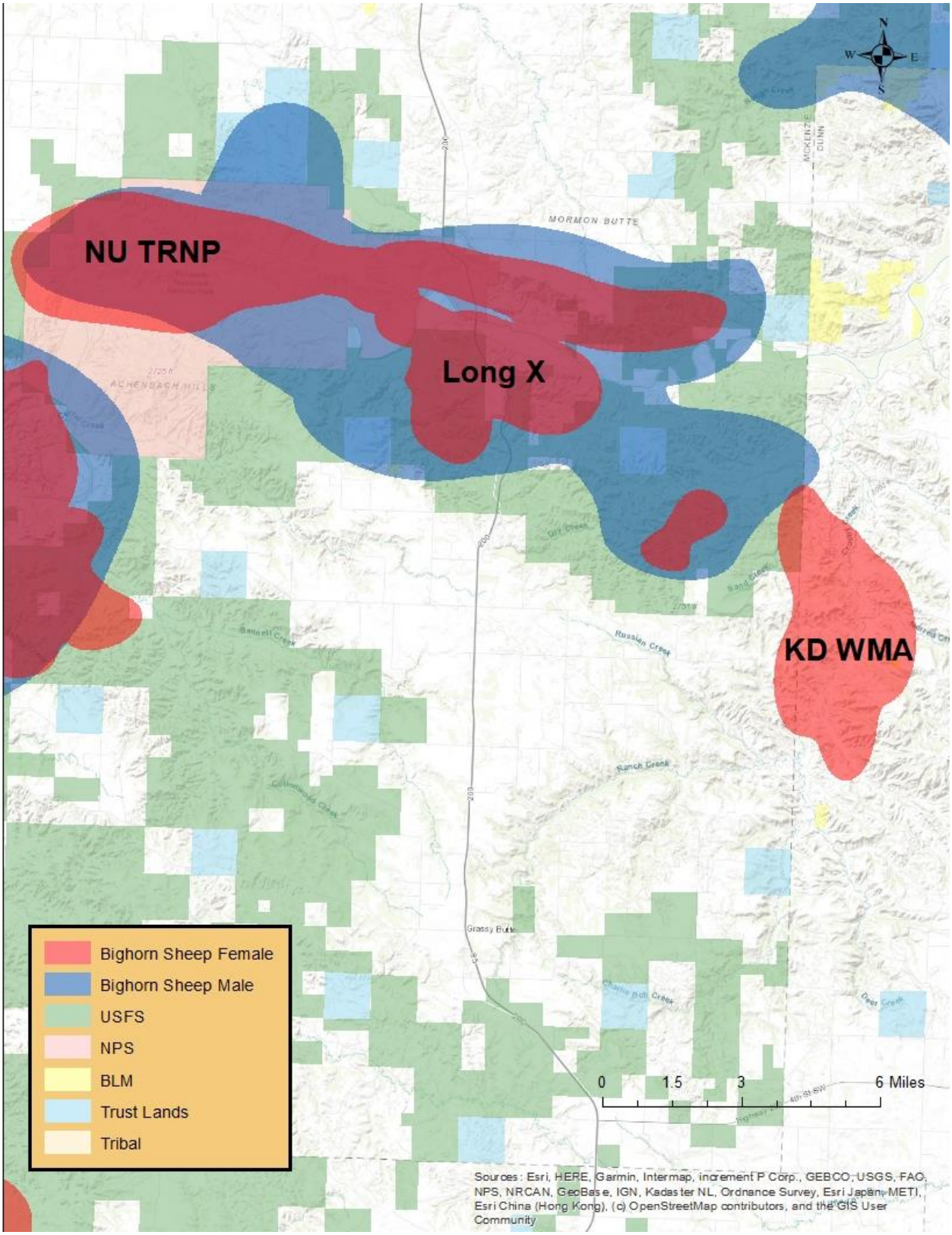


Figure 16. Distributions of male and female bighorn sheep comprising the Long X Herd (established in 1990), the Killdeer WMA Herd (established circa 1983), and the North Unit TRNP Herd (established in 1996) from dates of founding to 2023.

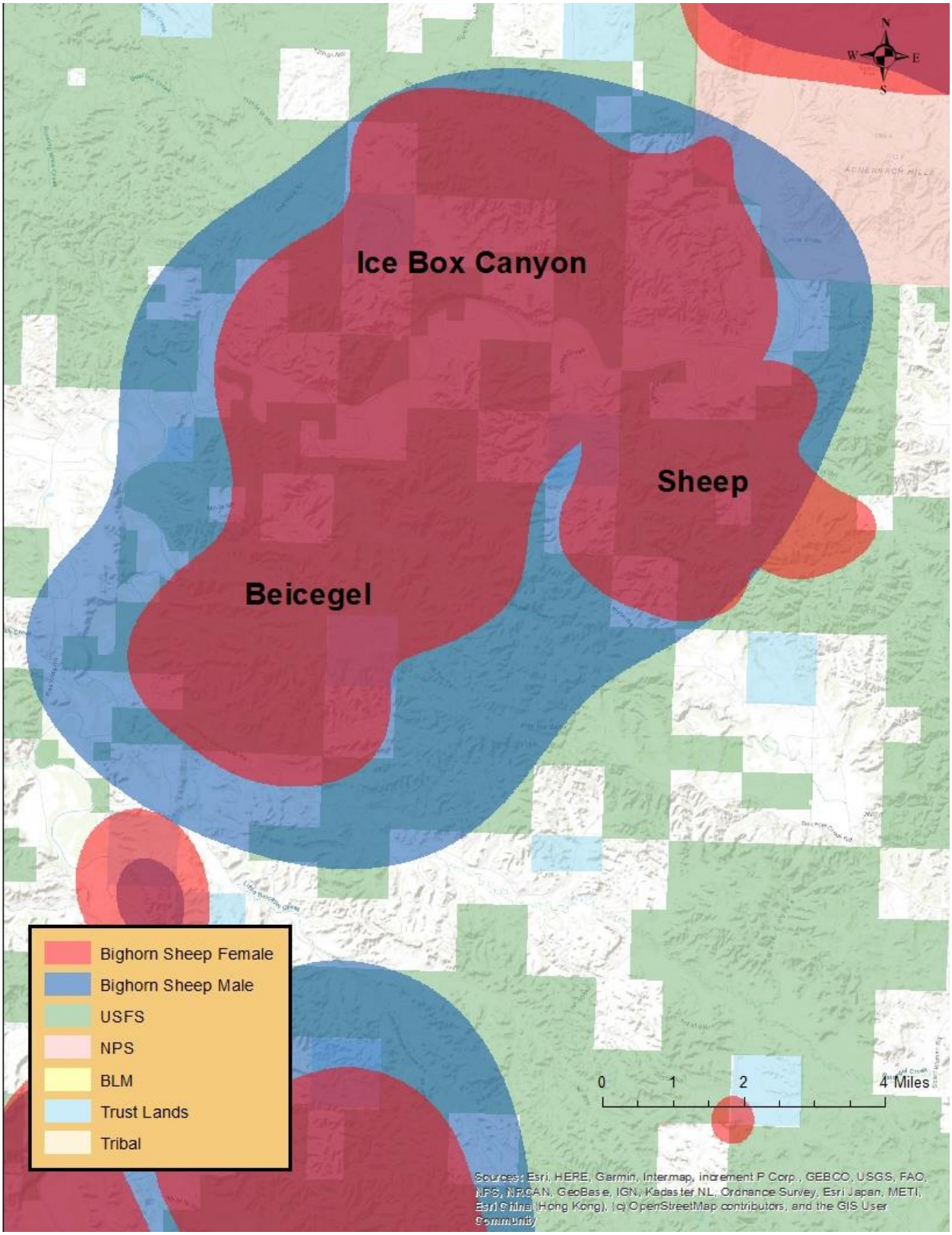


Figure 17. Distributions of male and female bighorn sheep comprising the Sheep Creek Herd (established in 1987), Ice Box Canyon Herd (established circa 1996), and Beicegel Creek Herd (established in 2007) from dates of founding to 2023.

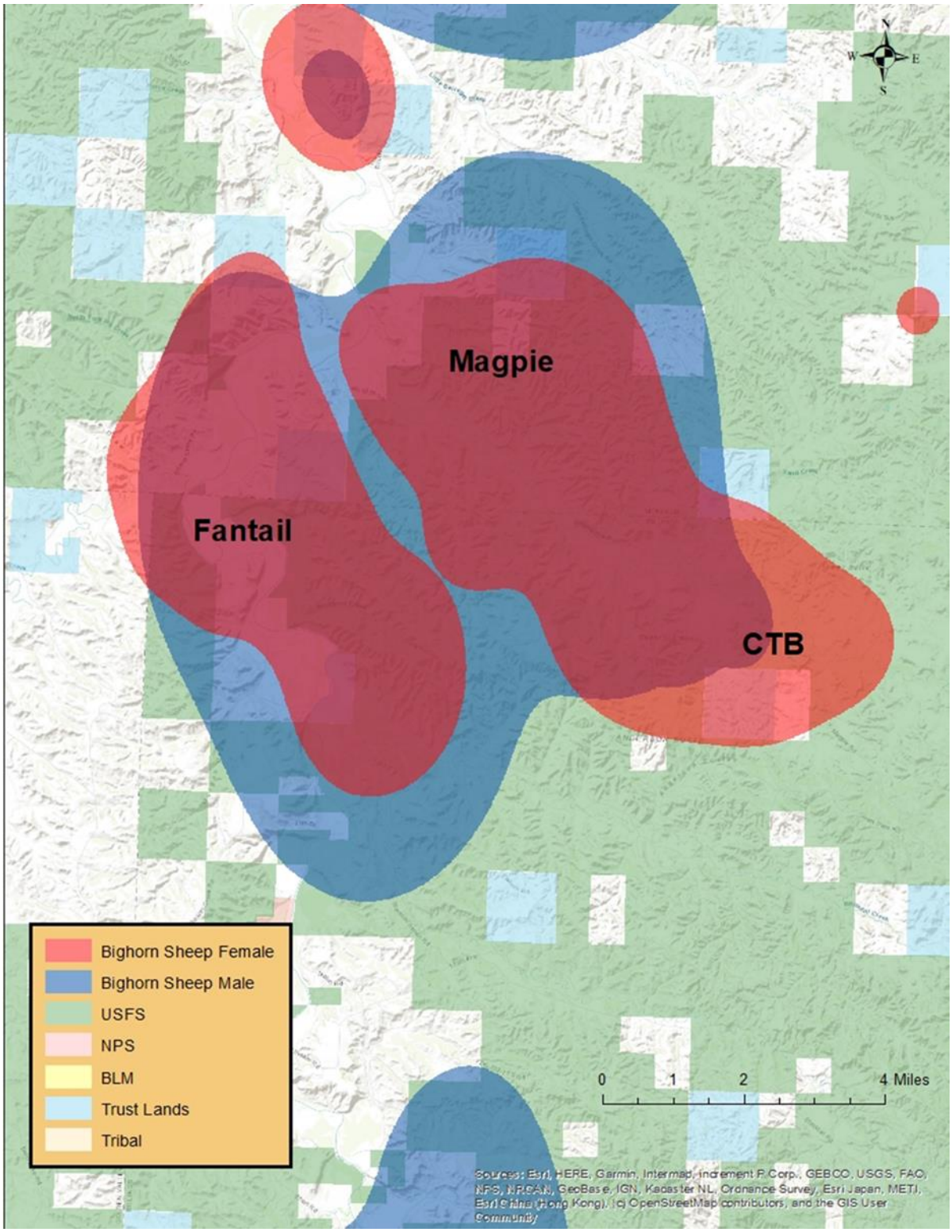


Figure 18. Distributions of male and female bighorn sheep comprising the Magpie Creek Herd (established in 1956), Cedar Top Butte Herd (established circa 2004), and Fantail Creek Herd (established 2004) from dates of founding to 2023.

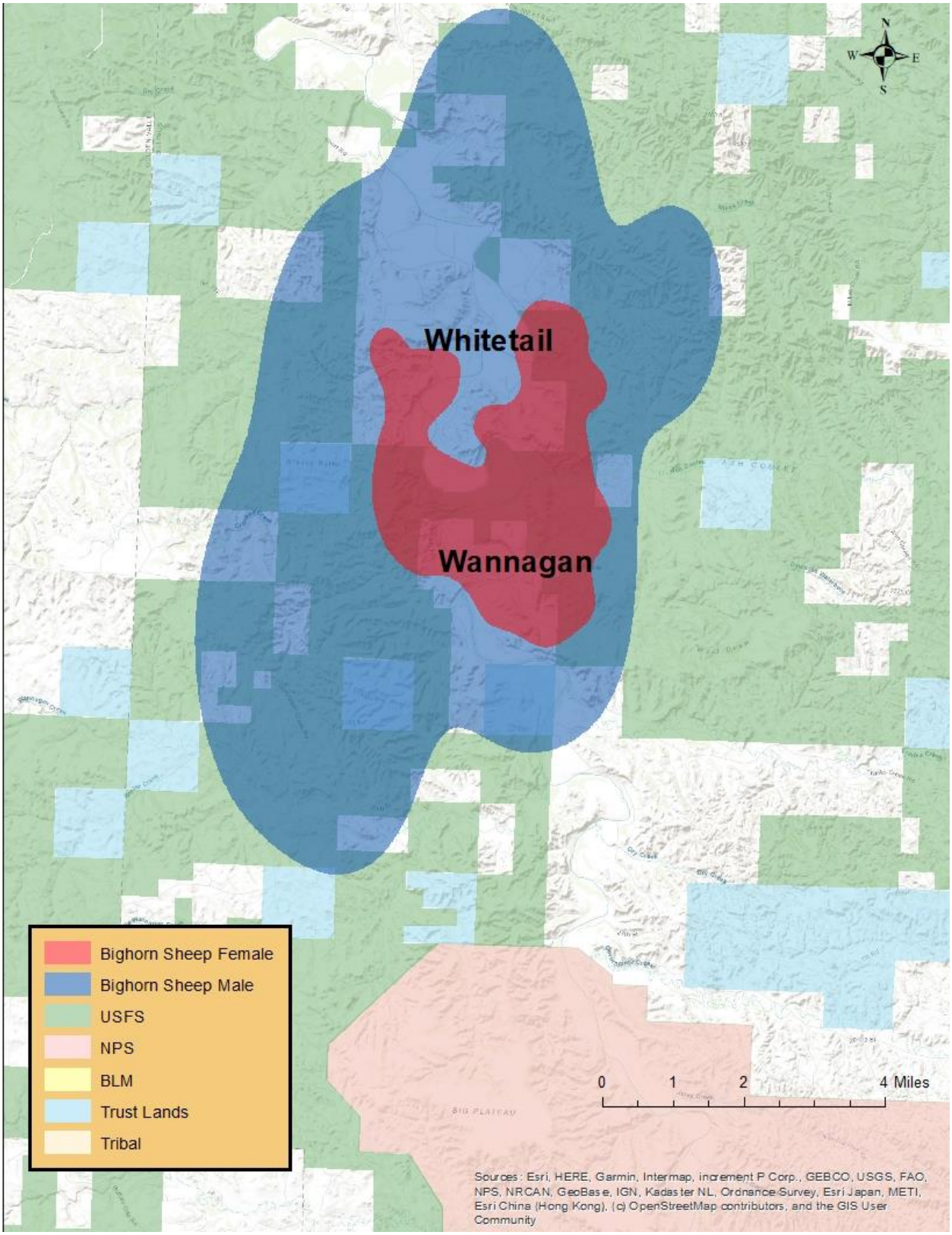


Figure 19. Distributions of male and female bighorn sheep comprising the Wannagan Creek Herd (established in 1991) and the Whitetail Creek Herd (established in 2008) from dates of founding to 2023.

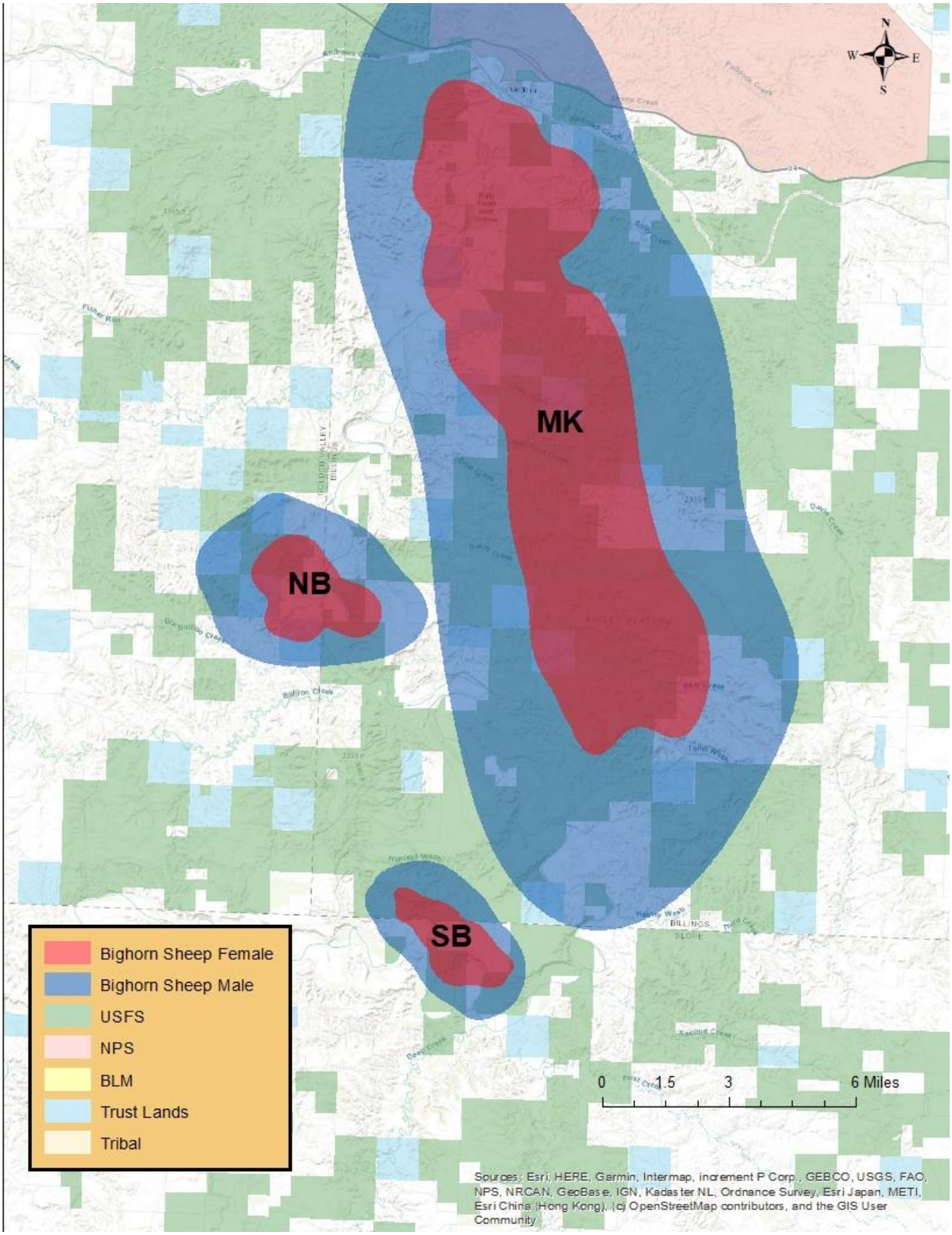


Figure 20. Distributions of male and female bighorn sheep comprising the North-South Bullion Butte Herd (established in 1989) and the Moody-Kendley Plateau Herd (established in 2003) from dates of founding to 2023.

Table 4. Home ranges of bighorn sheep (*N*=12 herds) in the northern metapopulation (north of Interstate 94) from 2020–2023.

| Herd[1] | Females (mi$^2$) | Lambing (mi$^2$) | Males (mi$^2$) |
|---|---|---|---|
| Burnt Creek | 9.7 | 7.4 | NA |
| BLM | 11.5 | 8.1 | 29.9 |
| Killdeer WMA | 5.2 | 6.0 | NA |
| Long X | 6.3 | 6.1 | 47.1 |
| Sheep Creek | 3.2 | 2.5 | NA |
| Ice Box Canyon | 8.4 | 7.0 | 41.1 |
| Beicegel Creek | 5.6 | 4.1 | NA |
| Magpie Creek | 9.5 | 7.9 | 29.0 |
| Cedar Top Butte | 4.2 | 4.0 | NA |
| Fantail Creek | 4.4 | 3.5 | NA |
| Wannagan Creek | 1.8 | 0.9 | 23.6 |
| Whitetail Creek | 14.6 | 9.2 | NA |
| **Mean (SD)** | 7.0 (±3.6) | 5.6 (±2.4) | 34.1 (±8.6) |

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

Table 5. Home ranges of bighorn sheep (*N*=2 herds) in the southern metapopulation (south of Interstate 94) from 2020–2023.

| Herd[1] | Females (mi$^2$) | Lambing (mi$^2$) | Males (mi$^2$) |
|---|---|---|---|
| Moody-Kendley | 15.5 | 12.1 | 28.3 |
| North-South Bullion | 10.2 | 9.3 | NA |
| **Mean (SD)** | 12.9 (±2.7) | 10.7 (±1.4) | NA |

[2] 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, and 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, like that found in North Dakota, could support a density of 10.0 individuals/mi$^2$, or a total of 12.5 mi$^2$ of potential habitat to support a MVP of 125 bighorn sheep. Holl (1982) and McKinney et al. (2003) reported that the quantity of escape terrain—which in North Dakota is represented by or is described as lambing habitat—is a more meaningful determinant of carrying capacity than is forage availability. Because the quantity of lambing habitat (Fig. 21) is the primary limiting factor in North Dakota, we used lambing HRs of females from extant herds (99% isopleth, April – August) to determine population goals for each of the herds (Zeigenfuss et al. 2000). We also estimated goals for areas that currently are unoccupied but where future introductions are planned (Figs. 22 and 23).

Using these methods, we calculated 10 females/mi$^2$ for lambing HRs to estimate carrying capacity for females in each herd, and then used half that total to determine population goals for females in each of those herds. 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 anticipated in those areas. We then applied a ratio of 55 males per 100 females to determine population goals for males. Based on these criteria, the management goal for the number of bighorn sheep in the Grassland of North Dakota is 794 individuals (283 males and 511 females (Tables 6 and 7).

Figure 21. The quantity of lambing habitat is the primary limiting factor for abundance of bighorn sheep in North Dakota.

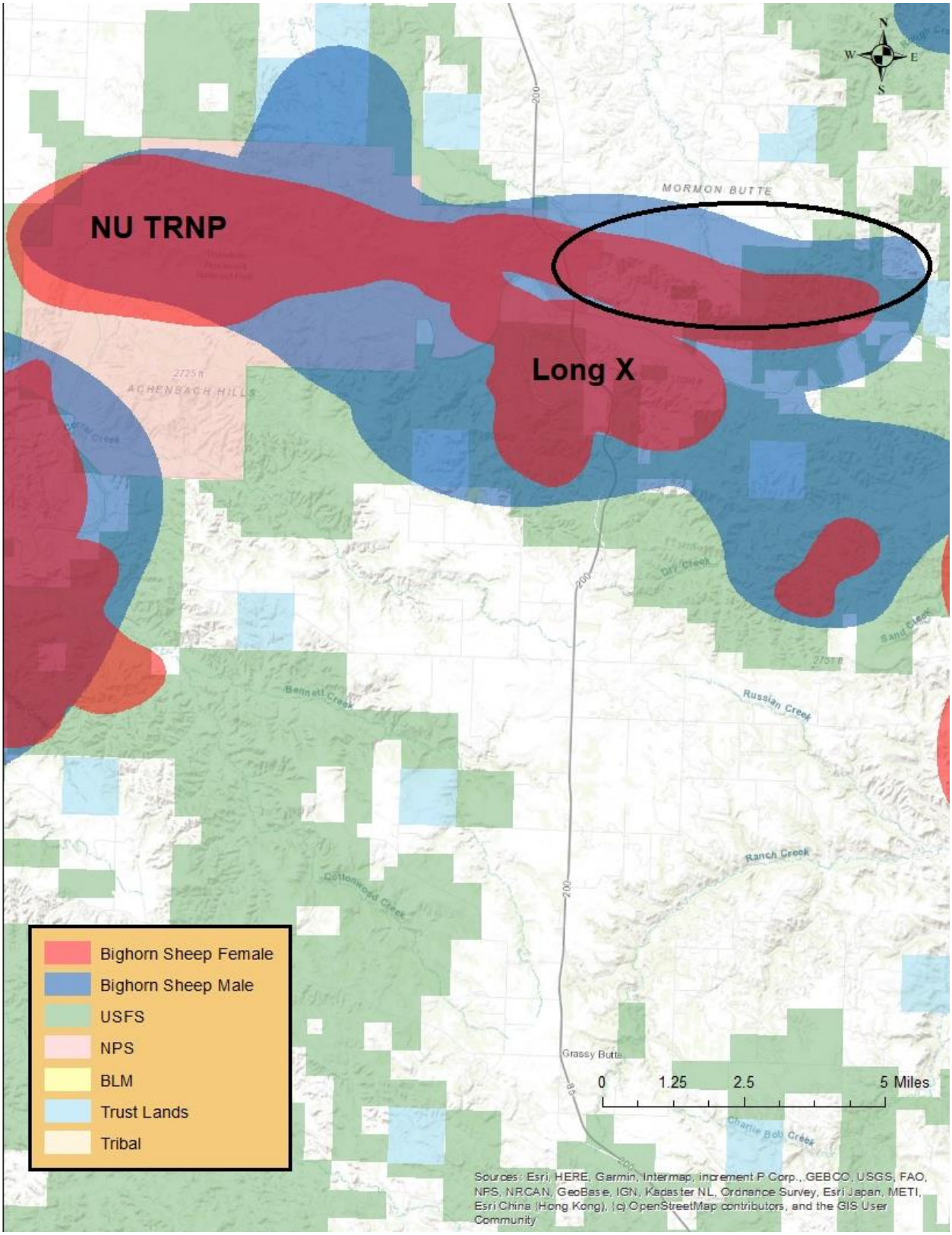


Figure 22. The ellipse represents the general area of a potential introduction at Morman Butte near the NUTRNP and Long X herds of bighorn sheep.

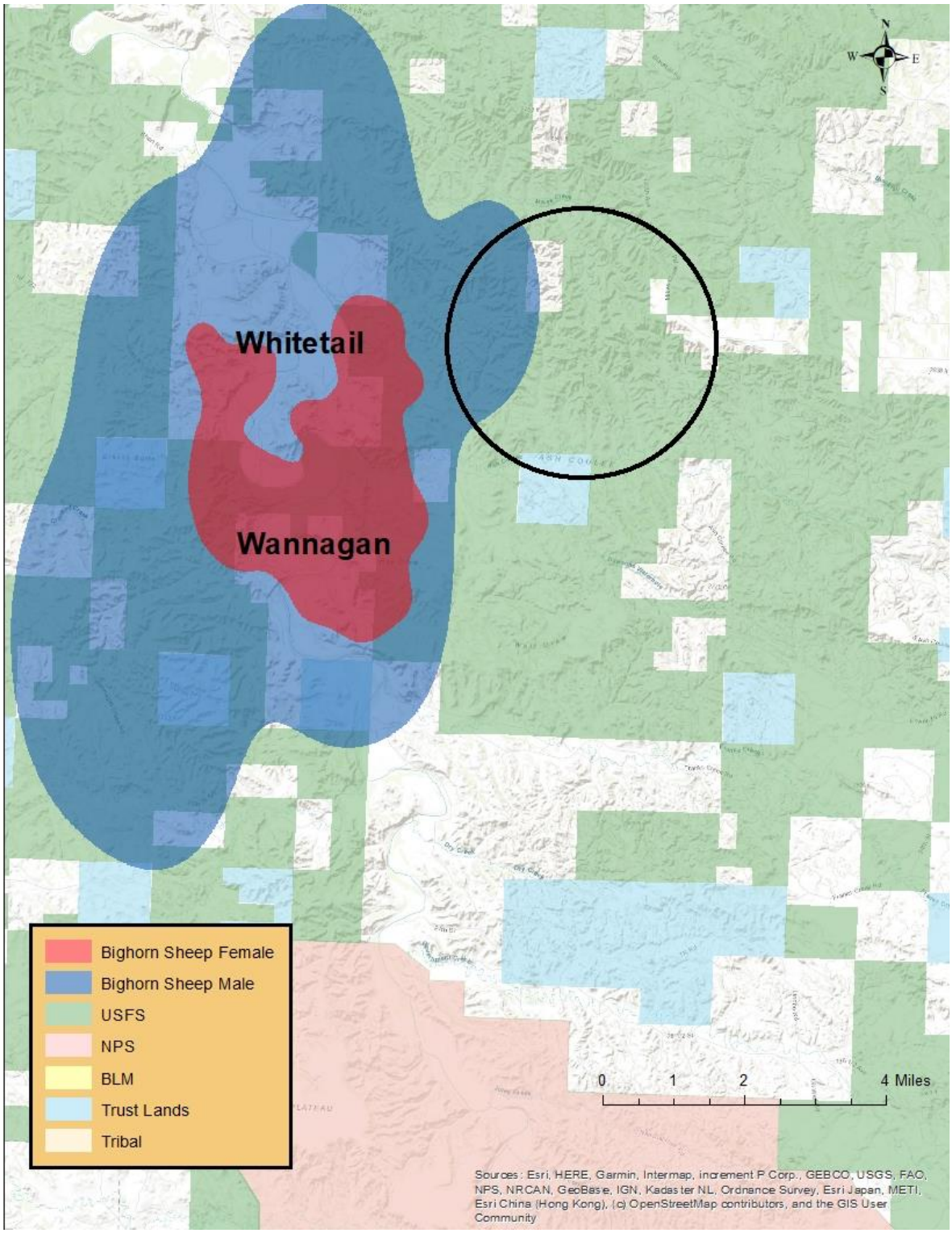


Figure 23. The ellipse represents the general area of a potential introduction at Mikes Creek, near the Wannagan and Whitetail herds of bighorn sheep.

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

| Herd[1] | 2023 Males | 2023 Females | 2023 Lambs | 2023 Total | Goal: Males | Goal: Females | Goal: Total |
|---|---|---|---|---|---|---|---|
| Burnt Creek | 12 | 15 | 6 | 33 | 20 | 37 | 57 |
| BLM | 13 | 28 | 9 | 50 | 23 | 41 | 64 |
| Killdeer WMA[2] | 1 | 9 | 0 | 10 | 17 | 30 | 47 |
| Long X[3] | 17 | 30 | 10 | 57 | 22 | 40 | 62 |
| Morman Butte[4, 7] | 0 | 0 | 0 | 0 | 22 | 40 | 60 |
| Sheep Creek[5] | 2 | 21 | 5 | 28 | 14 | 25 | 39 |
| Ice Box Canyon[6] | 19 | 28 | 5 | 52 | 19 | 35 | 54 |
| Beicegel Creek | 4 | 18 | 9 | 31 | 22 | 40 | 62 |
| Magpie Creek | 22 | 15 | 0 | 37 | 22 | 40 | 62 |
| Cedar Top Butte | 1 | 13 | 4 | 18 | 11 | 20 | 31 |
| Fantail Creek | 1 | 4 | 3 | 8 | 10 | 18 | 28 |
| Whitetail Creek | 1 | 10 | 3 | 14 | 17 | 30 | 47 |
| Mikes Creek[7] | 0 | 0 | 0 | 0 | 17 | 30 | 47 |
| Wannagan Creek | 9 | 3 | 1 | 13 | 8 | 15 | 23 |
| **TOTAL** | **102** | **195** | **55** | **352** | **244** | **441** | **685** |

[1]Color denotes connectivity among herds via movements of males.
[2]Includes Killdeer WMA and Crosby Creek.
[3]Includes Long X and Summit Creek.
[4]Morman Butte is currently unoccupied. All individuals from his herd were translocated to Burnt Creek and Magpie Creek in February 2013 due to vehicles collisions on HW85. [4]
[5]Includes Bennett Creek and Sheep Creek.
[6]Includes Bowline Creek, Bummer Creek, Ice Box Canyon, and Red Wing Creek.
[7]Proposed area for introduction via translocation.

Table 7. Population goals for bighorn sheep in the southern metapopulation (south of Interstate 94)[1].

| Herd[2] | 2023 Males | 2023 Females | 2023 Lambs | 2023 Total | Goal: Males | Goal: Females | Goal: Total |
|---|---|---|---|---|---|---|---|
| Moody-Kendley[3] | 0 | 2 | 0 | 2 | 17 | 30 | 47 |
| North-South Bullion | 4 | 3 | 1 | 8 | 22 | 40 | 62 |
| **TOTAL** | **4** | **5** | **1** | **10** | **39** | **70** | **109** |

[1]Due to proximity of domestic sheep, management actions have ceased in the southern metapopulation, and these goals are currently unachievable.
[2]Color denotes connectivity among herds via movements of males.
[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 ~$3,000 per animal – and often have failed or not met objectives (Fig. 24). Therefore, a translocation program 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.

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 translocate 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 the Federal Aid in Wildlife Restoration (Pittman-Robertson) Program have been instrumental in accomplishing translocation projects that have occurred in North Dakota.

Since 1956, NDGF has completed 11 additional interstate translocations totaling 224 individuals (50 males, 174 females) from sources in Alberta, British Columbia, Idaho, Montana, and Oregon (Fig. 25). 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, and the Three Affiliated Tribes Fish and Wildlife Division introduced 30 bighorn sheep (5 males, 25 females) from Rocky Boy's Reservation in central Montana to the Fort Berthold Reservation in 2020. Animals from 10 of 12 interstate translocations were released directly from transport vehicles (hard-release; 43 males, 173 females), and two groups were released into enclosures (soft release; 12 males, 16 females).

NDGF has conducted a total of 47 intrastate translocations from 1959 to 2023 (Fig. 26) totaling 260 individuals (89 males, 171 females). Twenty-two of those translocations (30 males, 59 females) included moving animals among four captive sources; 12 others included hard-releases (34 males, 30 females) from captive sources, and 13 included capturing free-ranging stock (25 males, 82 females) from intrastate sources and subsequent hard releases elsewhere in the state. Use of stock from captive sources was abandoned in 1992 in favor of free-range stock from inter- and intrastate sources.

Much of the bighorn range in North Dakota currently is occupied; however, most herds are below population objectives. Further, introductions to unoccupied habitat at Morman Butte (Fig. 22) and Mikes Creek (Fig. 23) are planned. Similar to most

wildlife agencies, translocations will remain a fundamental part of NDGF's management strategy for bighorn sheep.

Figure 24. Capturing bighorn sheep using net-guns fired from helicopters is expensive, but generally has been a safe and cost-effective technique.

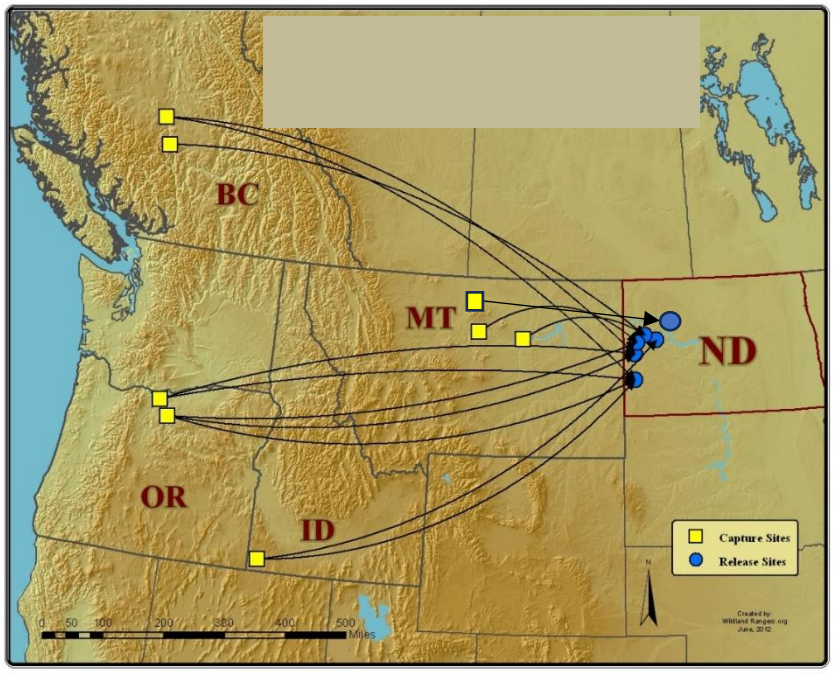


Figure 25. Interstate translocations of bighorn sheep to North Dakota, 1956–2023 (courtesy WAFWA Wild Sheep Working Group).

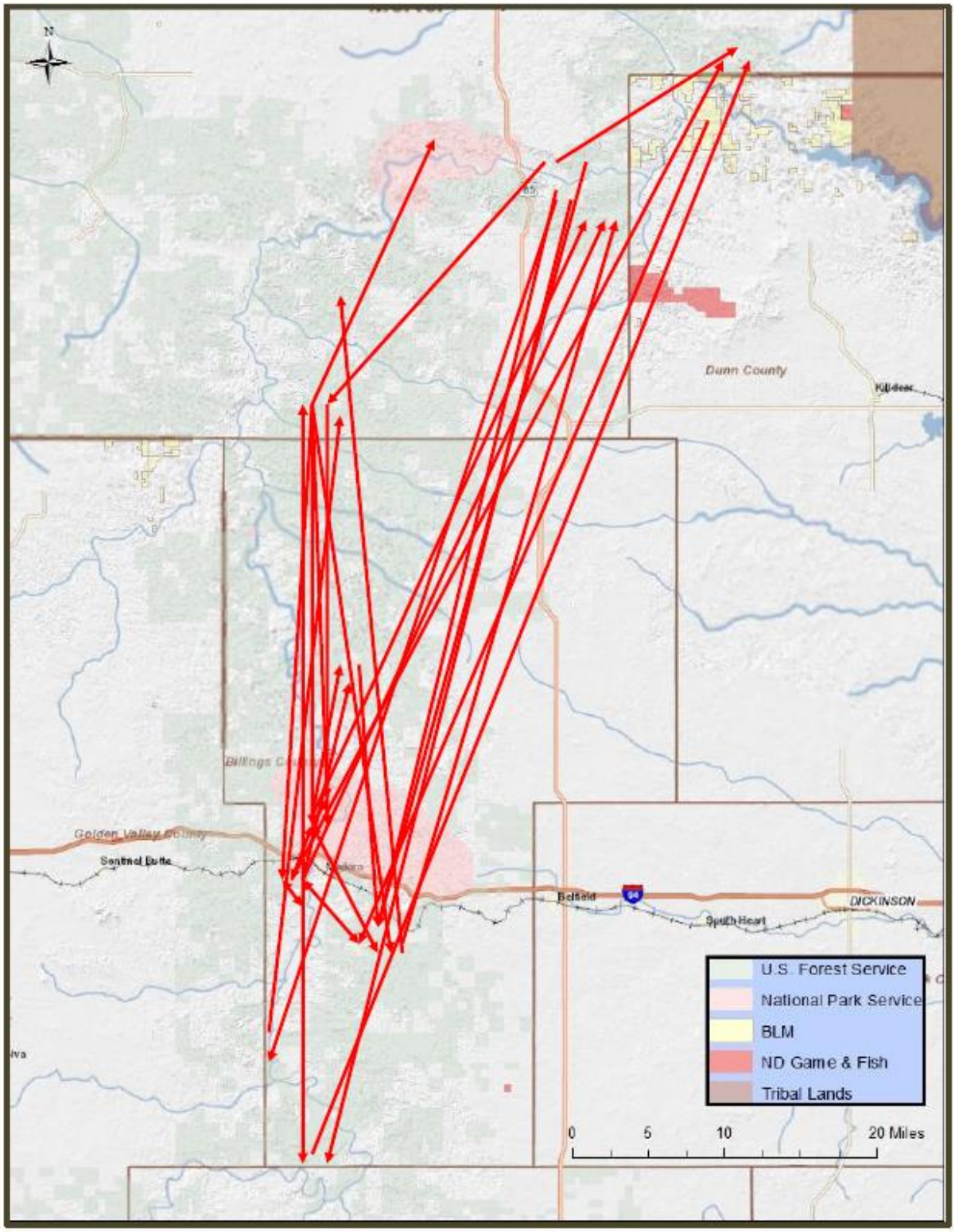


Figure 26. Intrastate translocations of bighorn sheep conducted in North Dakota, 1959–2023.

## Translocation Guidelines

General guidelines for the capture and translocation of North American wild sheep recently were revised and have been published by the Western Association of Fish and Wildlife Agencies. The following relate specifically to North Dakota:

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 the removal of too many individuals from source populations.
7. Source populations should have an acceptable health history, and populations with recent episodes of disease should not be used for translocation stock;
8. Translocated stock should be closely monitored for at least one year by deploying GPS radio-collars to provide location and survival information;
9. A translocation database should be developed, maintained, and should include histories of disease outbreaks.

## 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 Montana have fared much better in North Dakota's continental climate than smaller-bodied stock indigenous to a milder region in southcentral 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 are 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. Intrastate sources should be used sparingly to ensure removals do not jeopardize long-term viability of those populations. Few populations in North Dakota are large enough to exploit for

translocation stock and intrastate sources should be used with caution.

## Establishing New Populations

1. The persistence and health of extant populations must take precedence over establishing new populations;
2. Preference should be given to those areas that provide the highest quality habitat and where bighorn sheep are most likely to thrive, rather than USFS 3.51s, which are areas that were arbitrarily designated as bighorn sheep "management areas" in the USFS's most recent Dakota Prairie Grasslands Management Plan (USFS 2001);
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 likely 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 strategy 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 and lamb pair-bonds are broken much earlier than in other species of 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 ≤300 m from escape terrain and they should preferably travel uphill;
7. Animals should be allowed to leave trailers passively, 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 and females employ differing life history strategies and they are segregated from each other during most of the year. These strategies are profoundly different in terms of their potential effects on conservation. Thus, there are advantages to maintaining the integrity of ranges used by males or females for the majority of the year, and such should be a consideration when identifying locations to which bighorn sheep may be introduced;

10. All translocated stock from intra- and interstate sources should be fitted with GPS radio-collars and monitored closely post-release;
11. Domestic sheep should be ≥16 km from release sites where substantial barriers to separation are not present (Singer et al. 2000);
12. Stock should not be introduced ≤16 km 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;

13. Because bighorn sheep males travel substantial distances between subpopulations of females within a metapopulation, 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. Male bighorn sheep must be able to travel among subpopulations of bighorn sheep females without encountering domestic sheep;
14. Precedence should be given to those areas where most bighorn sheep habitat occurs on public land (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 proposed 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 intend to acquire domestic sheep in the future;
    - Ensure that nearby landowners will not be opposed to introduced bighorn sheep that may appear on their property;
    - Ensure that nearby landowners will allow hunting of bighorn sheep when NDGF determines that introduced populations can be hunted;
    - Ensure that NDGF personnel can access private property during annual surveys or to investigate mortalities;

15. NDGF should assume all risks associated with the potential 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 (Fig. 27; Appendix B);
16. 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 develop a cohort of mature males, and to allow translocated males several years to tend females.

Figure 27. 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 sheep herds.

## Augmenting Extant Populations

1. Adhere to criteria 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 (i.e., cougars) from areas where there are continuing losses of bighorn sheep to predation (Fig. 28). 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 USDA Wildlife Services personnel can remove cougar(s) from those areas;
    c. Vehicle mortality – Do not augment populations that have experienced frequent losses to vehicle collisions until structures are in place that reduce the likelihood that introduced stock will wander onto roads (Fig. 29);
    d. Habitat – Do not augment populations occupying habitat where juniper encroachment has substantially reduced high-visibility areas, or access to good quality forage cannot support greater numbers of bighorn sheep.

Figure 28. Bighorn sheep are vulnerable to cougar predation, especially small, fragmented populations like those found in North Dakota.

Figure 29. GPS locations from bighorn sheep were critically important in determining the location of a wildlife crossing near the Long X Bridge on Highway 85 in McKenzie County, 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 and Management Act, Sikes Act, Wilderness Act, and USFS policies, the USFS and state wildlife agencies share authority for managing wildlife occupying USFS lands. State wildlife agencies have jurisdiction over managing wildlife populations on those lands, whereas the USFS has jurisdiction over managing habitats on those lands.
    b. Bighorn sheep occupying the Little Missouri National Grassland are managed in accordance with the USFS's current Land and Resource Management Plan (Plan). The Plan assigns special Management Areas (3.51, 3.51A, 3.51B) specifically for bighorn sheep. Nevertheless, management directives and stipulations within most MA 3.51s are limited; for example, areas identified as MA 3.51B are managed for greater levels of oil and gas leasing within bighorn sheep range. Moreover, many bighorn sheep within the Grassland occupy other than areas identified as MA 3.51, 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). Further, 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,

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 areas designated MA 3.51.

2. Bureau of Land Management (BLM):
    a. Management of bighorn sheep on BLM lands is like 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 40 bighorn sheep occupy NU TRNP.
    b. The NPS has jurisdiction over the management of bighorn sheep within TRNP; however, NDGF routinely collaborates with the NPS in management efforts in or around TRNP as bighorn sheep frequently travel among NPS lands and those under other management jurisdictions, including private lands (Fig. 30).
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 30. Bighorn sheep occupy the North Unit of Theodore Roosevelt National Park, but range in and out of that area. 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 five years (1980–1983, 2015), hunting seasons have been held annually since. Hunting licenses are once-in-a-lifetime and issued via a lottery. In 1986, NDGF began offering one license to be auctioned to the highest bidder through the Wild Sheep Foundation to generate more funding for the management of bighorn sheep in the state (Fig. 31). NDGF subsequently signed a management partnership with the Wild Sheep Foundation – Midwest Chapter in 1999, and that group has auctioned North Dakota's fund-raising license annually since. From 1986 to 2024, the auction license has raised $2,208,500 (annual range $17,000–$226,000) for management projects in the state (Fig. 32). One hundred percent of the purchase price of the auction license is remunerated to NDGF for management of bighorn sheep, and a 5% buyer's fee is remunerated to WSF – Midwest Chapter. Since 1986, 37 of 38 auction hunters (97.4%) have been successful in harvesting a ram.

Hunting bighorn sheep has been restricted to males-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. NDGF issued 276 bighorn sheep licenses from 1975 to 2023, and 270 (97.8%) of those hunters were successful. Although hunters were required to hunt with

NDGF personnel during the first several seasons, hunters now are encouraged to 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. 33). 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 annual lottery. NDGF does not offer preference points for bighorn sheep. In 2023 there were four hunting units (Fig. 34).

All hunters must register harvested rams with 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 possessed in North Dakota, regardless of where they were harvested or collected, must be identified in the same manner. Possession of bighorn sheep skulls without a valid hunting license is prohibited in North Dakota. To discourage poaching, NDGF does not issue permits to individuals who find bighorn sheep skulls; such skulls must be surrendered to NDGF, and most are then donated to worthy organizations for educational purposes.

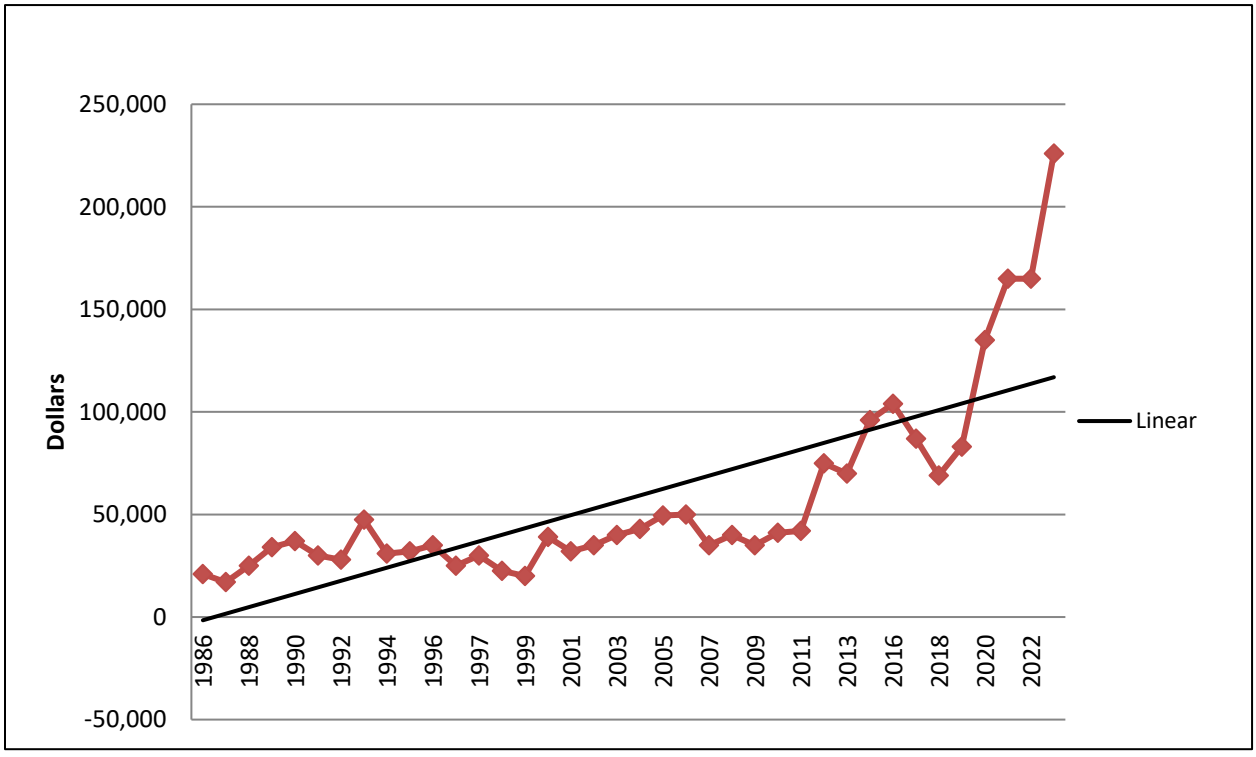


Figure 31. North Dakota's auction license has raised more than two million dollars for management of bighorn sheep, 1986–2024.

Figure 32. Since 1986, revenue from the state's auction license has been the primary source of funding for North Dakota's bighorn sheep management program.

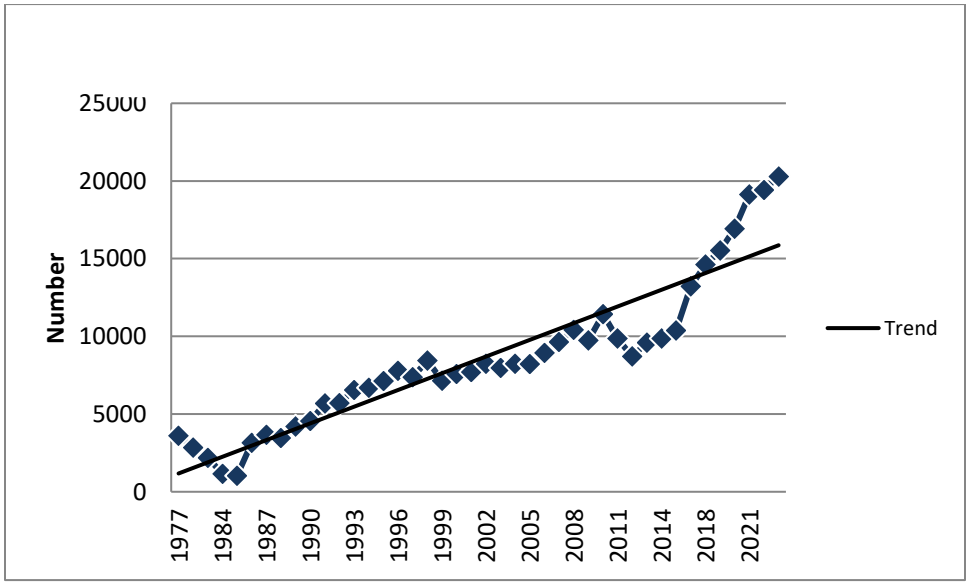


Figure 33. Interest in hunting bighorn sheep in North Dakota is evidenced by the number of applicants for lottery licenses, 1975 – 2023.

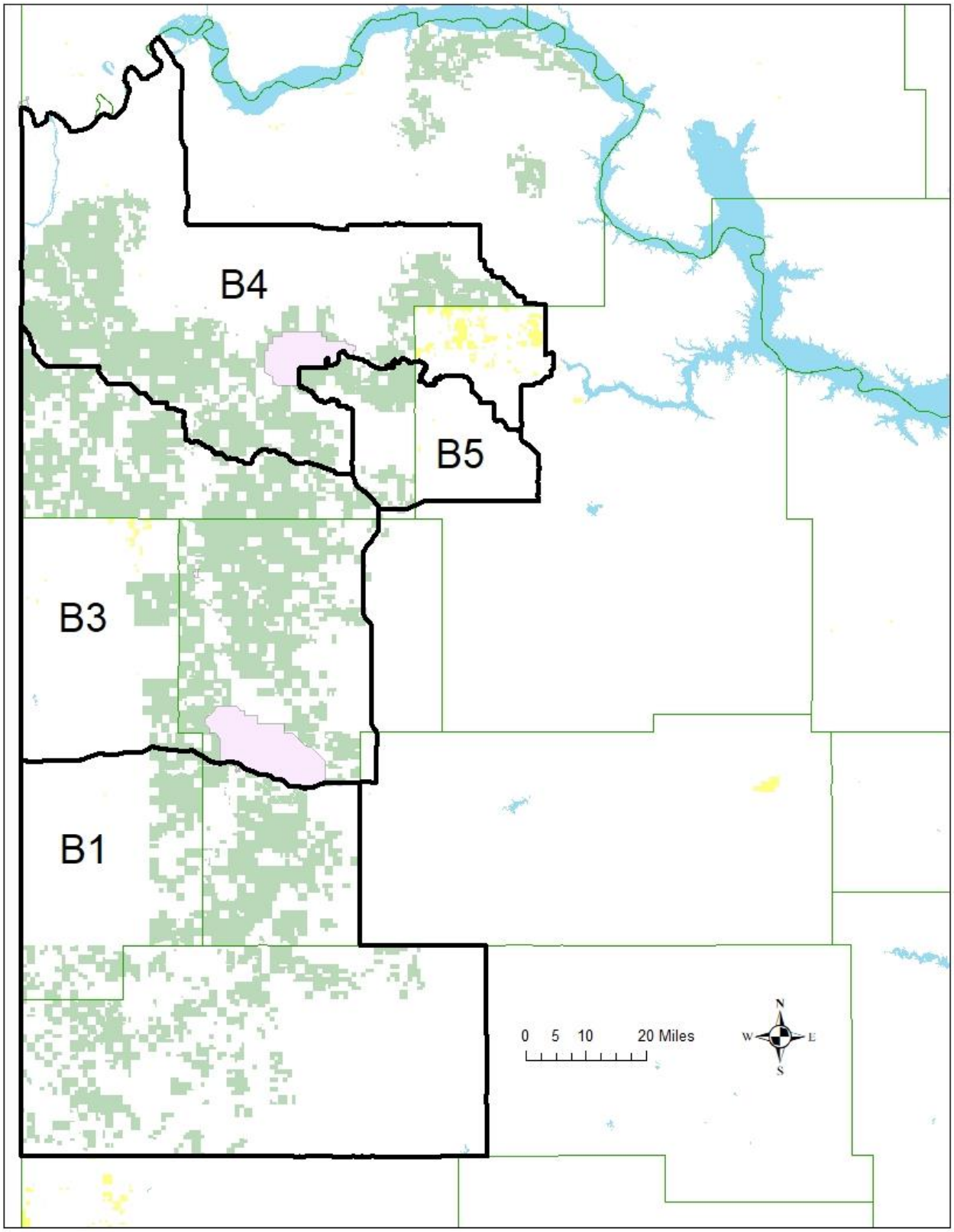


Figure 34. North Dakota bighorn sheep hunting units during 2023.

## Harvest Methodology

Bighorn sheep generally occur 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, Nevada, 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 12 by 2034 (Table 8).

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

Three primary factors are considered when determining the number of hunting licenses issued annually: abundance of males; age structure of the male cohort; and the ratio of males to females. These data are collected during the annual census and then are used to determine the number of licenses to be issued. There is no *one size fits all* method for setting the number of bighorn sheep licenses, but the following criteria are 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 should not 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 below:
    - 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 the male to female ratio is 0.55:1.0 (Fig. 35);
3. The goal for mean age of harvested rams is ≥7 years;
4. Although there is no goal for horn size, the long-term trend using the Boone & Crockett scoring system is recorded and revised annually.

Table 8. Recent history, and the 2034 goal for bighorn sheep hunting licenses in North Dakota.

| Year | Total Males[1] | Hunters | Hunter Days | Days/hunter | Harvest | Hunter Success % |
|---|---|---|---|---|---|---|
| 2013 | 85 | 4 | 10 | 12.0 | 4 | 100 |
| 2014 | 82 | 5 | 14 | 9.6 | 5 | 100 |
| 2015 | 88 | 0 | NA | NA | NA | NA |
| 2016 | 104 | 8 | 17 | 4.8 | 8 | 100 |
| 2017 | 91 | 5 | 15 | 9.0 | 5 | 100 |
| 2018 | 84 | 3 | 12 | 17.3 | 3 | 100 |
| 2019 | 77 | 5 | 10 | 9.6 | 5 | 100 |
| 2020 | 97 | 6 | 26 | 17.0 | 6 | 100 |
| 2021 | 99 | 5 | 33 | 18.8 | 4 | 80 |
| 2022 | 96 | 5 | 16 | 10.4 | 5 | 100 |
| 2023 | 106 | 6 | 25 | 4.2 | 6 | 100 |
| **2034** | **153** | **12** | **TBD** | **TBD** | **12** | **100** |

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

[2]2034 projection based on population growth of extant populations, and potential introductions at Moody Plateau, South Bullion, Mikes Creek, and Morman Butte.

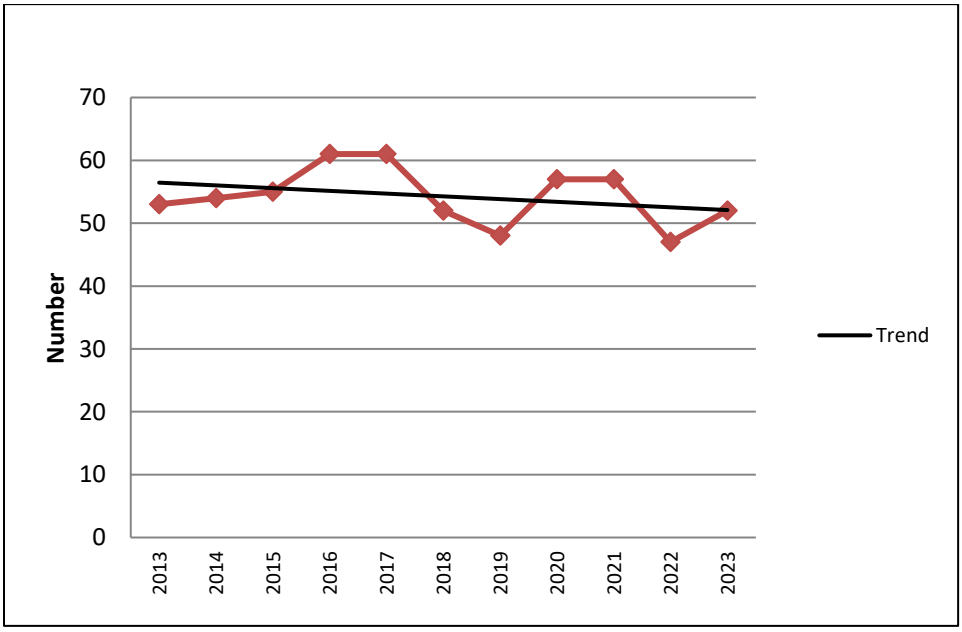


Figure 35. The ratio of males to females in North Dakota has exhibited a slight downward trend, 2013 – 2023.

# HEALTH MONITORING

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

**Bronchopneumonia** – Although much remains unknown about the precise mechanisms that cause acute bronchopneumonia in populations of wild sheep following association with domestic sheep or goats, recent research clearly has demonstrated that virulent strains of *Mycoplasma ovipneumoniae* likely are precursors that facilitate causative agents leading to epizootics in populations of wild sheep. Thus, the virulence of *M. ovipneumoniae* likely intensifies when it persists in conjunction with particular strains

of *Mannheimia haemolytica*, *Pasteurella multocida*, and *Bibersteinia trehalosi*. Consequently, multi-bacterial respiratory disease associated with these organisms is widely regarded as the factor most threatening populations of wild sheep in North America. This, in part, is 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 wild sheep.

Respiratory disease in wild sheep 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, disturbances of various types, and atmospheric dust (e.g., dust from gravel roads). Minimizing the presence of such stressors may result in healthier wild 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 reduce the probability of disease transmission from domestic sheep or goats to wild sheep:

1. Wildlife agencies should:
    - Assess wild sheep conservation value or status and complete risk assessments of interspecies contact in a metapopulation context;
    - Remove wild sheep that likely have associated with domestic sheep or goats and develop a policy to promptly respond to wild sheep wandering from occupied ranges of wild sheep (Appendix B);
    - Thoroughly explore and consider the demographic consequences of translocations and conduct appropriate analyses of habitat suitability and risk of disease transfer prior to implementing translocations;
    - Coordinate with other agencies, landowners, and interested 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 or regulations associated with private and public lands used for production of domestic sheep or goats;
    - Develop educational materials and outreach programs that describe 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 or tenures within

wild sheep habitat. For example, domestic sheep and goats should not graze on USFS, BLM, or state lands within 16 km of bighorn sheep range in North Dakota;

- Ensure that annual operating instructions or their equivalent include measures to minimize domestic sheep association with wild sheep, and confirm and implement 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 or extension efforts to all parties;
    - Negotiate alternatives and incentives for domestic sheep or goat grazers on private or public land to find alternative grazing areas disjunct from wild sheep habitat;
    - Advocate for and support research concerning diseases and risk of transmission associated with domestic sheep or goats in proximity to wild sheep.
4. Domestic sheep and goat permittees or owners should:
    - Implement best management practices (BMPs) to prevent straying by domestic sheep or goats and 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 for or observations of association between domestic sheep or goats and wild sheep to local wildlife agencies.

Respiratory disease 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 sheep range. Since 1999, NDGF has collected biological samples from all harvested males and mortalities of radio-marked animals (Fig. 36).

Figure 36. Disease sampling is collected opportunistically from translocation source-stock, harvested rams, and mortalities of radio-marked animals.

Nasal and tonsillar swabs collected from dead bighorn sheep are sent to diagnostic labs for the detection of virulent pathogens. Translocated stock from inter-state sources are also tested for pathogens.

**Verminous Pneumonia** – Verminous pneumonia is a parasitic disease caused by the lungworms *Protostrongylus rushi* and *P. stilesi*. Although lungworm is a naturally occurring parasite, population-level consequences to bighorn sheep can occur when individuals become burdened with high lungworm loads. *P. stilesi* can be especially troublesome because transplacental transmission of larvae occurs and may lead to acute pneumonia among neonates. *P. stilesi* can also lead to what is commonly referred to as "summer pneumonia," whereby 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 multi-bacterial pneumonia 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 medicated feed, attempts in North Dakota were ineffective, may have increased lungworm loads through concentrating animals, and risk the development of anthelmintic resistance with lungworm populations. Therefore, reducing population densities via translocations or hunting likely are more effective at reducing the impacts of lungworm infestations than are anthelmintics.

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 a disease believed to be caused by bacterial infections facilitated by infestations 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, North Dakota Game and Fish Department, personal communication), and bighorn

sheep have been observed with behaviors consistent with animals suffering from sinusitis, but it has not been documented among bighorn sheep in North Dakota.

**Bluetongue and EHD** – Epizootic Hemorrhagic Disease (EHD) and bluetongue are transmitted by a biting gnat (*Culicoides variipennis*) that is most prevalent during years with wet spring weather followed by a hot, dry summer. Bluetongue can be fatal to bighorn sheep but apparently is rare with only a few cases having been confirmed in three states. A single mortality caused by EHD has been documented in North Dakota's population of bighorn sheep, but it is not a limiting factor.

**Johne's Disease** – Paratuberculosis is caused by *Mycobacterium paratuberculosis* and apparently is rare in bighorn sheep. Clinical signs include emaciation, diarrhea, and submandibular edema (i.e., bottle jaw). Infected individuals may shed bacteria in their feces over a period of many 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 secondarily may be fatal to nursing lambs that are not permitted to suckle due to the discomfort the lesions cause their dams. 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 encephalopathy (TSE) that affects domestic sheep. The only TSE that has been found in free-ranging ungulates, however, is Chronic Wasting Disease (CWD), which has been detected exclusively in cervids. Scrapie has not been found in bighorn sheep.

**Brucellosis –** Brucellosis is a highly contagious bacterial disease that is typically spread via the consumption of 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 domestic 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 as an aerosol or by contact with bodily fluids. Several bighorn sheep in North Dakota were tested for bovine tuberculosis after a nearby

herd of cattle tested positive; all bighorn sheep tested negative for the disease.

# CONSERVATION STRATEGIES

## Goal

Maximize bighorn sheep populations in areas that are feasible and compatible with habitat and the presence of people; and provide unique hunting or 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 12 licenses by 2034;

## Issues and Strategies

### Issue one

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

#### Strategies

1. Work with federal and state agencies to initiate controlled burns, or mechanical removal of juniper, or both, to enhance habitat quality, especially near identified lambing areas (Figs. 37 and 38);

Figure 37. Decades of fire suppression has led to substantial encroachment of Rocky Mountain juniper throughout most of the badlands and has severely degraded wildlife habitat.

Figure 38. Prescribed fire can transform the badlands from an unproductive landscape dominated by juniper to high-quality habitat preferred by wildlife and livestock.

2. Work with private landowners to initiate controlled burns or mechanical removal of juniper, or both, 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 sheep habitat;
4. Work in conjunction with federal and state agencies, along with conservation groups such as the Wild Sheep Foundation (WSF) and Wild Sheep Foundation – Midwest Chapter, to contribute to habitat enhancement projects on federal, state, and private lands that consist of or include bighorn sheep habitat;
5. Work with WSF and WSF – Midwest Chapter to contribute to easements and hunter access programs on private lands;
6. Continue research to better define habitat characteristics preferred by bighorn sheep. Such a collaborative project is currently *in progress* by NDGF and the University of Nevada Reno;
7. Continue to work with federal agencies regarding the development and implementation of policies and practices relating to habitat management issues or actions;
8. Work with the USFS to align Bighorn Sheep MA 3.51 areas more accurately with the current distribution of bighorn sheep and eliminate those MA 3.51 areas not occupied currently by bighorn sheep and where introductions are currently not anticipated.

**Issue two**

Direct and indirect loss of habitat because of 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 relative to their impacts on bighorn sheep (Fig. 39);
2. Use NDGF's Critical Bighorn Sheep Range model (Fig. 10) and lambing HR analyses to provide information about critically important areas occupied by bighorn sheep wherein bighorn sheep are most sensitive to disturbance;
3. Work with federal and state agencies to ensure that existing bighorn sheep distribution and future range expansions are considered when proposing future oil and gas leases, rather than focusing solely on arbitrary "management areas" such as those identified as a USFS MA 3.51;

4. Provide input for proposed energy development early during the planning process;
5. Place wells ≥600 m from lambing habitat;
6. Place roads ≥200 m from lambing habitat;
7. Gate roads and pads near lambing habitat to minimize traffic not related to access for oil and gas extraction;
8. Place tank batteries ≥600 m from pads that are ≤600 m from lambing habitat to reduce vehicular activity at those sites;
9. Avoid drilling, construction, seismic exploration, surveying, and similar activities during the lambing season (April 1–July 15).

Figure 39. Construction of roads and oil wells can displace bighorn sheep from critically important habitats.

**Issue three**

Development of tourism and residential home construction within bighorn sheep habitat including trails, roads, golf courses, and other anthropogenic features, etc.

**Strategies**

1. Use NDGF's Critical Bighorn Sheep Range model (Fig. 10) and lambing HR analyses to provide information about critically important areas used by bighorn sheep and that are most sensitive to disturbance;
2. Work with federal, state and local agencies, along with private organizations that advocate tourism when proposing or constructing trails, campgrounds, housing, or other anthropogenic features;
3. Place trails, campgrounds, structures, etc., ≥600 m from lambing habitat.

**Issue four**

Disease transmission from domestic sheep and goats within bighorn sheep range.

**Strategies**

1. Monitor distribution and proximity of domestic sheep or goats to bighorn sheep range, and work with private landowners to remove domestic sheep from areas ≤16 km from bighorn sheep range;
2. Work with federal and state agencies and private landowners in efforts to eliminate the potential for association between domestic sheep or goats and bighorn sheep;
3. Provide information (e.g., Recommendations for Domestic Sheep and Goat Management in Wild Sheep Habitat) and expand public outreach regarding the seriousness of pathogen transmission from domestic sheep or goats to bighorn sheep, and the consequences thereof;
4. Provide information regarding adequate separation parameters between domestic sheep or goats and bighorn sheep;
5. Encourage private landowners to change from raising domestic sheep or goats to cattle within bighorn sheep range.

**Issue five**

Survival rates of bighorn sheep.

**Strategies**

1. Monitor distribution and proximity of domestic sheep or goats to bighorn sheep range, and work with private landowners to remove domestic sheep from areas ≤16 km from bighorn sheep range;

2. Euthanize any bighorn sheep that has likely associated with domestic sheep or goats;
3. Continue to gather information pertaining to cause-specific mortality of bighorn sheep;
4. Direct licensed hunters to harvest mountain lions from areas where predation on bighorn sheep occurs on a regular basis.

**Issue six**

Reliable and accurate census information.

**Strategies**

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

**Issue seven:**

Trap and translocate bighorn sheep within the two metapopulations.

**Strategies:**

1. Continue to identify areas where new bighorn sheep herds can be established.
2. Continue to identify extant herds that may benefit from augmentations.
3. Continue to monitor the need for and feasibility of interstate and intrastate translocation sources.

**Issue eight:**

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

**Strategies:**

1. Encourage federal and state agencies to improve the quantity and quality of forage near lambing habitat. Such actions may include the seasonal reduction in livestock grazing near lambing areas from April to July 15.

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**Appendix A. History of Bighorn Sheep Translocations in North Dakota (1956 – 2023). 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. |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 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. 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. |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 3/20/90 | Chateau De Mores | SUTRNP Enclosure #2 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | Used helicopter and net gun. |
| 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. |

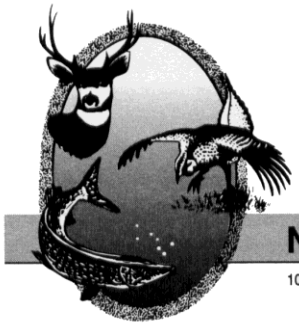
| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 1/25/95<br>2/1/95<br>2/17/95<br>3/8/95 | SUTRNP Enclosure | Wannagan Creek | 3 | 0 | 1 | 1 | 0 | 0 | 5 | Clover trapped. One adult male died within a week of release. |
| 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 |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| | | | | | | | | | | animals in good condition when released (one female died of capture myopathy). |
| 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. |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 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. |
| 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. |
| 2/12/14 | Luscar Mine, Alberta | Sheep Creek | 2 | 0 | 0 | 21 | 2 | 0 | 25 | Used helicopter and net gun. One ewe was euthanized at release site; 21 died during 2014/2015 due to pneumonia-related die-off. All VHF collars had a blue tag with unique number. |

| Date Released | From | To | Composition | | | | | | | Comments: |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | | Female | | | | |
| | | | Adt | Yrlg | Lamb | Adt | Yrlg | Lamb | Total | |
| 1/27/20 | Rocky Boy's, Montana | Fort Berthold Reservation, ND | 2 | 3 | 0 | 22 | 3 | 0 | 30 | Used helicopter and net gun. All fitted with GPS collars and in good condition when released. 3-13 released at Mandaree; 2-12 released at Twin Buttes. |

## 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** 1 May 2021

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

**JUSTIFICATION**

Domestic sheep (*Ovis aries*) are known carriers of pathogenic strains of *Mycoplasma ovipneumoniae (Movi)*, which can cause pneumonia-induced die-offs in populations of wild sheep (Besser *et al*. 2008, 2014). Mortality of bighorn sheep after exposure to *Movi* has ranged from 10 to 100% (Cassirer *et al*. 2013, 2017), and lamb recruitment can remain stagnant for decades causing long-term population declines (Manlove *et al*. 2016).

Further, domestic goats were the likely disease vector of pathogens that caused die-offs of bighorn sheep in Hells Canyon, Oregon in 1995 (Rudolph 1998) and in the southern badlands of North Dakota in 1998 (Wiedmann and Hosek 2013).

Exotic sheep and goats can also carry pathogenic strains of bacteria found in domestic and exotic sheep (Ward et al. 2002). Therefore, interactions among bighorn sheep and mouflon sheep (*Ovis orientalis; Foreyt* 1994), *Capra spp*. (goats, ibex, tur and markor), *Ammotragus lervia* (barbary sheep) and *Hemitragus* (tahr) also pose a serious threat to the health of North Dakota's bighorn sheep.

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 bighorns, especially young rams, can be prevented from wandering near domestics. Therefore, the North Dakota Game & Fish Department (NDGF) has adopted the following policy, which is similarly held by most western states and provinces, regarding incidents in which bighorn sheep interact with domestic sheep or goats.

**POLICY**

1. NDGF personnel will immediately attempt to euthanize any bighorn sheep that has interacted with domestic or exotic sheep and goats, and biological samples will be collected in conjunction with a comprehensive necropsy.
2. Any NDGF employee who observes a bighorn sheep near domestic sheep or goats 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 culled, 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 culling of a bighorn sheep if he or she deems it necessary. However, the Director, Deputy Director, Wildlife Chief or Assistant Wildlife Chief will be promptly notified following the culling of the bighorn.
5. Any bighorn sheep euthanized will be done so as discreetly as possible.
6. No bighorn sheep will be euthanized on private property without first notifying the landowner and providing the landowner with 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.

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