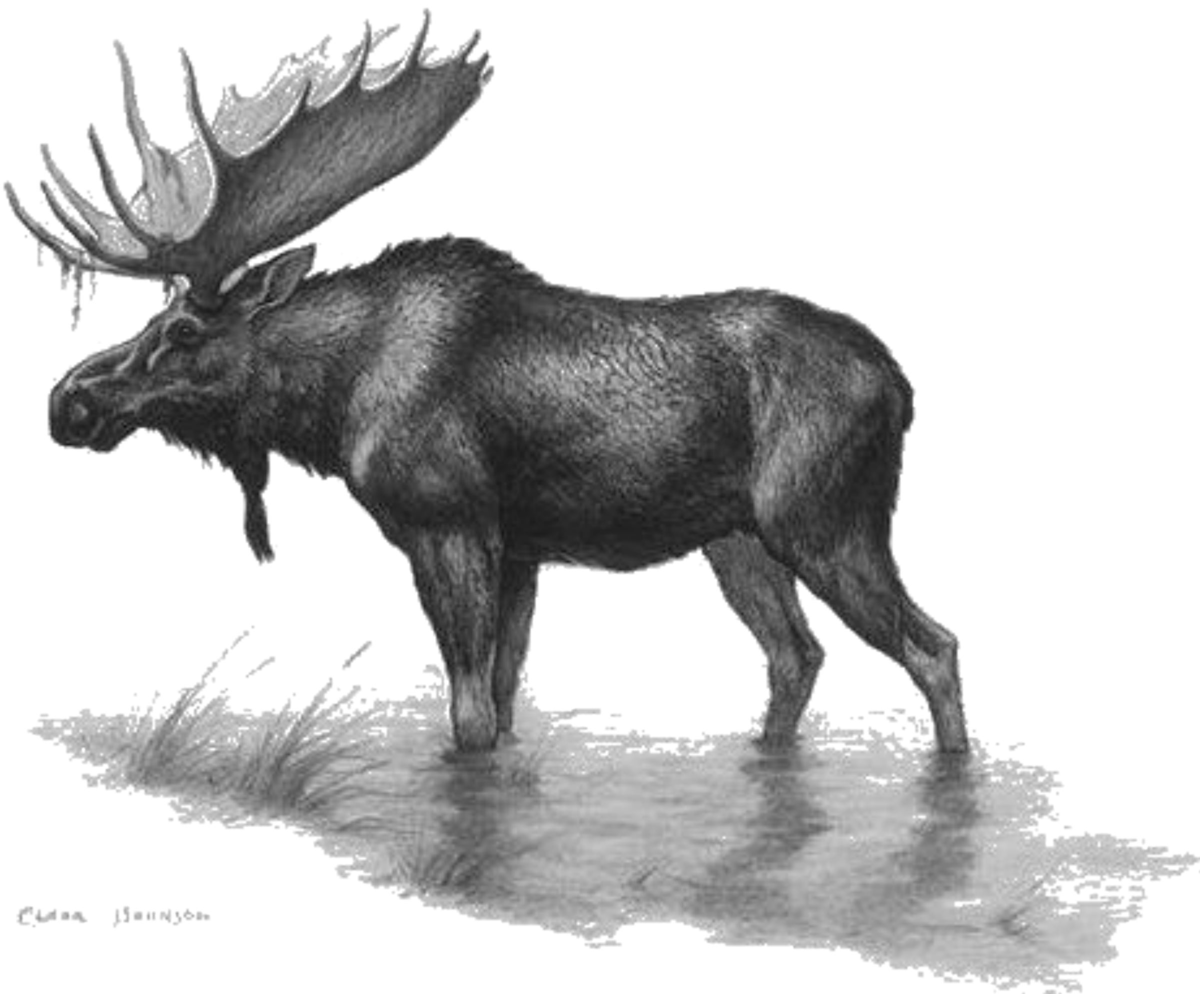
UTAH MOOSE
STATEWIDE MANAGEMENT PLAN



UTAH DIVISION OF WILDLIFE RESOURCES
DEPARTMENT OF NATURAL RESOURCES

UTAH DIVISION OF WILDLIFE RESOURCES
STATEWIDE MANAGEMENT PLAN FOR MOOSE

I. PURPOSE OF THE PLAN

A. General

This document is the statewide management plan for moose in Utah. This plan will provide overall guidance and direction to Utah's moose management program. This plan assesses current information on moose; identifies issues and concerns relating to moose management in Utah; and establishes goals, objectives, and strategies for future moose management. This plan will be used to provide overall guidance and direction for management plans on individual moose units throughout the state.

B. Dates Covered

This moose plan was approved by the Wildlife Board on November 30, 2017. The plan is subject to review within 10 years of this date.

II. SPECIES ASSESSMENT

A. Natural History

Moose (*Alces alces*) are the largest member of the deer family with 4 subspecies recognized in North America: Shiras moose (*A. a. shirasi*), Eastern moose (*A. a. americana*), Northwestern moose (*A. a. andersoni*), and Alaskan moose (*A. a. gigas*) (Bubenik 2007). Shiras is the smallest subspecies and the only one to occur in Utah and the western United States. Shiras bulls weigh considerably less than other moose but can still reach 800 pounds. Moose produce the largest antlers of any living mammal and use the antlers in dominance displays and fighting during the rut or breeding season. In Utah, the rut begins in early September and lasts for several weeks, peaking in late September. Both cows and bulls vocalize and are very aggressive during the breeding season. Gestation for moose is approximately eight months and calving peaks in late May. Cows usually give birth to one or two young with one calf being most common in Utah. Calves grow rapidly and achieve sufficient size by five months of age to endure deep snow and cold weather conditions.

Historical records indicate moose were not present in Utah prior to the early 1900's (Barnes 1927). Moose naturally immigrated into Utah from Idaho and Wyoming, and the first recorded sighting of a moose in Utah was in 1906 or 1907 at the head of Spanish Fork Canyon. The next reported sighting was in 1918 in the Bear River Drainage of the Uinta Mountains. Sparse reports over the next few decades were mainly from the north slope of the Uintas where a population gradually established itself. It was not until 1947 that it was determined a resident herd existed on the North Slope.

The first aerial survey specifically for moose was conducted along the north slope of the Uintas in the spring of 1957 where 59 moose were counted. Moose populations continued to expand on the North Slope and observations in other areas of northern Utah began to increase. Moose numbers have gradually increased since then and have expanded throughout the mountainous areas of the northern half of Utah (Figure 1, Figure 2).

B. Management

1. DWR Regulatory Authority

The Utah Division of Wildlife Resources (DWR) presently operates under authority granted by the Utah Legislature in Title 23 of the Utah Code. The Division was created and established as the wildlife authority for the state under Section 23-14-1 of the Utah State Code. This Code also vests the Division with its functions, powers, duties, rights, and responsibilities. The Division's duties are to protect, propagate, manage, conserve, and distribute protected wildlife throughout the state.

The Utah Division of Wildlife Resources is charged with managing the state's wildlife resources and assuring the future of protected wildlife for its intrinsic, scientific, educational, and recreational values. Protected wildlife species are defined in code by the Utah Legislature.

2. Past and Current Management

Aerial Surveys

DWR began conducting winter aerial surveys to obtain estimates of minimum abundances of moose beginning in 1957. Surveys were first conducted with fixed-wing aircraft (1957–1962) and later with helicopters (1963–present). Management units were initially surveyed every year, but now are surveyed on a rotational schedule in which DWR attempts to survey units once every 3 years dependent on adequate snow cover. During surveys, all suitable habitat within each management unit is surveyed according to expert opinion of biologists and routes are flown as consistently as possible across years with moose classified by sex and age-class (calf or adult). Data from aerial surveys are used to estimate population size and distribution, herd productivity, and bull:cow ratios.

Harvest

The first legal hunting season for moose in Utah was held in 1958, and moose permits have been available every year since that time (Figure 3, Table 1). Harvest is carefully monitored to assure older age class bulls are maintained in populations and balanced sex ratios are sustained. Data on success rates and antler size have been collected since hunts began. Initial data was collected using mail questionnaires and telephone surveys, but in 2004, the Division implemented mandatory online harvest reporting for bull-moose hunters. Antlerless moose harvest data is collected using a combination of telephone and internet-based surveys. Between 1958 and 2016, 7,552 (6,287 bulls and 1,265 antlerless) moose were legally harvested in Utah by 8,218 hunters. The mean success rate for moose hunters in Utah is 92%, with bull hunter success tending to be higher than cow hunter success. Compared to other western states, Utah has the highest bull hunter success averaging 96%, whereas other states average between 74% and 92% (Nadeau et al. 2017).

DWR attempts to balance opportunity to hunt moose with the ability to harvest a large-antlered bull. This balance is accomplished by managing for an average age of harvested bulls. The higher the average age, the greater the likelihood of a hunter harvesting a large-antlered bull and the higher the success rate, but fewer permits can be issued. Utah has age data from 1986 to present. In Utah, moose reach their maximum antler spread around age 5 (Figure 4). From 1986 to 2016, harvested bulls averaged 4.5 years old with a low of 3.6 in 1988 and a high of 5.0 in 2006. In 2016, harvested bulls averaged 4.4 years old and the latest 3-year average (2014–2016) was 4.5 years old (Table 2).

In Utah, there is very high demand for bull-moose hunting permits (Table 3). Hunting permits for Shiras moose are considered one of the most difficult permits to obtain of any North American big game species. For Utah residents, applications currently exceed available permits by more than 220:1, and moose are the most difficult permits to draw in the state. The odds of drawing a permit for nonresidents are even lower at 1,644:1 in 2017. There is also a tremendous demand for antlerless moose permits in Utah. Antlerless moose are also managed using a bonus point system with a 5-year waiting period for hunters who successfully draw a permit. Due to recent population declines, few antlerless permits have been issued since 2011. Nonetheless, several thousand hunters each year have been applying for antlerless preference points in hopes of obtaining a permit when moose populations recover. In 2017, the odds of obtaining an antlerless moose permit were 167:1.

Transplants

Utah has transplanted moose since 1973. This program was initiated to encourage expansion of moose populations into other areas of the state. Moose have been relocated from northern Utah to the Manti, Fishlake, Currant Creek, and Book Cliffs management units with mixed success (Table 4). Although a viable population has been established in Currant Creek, populations failed to thrive in the other release areas. Unfortunately, those transplants were not monitored sufficiently to fully understand why new populations were not successfully established. Poaching, predation from cougars, lack of adequate riparian habitats, excessive summer temperatures, and an insufficient starting number of animals have all been hypothesized, but the true reason remains unknown. In more recent years, moose from Utah have been relocated to more southern latitudes in Colorado and on the Tavaputs Plateau with better results (Duckett 2009, UDWR unpublished data). These recent successes demonstrate that there may be potential for further expansion of moose populations in Utah, and it is essential that future transplants be closely monitored to provide better information on success or failure and reasons for the outcome. All transplants will be conducted in accordance with Utah Code 23-14-21, and a list of potential transplant sites is found in Table 5.

In addition to organized transplants, nuisance moose that wander out of the mountains and into populated areas are also relocated. DWR relocates these animals because of public safety concerns. Most nuisance moose occur along the Wasatch Front in the spring and summer months when younger moose are dispersing. Additionally, depending on winter severity, moose may wander into towns during the winter months while they are searching for areas with less snow. Some of those moose have been moved to areas throughout Utah to help bolster previously transplanted populations or to start new populations. More commonly, nuisance moose have simply been relocated to suitable habitat within the same or nearby units to move the animals away from cities and towns.

C. Population Status

Moose are well established in the northern half of Utah with the majority existing on 9 management units with smaller populations occurring on 4 adjacent units (Figure 1). The current (winter 2017) statewide population in Utah is estimated at 2,650 animals. Since establishment in the late 1940's, moose populations trended upward for 4 decades in Utah with an average annual growth rate (λ) of 1.12 from 1957 to 1991. From 1992 to 1996 moose populations declined likely due to above average mortality during winter 1992–1993 and moose populations exceeding carrying capacity on some management units. During the late 1990's and early 2000's, moose population again expanded and reached a record population size in 2005 of an estimated 4,000 moose. Since 2005, the moose population has again declined and reached an estimated population low of 2,615 moose in 2013. Unlike in the mid-1990's, when populations quickly rebounded following the crash, moose numbers have held steady between 2,600 and 2,700 animals for the past 6 years mostly in the absence of antlerless harvest.

On the management unit level, population trends vary considerably with some herds increasing rapidly whereas others are stable or declining. Some herds, especially in the northern part of the state, may exceed carrying capacity and harvest has been used to stabilize or decrease those populations to prevent habitat degradation. Interestingly, moose continue to naturally expand onto the Nine Mile Unit in southeastern Utah, and onto the Box Elder Unit in extreme northwestern Utah. The Box Elder expansion is likely due to animals migrating from southern Idaho. Additionally, some remnant populations still exist on the Manti, Mount Nebo, and Fishlake units, but little to no growth is occurring, and it is unlikely that they will grow to huntable populations in the near future without assistance.

D. Habitat

The primary limiting factor for moose in Utah and across their range is the availability of suitable habitat. Moose are primarily browsers and depend on shrubs and young deciduous trees for food during much of the year. In more northern climes, moose are often associated with river bottoms, ponds, and lakes with an abundance of shrubby and aquatic vegetation. Although moose in Utah are also associated with riparian habitat types, particularly on the north slope of the Uintas, they are not exclusively tied to them. Moose have done well in drier habitats in northern Utah which are dominated by mountain mahogany (*Cercocarpus* spp.), Gambel's oak (*Quercus gambelii*), serviceberry (*Amelanchier utahensis*), quaking aspen (*Populus tremuloides*), and burned over coniferous forests. Moose use thick stands of conifer as shelter in winter and to help stay cool during summer.

Geist (1971) recognized two types of moose habitat, permanent and transient. Permanent habitats are those that persist through time and do not succeed to other vegetative communities (Peek 2007). Examples of permanent habitat include riparian and high elevation shrub communities. Annual flooding, avalanches, or timberline conditions help maintain those more permanent moose habitat types. Transient habitat is more common and is usually associated with forest fires and timber harvest which remove coniferous trees and reverts the habitat to early seral stages. Throughout much of North America, moose are associated with short-lived, subclimax plant communities that follow in the wake of forest fires (Geist 1971). Habitat improvement projects which favor early seral stages and increased shrub growth can benefit moose. Fire can also be used to improve moose habitat.

Winter weather and snow depth is not thought to be a limiting factor to moose in Utah, although increased mortality and decreased calf recruitment have been noted during severe winters (e.g., 2016–2017, UDWR unpublished data). Moose are well adapted, as a result of their long legs and heavy black fur, to tolerate deep snow and cold weather. In Utah, moose generally live at higher elevations throughout the year, although some moose are observed at lower elevation habitats even in summer. Interestingly, analysis of aerial count data suggests that light winters with minimal spring snow cover may have a greater impact on moose than harsh winters (Ruprecht 2016). This pattern may be the result of increased survival of ticks during winters with light snow cover followed by high numbers of winter ticks on moose, resulting in increased moose mortality and decreased calf production.

E. Research

Utah's moose population has been the subject of several research projects. Most research has taken place on the north slope of the Uinta Mountains, where studies were conducted to determine the distribution and movements of moose, food habits and key browse species for moose, the effects of moose utilization of various browse species, and the overall habitat quality and carrying capacity of this area for moose (Van Wormer 1967, Wilson 1971, Babcock 1977, Babcock 1981). Because of population declines in the late 2000's, DWR in conjunction with Utah State University initiated a large scale capture and collaring effort on the North Slope and Wasatch units in January 2013. The purpose of this study was to collect data on demographic parameters and identify potential limiting factors for Utah's moose populations. Results from this study showed a significant relationship between moose body condition and the probability of pregnancy, calving, and recruiting a calf (Rupracth et al. 2016), all of which provide further evidence for the need to provide high quality habitat and maintain moose populations at appropriate numbers. Due to continued stagnant moose populations, this study was extended in 2016 with the addition of satellite GPS collars to get an improved understanding of timing and causes of mortality. This study will also improve our understanding of needed harvest levels to prevent habitat degradation and future population declines.

III. ISSUES AND CONCERNS

A. Habitat Degradation

The single biggest influence on moose populations in Utah is the quantity and quality of available habitat. Moose in Utah are at the southern extent of their range and, as such, may reside in less quality habitat than moose in the core of their range (Peek 1974). Indeed, Ruprecht et al. (2016) found that moose in Utah had lower ingesta-free body fat, pregnancy rates, twinning rates, and fecundity rates than moose at higher latitudes, which could indicate suboptimal moose habitat.

In Utah, moose populations thrived when they first became established, but have experienced 2 large-scale population crashes (one in the mid-1990s and one in the late-2000s) when numbers exceeded 3,000–3,500 counted moose (Figure 1). Additionally, calf production has declined since moose have become established in Utah (Figure 5) and twinning rates from June 2013 to June 2017 are very low ($x=1.7\%$, range = 0%–3.2%, UDWR unpublished data). Those data likely indicate that resources are limiting for moose in Utah, and habitat loss or degradation are of major concern.

Habitat can be degraded, fragmented, or lost to a variety of causes including human development and plant succession. Reductions in quality or quantity of habitat can result in corresponding population declines. As Utah's human population continues to grow, moose habitat will continue to be lost. Conversion of moose habitat into highways, summer homes, ski resorts, or other developments, results in a permanent loss of habitat. Moose habitat can also be lost or degraded due to plant succession. As deciduous forests are converted to coniferous forests, moose habitat is altered and provides less forage. Forest fires and logging can help remove coniferous trees and return the habitat to early successional stages which are beneficial for moose. Additionally, it is crucial to manage moose numbers at appropriate densities to prevent habitat damage and subsequent population declines. If habitats are damaged, it can take years or decades to recover and result in long-term population declines.

B. Disease/Parasites

Identifying, understanding, and monitoring disease is important for moose management in Utah. Moose are susceptible to a wide variety of viral, bacterial, and parasitic diseases. Recent collar data has shown that adult and juvenile moose mortalities are prevalent during the late winter and early spring with the majority of these mortalities attributed to malnutrition, starvation, and high tick loads. Past reports of diseases in Utah moose have included symptoms such as opaque corneas or blindness, emaciation, excessive salivation, bloody feces, and nasal mucous discharge, however definitive diagnoses were not obtained in these cases (Wolfe et al. 2010). Parasites and infectious diseases considered a concern to Utah moose populations include winter tick (*Dermacentor albipictus*) infestations, elaeophorosis, infectious kerato-conjunctivitis (IKC), chronic wasting disease (CWD), and hemorrhagic diseases such as bluetongue (BTV), epizootic hemorrhagic disease (EHD), adenovirus, malignant catarrhal fever (MCF), and meningeal worms (*Parelaphostrongylus tenuis*).

Infestation with winter ticks and resulting anemia, alopecia, and emaciation, is considered a significant cause of mortality in moose populations in North America (Samuel 2004, Wünschmann et al. 2015). High tick loads cause significant blood loss, increased grooming, hair loss, subsequent heat loss, and early depletion of energy reserves (Mooring and Samuel 1999, Samuel 2004). Significant tick infestations have been observed in Utah moose (Wolfe et al. 2010), and high levels of infestation was associated with increased probability of late winter mortality and a decreased probability of having a calf in spring (Ruprecht 2016).

Nutritional stress and mineral deficiencies have been reported in moose from Wyoming, Minnesota, Alaska, and Sweden (O'Hara et al. 2001, Custer et al. 2004, Frank 2004, Murray et al. 2006, Becker et al. 2010) and have also been detected in moose in Utah. Inadequate winter range conditions and high ectoparasite loads may be contributing factors, but the effect of those factors on moose population performance in Utah warrants further investigation.

The arterial worm *Elaeophora schneideri* is a parasite that mainly resides in the carotid and maxillary arteries of wild and domestic mammals. The parasite is transmitted from animal to animal with horse flies (Williams and Barker 2001). Microfilaria, larvae, and adult nematodes cause inflammation and potentially complete occlusion of the blood vessel, leading to ischemic necrosis of the tissue that the blood vessels supply. Clinical signs can include cropping of ears, necrosis of the muzzle, brain damage, traveling in circles, and blindness (Williams and Barker 2001). In Utah, *E. schneideri* nematodes have frequently been detected in the carotid arteries of moose during necropsies of both sick animals and hunter-harvested moose, but the impact on the Utah moose population remains largely unknown.

IKC or "pinkeye" is a disease caused by eye infection with bacteria such as *Moraxella*, *Chlamydia*, and *Mycoplasma* sp (Brown et al. 1998). The bacteria are spread from animal to animal by flies, and mule deer, bighorn sheep, elk, and moose can become infected (Taylor et al. 1996, Dubay et al. 2000, Jansen et al. 2006). Infections are most common in the late fall and early winter, and clinical signs include corneal opacity, ulceration, and potentially blindness (Dubay et al. 2000). Clinical IKC has been observed in Utah moose, deer, bighorn sheep, and elk populations.

Chronic wasting disease was first documented in Utah in late 2002 and has now been detected in deer management units 8, 9, 13, 14, and 16. Chronic wasting disease can infect moose (Baeten et al. 2007), but to date, no infected moose have been detected in Utah. Chronic wasting disease continues to be of high concern for cervids in Utah, and the highest risk for CWD infection in moose is currently on the North and South Slope of the Uinta Mountains, where CWD infected deer and elk have been detected.

Moose are also susceptible to a variety of hemorrhagic diseases including bluetongue, epizootic hemorrhagic disease, adenovirus, and malignant catarrhal fever. Overall, the risk of population level impacts of hemorrhagic diseases on moose in Utah is low, but these diseases could be associated with individual mortalities. Natural mortalities due to EHD and BTV have not been confirmed in Utah moose, but a recent serological survey for BTV and EHD in Utah moose showed that 60% (15/25) of moose from the North Slope, and 4% (1/25) of moose from the Wasatch Mountains were seropositive for BTV, and 4% (1/25) from the North Slope and 0% (0/25) of moose from the Wasatch were seropositive for EHD. Adenovirus has not been detected in Utah's cervids to date, but has been detected in cervids in surrounding western states and must be considered as a differential diagnosis if mortalities due to hemorrhagic disease are detected. Malignant catarrhal fever is a highly fatal hemorrhagic disease that has been diagnosed in deer in northern Utah, but clinical cases of MCF have not been confirmed in Utah moose, although they are considered susceptible to infection.

Lastly, although not presently found in Utah, *P. tenuis*, or meningeal worms, has the potential to have a significant negative influence for Utah moose if introduced. The parasite is carried asymptomatically by white-tailed deer, but causes severe neurologic infections in moose, elk, and caribou. Clinical signs include aimless wandering, blindness, ataxia, lameness, circling, and paralysis. The disease is a significant cause of mortalities in moose in the northeastern US (Lankester 2010) and is suspected to have contributed to the decline of moose in areas with significant white-tailed deer populations (Lenarz 2009, Lankester 2010).

C. Poaching

Poaching of moose has been a significant problem in Utah. Many moose have been killed intentionally or unintentionally during the deer and elk hunting seasons. Poaching may have been the main cause of the failure of the original moose transplant on the Manti Unit since more moose were documented to have been poached over a several year period than were originally released on the unit (UDWR, unpublished data). The Northern Region has also experienced extensive poaching of moose. Publication of high profile moose poaching cases including assessed fines has contributed to fewer moose poaching cases. An extensive public information campaign and signing effort has helped reduce the number of moose kills due to misidentification.

D. Human Interaction

Moose are generally tolerant and less afraid of humans than other wild ungulates, which results in frequent interaction. During spring, summer, and harsh winters, moose frequently wander from the mountains into the valleys where they interact with people. As human populations continue to grow in Utah, moose-human interaction will become more common. Although nuisance moose rarely cause serious problems, the potential exists, and they need to be captured and relocated. Additionally, much work is needed to educate people who come in contact with moose about the potential dangers these animals can pose.

Auto collisions with moose are a major problem in some parts of North America. A survey of 16 US states and Canadian provinces indicated that nearly 3,000 moose/vehicle accidents occur annually, and that is considered to be a minimum estimate (Childs 2007). Although moose exhibit some avoidance of roads, moose-vehicle collisions are common and very dangerous for vehicle occupants. Since 2010, Utah has averaged 27 moose roadkills reported during road surveys by state agencies annually. The cost of one moose-vehicle collision is estimated to be $30,773 (Hjuiser 2008), which translates into an annual cost of almost $1 million in Utah. Roadkills occur throughout the year with the largest peak occurring in June when yearlings disperse. The majority of roadkills in Utah occur in 5 locations: US-40 near Jordanelle Reservoir, US-40 in Daniel’s Canyon, I-80 in Parley’s Canyon, I-80 near Kimball Junction, and I-80 near Emory. In these areas, Utah Department of Transportation has installed some highway fencing and crossing structures have been constructed with some success. These areas and other high-risk sites need to continue to be monitored, and, if needed, further action should be taken to reduce the risk of property damage and serious personal injury.

E. Competition

Moose coexist with other wild ungulates and domestic livestock across much of their range in Utah. Moose are found in the same areas as mule deer, elk, cattle, sheep, and to a lesser extent bighorn sheep, mountain goats, and pronghorn. The reason similar species can coexist is best summarized by Boer (2007). "Resource partitioning mechanisms facilitate coexistence of sympatric species of large mammals; they may take the form of spatial or temporal segregation, species-specific preferences for forage plants and plant parts, and different feeding heights." Although there is overlap in use areas, moose utilize a forage resource which is largely unavailable to other ungulates. Moose eat primarily browse and to a lesser extent grass and forbs. Moose also feed at a height which is well above the ability of other ungulates to reach, and moose live in a deep snow environment during critical winter months where few other ungulates can survive. Nonetheless, interspecies competition between moose and other ungulates undoubtedly occurs particularly when moose are using nontypical habitat more closely resembling habitats used by deer and elk. Habitats need to be closely monitored and populations maintained at appropriate levels to ensure long-term habitat damage that could negatively impact all species does not occur.

F. Predators

In Utah, black bears and mountain lions are the principal predators that have the potential to kill moose. Despite their large size, adult moose are killed by mountain lions. In 1995 on the Manti Unit, mountain lions killed 57% (4/7) of radio-collared moose, and 22% (2/9) of collared moose on the Fishlake Unit were killed by cougars (UDWR, unpublished data). However, those moose were recent transplants and may have been more susceptible to cougar predation. Of 120 collared adult cow moose on the North Slope and Wasatch units from 2013 to 2016, 0 of 36 mortalities were assigned to cougars. Interestingly, in winter 2017, 2 of 11 moose calves collared as 7-month olds on the Wasatch Unit were killed by cougars in late winter (3/28 and 4/19, respectively). This study is the first to collar moose calves in Utah so it remains unknown how common of an occurrence cougar predation is on moose calves.

Black bears are efficient predators of newborn moose calves. Black bears have been reported to kill 2–50% of the calves in moose populations (Ballard and Van Ballenberghe 2007); however, black bear densities in Utah are much lower than those in the previous study. Furthermore, Heward et al. (2004) examined black bear scats (n=179) from the Hobble Creek area of the Wasatch Mountains Management Unit and found no evidence of moose remains in any samples. Although predation can slow moose population growth or have an impact on recently transplanted populations, it is likely not a major limiting factor on a statewide basis. Other factors, such as habitat degradation and parasites, are likely more important in determining the size of the overall population.

G. Movements and Migrations

Currently, we have limited information on the movement patterns of moose. Much of the research that is available comes from studies of populations in Scandinavia and other parts of North America. Migration, dispersal, and activity near roads are key aspects of moose movements. Migratory movements vary greatly among populations and individuals within populations (Hundertmark 2007). Some populations are completely migratory; however, most consist of both migrants and residents (Selier et al. 2003). Migration appears to be triggered when snow depths exceed 40 cm (16 in), and snow depths greater than 70 cm (27 in) cause moose to reduce their movements significantly (Sweanor and Sandegren 1989). Documented migration distances range from 2 km (1.2 mi) to over 100 km (60 mi), with individuals in mountainous terrain generally migrating farther than those that occupy habitats that are relatively flat (Hundertmark 2007).

Roads can be a barrier to the movements of moose (Bartzke et al. 2015). In Norway, moose avoided areas within 500 m (547 yd) of highways and forest roads (Dussault et al. 2007). Additionally, the construction of a new highway in Sweden created a barrier to moose movements, even with the installation of wildlife crossings to facilitate movement (Selier et al. 2003). The importance of moose vehicle collisions has been highlighted already in the human interaction section of this plan.

The limited research that is available on moose dispersal indicates that most individuals that disperse are juvenile males (Hundertmark 2007). The percentage of individuals that disperse varies from 1% to 30% and dispersal distances (1–4 km, 0.6–2.5 mi) are relatively short (Gasaway et al. 1985, Ballard et al. 1991). In Utah, there is currently a study underway in collaboration with Utah State University to evaluate juvenile dispersal in the North Slope and Wasatch moose populations.

In Utah, our ability to manage moose and conserve their habitats could be improved by focusing monitoring and research on the percentage of animals within each population that are migratory, the timing of migration, movement corridors connecting summer and winter ranges, and identifying potential movement barriers for moose.

H. Native Status

Although not present at settlement times, moose immigrated into Utah of their own accord and are considered a native species by UDWR.

IV. CONCLUSION

Moose are a unique and valuable part of our wildlife heritage in Utah. Observing a moose in the wild is an exciting experience for most people, and hunting moose is a unique opportunity for a limited number of hunters. High quality viewing and hunting opportunities should be expanded in the state where possible.

Moose are relatively recent arrivals in our state with no record of moose prior to the twentieth century. They have become well established in the mountainous areas of the northern half of Utah with a statewide population of approximately 2,600 animals in winter 2017. Moose need to be carefully managed in Utah to ensure herds are productive and balanced with available habitat. In the past 25 years, there have been 2 population crashes indicating that moose in Utah are susceptible to habitat limitation and cannot be allowed to grow unchecked. Moose require proactive management and need to be managed at appropriate densities to maintain healthy populations and prevent future declines in Utah moose populations.

VI. STATEWIDE MANAGEMENT GOALS AND OBJECTIVES

A. Population Management Goal: Achieve optimum populations of moose in all suitable habitat within the state.

Objective 1: Increase moose populations within the state as conditions allow and maintain populations at objectives to prevent population declines.

Strategies:

a. Update management plans for individual units including population goals and objectives as needed.
b. Survey all moose herd units by helicopter every 3 years to monitor population size and herd composition.
c. Use population and/or sightability models to determine the relationship between population surveys and population size.
d. Recommend antlerless harvest to control and maintain populations at desired densities and prevent population declines.
e. Transplant moose to bolster existing populations and establish new populations in all suitable habitat in Utah. Transplant sites are listed in Table 5.
f. Continue research projects to determine limiting factors to moose populations in Utah.
g. If predators are determined to be a limiting factor for moose, initiate predator management as specified in predator management plans.
h. Identify locations of high moose-vehicle collisions and construct sufficient wildlife crossing structures or other mitigation options.
i. Support law enforcement efforts to reduce illegal take of moose.

B. Habitat Management Goal: Assure sufficient habitat is available to sustain healthy and productive moose populations.

Objective: Maintain or enhance the quantity and quality of moose habitat to allow herds to reach population objectives.

Strategies:

a. Identify crucial moose habitats (including calving, winter, summer, and year-long) and work with public and private land managers to protect and enhance those areas.
b. Assist land management agencies in monitoring the condition and trend of moose habitats.
c. Work with public land management agencies to minimize, and where possible, mitigate loss or degradation of moose habitat.
d. As part of the Utah Migration Initiative, identify migration routes and corridors along with any barriers (e.g., fences, highways) that impede moose. Modify or mitigate any barriers that impede movement of moose.
e. Initiate prescribed burns, timber harvests, and other vegetative treatment

projects to improve moose habitat lost to ecological succession or human impacts.

f. Under the Utah Watershed Restoration Initiative, design, implement, and monitor the effectiveness of habitat improvement projects to benefit moose and other wildlife.
g. Maintain populations at appropriate densities to maintain habitat quality.
h. Support the establishment of multi-agency OHV travel plans developed on a county level or management unit level, and support ongoing education and enforcement efforts to reduce illegal OHV use to prevent resource damage and to protect crucial moose habitats.

C. Recreation Goal: Provide high-quality opportunities for hunting and viewing of moose.

Objective 1: Increase hunting opportunities as populations allow while maintaining quality hunting experiences.

Strategies:

a. Manage for a 3-year average age of harvested bulls of 3.75–4.25 on all units to ensure sufficient numbers of older age class bulls, while maximizing hunter opportunity.
b. Use subunits to maximize hunting opportunities and distribute hunters.
c. Recommend long hunting seasons to provide extended hunting opportunity.

Objective 2: Increase opportunities for viewing moose, while educating the public concerning the needs of moose and the potential issues they face

Strategies:

a. Work with social media and news media sources to inform and educate the public about moose and moose management in Utah.
b. Work with local communities to reduce conflicts with moose in urban areas.
c. Use data from the Wildlife Migration Initiative to generate interest and excitement for moose in Utah.

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Figure 1. Statewide moose population trends, Utah 1957–2016. Abundance estimates are based on count data and have not been corrected for sightability.

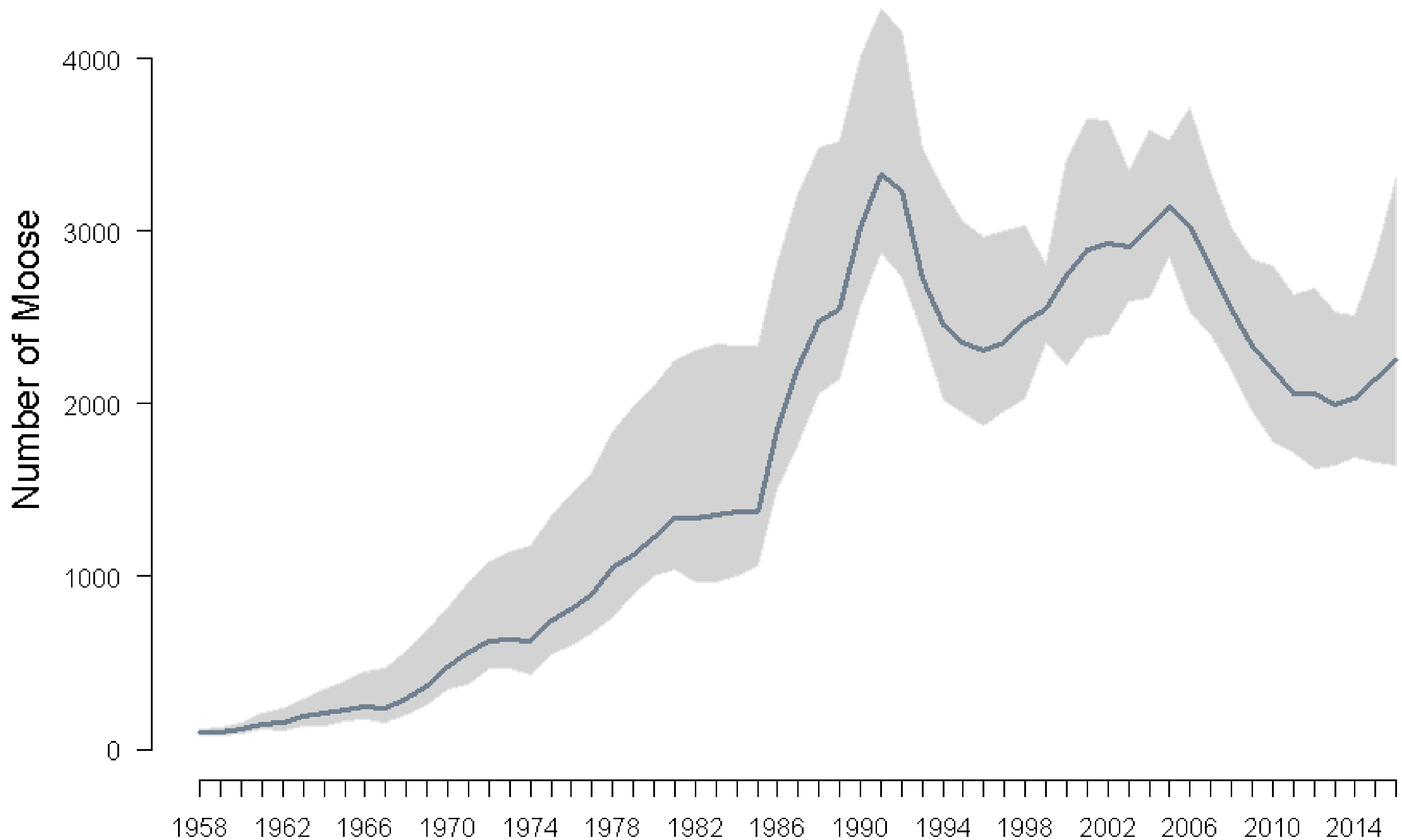

Figure 2. Current moose distribution by big game management unit, Utah 2017.

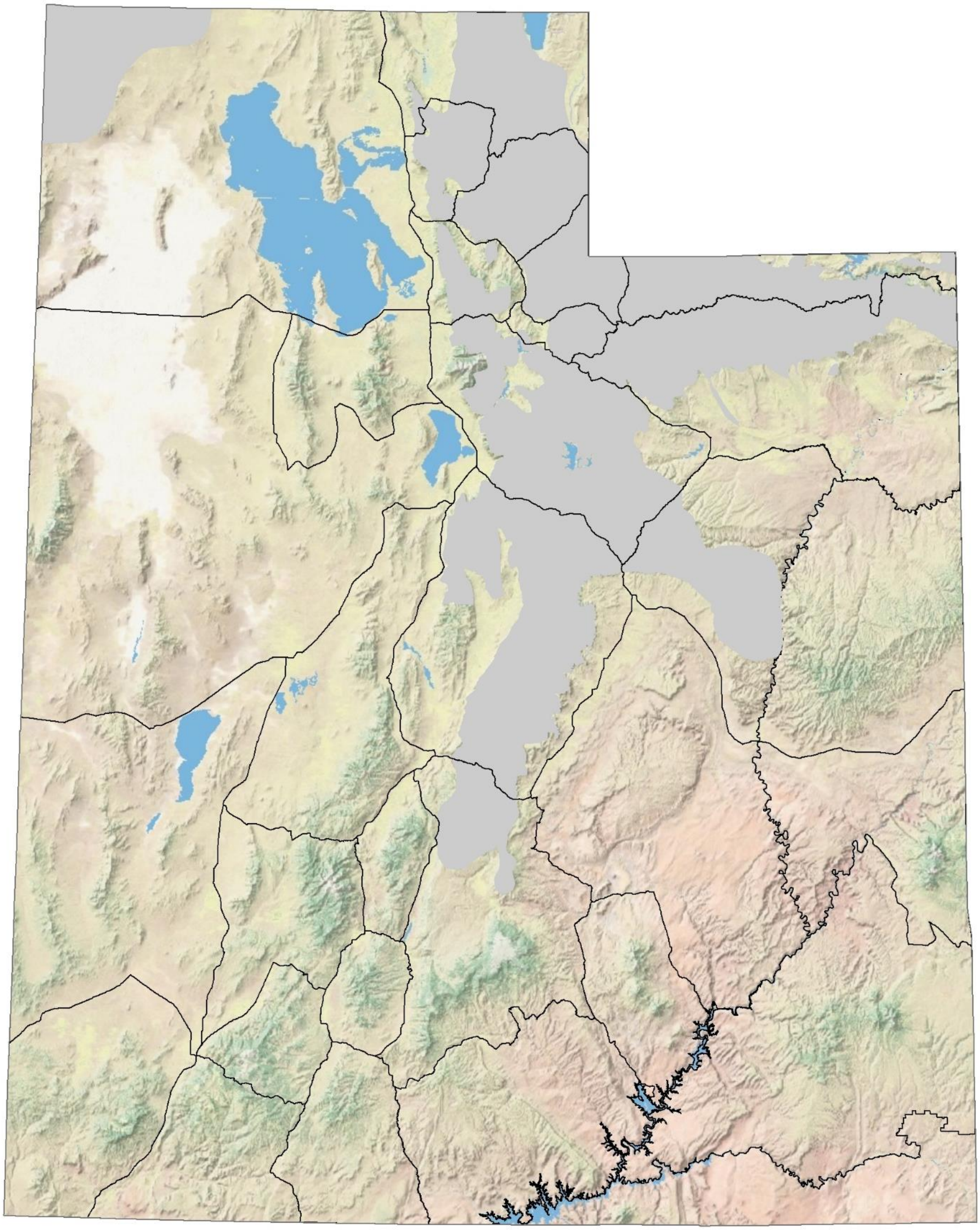

Figure 3. Statewide trends in moose harvest (bulls and cows) and hunters afield, Utah 1958–2016.

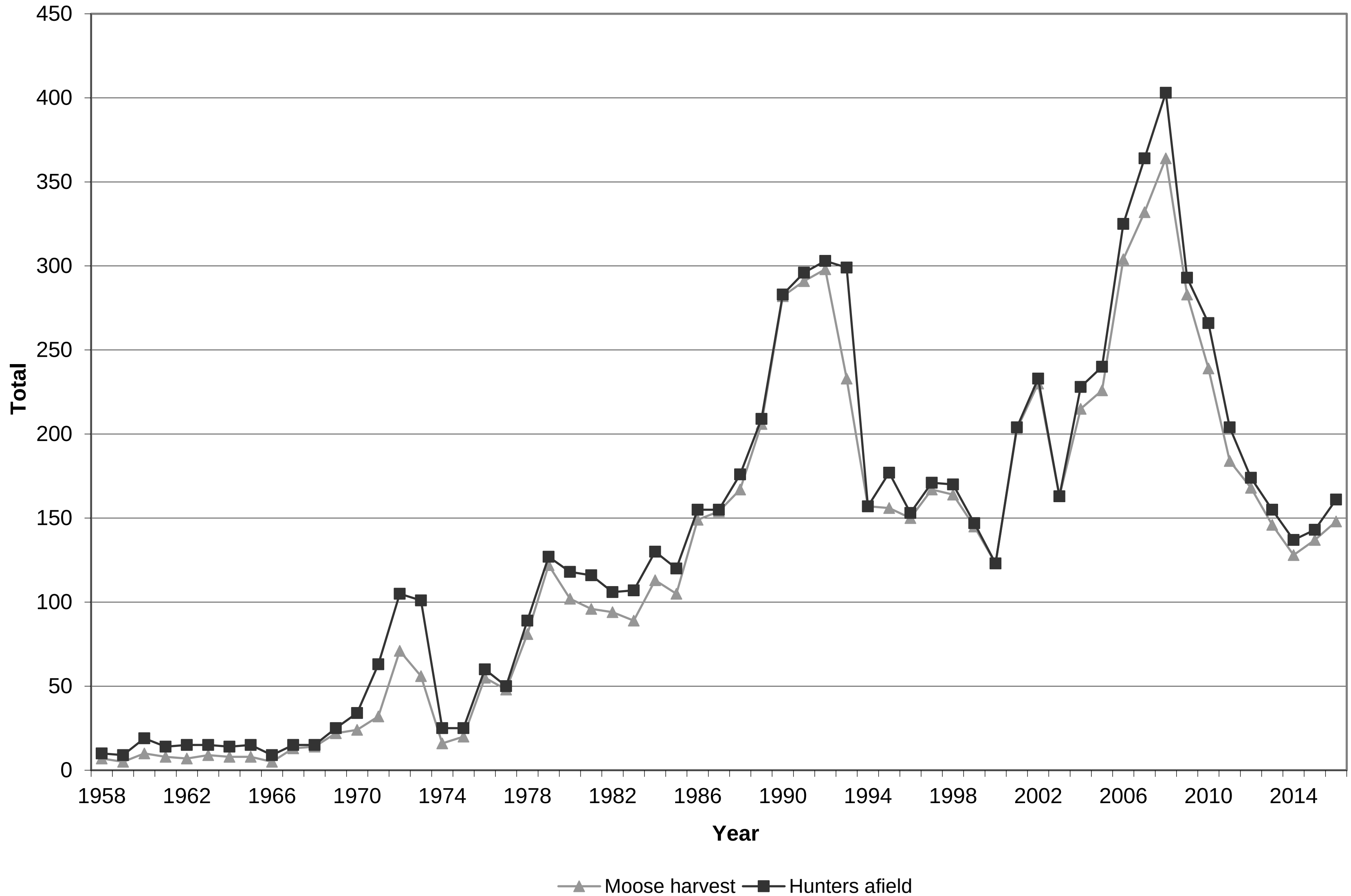

Figure 4. Harvested bull moose antler spread by age, Utah 1986–2016.

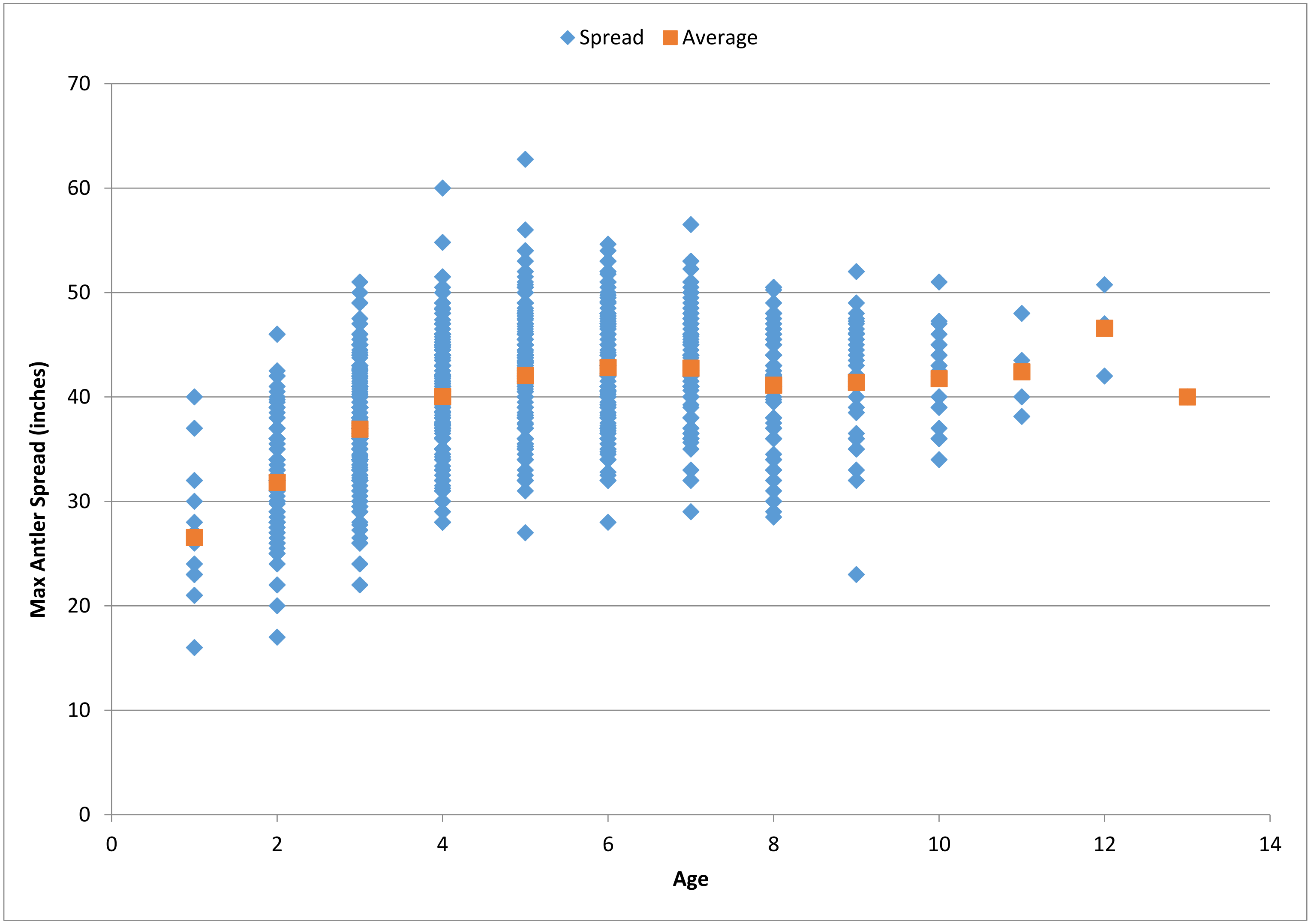

Figure 5. Statewide calves/100 cows from winter aerial surveys, Utah 1958–2017.

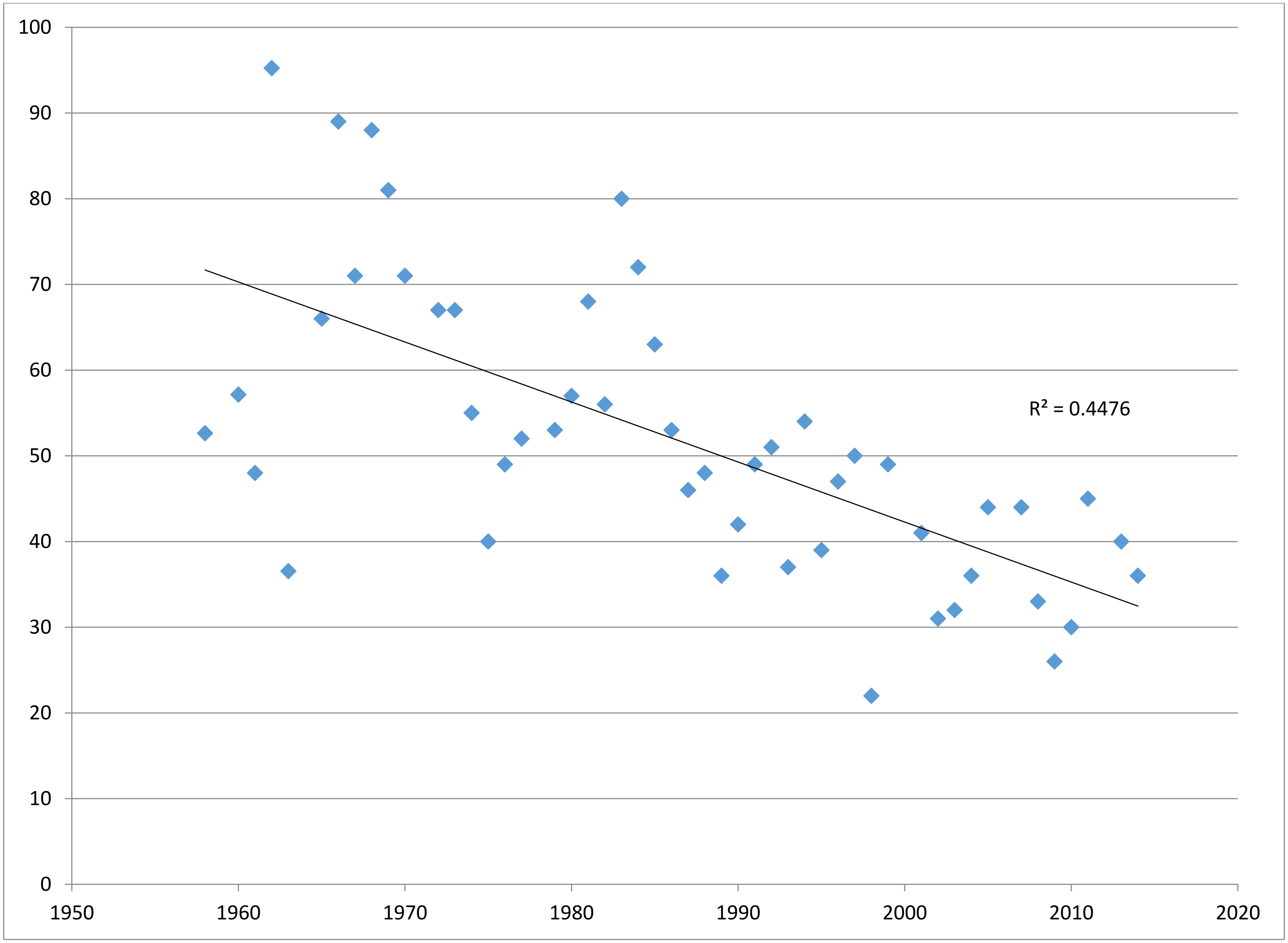

Table 1. Historical statewide moose harvest, Utah 1958–2016.

Year	Bull harvest	Cow harvest	Total harvest	Hunters afield	% success
1958	7	0	7	10	70
1959	5	0	5	9	56
1960	10	0	10	19	53
1961	8	0	8	14	57
1962	7	0	7	15	47
1963	9	0	9	15	60
1964	8	0	8	14	57
1965	8	0	8	15	53
1966	5	0	5	9	56
1967	13	0	13	15	87
1968	14	0	14	15	93
1969	22	0	22	25	88
1970	24	0	24	34	71
1971	32	0	32	63	51
1972	71	0	71	105	68
1973	56	0	56	101	55
1974	16	0	16	25	64
1975	20	0	20	25	80
1976	55	0	55	60	92
1977	30	18	48	50	96
1978	65	16	81	89	91
1979	57	65	122	127	96
1980	81	21	102	118	86
1981	78	18	96	116	83
1982	94	0	94	106	89
1983	89	0	89	107	83
1984	113	0	113	130	87
1985	105	0	105	120	88
1986	134	15	149	155	96
1987	140	14	154	155	99
1988	141	26	167	176	95
1989	181	25	206	209	99
1990	192	90	282	283	100
1991	192	99	291	296	98
1992	198	100	298	303	98
1993	174	59	233	299	78
1994	110	47	157	157	100
1995	140	16	156	177	88

Table 1. Historical statewide moose harvest, Utah 1958–2016 (cont.).

Year	Bull harvest	Cow harvest	Total harvest	Hunters afield	% success
1996	139	11	150	153	98
1997	142	25	167	171	98
1998	137	27	164	170	96
1999	110	35	145	147	99
2000	97	26	123	123	100
2001	169	34	203	204	100
2002	174	56	230	233	99
2003	139	24	163	163	100
2004	201	14	215	228	94
2005	205	21	226	240	94
2006	223	81	304	325	94
2007	236	96	332	364	91
2008	266	98	364	403	90
2009	243	40	283	293	97
2010	214	25	239	266	90
2011	176	8	184	204	90
2012	168	0	168	174	97
2013	146	0	146	155	94
2014	128	0	128	137	93
2015	137	0	137	143	96
2016	133	15	148	161	92

Table 2. Average age of harvested bull moose by hunt unit, Utah 2007–2016.

Unit		Year										Average
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
2	Cache	4.6	4.5	4.1	4.9	3.7	3.8	3.8	3.4	4.6	5.1	4.4
3	Ogden	4.6	4.1	3.9	4.5	3.8	4.3	3.6	3.0	4.0	6.8	4.6
4	Morgan-Rich	3.9	4.4	4.9	4.7	4.3	4.3	4.2	4.5	5.1	4.6	4.7
5	East Canyon	3.6	4.6	3.0	4.7	3.2	4.2	3.0	3.4	4.6	3.8	3.9
6	Chalk Creek	4.8	4.3	4.8	3.6	4.0	4.1	4.2	4.0	4.9	3.7	4.2
7	Kamas	5.5	3.5	4.0	5.0	2.7	3.0	9.0	—	—	3.0	3.0
8A	North Slope, Summit	6.2	5.4	5.4	5.3	4.2	4.6	5.3	5.0	5.1	5.9	5.3
8BC	North Slope, W Daggett / Three Corners	5.0	3.9	5.7	4.2	6.0	3.7	5.0	4.0	5.0	4.5	4.5
9A	South Slope, Yellowstone	5.3	3.7	6.3	4.3	4.2	4.5	3.5	6.5	4.0	5.7	5.4
9BC	South Slope, Vernal / Diamond Mountain	4.0	5.0	5.5	4.3	3.0	4.0	—	—	—	3.0	3.0
17	Wasatch, Mountains	4.5	4.1	3.8	4.1	4.0	4.4	4.6	4.6	4.3	3.7	4.2
	Statewide	4.7	4.4	4.4	4.5	3.9	4.3	4.3	4.3	4.7	4.4	4.5

Table 3. Limited Entry drawing odds of obtaining a bull moose permit, Utah 1998–2016.

Year	Residents			Nonresidents		
	Applicants	Permits	Odds	Applicants	Permits	Odds
1998	4,501	102	1 in 44	151	3	1 in 50
1999	5,592	102	1 in 55	245	4	1 in 61
2000	7,048	110	1 in 64	372	7	1 in 53
2001	8,494	115	1 in 74	608	7	1 in 87
2002	10,595	121	1 in 88	755	8	1 in 94
2003	11,930	124	1 in 96	906	7	1 in 129
2004	12,902	142	1 in 91	1,037	7	1 in 148
2005	14,136	146	1 in 97	1,247	8	1 in 156
2006	15,078	163	1 in 93	1,433	10	1 in 143
2007	16,588	174	1 in 95	1,707	9	1 in 190
2008	16,085	201	1 in 80	1,566	14	1 in 112
2009	16,161	180	1 in 90	3,408	13	1 in 262
2010	16,344	161	1 in 102	3,555	9	1 in 395
2011	16,405	120	1 in 137	3,592	6	1 in 599
2012	16,763	106	1 in 158	3,925	8	1 in 491
2013	17,491	97	1 in 180	4,270	6	1 in 712
2014	18,186	86	1 in 211	4,644	7	1 in 663
2015	19,175	100	1 in 192	5,115	5	1 in 1,023
2016	20,391	112	1 in 182	5,668	3	1 in 1,889
2017	21,354	97	1 in 220	6,575	4	1 in 1,644

Table 4. History of moose transplants, Utah 1973–2017.

Year	Unit #	Source unit	Unit #	Release unit	Number released	Release area
1973	9	North Slope	16B	Central Mountains, Manti	18	Fish Creek
1974	6	Chalk Creek	16B	Central Mountains, Manti	19	Fish Creek
1978	9	North Slope	16B	Central Mountains, Manti	6	Fish Creek
1987	4	Morgan-South Rich	16B	Central Mountains, Manti	4	Fish Creek
1987	4	Morgan-South Rich	16B	Central Mountains, Manti	22	Joe's Valley
1988	4	Morgan-South Rich	25A	Plateau	27	Fish Lake
1989	4	Morgan-South Rich	16B	Central Mountains, Manti	12	Joe's Valley
1989	4	Morgan-South Rich	17B	Wasatch Mountains	6	Currant Creek
1989	4	Morgan-South Rich	25A	Plateau	10	Fish Lake
1990	6	Chalk Creek	25A	Plateau	32	Fish Lake
1990-1994		Wasatch Front	10A	Book Cliffs	38	Hill Creek
1991	3	Ogden	10A	Book Cliffs	19	Hill Creek
1991	3	Ogden	17B	Wasatch Mountains	12	Currant Creek
1992	3	Ogden	25A	Plateau	30	Fish Lake
1993	9	North Slope	10A	Book Cliffs	20	Hill Creek
1994-1999	—	Wasatch Front	9	South Slope	5	———
1994-1999	—	Wasatch Front	10A	Book Cliffs	15	Hill Creek
1995	9	North Slope	16B	Central Mountains, Manti	26	Joe's Valley
2000	3/4	Ogden / Morgan-South Rich	10A	Book Cliffs	20	Hill Creek
2001	5	East Canyon	17B	Wasatch Mountains	4	Currant Creek
2005	2/3/5/17	Cache / Ogden / East Canyon / Wasatch Mtns	—	Colorado	22	Grand Mesa
2005	4	Morgan-South Rich	—	Colorado	22	Grand Mesa
2006	2/3/5/17	Cache / Ogden / East Canyon / Wasatch Mtns	—	Colorado	16	Grand Mesa
2006	4	Morgan-South Rich	—	Colorado	24	Grand Mesa
2007	2/3/5	Cache / Ogden / East Canyon	8A	North Slope	—	Summit
2008	3	Ogden	—	Colorado	19	East of Meeker
2012-2017	—	Wasatch Front	11B	Nine Mile, Range Creek	16	Tavaputs Plateau

Table 5. Potential augmentation and reintroduction sites for future moose releases, Utah 2017–2027.

Region	Transplant_Type	Unit		Location
Northern	Augmentation	1	Box Elder	Raft Rivers - Clark's Basin, Johnson Canyon, One Mile Grouse Creek - Ingham Pass, Kimbell Creek
Central	Augmentation	16	Central Mtns, Nebo	Payson Lakes
Central/ Southeastern	Augmentation	16	Central Mtns, Manti	Fairview Canyon Huntington Canyon Pondtown-Upper Fish Creek Potter's Pond Skyline Drive-Ephraim Tunnel Upper Ferron Creek Upper Muddy Creek
Southeastern	Augmentation	11	Nine Mile, Range Creek	Tavaputs Plateau
Southern	Initial	22	Beaver	North Creek Merchant Valley-Three Creeks
	Augmentation	25	Plateau, Fishlake	Gooseberry-Seven Mile- UM Creek

In accordance with Utah Code 23-14-21.