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. The plan will provide overall guidance and direction to Utah's moose management program. The 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 programs. The plan will be used to provide overall guidance and direction for management plans on individual moose units throughout the state.

B. Dates Covered

The moose plan will be in effect for a period of eight years upon approval of the Wildlife Board. (dates covered: December 3, 2009 – December 3, 2017).

II. SPECIES ASSESSMENT

A. Natural History

The moose (*Alces alces*) is largest member of the deer family. Four subspecies of moose are recognized in North America including Shira's moose (*A. a. shirasi*), Eastern moose (*A. a. americana*), Northwestern moose (*A. a. andersoni*), and Alaskan moose (*A. a. gigas*) (Bubenik 2007). The Shiras or Wyoming moose is the subspecies found in Utah and is the smallest of the four subspecies. Mature Shiras moose bulls weigh considerably less than other moose but can still reach 800 pounds. Moose produce the largest antlers of any mammal and use the antlers in dominance displays and fighting behavior 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. 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 (Wilson 1971). 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 was gradually establishing 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 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 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 to manage the state's wildlife resources and to assure 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

Management programs for moose have included regular aerial surveys of populations, management of harvest, transplants, and research. Aerial surveys have been done primarily by helicopter in areas where moose populations are well established. During surveys, moose are counted and classified as bulls, cows, and calves to estimate population size, herd productivity, and bull:cow ratios.

The first legal hunting season for moose in Utah was held in 1958, and a moose hunt has been held 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 using mail questionnaires and telephone surveys. In 2004, the Division implemented mandatory harvest reporting for bull-moose hunters to ensure accurate data. Antlerless moose harvest data is collected using telephone surveys. Between 1958 and 2008, a total of 6,119 (4,942 bulls and 1,177 antlerless) moose have been legally harvested in Utah by a total of 6,685 hunters with an overall mean hunter success rate of 92%. Harvest age data was available from 1986 to 2008, and harvested bulls have averaged 4.5 years old over that time with a low of 3.6 in 1988 and a high of 5.0 in 2006. In 2008, harvested bulls averaged 4.4 years old and the latest 3-year average (2006–2008) was 4.7 years old (Table 2).

Utah has also been involved in a moose transplant program since 1973. This program was initiated to encourage expansion 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 limited success (Table 3). Although a viable population has been established in Currant Creek where some resident moose existed prior to the transplant, only a few moose remain in the other release areas. In more recent years, moose from Utah have been relocated to Colorado with better results. The reasons for Colorado's success are not fully known, but it is thought that the

higher elevation mountain ranges in Colorado probably provide better moose habitat.

In addition to organized transplants, moose that wander out of the mountains and into populated areas are also relocated. Most nuisance moose situations 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. Still others have been simply been relocated to suitable habitat within nearby units away from cities and towns.

Research has been conducted on several moose populations in Utah. Most of 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). The Division has also been actively involved in monitoring transplanted moose on the Manti and Fishlake management units to determine general movements, habitat use, and overall transplant success.

C. 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 a diet of shrubs and young deciduous trees for 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, they are not exclusively tied to them. Moose have done well in drier habitats in northern Utah which are dominated by mountain mahogany, Gambel oak, serviceberry, quaking aspen, and burned over coniferous forests. Moose also use thick stands of conifer as shelter in the winter and for thermoregulation during the summer.

Winter weather and snow depth is not thought to be a seriously limiting factor to moose in Utah. Moose are well adapted, as a result of their long legs and heavy black fur, to live in some of the coldest climates in the world and tolerate deep snow and cold weather very well. In Utah, moose generally live at higher elevations throughout the year, although some moose are observed at lower elevation habitats even in summer. It is possible that moose are limited by prolonged hot weather in parts of Utah. The lack of success of transplants to central and southern Utah may well be due to summer climatic conditions and lack of high elevation habitat.

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 harvesting which remove coniferous trees and revert the habitat to

early seral stages dominated by shrubs and young deciduous tress. Throughout much of its range in North America, the moose is 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 be very beneficial to moose. The use of fire can also be used to dramatically improve moose habitat.

D. Population Status

Moose are well established in the northern half of Utah with the majority of the moose existing on 9 management units (Table 4). The current statewide population in Utah is estimated at 3200 animals. The general trend of the moose herd has been upward since the late 1950's, with an average annual growth rate of 1.12 from 1957 to 1991. From 1992-1996, 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 grew and reached a record population size of nearly 4000 moose in 2005. Since 2005, the moose population has been intentionally reduced due to habitat degradation concerns.

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, appear to be reaching or exceeding carrying capacity and harvest has been used to stabilize or decrease those populations. In the more southern moose units in Utah, some natural expansion continues to occur, but it is relatively limited. Additionally, some remnant populations still exist on the Manti, but little to no growth is occurring, and it is unlikely that they will grow to viable populations.

III. ISSUES AND CONCERNS

A. Habitat Degradation or Loss

The single biggest influence on moose populations in Utah is the quantity and quality of available habitat. Habitat can be degraded, fragmented, or lost to a variety of causes including human development and plant succession. Reductions in habitat can result in corresponding population declines. Improvements in habitat can mitigate losses and result in increased moose populations.

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 degraded. Forest fires and carefully planned logging can help remove coniferous trees and return the habitat to early successional stages which are beneficial for moose.

B. 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.

C. Disease

Like all wild ungulates, moose are susceptible to a wide variety of viral, bacterial, and parasitic diseases. Although diseases caused by parasites are not always fatal, they may affect the animal physiologically and alter behavior enough to eventually cause death (Lankester and Samuel 2007). Reports of sick and dying moose are prevalent during the late-summer to early-spring months throughout northern and northeastern Utah. Reported clinical signs usually consist of animals with opaque corneas or blindness, excessive salivation, bloody and/or mucousy discharge, and varying states of emaciation. Unfortunately, because of the large size of these animals and their remote locations, diagnoses have been very difficult to obtain. Some of the diseases and parasites either documented or considered a concern to Utah moose populations include bluetongue (BTV), epizootic hemorrhagic disease (EHD), chronic wasting disease (CWD), elaeophorosis, infectious kerato-conjunctivitis (IKC), malignant catarrhal fever (MCF), and white muscle disease.

BTV and EHD are arboviruses that are transmitted by sand flies and biting gnats (*Culicoides* spp.) mainly from mid-summer to early fall (Trainer 1970, Nettles and Stallknecht 1992). BTV and EHD are nearly indistinguishable from one another, and the clinical signs of these diseases are characterized by lethargy, decreased wariness, high temperature, edema in the head and neck, hemorrhage, and mucous membranes that have a cyanotic appearance (Lankester 1987). In 1990, the necropsy of a sick adult bull moose from northern Utah yielded positive results for bluetongue; however, the exact cause of death was undetermined (UDWR unpublished data). From 2000–2002, a sero-prevalence survey was conducted on moose that were moved from urban areas in northern Utah. Of the 35 samples that were collected, 11% of the animals were sero-positive for BTV/EHD antibodies. Since both diseases are known to occur throughout Utah, they may be of concern for moose, although no clinical disease has been observed when moose were experimentally infected with EHD (Hoff and Trainer 1978).

CWD is a contagious, slow-acting, and fatal degenerative disease known to affect members of the cervid family including whitetail deer (*Odocoileus virginianus*), mule deer (*O. hemionus*) (Williams and Young 1980, Miller and Wild 2004), elk (*Cervus elaphus*) (Williams and Young 1982, Miller et al. 1998, Miller et al. 2000, Williams et al. 2002), and moose (Kreeger et al. 2006, Baeten et al. 2007). CWD affects the central nervous system of an infected animal resulting in weight loss, deterioration of body condition, and eventually death (Williams and Young 1980, Williams and Young 1982, Spraker et al. 1997, Williams and Young 1992,

Williams et al. 2002). CWD was first documented in Utah in late 2002 and has been found to occur in three distinct geographic areas: the North Slope and South Slope units near Flaming Gorge and Brush Creek, the La Sal Mountains Unit, and the Central Mountains Unit near Fountain Green and the Spencer Fork Wildlife Management Area. At this time, the threat of CWD to Utah moose populations is minimal, as CWD has not been detected in areas where large moose populations occur. Probably, the largest threat of CWD to moose would occur on the North Slope Unit, but the prevalence rate for CWD in mule deer found in this area is <1% and moose are not known to frequent the areas where CWD has been detected. Currently all symptomatic and clinically ill moose are tested for CWD, and this disease has not been detected in moose from Utah.

The arterial worm *Elaeophora schneideri* is a non-pathogenic parasite of the carotid and maxillary arteries of wild and domestic mammals. Horsefly species (*Hybomitra* spp. and *Tabanus* spp) obtain microfilaria from feeding on infected animals, and after a period of incubation in the fly, the infective larvae are passed onto other vertebrates (Hibler and Adcock 1971). The larvae migrate through the blood stream of the new host and can eventually be found in the carotid arteries, maxillary arteries, and concentrated in capillaries around the forehead and face (Lankester and Samuel 2007). Clinical signs include cropping of the ears, necrosis of the muzzle, brain damage, traveling in circles, and a condition known as clear-eyed blindness, which is a lack of the pupil to respond to stimuli (Hibler and Adcock 1971, Lankester 1987). *E. schneideri* has been shown to have detrimental effects on elk (Raedeke et al. 2002) and moose (Madden et al. 1991), but is non-pathogenic in mule deer (Hibler and Metzger 1974). In Utah, most, if not all, moose populations share significant ranges with mule deer, providing a transmission opportunity for *E. schneideri* microfilaria. Elaeophorosis has been identified as the cause of death in 7 moose from northeastern Utah and an additional 10 moose from northern Utah, with as many as 80-96 arterial worms found in the branching portion of the carotid arteries of some moose (UDWR unpublished data).

IKC or “pinkeye” is a concern for Utah moose populations, and moose appear to be very susceptible to infections. IKC is usually associated with a bacterial infection (*Moraxella* spp.), which causes corneal opacity and ulceration in many wild and domestic ruminants (Thorne 1982, Dubay 2000). Infections occur from mid-summer to late fall and, on average, 5–10 moose are reported throughout northern Utah with this affliction annually (UDWR unpublished data). IKC is commonly associated with cattle and transmission usually occurs from close contact with other infected animals (Lankester and Samuel 2007). Although sporadic and occasional, these outbreaks may have population implications in some areas.

MCF is a highly infectious form of gamma-herpes virus that is often fatal. Animals exhibiting clinical signs of MCF show neurological disorders, high fever, severe lethargy, swollen lymph nodes, salivation, diarrhea, dermatitis, and ocular lesions that lead to clear-eyed blindness. Domestic sheep and goats are often asymptomatic carriers of this disease and pass it readily to ruminants, particularly cervids (Zarnke et al. 2002, Vikoren et. al. 2006). Research has suggested that MCF in moose may be highly lethal (Li et al. 1996, Vikoren et al. 2006). Moose share many of their summer and winter ranges in Utah with domestic sheep and may be at risk for MCF. Although not confirmed, MCF is suspected in the deaths of several moose in northern Utah because they exhibited clinical symptoms similar to those found in animals infected with

MCF. Before death, moose were observed with diarrhea, bloody stools, a thick mucous discharge from their nasal cavity, opaque colored eyes, drooped head, and lethargy. The intestinal membranes also had lesions suggestive of MCF although the virus could not be isolated, most likely due to sample degeneration or contamination (UDWR unpublished data).

White muscle disease is a disorder caused by a vitamin E or selenium deficiency. In cattle, poor winter-feeding can induce such a deficiency. Affected animals usually exhibit lameness, excessive salivation, and sudden death from heart degeneration (Blowey and Weaver 2003). Since 2003 as many as 12 moose have been documented with this condition, identified through toxicology surveys as selenium deficient. Most of those animals were found late-winter to late-spring (UDWR unpublished data). Those occurrences may likely have to do with habitat and winter range conditions and their possible contributions to this deficiency should be examined further.

D. 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 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.

E. Predators

In Utah, black bears and mountain lions are the principal predators of moose. Despite their large size, adult moose are killed by mountain lions. Four out of 7 radio collared moose released on the Manti in 1995 were killed by mountain lions (UDWR, unpublished data). Geist (1998) discussed the efficiency of moose in avoiding pursuing and pack hunting predators such as wolves; however, moose may not be as well adapted to ambush type predators such as the mountain lion. Black bears are also 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. Although predation can slow moose population growth, other factors, such as habitat, are likely more important in determining the size of the overall population.

F. Human Interaction

Moose are generally tolerant and less afraid of humans than other wild ungulates, which results in frequent interaction. Additionally, humans live in some of the best moose habitat in the state. During spring, summer, and harsh winters, moose frequently wander from the mountains into the valleys where they interact with people. Although those moose rarely cause serious problems, the potential exists, and they need to be captured and relocated.

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 3000 moose/vehicle accidents occur annually, and that is considered to be a minimum estimate (Childs 2007). Auto collisions with moose usually result in extensive vehicle damage and serious injury to the occupants. Although moose/auto collisions are infrequent and not a widespread problem in Utah, largely due to the relatively small moose population, collision rates should be monitored, and, if needed, action should be taken to reduce the risk of property damage and serious personal injury.

G. Wilderness/Native Status

There are some who question the native status of moose in Utah. Although not present at settlement times, moose immigrated into Utah of their own accord and are considered a native species by the Division. Moose inhabiting wilderness areas in Utah should be considered native.

H. Transplants

Utah has been involved in an experimental moose transplant program since 1973 (Table 3). It has been shown that moose can be successfully captured, transported, and released into new areas. However, it appears that most transplants have not resulted in the establishment of new viable populations. Numerous moose have been released on both the Manti and the Fishlake with minimal success. The reasons for this lack of success are unclear especially in light of the success of transplants from Utah to Colorado. Because of the low success rate in Utah, most managers are now hesitant to pursue further transplant projects to new areas. Future transplants should focus on supplementing previous transplants or expanding small populations where moose have pioneered on their own. Future transplants will be conducted in accordance with Utah Code 23-14-21.

I. Hunting

Moose are often more easily observed and approached than other big game animals causing some people question whether or not moose should be hunted in Utah. However, most moose herds produce surplus animals which can be harvested without harming the population. In fact, most moose populations in Utah need to be hunted to control population size and keep herds in balance with limited habitat. Hunting of moose is an important management tool and should remain a legitimate use of a natural resource. However, hunters need to be ethical, proficient, safe, and socially responsible while hunting moose or any other wildlife.

Across most of their range, moose are managed primarily for their meat value with less emphasis on trophy management (Timmerman and Buss 2007). In Utah, however, moose are highly sought after by hunters primarily as trophy animals and secondarily for their meat. Because moose hunting is a once-in-a-lifetime opportunity in Utah and permits are difficult to draw, many hunters who draw a permit expect to harvest a mature bull and are disappointed if they don't.

The first legal hunting season for moose in Utah was held on the north slope of the Uinta Mountains in 1958. Ten permits were sold for this hunt and 7 bulls were harvested. Utah has

held a moose hunt every year since 1958, and permits have generally been increasing (Figure 3, Table 1). In 2008, Utah harvested 364 total moose (266 bulls and 98 cows) with a combined success rate of 90%. The number of bull moose and total moose harvested were the highest ever for the state.

IV. USE AND DEMAND

Moose are an important wildlife species in Utah which should be managed for their intrinsic, scientific, educational, and recreational values. In Utah, there is very high demand for bull moose hunting permits (Table 5). Hunting permits for Shiras moose are considered one of the most difficult permits to obtain of any North American big game species other than bighorn sheep. For Utah residents, applications currently exceed available permits by more than 80:1 and have been as high as 97:1. The odds of drawing a permit for nonresidents are even worse with the odds of drawing a permit in 2008 being 112:1 and as high as 190:1.

Moose are also an important watchable wildlife species for many Utahans. Most people who have the opportunity to view moose in the wild consider it a unique and exciting experience, and it is often the highlight of a camping or hiking trip. Viewing opportunities for moose have not been extensively promoted by the Division, and there are many options to expand viewing opportunities of moose in Utah that need to be explored.

V. CONCLUSION

Moose are a unique and valuable part of our wildlife heritage in Utah. 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 3200 animals in winter 2009.

Moose are well adapted to the riparian and mountain browse habitats in northern Utah. They can easily withstand the deep snow and cold weather in Utah's northern mountains but may not be as well suited for the warmer climates found in southern Utah.

The Division of Wildlife Resources has carefully managed Utah's moose populations to ensure herds are productive and balanced with available habitat. Southern expansion of moose has been encouraged by transplant efforts, but have only been met with limited success. There are numerous issues involved in the proper management of moose including habitat loss, competition, disease, poaching, predators, human interactions, wilderness management, transplants, and hunting. Those issues should all be considered in future management programs.

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 sportsmen. High quality viewing and hunting opportunities should be expanded in the state where possible.

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. Once unit objectives are established, bring all populations to objective by 2017.

Strategies:

a. Develop management plans for individual units with population goals and objectives.
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. Conduct research projects to determine limiting factors to moose populations in Utah.
e. If necessary, initiate predator management as specified in predator management plans
f. Support law enforcement efforts to reduce illegal taking 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. Initiate prescribed burns and other vegetative treatment projects to improve moose habitat lost to ecological succession or human impacts.
e. Under the Utah Watershed Restoration Initiative, design, implement, and monitor the effectiveness of habitat improvement projects to benefit moose and other wildlife.
f. Recommend antlerless harvest to control populations and maintain habitat quality.
g. 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 population allow while maintaining high quality hunting experiences.

Strategies:

a. Manage for a 3-year average age of harvested bull of 4.0–6.0 years of age on all units to ensure sufficient numbers of older age class bulls are in the herd, while maximizing hunter opportunity.
b. Use subunits to maximize hunting opportunities and distribute hunters.
c. Recommend long hunting seasons to provide extended hunting opportunity.
d. Maintain high hunter success (>80%) on all units.

Objective 2: Increase opportunities for viewing moose, while educating the public concerning the needs of moose and the importance of habitat.

Strategies:

a. Install interpretive signs in moose areas for public information.
b. Produce written guides or brochures to help educate the public and provide viewing opportunities.
c. Work with news media sources to inform and educate the public about moose and moose management programs in Utah.

Literature Cited

Babcock, W. H. 1977. Continuing investigations of the Unita North Slope moose herd. Utah Division of Wildlife Resources Publication 77–19. Salt Lake City, Utah, USA.

Babcock, W. H. 1981. Ecology of the Uinta North Slope moose herd. Utah Division of Wildlife Resources, Salt Lake City, Utah, USA.

Baeten, L. A., B. E. Powers, J. E. Jewell, T. R. Spraker, and M. W. Miller. 2007. A natural case of chronic wasting disease in a free-ranging moose (*Alces alces shirasi*). Journal of Wildlife Diseases 43:309–314.

Ballard, W. B., J. S. Whitman, and D. J. Reed. 1991. Population dynamics of moose in south-central Alaska. Wildlife Monographs 114. 49 pages.

Ballard W. B., and V. Van Ballenberghe. 2007. Predator/prey relationships. Pages 247–274 *in* A. W. Franzmann and C. C. Schwartz, editors. Ecology and Management of the North American Moose, 2nd Edition. University Press of Colorado, Boulder, Colorado, USA.

Blowey, R. W. and A. David Weaver. 2003. Color atlas of diseases and disorders of cattle. Second edition. Mosby Incorporated, St. Louis, MO. 223 pages.

Boer, A. H. 2007. Interspecific relationships. Pages 337–350 *in* A. W. Franzmann and C. C. Schwartz, editors. Ecology and Management of the North American Moose, 2nd Edition. University Press of Colorado, Boulder, Colorado, USA.

Bubenik, A. B. 2007. Evolution, taxonomy, and morphophysiology. Pages 77–124 *in* A. W. Franzmann and C. C. Schwartz, editors. Ecology and Management of the North American Moose, 2nd Edition. University Press of Colorado, Boulder, Colorado, USA.

Child, K. N. 2007. Incidental mortality. Pages 275–302 *in* A. W. Franzmann and C. C. Schwartz, editors. Ecology and Management of the North American Moose, 2nd Edition. University Press of Colorado, Boulder, Colorado, USA.

Dubay, S. A., E. S. Williams, K. Mills, and A. M. Boerger-Fields. 2000. Association of *Moraxella Ovis* with keratoconjunctivitis in mule deer and moose in Wyoming. Journal of Wildlife Diseases 36:241–247.

Franzmann, A. W., C. C. Schwartz, and R. O. Peterson. 1980. Moose calf mortality in summer on Kenai Peninsula, Alaska. Journal of Wildlife Management 44:764–768.

Geist, V. 1998. Deer of the World, Their Evolution, Behavior, and Ecology. Stackpole Books, Harrisburg. Pennsylvania, USA.

Geist, V. 1971. Traditions and the evolution of social systems: sheep versus moose. Pages 117–129 *in* V. Geist, editor. Mountain sheep: A Study in Behavior and Evolution. University of Chicago Press, Chicago, Illinois, USA.

Hibler, C. P., and C. J. Metzger. 1974. Morphology of the larval stages of *Elaeophora schneideri* in the intermediate and definitive hosts with some observations on their pathogenesis in abnormal definitive hosts. Journal of Wildlife Diseases 10:361–369.

Hibler, C. P., and J. L. Adcock. 1971. Elaeophorosis. Pages 263–278 *in* J. W. Davis and R. C. Anderson, editors. Parasitic Disease of Wild Mammals. Iowa State University Press. Ames, Iowa, USA.

Hoff, G. L., and D. O. Trainer. 1978. Bluetongue and epizootic hemorrhagic disease viruses: their relationship to wildlife species. Advances in Veterinary Science and Comparative Medicine 22:111–132.

Kreeger, T. J., D. L. Montgomery, J. E. Jewell, W. Schultz, and E. S. Williams. 2006. Oral transmission of chronic wasting disease in captive Shira's moose. Journal of Wildlife Diseases 42:640–645.

Lankester, M. W. 1987. Pests, parasites and diseases of moose (*Alces alces*) in North America. Swedish Wildlife Research Supplement 1:461–489.

Lankester, M. W., and W. M. Samuel. 2007. Pests, parasites and diseases. Pages 479–518 *in* A. W. Franzmann and C. C. Schwartz, editors. Ecology and Management of the North American Moose, 2nd Edition. University Press of Colorado, Boulder, Colorado, USA.

Li, H., D. A. Jessup, D. P. Knowles, J. R. Gorham, T. Thorne, D. O'Toole, and T. B. Crawford. 1996. Prevalence of antibody to malignant catarrhal fever virus in wild and domestic ruminants by competitive-inhibition ELISA. Journal of Wildlife Diseases 32:437–443.

Madden, D. J., T. R. Spraker, and W. J. Adrian. 1991. *Elaeophora schneideri* in moose (*Alces alces*) from Colorado. Journal of Wildlife Diseases 27:340–341.

Miller, M. W., E. S. Williams, C. W. McCarty, T. R. Spraker, T. J. Kreeger, C. T. Larsen, and E. T. Thorne. 2000. Epizootology of chronic wasting disease in free-ranging cervids in Colorado and Wyoming. Journal of Wildlife Diseases 36:676–690.

Miller, M. W., and M. A. Wild. 2004. Epidemiology of chronic wasting disease in captive white-tailed and mule deer. Journal of Wildlife Diseases 40:320–327.

Miller, M. W., M. A. Wild, and E. S. Williams. 1998. Epidemiology of chronic wasting disease in captive Rocky Mountain elk. Journal of Wildlife Diseases 34:532–538.

Nettles, V. F., and D. E. Stallknecht. 1992. History and progress in the study of hemorrhagic disease of deer. Transactions of the North American Wildlife and Natural Resources Conference 57:499–516.

Peek, J. M. 2007. Habitat relationships. Pages 351–376 *in* A. W. Franzmann and C. C. Schwartz, editors. Ecology and Management of the North American Moose, 2nd Edition. University Press of Colorado, Boulder, Colorado, USA.

Raedeke, K. J., J. J. Millspaugh, and P. E. Clark. 2002. Population characteristics. Pages 449–492 *in* D. E. Toweill and J. W. Thomas, editors. North American Elk Ecology and Management. Smithsonian Institution Press, Washington D. C., USA.

Spraker, T. R., M. W. Miller, E. S. Williams, D. M. Getzy, W. J. Adrian, G. G. Schoonveld, R. A. Spowart, K. I. O'Rourke, J. M. Miller, and P. A. Merz. 1997. Spongiform encephalopathy in free-ranging mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*) and Rocky Mountain elk (*Cervus elaphus nelsoni*) in North-central Colorado. Journal of Wildlife Diseases 33:1–6.

Thorne, E. T. 1982. Infectious keratoconjunctivitis. Pages 81–84 *in* E. T. Thorne, N. Kingston, W. R. Jolley, and R. C. Bergstrom, editors. Diseases of Wildlife in Wyoming. Wyoming Game and Fish Department, Cheyenne, Wyoming, USA.

Timmerman, H. R., and M. E. Buss. 2007. Population and harvest management. Pages 559–616 *in* A. W. Franzmann and C. C. Schwartz, editors. Ecology and Management of the North American Moose, 2nd Edition. University Press of Colorado, Boulder, Colorado, USA.

Trainer, D. O. 1970. Bluetongue. Pages 55–59 *in* J. W. Davis, L. H. Karstad, and D. O. Trainer, editors. Infectious Diseases of Wild Mammals. Iowa State University Press, Ames, Iowa, USA.

Van Wormer, R. L. 1967. Distribution and habitat evaluation of the moose (*Alces americanus shirasii*) in the Uinta Mountains, Utah. Thesis, Utah State University, Logan, Utah, USA.

Vikoren, T., H. Li, A. Lillehaug, C. M. Jonassen, I. Bockerman, and K. Handeland. 2006. Malignant Catarrhal Fever in free-ranging cervids associated with OVHV-2 and CPHV-2 DNA. Journal of Wildlife Diseases 42:797–807.

Williams, E. S., M. W. Miller, T. J. Kreeger, R. H. Kahn, and E. T. Thorne. 2002. Chronic wasting disease of deer and elk: A review with recommendations for management. Journal of Wildlife Management 66:551–563.

Williams, E. S., and S. Young. 1980. Chronic wasting disease of captive mule deer: A spongiform encephalopathy. Journal of Wildlife Diseases 16:89–98.

Williams, E. S., and S. Young. 1982. Spongiform encephalopathy of Rocky Mountain elk. Journal of Wildlife Diseases 18:463–471.

Williams, E. S., and S. Young. 1992. Spongiform encephalopathies in Cervidae. Scientific and Technical Review Office of International Epizootics 11:551–567.

Wilson, D. E. 1971. Carrying capacity of the key browse species for moose on the north slopes of the Uinta Mountains. Utah Division of Wildlife Resources Publication Number 71-9, Salt Lake City, Utah, USA.

Zarnke, R. L., H. Li, and T. B. Crawford. 2002. Serum antibody prevalence of malignant catarrhal fever viruses in seven wildlife species from Alaska. Journal of Wildlife Diseases 38: 500–504.

Figure 1. Statewide moose population trends, Utah 1957–2009.

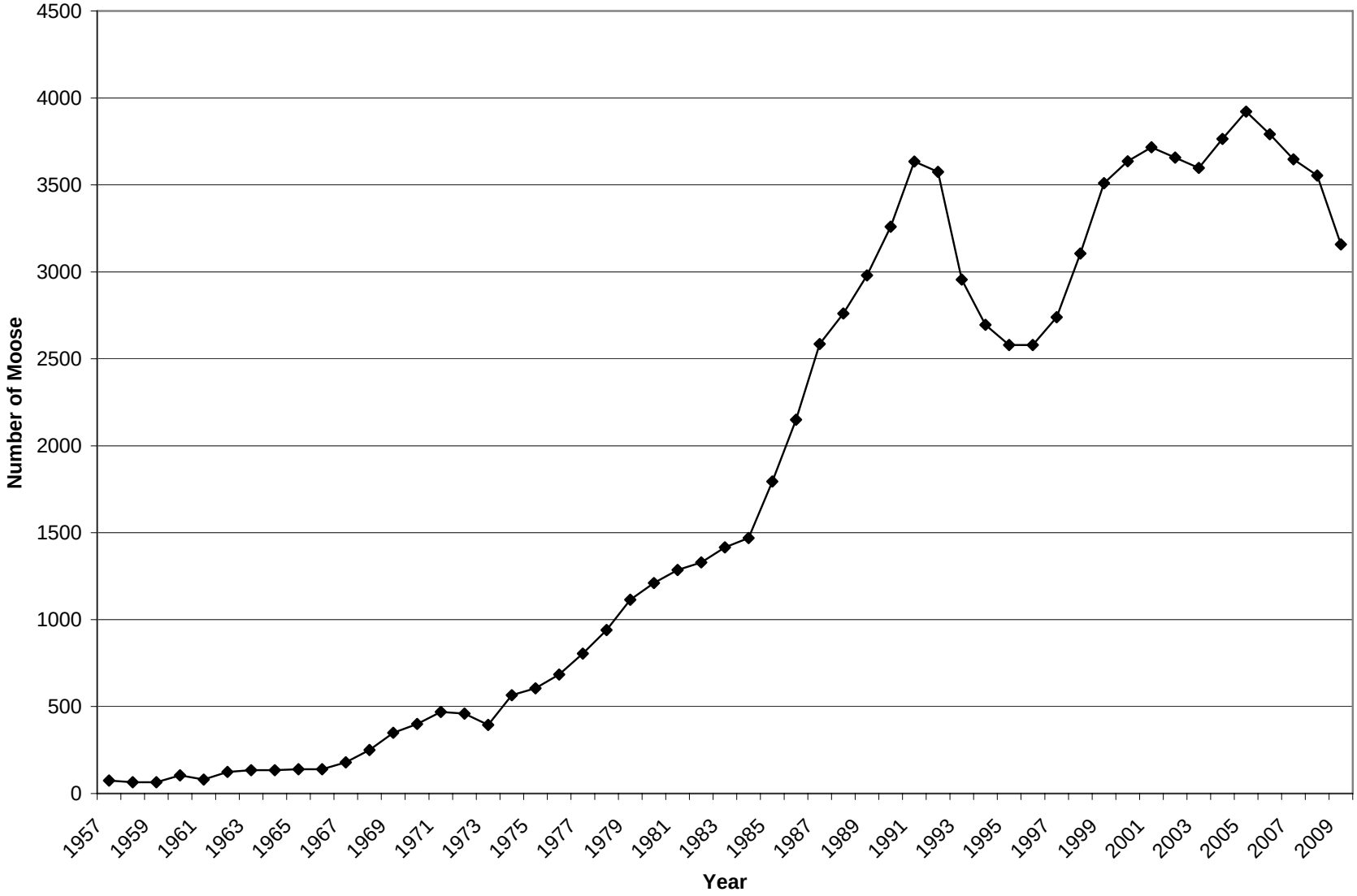

Figure 2. Potential moose habitat by big game management unit, Utah 2009.

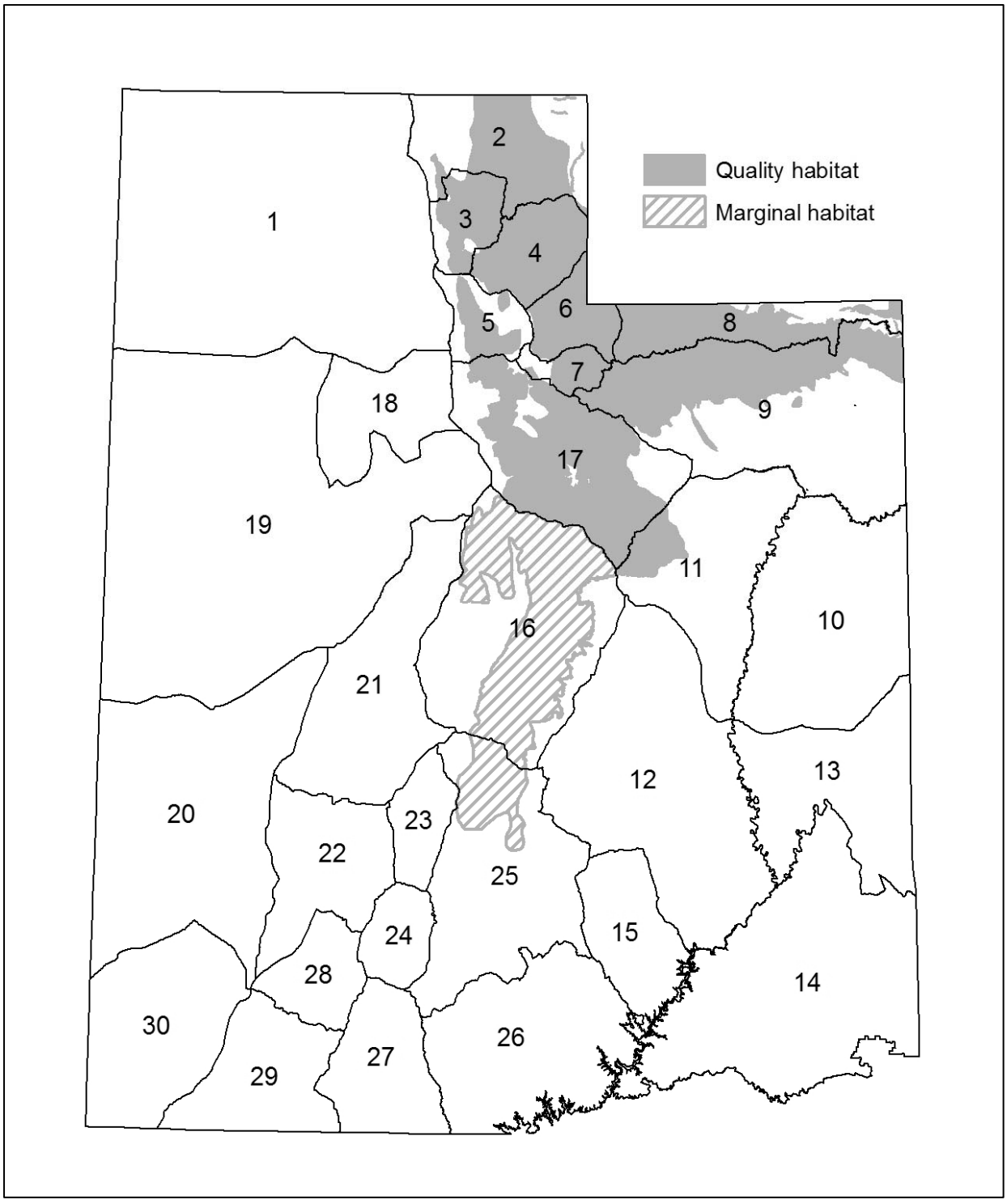

Figure 3. Statewide trends in moose harvest and hunters afield, Utah 1958–2008.

Table 1. Historic statewide moose harvest, Utah 1958–2008.

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. Historic statewide moose harvest, Utah 1958–2008 (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

Table 2. Average age of harvested bull moose by hunt unit, Utah 2002–2008.

Unit		Year							
		2002	2003	2004	2005	2006	2007	2008	3-year average
2	Cache	4.7	4.9	4.9	4.9	4.5	4.6	4.5	4.5
3	Ogden	5.1	4.5	5.1	5.4	5.5	4.6	4.1	4.7
4	Morgan_Rich	4.0	4.6	4.8	5.4	4.8	3.9	4.4	4.4
5	East Canyon	4.3	4.2	4.3	4.4	5.4	3.6	4.6	4.6
6	Chalk Creek	6.0	4.6	4.6	4.1	4.6	4.8	4.3	4.6
7	Kamas	4.0	4.5	4.3	4.7	5.0	5.5	3.5	4.7
8A	North Slope, Summit	5.1	6.1	5.3	6.0	5.4	6.2	5.4	5.7
8BC	North Slope, W Daggett / Three Corners	—	—	—	4.4	4.9	5.0	3.9	4.6
9A	South Slope, Yellowstone	—	—	—	2.6	5.9	5.3	3.7	4.9
9BC	South Slope, Vernal / Diamond Mountain	—	—	—	5.3	8.0	4.0	5.0	5.7
17	Wasatch, Mountains	—	—	—	3.8	4.5	4.5	4.1	4.4
Statewide average		4.8	4.7	4.8	4.7	5.0	4.7	4.4	4.7

Table 3. History of moose transplants, Utah 1973–2008.

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

Table 4. Current moose population estimates and trends by management unit, Utah 2009.

Unit		Region	Population estimate	5-year trend	10-year trend
2	Cache	NRO	200	Stable	Stable
3	Ogden	NRO	500	Stable	Down
4	Morgan_Rich	NRO	475	Down	Stable
5	East Canyon	NRO	375	Stable	Up
6	Chalk Creek	NRO	550	Stable	Stable
7	Kamas	NRO	75	Stable	Stable
8A	North Slope, Summit	NRO	225	Up	Down
8BC	North Slope, W Daggett / Three Corners	NERO	125	Stable	Stable
9A	South Slope, Yellowstone	NERO	125	Up	Up
9BC	South Slope, Vernal / Diamond Mountain	NERO	80	Up	Up
11B	Nine Mile, Range Creek	SERO	15	Up	—
16B	Central Mountains, Manti	SERO	25	Down	Down
17A	Wasatch, West	CRO	350	Up	Up
17B	Wasatch, Currant Creek	NERO	65	Stable	Stable
Statewide total			3185	Down	Stab le

Table 5. Limited Entry drawing odds of obtaining a bull moose permit, Utah 1998–2009.

Year	Residents			Nonresidents		
	Applicants	Permits	Odds	Applicants	Permits	Odds
1998	4,501	102	1 in 44.1	151	3	1 in 50.3
1999	5,592	102	1 in 54.8	245	4	1 in 61.3
2000	7,048	110	1 in 64.1	372	7	1 in 53.1
2001	8,494	115	1 in 73.9	608	7	1 in 86.9
2002	10,595	121	1 in 87.6	755	8	1 in 94.4
2003	11,930	124	1 in 96.2	906	7	1 in 129.4
2004	12,902	142	1 in 90.9	1,037	7	1 in 148.1
2005	14,136	146	1 in 96.8	1,247	8	1 in 155.9
2006	15,078	163	1 in 92.5	1,433	10	1 in 143.3
2007	16,588	174	1 in 95.3	1,707	9	1 in 189.7
2008	16,085	201	1 in 80.0	1,566	14	1 in 111.9
2009	16,161	180	1 in 89.8	3408	13	1 in 262.2