UTAH MULE DEER

STATEWIDE MANAGEMENT PLAN

Utah Division of
Wildlife Resources

UTAH DIVISION OF WILDLIFE RESOURCES
STATEWIDE MANAGEMENT PLAN FOR MULE DEER

I. PURPOSE OF THE PLAN

A. General

This document provides overall guidance and direction for managing Utah's mule deer populations. This plan provides general information on natural history, management, population status, habitat, and issues of concern for mule deer in Utah. This plan also outlines the goals, objectives, and strategies for managing mule deer populations and their habitats. The plan will be used to help set priorities for statewide mule deer management programs and provide guidance for individual unit management plans.

B. Dates Covered

The mule deer management plan will be presented to the Utah Wildlife Board on December 5, 2019 and, if approved, will be in effect for a period of 5 years from this date (Dates covered: December 5, 2019 – December 5, 2024).

II. SPECIES ASSESSMENT

A. Natural History

Mule deer (*Odocoileus hemionus*) are part of the deer or cervid family which includes moose (*Alces alces*), elk (*Cervus canadensis*), and caribou (*Rangifer tarandus*) among many other species. A unique feature of the cervid family is that males grow bony antlers that are shed each year. The name "mule deer" comes from their large ears, which resemble those of mules. The specific epithet *hemionus* means half mule. Mule deer occur throughout the western U.S. with as many as 11 subspecies described (deVos, 2003).

Mule deer males, females, and young are known as bucks, does, and fawns, respectively. Fawns are born as singles or more commonly as twins after a gestation period of approximately 7 months. Fawns are normally born in June with the mean fawning date in Utah ranging from June 7–20 (Robinette et al. 1977, Freeman et al. 2014). Fawns born too early have a higher likelihood of encountering late winter storms, which may decrease survival. Conversely, fawns born too late may not have time to grow large enough and build up sufficient fat reserves to withstand Utah's winters. Pregnancy rates for mule deer are high and typically exceed 95% (Freeman et al. 2014).

The antlers of bucks begin to grow as soon as the old antlers are shed in late winter. Bucks will generally live apart from does and fawns through the summer antler growing period (Geist 1998). The velvet, which covers and provides nourishment to the growing antlers, begins to shed in early September. In Utah, the rut or breeding period for mule deer peaks in mid-November. During the rut, bucks seek out and "tend" several does, waiting for them to come into estrus. During the peak of estrus, does are receptive for less than a day and sometimes for only a few hours. If females are not bred during the first estrous cycle, they will enter another estrous cycle about 4 weeks later (Wallmo 1978).

After the rut, bucks become reclusive again until they shed their antlers in late winter and join herds of does and fawns, blending in with the rest of the antlerless population. In late spring, the does seek solitude for fawning. At this time, yearlings from the previous year can be aggressively driven away by the does. Once new fawns are several months old, adult females form family groups for the remainder of the summer that often include yearlings born the previous year.

B. Management

1. UDWR Regulatory Authority

The Utah Division of Wildlife Resources (hereafter the Division) operates under the 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*. This Code also vests the Division with necessary functions, powers, duties, rights, and responsibilities associated with wildlife management within the state. Division duties are to protect, propagate, manage, conserve, and distribute protected wildlife throughout the state.

2. Past and Current Management

History of Mule Deer Management

Mule deer were common in Utah at the time of settlement, although not as abundant as today (Rawley 1985). Mule deer harvest was unrestricted until after the turn of the twentieth century. In 1908 the hunting season on deer was closed to help protect Utah's dwindling deer herd (Rawley 1980). In 1913 deer hunting resumed when the legislature enacted a buck-only law. However, as the deer herd increased game managers realized the need for antlerless harvest in order to keep the deer herds in balance with their habitat. The first limited harvest of does began in 1934 on 4 separate herd units. Multiple permits, multiple seasons, and extra permits for antlerless deer were common in the 1950s and early 1960s. Total deer harvest (bucks and does) peaked in Utah in 1961 when over 132,000 deer were harvested (Figure 1). As the number of hunters and permits increased, deer populations were gradually reduced and brought more in balance with available forage and habitat. Extra permits and antlerless harvest were gradually reduced through the mid-1960s and early-1970s.

By the mid 1970s it was apparent that deer populations were in decline and, in many areas, below the carrying capacity of the habitat. In 1975, Utah again adopted a statewide buck-only hunting strategy and a symposium was held in 1976 to discuss the decline of mule deer in the west (Workman and Low 1976). Under buck-only hunting deer populations went through a series of boom and bust cycles. The peak harvest of buck deer in the state occurred in 1983 when 82,552 bucks were harvested during the general season hunts. Buck hunter numbers also peaked in 1983 with 228,907 hunters participating in the general season deer hunt, whereas the total number of hunters peaked in 1988 with nearly 250,000 total hunters afield (Figure 1).

Mule Deer Management Plans

Management plans provide guidance and direction for deer populations in Utah. These plans are taken through a public process to gather input from interested constituents and then presented to the Utah Wildlife Board for approval. The first statewide deer management plan was approved in 1995 and called for managing public land general season units to a minimum regional average of 15 bucks per 100 does.

Individual management plans were then developed for 53 deer management units and approved by the Wildlife Board in 1996. This plan remained in effect until 2003 when it was updated and approved by the Wildlife Board. Unit management plans were revised in 1998 following a reduction in the number of deer management units from 53 to 30, and revised again in 2001 to incorporate new population objectives and habitat information. In 2008, the statewide plan was again revised and approved by the Wildlife Board. In 2011, the statewide plan was amended with the general season buck-to-doe objectives being raised from 15–25 to 18–25 bucks per 100 does as an average in each of the 5 regions.

Due to concerns over chronically low buck-to-doe ratios on specific management units within the regional hunt boundaries, the Wildlife Board amended the statewide plan again in 2012 and approved a general season unit-by-unit hunt structure. Under this management system, the state was divided into 30 general-season hunting units with 14 units managed at 15–17 bucks per 100 does and 16 units managed for 18–20 bucks per 100 does. The lower buck-to-doe ratio objective was designed to provide for increased hunting opportunity whereas the higher objective was intended to provide opportunity for hunters to harvest older and larger bucks. The statewide management plan was revised again in December 2014 and has been used as the guiding document for management over the last 5 years. After the 2014 revision of the statewide plan, there was a change in unit plans that resulted in 29 general-season hunting units. Currently 11 of those units are managed at 15–17 bucks per 100 does and 18 of those units are managed at 18–20 bucks per 100 does.

All unit plans were revised in 2006 and again in 2012. Unit plans are currently revised on a five-year rotation with each unit plan being revised the year following collection of range trend data. By doing so, the latest and most accurate habitat assessment can be incorporated into each unit plan. On some units, local working groups have been used to help with the development and implementation of unit plans. Those groups have been instrumental in garnering local support for mule deer management and providing local knowledge on factors limiting population growth and locations where habitat projects may be beneficial. Local working groups will continue to be used on an as-needed basis to assist in achieving the population and habitat management goals and objectives.

Recent Mule Deer Harvest Management

Following several years of drought and an unusually hard winter in 1992–1993, buck deer permits were capped for the first time in 1994. That year, 97,000 general-season buck permits were issued across 5 hunting regions. The 97,000 permit cap remained in place through 2005, but due to difficulties in monitoring over-the-counter permit sales, buck hunter numbers exceeded 97,000 permits in some years. Permit sales were closer to the 97,000 cap after implementation of a drawing system in 2000. Because of severe drought during the early 2000s, the permit cap was temporarily reduced to 95,000 in 2005 with 1,000 permits removed from both the Central and Northeastern regions. Due to continued drought concerns and, in some areas, severe winter weather, permits were held below the 97,000 cap through 2012, at which time unit-by-unit hunting was implemented and the statewide permit cap was removed. The total number of general-season deer permits available in 2019 was 89,900.

Prior to 1994, data on buck-to-doe ratios were collected by wildlife biologists but not used to determine permit numbers. The 1995 statewide mule deer management plan changed this management practice and set postseason buck-to-doe objectives for general season units at 15 bucks per 100 does for the 5 regions. The regions, and later individual units, have been managed for a set range of bucks per 100 does since that time. In 2018, 23 general-season units either met or exceeded their buck-to-doe ratio objective, whereas only 6 units were below objective (Table 1).

Over the past 20 years, an average of 27,619 bucks has been harvested in Utah each year. The harvest level has remained relatively constant over this time period with a low of 21,292 in 2011 and a high of 34,402 in 2016. During the same time period, buck-to-doe ratios have shown an increasing trend in Utah with average ratios on public lands across the state rising from 13 bucks per 100 does in 1998 to 19 bucks per 100 does in 2018 (Figure 2). With fewer hunters and higher buck-to-doe ratios, hunter success has increased on general-season units. Statewide average hunter success during the general-season any weapon hunt in 2018 was 39.3% compared to 31.1% during the 1998 any weapon hunt.

In addition to general season hunting opportunities, Utah also manages for premium limited-entry and limited-entry hunts which provide a high quality hunting experience, high hunter success, and few permits. There are 2 premium limited-entry hunting units in Utah: the Henry Mountains and the Paunsaugunt. From 2008 to 2014, these units were managed for a 3-yr average of 40–50 bucks per 100 does and 40–55% of the harvest ≥5 years of age. That strategy was slightly modified in 2015 and set the public draw permits at 49 for the Henry Mountains and 135 on the Paunsaugunt for the next 5 years, as long as the 3-yr average of >40% of the bucks harvested were ≥5 years of age. In 2008, management buck hunts (3 points or less on 1 antler) were added to these units to help reduce their buck-to-doe ratios and provide additional hunting opportunity while not reducing the top-end quality. In 2018, 205 premium limited-entry permits were issued, with a harvest of 189 bucks and a 3-yr average of 57% of bucks ≥5 years of age. Additionally, 55 management buck permits were issued and 48 bucks harvested. These 2 units met or exceeded both of their management objectives in 2018 (Table 2).

There are 7 limited-entry units in the state that are managed for a postseason buck-to-doe ratio of 25–35 bucks per 100 does. In 2018, all 7 units met or exceeded their management objectives (Table 3). In addition to managing limited-entry units based on buck-to-doe ratios, the Division also provides limited-entry hunts on general-season units based on the timing of the hunting season, either through early high-country buck hunts, or through muzzleloader hunts in early November. In 2018, the Division issued 1,402 limited-entry permits and 1,129 bucks were harvested.

In addition to hunting bucks, doe hunting has been used to address habitat concerns on rangelands and alleviate depredation on private lands. In 1995, the Utah Legislature passed a law that required the establishment of population objectives on each mule deer unit. In some instances, doe hunts have been used to meet population objectives, although the current approach is to evaluate range trends, annual winter browse utilization, and deer densities to determine if population objectives need to be adjusted before recommending doe permits.

C. Population Status

The 2018 postseason population estimate for mule deer in Utah was 372,500 deer; 82% of the long-term management objective of 453,100 deer. Since the large decline during winter 1992–1993, the statewide deer population has shown an increasing trend (Figure 3). The population had good growth during the mid-late 1990s, but then declined during the severe drought years from 2000 to 2003 when fawn production decreased (Figure 4). The harsh winters in northern Utah in 2007–2008 and in southern Utah in 2009–2010 negatively impacted adult and fawn survival, resulting in population declines. Weather conditions from 2011–2015 were very favorable for mule deer resulting in an increase of nearly 100,000 deer. Overall, the deer population in Utah has grown at an average rate of 1.6% over the past 20 years.

D. Herd Monitoring

Population sex and age composition for mule deer is determined through the use of postseason ground classification counts. On each unit, annual ground classification counts are conducted shortly after the general-season hunts (typically between November 15 and January 15) when mule deer are concentrated on winter range and bucks are in peak rut. Data are collected on representative areas throughout each unit and biologists attempt to classify a minimum of 400 does on each unit. Classification data are used to determine annual production and survival of young to 6-months old (fawn-to-doe ratios), to assess if herds are meeting their buck-to-doe objectives, and as input data for population models.

In addition to classification data, the Division also monitors survival and cause-specific mortality on 7 representative units across the state. Adult female survival has been shown to have the most influence on population growth, whereas fawn survival, although less influential, shows considerable temporal variation (White and Bartmann 1998, Gaillard et al. 2000). Beginning in 2009, survival data were collected using VHF radio collars on a sample of adult does and female fawns. This provided good estimates of overwinter and annual survival, but little information on timing and cause of mortality. In 2014, the Division switched from using VHF collars to satellite-GPS collar, which greatly improved the quantity and quality of data collected. The GPS collars send an email when they switch to mortality mode, enabling biologists to determine the timing and likely cause of mortality for each deer. Over the 10-year survival monitoring period, statewide adult female survival has averaged 83% (range 79-86%), whereas fawn survival has averaged 61% (range 30-82%, Table 4). During the 5 years of monitoring cause-specific mortality, 44% died due to predation, 19% due to malnutrition, 6% from vehicle collisions, 8% other causes, and 23% to unknown causes (Table 5). By understanding the extent and main sources of mortality, we are able to determine the likely limiting factors for each population and develop management actions to address those factors.

In 2014 the Division also began monitoring nutritional condition of mule deer entering winter using a combination of ultrasonography and palpation (Cook et al. 2010). Nutrition and the resultant nutritional condition can have substantial effects on virtually every aspect of physiology and productivity of animals (Cook 2002), and nutritional deficiencies can affect reproduction, growth and development, and survival (Gaillard et al. 2000, Cook et al. 2004, Parker et al. 2009). In addition to impacts on demography, deer in good body condition produce fawns that have the potential to grow larger antlers than females in poor body condition (Freeman et al. 2013). By knowing when and where nutrition is limiting mule deer populations, habitat treatment projects and other management actions can be implemented to improve population performance.

E. Habitat

Mule deer are adaptable to a wide variety of habitats throughout their range (Wallmo 1981). In North America, they live from the northern boreal forests to the hot deserts of the southwest and from the coastal rain forests to the Great Plains. In Utah, mule deer are found across the state, although they are less abundant in desert areas (Figure 5). Currently, 54% of the state is considered mule deer habitat. Total mule deer habitat in Utah is estimated at 29,370,577 acres with 10,189,038 acres of summer habitat, 13,787,762 acres of winter habitat, and 5,393,777 acres of transitional or year-long habitat.

Although mule deer occur in a wide variety of habitat types, there are many similarities in diet and habitat composition. Deer eat a wide variety of plants including browse, forbs and grasses. Deer are especially reliant on shrubs for forage during winter months. Similarly, fawn production is closely tied to

the abundance of succulent, green forage during the spring and summer months. Even though vegetative communities vary throughout the range of mule deer, habitat is nearly always characterized by areas of thick brush or trees interspersed with small openings. The thick brush and trees are used for escape and thermal cover, whereas the small openings provide forage and feeding areas.

Mule deer do best in habitats that are in the early stages of plant succession. This relationship is described in the Western Association of Fish and Wildlife Agencies (WAFWA) publication on mule deer, which states: "Mule deer thrive in early successional habitats, where forbs, grassy plants and shrubs dominate. These environments are not as stable as forest habitats, and they rely on fire or some other type of disturbance to return them to an early successional stage. If they are not disturbed, they become more stable plant communities dominated by large trees and large shrubs. Tree-dominated habitats offer mule deer a place to retreat from severe weather, but these areas offer little in the way of food. That is why it is important to provide a mosaic or pattern of habitats that can provide food, cover and water." (WAFWA 2003)

One of the major problems facing mule deer populations in Utah is many of the crucial deer ranges are in late successional plant community stages dominated by mature stands of pinyon-juniper or other conifer trees, and old even-aged stands of shrubs such as sagebrush. Many crucial deer winter ranges are covered with older shrubs with little or no recruitment of young plants, or are being replaced by annual grasses like cheatgrass (*Bromus tectorum*). Additionally, many forest aspen habitats are being replaced by conifers that provide little forage for mule deer. In order for mule deer populations to thrive in Utah, it is essential that extensive habitat treatments be completed to revert sagebrush habitats back to young, vigorous, shrub-dominated communities, and restore aspen communities to early seral stages. Habitat treatments vary by site but generally include chaining, bullhog, and pinyon-juniper lop and scatter on winter range and prescribed fire and logging on summer range. Figure 6 shows the habitat restoration priority areas for mule deer in Utah.

III. ISSUES AND CONCERNS

A. Habitat

Deer habitats are classified into three main categories based on season of use: winter, summer and transitional. Deer use high quality forage during the spring and early summer to aid in fat and protein deposition (Cook et al. 2013). The higher the quality of spring and summer forage, the better the antler growth in bucks, the better does are prepared for lactation, and the more fat reserves deer can build up for use during winter. Recent data from Utah's monitoring effort suggests the amount of fat deer have entering into winter is an important predictor of over winter survival. Similarly, high quality forage on winter range may help slow the rate of decline of accumulated fat reserves, helping deer survive. The size and condition of mule deer populations are primarily determined by the quantity and quality of these habitats as they provide the necessary nutrition to sustain deer throughout the year. Lack of quality habitat has been associated with decreased survival and recruitment of fawns, increased age at first reproduction, decreased reproductive output, and decreased survival by adults (Monteith et al. 2014).

Loss and degradation of habitat are thought to be the main reasons for mule deer population declines in western North America over the last few decades (Workman and Low 1976, WAFWA 2003). Crucial mule deer habitat has been and continues to be lost in many parts of Utah and severely fragmented in others due to human population expansion, development, and natural events. For purposes of this plan, crucial

mule deer habitat is defined as habitat essential to the life history requirements of mule deer. Continued degradation and loss of crucial habitat will lead to significant declines in carrying capacity and/or numbers of mule deer. Urbanization, road construction, off-highway vehicle (OHV) use, energy development, drought, catastrophic wildfire, and expansion of invasive plant species have all resulted in loss or degradation of mule deer habitat.

The quality and quantity of forage available on important mule deer ranges can be limited by a variety of factors. The encroachment of pinyon and juniper threatens to choke out understory forbs and shrubs and increase risk of catastrophic wildfire. Annual weeds such as cheatgrass alter natural fire cycles by increasing fire frequencies, often resulting in shrublands being converted to annual grasslands. Aspen habitat is declining in part due to conifer encroachment resulting from the suppression of naturally occurring fires. The seeding of aggressive introduced perennial grasses that outcompete native shrubs and forbs can reduce the ability of rangelands to meet the dietary requirements of mule deer. The DWR Range Trend Project has documented many of these threats and how mule deer habitat in Utah has changed over the last 30 years (UDWR 2014–2018). During the 1940s and 1950s, deer herds erupted in response to abundant shrub growth on mule deer ranges throughout the state, as a result of heavy grazing on most rangelands (deVos et al. 2003). Since that time, many shrub-dominated rangelands have gradually converted to juniper-dominated communities due to lack of fire or other disturbances. The conversion of shrublands to annual grasslands has also been accelerated in recent decades due to an increase in invasive weed species, drought, and large wildfires.

To address the decline in mule deer habitat throughout Utah, restoration projects are being implemented to target habitat improvement on crucial mule deer ranges that have shifted in dominance to less desirable types or have degraded and provide little productivity. In Colorado, Bergman et al. (2014) found higher deer fawn survival in pinyon-juniper areas that had been treated as compared to those with no treatment. Habitat restoration projects are designed to move communities to earlier successional states, while restoring community functionality by providing a diversity of grasses, forbs, and shrubs that are available during critical seasons throughout the year. Ideally, restoration projects that benefit mule deer should be large in scale, include mosaic patterns to increase patchiness and edge effects, and be conducted in areas with high potential for success. Although fire can be beneficial for mule deer habitat, particularly in high-elevation summer habitat, in some instances large wildfires can be extremely destructive (e.g., when on winter range). Projects in recently burned areas are designed to restore lost food and shelter and protect water and soil resources. Restoration of shrubs in these communities can be a slow process, but can improve mule deer habitat throughout Utah, which in turn, will provide the necessary habitat requirements to meet statewide and unit population objectives.

B. Water Distribution

Water is a fundamental need for mule deer. When browse, forbs, and grasses consumed by mule deer have high water content, mule deer don't need to drink as they can obtain adequate amounts of water from their food. However, when forage contains only limited amounts of water, access to drinking water becomes important. The spatial distribution of mule deer populations is often positively associated with the availability of water in arid regions of western North America (Hervert and Krausman 1986, Boroski and Mossman 1996). Consequently, recent work by state wildlife agencies depicts large expanses of the Intermountain West ecoregion as water-limiting to mule deer (Wasley et al. 2008). Wildlife water developments, or guzzlers, can help provide water to mule deer in arid areas, but need to be designed and placed in areas conducive to use by mule deer. To maximize benefits to mule deer, guzzlers should be built in areas used by females with young and spaced less than 5 km from other water sources.

Fencing should be of sufficient size to allow access (Krausman et al. 2006, Larsen et al. 2011, Shields et al. 2012).

C. Energy Development

A boom in energy development has claimed and fragmented thousands of acres of mule deer habitat in portions of Utah. Energy is a 4.7 billion dollar industry in Utah, and in 2012, Utah ranked 10th in natural gas production and 11th in crude oil production among US states (Utah Office of Energy Development 2014). Mule deer, particularly in eastern Utah, are facing the challenges associated with increased, large-scale energy development. The impacts of energy development on mule deer are not fully known but generally include direct and indirect loss of habitat, added physiological stress, disturbance and displacement, habitat fragmentation and isolation, and other secondary effects (e.g. oil/chemical spills and contamination, increased noxious weeds, etc.; Sawyer et al. 2002, Lutz et. al. 2011). Small, isolated disturbances within non-limiting habitats are of minor consequence within most ecosystems. However, larger-scale developments within limited habitat types are a major concern to managers because such impacts cannot be relieved or absorbed by surrounding, unaltered habitats (Watkins et al. 2007). For mule deer populations to thrive in areas of extensive energy development, it is essential to work closely with energy companies to minimize and mitigate for potential impacts.

D. Population Objectives

The current statewide population objective for mule deer in Utah is 453,100 and is based on the sum of the population objectives from individual unit plans. Deer unit plans are approved through a public process, and population objectives are set based on what the habitat can biologically support, while considering possible detrimental impacts to surrounding land uses. When deer unit plans are revised, it is essential that the best possible population and range data be used to assess the current unit conditions. In some instances, these data may indicate the population objective is too low and should be raised to allow for more deer. In other situations, the data may show that the objective is too high and cannot be attained under current habitat and climatic conditions. In these cases, population objectives should be lowered to reflect a realistic view of what can be obtained in the foreseeable future. Population objectives can be revisited as needed to address improving conditions for mule deer.

E. Predator Management

Predators are often identified as one of the main causes for mule deer herd declines in Utah. However, predator-prey relationships are complex and not always easily understood. There are often many factors which can negatively affect mule deer populations including predation. The complex relationship between predators and habitat is described by Geist (1999). “Inevitably predators are blamed for declining mule deer populations, in particular when the survival of fawns is low. There is no doubt that today’s predators are effective in killing deer. However, predation is not independent of poor habitat quality. Such translates itself less as a reduced birth rate, but as fawns born too small, too poorly developed and too weak to be viable. Here predators take fawns that have a low chance of survival anyway. Improved habitat quality, which leads to better growth and larger body size in deer, is also expected to lead to large, vigorous fawns that are more difficult for predators to catch.”

Ballard et al. (2001) reviewed 40 published papers on the response of deer to predator control and found removing predators is most effective when 1) the deer population is below carrying capacity, 2) predation is identified as a limiting factor, 3) control efforts reduce predator populations enough to yield

results, 4) removal of predators occurred just prior to the reproductive periods of predators or deer, and 5) control efforts occurred at a focused scale. Mountain lions, coyotes, and in some areas black bears are the primary predators of mule deer in Utah (Smith 1983). On Monroe Mountain In southern Utah, Hall (2018) determined the primary cause of death among fawn mule deer is predation by both coyotes and mountain lions, and predator control can enhance the likelihood that fawns survive their first six months of life.

Since 2014, UDWR and its partners have monitored the survival of roughly 2000 individuals and the cause-specific mortality of approximately 500 adult and fawn mule deer. The Division has also been examining the interactive effects of habit (examined using body condition or fat stores in individual deer) and predation. Although, coyotes and mountain lions both take a significant number of mule deer fawns and adults, the resultant effects on the population are not necessarily equal. Coyotes tend to take animals in relatively poor body condition that have a low likelihood of survival to the subsequent year. In contrast, mountain lions take more adult deer than coyotes and are more likely to take deer that are prime-aged and in good condition.

By monitoring body condition, survival, and cause-specific mortality on many herds throughout the state, managers have the ability to identify populations that appear to be limited by predation (e.g. mountain lions are removing a significant proportion of the adult population each year) and not habitat (i.e., animals are in relatively good body condition with significant fat stores). In these areas, it is likely for predation to be an additive source of mortality, and, as such, predator control is more likely to lead to an increase in the size of the mule deer population. In contrast, we can also identify populations that are in relatively poor body condition suggesting that the population has exceeded the carrying capacity of the available habitat. Predator control in such areas would likely have little or no effect on the mule deer population as predation is likely a source of compensatory mortality; habitat improvement would be the only way to enhance populations in those areas.

Predator management in Utah is guided by a predator management policy (UDWR 2011*a*). This policy specifies that predator management can occur on units well below population objectives providing a predator management plan is written and approved. The Utah Wildlife Board has set triggers to evaluate if a predator management plan should be written. Intensive predator management is costly, and therefore is probably not warranted on units that are near objective or where habitat is limiting population growth. Mountain lion populations should be managed at levels that allow mule deer population objectives to be met. On some units, this may require additional reduction of mountain lion populations which are negatively impacting mule deer populations. In regards to coyotes, the Utah Legislature passed the Mule Deer Protection Act in 2012 which allocates additional funds for coyote control efforts in Utah. These funds allow for a statewide bounty and targeted removal of coyotes by USDA Wildlife Services and private contractors.

F. Disease

Identifying, understanding, and monitoring disease is important for mule deer management. Chronic Wasting Disease (CWD) is a contagious, chronic, degenerative disease that affects members of the cervid family including mule deer, white-tailed deer, elk, and moose. CWD affects the central nervous system of an infected animal, which results in weight loss, progressive neurologic deterioration, and death. At present, there is no known vaccine, treatment, or way to eradicate the disease. CWD was first detected in Utah in 2003 and is currently the biggest disease concern for mule deer populations in the

state. Appendix A contains the CWD plan, which provides more information on CWD and adaptive management actions aimed at preventing the spread of CWD within Utah.

Epizootic Hemorrhagic Disease (EHD), and less commonly Bluetongue, are viral diseases that may affect mule deer in Utah. Outbreaks of EHD generally occur during late summer and early autumn where the insect vector *Culicoides* is most active. EHD outbreaks have been documented in several areas throughout Utah in recent years, and although losses to these diseases can be substantial within focal areas, they are isolated events and populations generally recover quickly.

Other diseases that occasionally have been diagnosed in mule deer across Utah have included pneumonia, diarrhea, neoplasms, brain abscesses, exotic lice (*Bovicola tibialis*) infestation, *Eleaophora* infection, malignant catarrhal fever, and mineral deficiencies. However, in most cases only single individuals have been affected.

G. Access Management

The use of Off-Highway Vehicles (OHVs) in Utah has dramatically increased in recent years. OHV registrations increased more than tripled from 1998 to 2006 (from 51,686 to 172,231) and that trend continues to increase (Smith 2008). Uncontrolled use of motorized vehicles and OHVs can cause damage to mule deer habitat and disturbance to mule deer during critical phases of their life cycle. State and federal land management agencies are currently struggling with issues involving the use of OHVs on public land. Those agencies acknowledge OHVs as a legitimate use of public land, but also recognize the potential problems associated with uncontrolled activity. As such, these agencies have developed or are currently working on travel management plans on federal lands.

Shed antler gathering and the associated human disturbance on crucial winter ranges, especially with the use of vehicles, can cause undue stress on mule deer during a time when they must conserve energy.

There is also a demand for walk-in and horseback only access areas in Utah. Many hunters want the opportunity to hunt in a remote area that has lower hunter densities, where they don't have to compete with vehicle traffic. Biologically, limiting areas to foot and horse travel can limit hunter pressure, reduce harvest, and increase buck to doe ratios.

H. Depredation Issues

Depredation of private croplands is an ongoing challenge and, in some areas, can be a significant problem for deer to reach their management objectives. The Division has committed substantial resources to address depredation concerns, and there are numerous programs designed to assist landowners with depredation situations. Depredation problems need to be addressed within the sideboards of state code, rule, and policy, and in a timely and efficient manner so that landowners will better tolerate migratory mule deer populations on their lands.

I. Private Land / Cooperative Wildlife Management Unit Issues

The value of private lands to the overall deer population in Utah cannot be overstated. Many crucial mule deer habitats throughout the state are on privately owned lands. Unfortunately, some of those private rangelands have been converted from mule deer habitat to housing developments, recreational

properties, or other uses. As such, programs that provide incentives to private landowners to manage their properties for mule deer and other wildlife are critical to the success of the state's deer management program. Programs like cooperative wildlife management units (CWMUs), landowner associations (LOAs), general-season landowner permits, and walk-in access currently provide incentives for landowners to manage for healthy habitat and deer populations on their properties. Additionally, the Utah Watershed Restoration Initiative (WRI) has worked with numerous cooperating landowners to provide funding and other resources to accomplish vegetation treatments on private and public lands to benefit mule deer and other wildlife, as well as livestock.

J. Winter Feeding

Supplemental feeding is often viewed by the public as a solution to a lack of forage on crucial deer winter ranges, especially during severe winters. However, there is evidence that the potential harm created by feeding mule deer may outweigh the limited benefits (WAFWA 2003). Winter feeding programs are generally costly and can potentially cause problems for mule deer including disruption of natural movement patterns, range destruction, and increased disease transmission. Additionally, feeding deer in winter may have limited value because of the complex and highly specialized digestive system of mule deer (WAFWA 2013). If deer do not adapt quickly enough to dietary changes, deer may die of starvation despite having a full stomach. Moreover, adult deer will likely outcompete fawns for available feed, causing increases in fawn mortality at feeding sites.

In some situations, it may be necessary to feed deer to sustain a base population (WAFWA 2003). If necessary, winter feeding of mule deer in Utah will be guided by the winter feeding policy (UDWR 2011*b*). The Division will not participate in any emergency big game feeding program that occurs within the known range or use area of any big game population where CWD, brucellosis, or tuberculosis has been detected as feeding concentrates animals and can increase disease transmission and prevalence.

K. Competition

Competition occurs when two species use the same limited resource, and both of the species suffers in some way because of that use (WAFWA 2003). When resources are limited, competition may potentially occur between deer and other ungulates such as horses, livestock or elk. This competition could be direct for specific resources such as food or water, or a more general displacement of a species from preferred habitats due to behavioral characteristics.

From a direct resource competition standpoint, it is often assumed that deer and elk do not compete for forage since elk diets consist primarily of graminoids (grasses) and mule deer largely consume woody vegetation or browse. Although this may be true much of the year, there are circumstances when diet overlap can become a concern. For example, during a hard winter when forage is limited, elk can successfully shift to a diet largely comprised of browse causing a high degree of diet overlap with mule deer (Frisina et al. 2008). This overlap can create direct competition for forage between elk and mule deer when mule deer are most vulnerable.

Mule deer can also experience behavioral and spatial competition with elk. Behavioral competition is most likely to occur on summer ranges during drought years or on generally arid units. The mere presence of elk may displace mule deer into lower quality habitats. GPS collar data has shown that mule deer avoid elk when selecting habitat, but elk habitat selection is independent of mule deer distribution (Stewart et al. 2002).

Feral horse populations in Utah continue to grow. Horses are less efficient at extracting nutrients from forage than ruminants like mule deer and elk. As such, horses must consume larger quantities of forage to survive. In arid environments, horses may also defend water sources from other species (Gooch et al. 2017, Hall et al. 2016). More specifically, feral horses have a negative effect on water use by mule deer (Hall et al. 2018) suggesting that an increase in horse numbers will negatively affect populations of mule deer. It is crucial that the Division work closely with federal land management agencies to actively manage horses on federal lands to minimize negative impacts to wildlife habitat.

Crucial ranges where elk, livestock, and/or horses coexist with mule deer should be closely monitored to prevent overuse and competition. Although competition may exist in some areas where resources are limited, the Division continues to work closely with our partners to restore and improve habitats to benefit both wildlife and livestock.

L. Movements and Migration Corridors

One of the primary ways that mule deer respond and adapt to changes in the environment is through movement. The ability to freely move allows deer to take advantage of seasonal resources, colonize new habitats and find mates. It also helps them avoid competitors, predators and parasites.

Some of the longest movements that mule deer make are seasonal migrations between summer and winter ranges. Most mule deer in Utah are migratory, with some individuals moving up to 70 miles. In Wyoming, mule deer migrations up to 150 miles have been documented (Sawyer et al. 2016). Mule deer exhibit high fidelity to their seasonal ranges and often use the same migration corridors year after year to move between seasonal ranges (Brown 1992). However, even for well studied species such as deer, little is known about the locations of migration corridors.

In 2017, the Division founded the Utah Wildlife Migration Initiative to document, preserve, and enhance wildlife movement throughout Utah. This initiative uses state-of-the-art GPS tracking technology to monitor the movements of species in near real-time. Information generated by tracking collars is used to define critical habitats for species, including migration corridors. Currently, the Migration Initiative is putting a large focus on documenting mule deer movements. For example, in 2019 there were over 900 mule deer with GPS tracking collars in 15 wildlife management units throughout the state (Figure 7).

GPS tracking information allows the Division to precisely define migration corridors for mule deer (Figure 8). The Division uses the information to work with partners to place wildlife crossings on roads, which preserves wildlife movement and reduces deer-vehicle collisions. The information is also used to work with landowners and municipalities to preserve open space for deer and other wildlife to move across the landscape. Additionally, the information is used to target habitat treatment locations and evaluate the success of habitat improvements.

M. Translocations

Translocation projects are an increasingly common strategy for managing wildlife populations on modified landscapes. Recent work in Utah shows that managers can expect the following outcomes associated with translocation of mule deer: 1) approximately 50% survival of adults during the first year, 2) higher survival for younger animals, 3) high survival in year 2 that is similar to resident deer, 4) high site fidelity (i.e., most surviving deer returned to winter range where they were released during the

second year), and 5) reproduction similar to that of resident deer (Smedley 2016, Smedley et al. 2019). This same study found no difference in survival for deer captured and released in early (January) compared to late (March) winter suggesting that translocation could occur throughout the winter.

Translocation of mule deer can be an expensive and time-intensive management activity. Costs can range from roughly $100 to $1,000 per animal based on the number of animals involved, capture method used, and duration of the project. Additional costs can include purchasing radio-collars, disease testing, and monitoring of translocated animals. Partnering with local governments, conservation groups, and other interested parties can help defray some of the costs associated with mule deer translocations.

All mule deer translocations in Utah will be conducted in accordance with the approved mule deer transplant list (Appendix B). Although situations exist where transplants may be considered, the use of translocations is expected to be minimal due to the associated risks (e.g., disease transmission, transport of exotic lice, etc.). Deer that reside in CWD positive areas will not be considered for translocation, and special consideration should be taken when transplanting deer into CWD positive areas due to increased risks of large-scale deer movements and disease transmission. Translocated deer should be moved a minimum of 50 km to limit the return of translocated animals (Eberhardt and Pickens 1979). Finally, efforts should be made to reduce handling time and stress on animals during capture and translocation.

N. Poaching

The effect of poaching on wildlife populations can be difficult to assess. Poachers can be motivated by a variety of things including a desire to get a jump on hunting season, annoyance with state game laws, a desire to shoot and kill something, or the money and prestige associated with trophy-sized antlers During winter 2009–2010, Utah experienced an increased number of illegally taken deer on winter ranges, likely due to the increased snow in southern Utah. In response, conservation officers conducted winter range patrols in an effort to protect vulnerable wintering deer herds. A concerted outreach effort was implemented to solicit assistance from conservation groups and the public to recognize and report suspicious activities while in the field. Law enforcement will continue to make mule deer protection a high priority by concentrating efforts on prioritized winter ranges. Success will only be achieved when poaching is no longer socially acceptable and only with assistance from our conservation partners and the general public.

IV. USE AND DEMAND

Mule deer are the most important game animal in Utah. Hunter demand and interest has always been high and the family tradition of mule deer hunting is strongly rooted in Utah. From 1960 to 1993, no fewer than 150,000 hunters participated in the annual mule deer hunt. Over 200,000 hunters participated in the deer hunt each year from 1977 to 1992, except in 1984.

Although the number of permits has been relatively stable for over 2 decades, the number of applicants for permits has increased causing the demand for both limited-entry and general-season permits to rise (Table 6). In 2018, the overall odds of drawing a limited-entry buck permit were 1 in 33.1, compared to 1 in 8.3 in 1998. The odds of drawing a general-season permit also increased from 1 in 1.1 in 2000 to 1 in 1.9 in 2018. Although limited-entry permits are popular, it is clear that many Utah hunters are also interested in being able to hunt every year. As demand for both permit types continues to increase

faster than supply, many hunters are giving up on the sport. The North American model of wildlife management is based on the premise that hunters are largely responsible for funding the management of game animals. If we continue to lose hunters and fail to recruit youth hunters, the current system under which we manage wildlife may be in jeopardy. Thus, it is critical to the future of hunting and wildlife management in Utah to provide people with both the opportunity to hunt and a high-quality hunting experience.

Mule deer are also a high interest watchable wildlife species since nearly everyone enjoys seeing deer in the wild. Many thousands of hours and considerable dollars are expended each year in deer watching activities. Units that produce large bucks are especially attractive not only to hunters but wildlife watchers and photographers as well.

V. CONCLUSION

Mule deer are the most abundant big game animal in Utah and are of high interest to sportsmen and women and nonconsumptive users. The mule deer population in Utah is lower than what it was in the 1960s and 1980s, but it has been increasing over the past 2 decades with overall numbers approaching what was present 30 years ago. Mule deer face a myriad of factors that can have a cumulative impact on their ability to flourish. The loss and degradation of habitat, combined with unfavorable weather conditions, have likely had the most significant impact on mule deer numbers. Other factors such as predation and disease are intensified when habitat quality is reduced. If deer herds are to reach their population objectives in Utah, extensive habitat work will need to be done to rehabilitate crucial mule deer ranges and compensate for a climatic trend toward hotter and drier conditions. It is vital that the Division, state agencies, Native American tribes, federal agencies, conservation organizations, private landowners, and others work together to protect and improve mule deer habitat if we hope to maintain and expand mule deer populations to meet management goals.

VI. STATEWIDE MANAGEMENT GOALS AND OBJECTIVES

Population Management Goal: Expand and improve mule deer populations throughout the state within the carrying capacity of available habitats and in consideration of other land uses.

Population Objective: By 2024, manage mule deer populations within the state as conditions allow and bring all populations to their unit objective (453,100 in 2019)

Implications: This objective can be accomplished if favorable environmental conditions exist and through the implementation of the strategies in this plan

Strategies:

A. Population Objectives
    a. Review individual unit management plans and revise where necessary to provide consistency with this plan. Unit plans will be revised and approved internally by the Division Director unless:
        i. New unit plan
        ii. Change in the population objective
        iii. Major boundary change.
    b. Use current research (body condition scores (BCS), cause-specific mortality, range trend data, etc.), historic population estimates, and production data to set realistic and attainable population objectives
    c. Manage mule deer populations below biological carrying capacity to increase herd productivity
    d. Use the most reliable population models to evaluate herd size and population trends over time
    e. Manage predators according to the predator management policy, where habitat is not limiting and predators are demonstrated to have a negative impact on the population
    f. Work with UDOT to construct sufficient wildlife crossing structures, fencing or other mitigation options to minimize deer vehicle collisions
    g. Continue to support law enforcement efforts to educate the public concerning poaching and reduce illegal take of deer
    h. Implement emergency feeding when needed in accordance with the DWR feeding policy and educate the public on the implications of winter deer feeding
    i. Work with federal and state land management agencies to adopt seasonal closures or travel restrictions to minimize human disturbance of mule deer during critical phases of their life cycle

B. Population Management
    a. Use antlerless harvest as the primary tool to manage deer populations
    b. Use antlerless harvest in combination with the Urban Deer Rule to reduce conflict and damage in urban areas
    c. Investigate and manage diseases that threaten mule deer populations
    d. Monitor and manage CWD in accordance with CWD plan (Appendix A)

C. Population Monitoring and Research
    a. Continue to monitor all mule deer populations annually to evaluate fawn production, herd composition, and habitat use
    b. Continue to collect annual adult doe and fawn survival rates, body condition scores, and cause specific mortality across the state
    c. Support the Utah Migration Initiative in identifying and protecting migratory corridors
    d. Evaluate the effectiveness of the crossing structures and other mitigation options over time and implement new technologies to minimize highway mortality
    e. Continue to implement research studies on specific herd units that are chronically below population objective to identify limiting factors and recommend solutions

D. Populations on Private Lands
    a. Support incentive programs for landowners that will increase tolerance and promote deer populations on private lands such as the CWMU, landowner permit, and Walk-In Access programs
    b. Explore cultivated lands only doe permits and allow private landowners the ability to alleviate crop damage using public hunters
    c. Address all depredation problems in a timely and efficient manner to increase landowner tolerance of mule deer
    d. Educate, advocate and work with municipalities/counties to enact sound management plans on zoning decisions in order to minimize and mitigate the loss of crucial mule deer habitat and to maintain the integrity of migration corridors
    e. Educate the public on the value of private landowner incentive programs

Habitat Goal: Conserve, improve, and restore mule deer habitat throughout the state with emphasis on crucial ranges

Habitat Objective 1: Maintain mule deer habitat throughout the state by protecting and enhancing existing crucial habitats and mitigating for losses due to natural and human impacts

Implications: Loss of crucial mule deer habitat will need to be minimized to achieve population objectives. Mitigation is essential for loss or degradation of all crucial habitats due to natural and human impacts

Strategies:

A. Habitat Classification and Assessment
    a. Continue to identify, map, and characterize crucial mule deer habitats including migration routes throughout the state
    b. Identify and rank threats and limiting factors within each unit plan
    c. Continue to support the interagency Big Game Range Trend Studies crew in monitoring the long-term trends of crucial mule deer ranges throughout the state

B. Habitat Management and Conservation
    a. Work with local, state and federal land management agencies via land management plans and with private landowners to identify and properly manage crucial mule deer habitats, especially fawning, wintering, and migration areas
    b. Minimize impacts and recommend mitigation for losses of crucial habitat due to human impacts
    c. Acquire additional crucial mule deer habitats through fee title and conservation easements
    d. Educate, advocate and work with municipalities/counties to enact sound management plans on zoning decisions in order to minimize and mitigate the loss of crucial mule deer habitat and to maintain the integrity of migration corridors
    e. Conduct any mule deer feeding in accordance with Division policy to limit habitat damage.
    f. Manage elk populations to minimize competition with mule deer on crucial ranges
    g. Work with local, state and federal land management agencies and ranchers to properly manage livestock to enhance crucial mule deer ranges
    h. Encourage and support federal land management agencies, state agencies, and tribal entities efforts to minimize competition with wildlife from horses and burros and to manage these animals at appropriate management levels (AML)

C. Travel Management and Development
    a. Support the establishment of multi-agency OHV travel plans developed on a county or federal land management plan level and ongoing efforts to reduce illegal OHV use to prevent resource damage and protect crucial mule deer habitat

b. Where appropriate, work with county, federal and state land management agencies to adopt seasonal motorized route closures to minimize human disturbance in existing crucial mule deer habitats
c. Work with county, state, and federal agencies to limit the negative effects of roads by reclaiming unused roads, properly planning new roads, and installing fencing and highway passage structures where roads disrupt mule deer migration patterns
d. Use established energy guidelines (e.g. WAFWA Energy Development Guidelines for Mule Deer) to minimize and mitigate impacts to mule deer from energy development and other habitat disturbances

D. Private Lands
    a. Support existing and explore additional incentive programs for landowners that will increase tolerance, enhance habitat, and promote deer populations on private lands such as the CWMU, landowner permit, Walk-In Access programs, etc.

Habitat Objective 2: Improve the quality and quantity of vegetation for mule deer on a minimum of 500,000 acres of crucial range by 2024

Implications: Habitat will need to be improved on at least 500,000 acres of crucial mule deer range to meet the population objectives in this plan. If habitat improvement projects cannot be completed because of inadequate funding, environmental restrictions, or unfavorable climatic conditions, population objectives may not be achieved. Additionally, because habitat treatments often require a number of years before they provide optimal benefits to mule deer, and if large catastrophic wildfires and energy developments continue to negatively impact crucial mule deer ranges, the population and habitat goals of this plan may not be achieved within the 5-year life of this plan

Strategies:

A. Watershed Restoration Initiative
    a. Continue to support and provide leadership for the Utah Watershed Restoration Initiative, which emphasizes improving sagebrush-steppe, aspen, and riparian habitats throughout Utah
    b. Work with land management agencies, conservation organizations, private landowners, and local leaders through the regional Watershed Restoration Initiative working groups to identify and prioritize mule deer habitats that are in need of enhancement or restoration (Figure 6). Emphasis should be placed on crucial habitats including sagebrush winter ranges and aspen summer ranges
    c. Work with university extension to increase landowner participation in the Watershed Restoration Initiative program
    d. Initiate broad scale vegetative treatment projects to improve mule deer habitat with emphasis on drought or fire damaged sagebrush winter ranges, ranges that have been taken over by invasive annual grass species, and ranges being diminished by encroachment of conifers into sagebrush or aspen habitats, ensuring that seed mixes contain sufficient forbs and browse species

e. Encourage land managers to manage portions of pinyon-juniper woodlands and aspen-conifer forests in early successional stages using various methods including timber harvest and managed fire
f. Continue to support the conservation permit and habitat enhancement programs which provide critical funding for habitat improvement efforts

B. Public Support
    a. Educate the public on the value of the general license, conservation, and convention permits for mule deer habitat improvement projects
    b. Promote and enhance programs that encourage volunteer participation in habitat restoration projects that benefit mule deer

Recreation Goal: Provide a diversity of high-quality mule deer hunting and viewing opportunities throughout the state

Recreation Objective 1: Provide mule deer hunting that encourages a variety of quality hunting opportunities while maintaining population objectives

Implications: Current hunting programs can be maintained if population objectives are met

Strategies:

A. Hunting Strategies: Continue to provide three hunt unit categories (general season, limited entry and premium limited entry) in approximately the current distribution to provide a variety of hunting opportunities
    a. General Season
        i. Manage general-season units for 15–17 or 18–20 bucks per 100 does (see Table 1 for management objectives by unit)
            1. Individual unit plans may change a unit objective from a 15–17 to a 18–20 and vice versa when updated, presented, and passed by the Wildlife Board
        ii. Biologists should take into account buck-to-doe ratio, (current estimate, 3-year average, and trend) as well as adult and fawn survival when making permit recommendations
        iii. Annual permit recommendations on public land units (>50% of deer habitat is on public land) should be made to make progress toward the buck:doe ratio objective for the unit
    b. Limited Entry
        i. Manage limited-entry units for 25–35 bucks per 100 does (see Table 3 for units and objectives)
        ii. Biologists should take into account buck-to-doe ratio, (current estimate, 3-year average, and trend) when making permit recommendations
        iii. Annual permit recommendations should be made to achieve a target buck-to-doe ratio of 30 bucks per 100 does
    c. Premium Limited Entry
        i. Manage premium limited-entry units for 40–55 bucks per 100 does with >40% of harvested deer 5 years of age or older (see Table 2 for units and objectives)
        ii. Premium limited-entry baseline permits for the public draw will be set by this plan at 49 on the Henry Mountains and 135 on the Paunsaugunt
        iii. Reductions in permits will occur if <40% of the harvested bucks (3-year average) are 5 years of age or older to achieve the objective
        iv. Permit numbers will be returned to baseline numbers when the age objectives are being met
        v. Continue to provide management buck hunts on these units with a minimum of 10 permits on each unit
        vi. If the buck-to-doe ratio exceeds 55 bucks per 100 does, management buck permits will be increased to bring the population to objective

B. Hunt Types/Weapon Splits
    a. Recommend permits for the 3 weapon types based on the following percentages: 20% archery, 20% muzzleloader, and 60% any weapon. On some units, these percentages may be altered to help achieve buck-to-doe ratio objectives
    b. On general-season units where crowding may be a concern, additional hunts may be added or weapon type percentages may be altered to manage to approved buck-to-doe ratios
    c. On limited-entry and premium limited-entry units with sufficient public draw permits, provide a multi-season hunting opportunity that will allow 3% of the hunters to hunt all seasons for an increased fee. The permits for this hunt will be removed from the any-weapon quota

C. Hunting Seasons
    a. Establish season lengths that provide adequate hunting opportunity as follows:
        i. 28-day archery season
        ii. 9-day muzzleloader season
        iii. 5-day early any weapon season (on select units)
        iv. 9-day any weapon season
        v. 9-day late muzzleloader season
    b. Limited-entry hunts on all general-season units
        i. Permits will be recommended up to 0.5% of the general-season draw permit total with a minimum of 5 permits on each unit
    c. Season lengths for some hunts may be altered to accommodate:
        i. High-country buck hunts/overlapping deer and elk seasons
        ii. Deer migration
        iii. Extended archery areas
        iv. Management buck hunts
        v. Cactus buck hunts
        vi. Handgun, archery, muzzleloader, shotgun (HAMS) hunts
        vii. Multi state agreements

D. Additional Hunt Strategies
    a. Continue to evaluate hunt boundaries to manage hunting pressure on a unit/subunit scale. Unit hunt boundaries should:
        i. Encompass the majority of the movements of specific deer herds
        ii. Maintain easily identifiable boundaries
        iii. Consider private lands issues
    b. Explore additional opportunities to provide incentives to landowners that provide habitat for mule deer
    c. Evaluate units and subunits for handgun, archery, muzzleloader, shotgun (HAMS) hunts as an additional LE opportunity. Potential units will typically meet at least one of the following criteria:
        i. Low densities of deer

ii. Underutilized by hunters
iii. High potential for conflict with humans
iv. Migratory deer populations that are not able to be hunted during standard seasons

d. Continue to evaluate areas for new extended archery hunt units
e. Explore having over the counter extended archery permits to provide increased hunting opportunity and reduce point creep
f. Work with the mammals program to have spot-and-stalk cougar permits with season dates that overlap deer seasons
g. To address point creep in general-season units, support the acquisition of a buck deer permit resulting in the loss of all preference points
h. Work with land managers to maintain access during hunting seasons where appropriate
i. Consider cactus buck hunts on units with an appreciable number of cactus bucks

Recreation Objective 2. Increase opportunities to educate the public about the needs of mule deer and the importance of habitat and other limiting factors

Implications: In order to gain support for mule deer and mule deer management, it is crucial that the public understand factors that drive and limit mule deer populations. Efforts need to be made to educate the public about mule deer and promote everything that is being done to benefit mule deer and mule deer habitat in Utah

Strategies:

A. Education and Nonconsumptive Use
    a. Work with partners (conservation organizations, state and federal agencies, etc.) to increase outreach efforts to promote mule deer conservation
    b. Use electronic media, podcasts, and traditional media to educate the public about mule deer and mule deer management
        i. Conservation
            1. Information on where and how to view mule deer
            2. The importance of proper population management
            3. Provide updates on current research and management actions
        ii. Habitat restoration
            1. The importance of the Watershed Restoration Initiative
            2. Identifying and protecting migration routes and corridors
        iii. Impacts of disturbance
            1. Impacts of highways and development and the importance of crossing structures that offer safe passage
            2. Potential positive and negative impacts of wildfire
            3. Human activities on winter range
        iv. Factors that impact mule deer population growth
            1. Impacts of predators on mule deer populations
            2. Habitat carrying capacity and how it is dynamic
            3. Effects of severe weather

4. Deer-vehicle collisions
5. Disease outbreak

Literature Cited

Ballard, W. B., D. Lutz, T. W. Keegan, L. H. Carpenter, J. C. deVos Jr. 2001. Deer-predator relationships: a review of recent North American studies with emphasis on mule and black-tailed deer. Wildlife Society Bulletin 29:99–115.

Bergman, E. J., C. J. Bishop, D. J. Freddy. G. C. White, and P. F. Doherty. 2014. Habitat management influences overwinter survival of mule deer fawns in Colorado. Journal of Wildlife Management 78:448–455.

Boroski, B. B. and A. S. Mossman. 1996. Distribution of mule deer in relation to water sources in northern California. Journal of Wildlife Management 60:770–776.

Brown, C. G. 1992. Movement and migration patterns of mule deer in southeastern Idaho. Journal of Wildlife Management 56:246–253

Cook, J. C. 2002. Nutrition and food. Pages 259–349 *in* D. E. Toweill and J. W. Thomas, editors. North American Elk: Ecology and Management. Smithsonian Institution Press, Washington, USA.

Cook, J. G., B. K. Johnson, R. C. Cook, R. A. Riggs, T. Delcurto, L. D. Bryant, and L. L. Irwin. 2004. Effects of summer–autumn nutrition and parturition date on reproduction and survival of elk. Wildlife Monographs 155:1–61.

Cook, R. C., J. G. Cook, T. R. Stephenson, W. L. Myers, S. M. McCorquodale, D. J. Vales, L. L. Irwin, P. B. Hall, R. D. Spencer, S. L. Murphie, K. A. Schoenecker, and P. J. Miller. 2010. Revisions of rump fat and body scoring indices for deer, elk, and moose. Journal of Wildlife Management 74:880–896.

Cook, R. C., J. G. Cook, D. J. Vales, B. K. Johnson, S. M. McCorquodale, L. A. Shipley, R. A. Riggs, L. L. Irwin, S. L. Murphie, B. L. Murphie, K. A. Schoenecker, F. Geyer, P. B. Hall, R. D. Spencer, D. A. Immell, D. H. Jackson, B. L. Tiller, P. J. Miller, and L. Schmitz. 2013. Regional and seasonal patterns of nutritional condition and reproduction in elk. Wildlife Monographs 184:1–45.

deVos, J. C., M. R. Conover, and N. E. Headrick. 2003. Mule deer conservation: Issues and management strategies. Jack H. Berryman Institute Press, Logan, Utah, USA.

Eberhardt L. E. and H. C. Pickens. 1979. Homing in mule deer. Southwestern Naturalist 24:705–706.

Freeman, E. D., R. T. Larsen, K. C. Klegg, and B. R. McMillan. 2013. Long-lasting effects of maternal condition in large ungulates. PLoS ONE 8(3):e58373.

Freeman, E. D., R. T. Larsen, M. E. Peterson, C. R. Anderson, K. R. Hersey, and B. R. McMillan. 2014. Effect of male-biased harvest on mule deer: Implications for rates of pregnancy and synchrony/timing of parturition. Wildlife Society Bulletin 38(4):806–811.

Frisina, M. R., C. L. Wambolt, W. W. Fraas, and G. Guenther. 2008. Mule deer and elk winter diet as an indicator of habitat competition. USDA Forest Service Proceedings RMRS-P-52.

Gaillard, J.-M., M. Festa-Bianchet, N. G. Yoccoz, A. Loison, and C. Toigo. 2000. Temporal variation in fitness components and population dynamics of large herbivores. Annual Review of Ecology and Systematics, 31:367–393.

Geist, V. G. 1998. Deer of the world. Stackpole Books, Mechanicsburg, Pennsylvania, USA.

Geist, V. G. 1999. Mule deer country. Northword Press, Minnetonka, Minnesota, USA.

Gooch, A. M. J., S. L. Petersen, G. H. Collins, T. S. Smith, B. R. McMillan, and D. L. Eggett. 2017. The impact of feral horses on pronghorn behavior at water sources. Journal of Arid Environments 138:38.

Hall, J.T. 2018. Survival of neonate mule deer fawns in southern Utah: Effects of coyote removal and synchrony of parturition. M.S. Thesis, Brigham Young University, Provo, Utah, USA.

Hall L. K., R. T. Larsen, M. D. Westover, C. C. Day, R. N. Knight, and B. R. McMillan. 2016. Influence of exotic horses on the use of water by communities of native wildlife in a semi-arid environment. Journal of Arid Environments 127:100–105.

Hall, L. K., R. T. Larsen, R. N. Knight, and B. R. McMillan. 2018. Feral horses influence both spatial and temporal patterns of water use by native ungulates in a semi-arid environment. Ecosphere 9(1):e02096.

Hervert, J. and P. R. Krausman. 1986. Desert mule deer use of water developments in Arizona. Journal of Wildlife Management 50:670–676.

Krausman, P. R., S. S. Rosenstock, and J. W. Cain III. 2006. Developed waters for wildlife: science, perception, values, and controversy. Wildlife Society Bulletin 34:563–569.

Larsen, R. T., J. A. Bissonette, A. C. Robinson, and J. T. Flinders. 2011. Does small-perimeter fencing inhibit mule deer or pronghorn use of water developments? Journal of Wildlife Management 75:1417–1425.

Lutz, D. W., J. R. Heffelfinger, S. A. Tessmann, R. S. Gamo, and S. Siegel. 2011. Energy Development Guidelines for Mule Deer. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies, USA.

Monteith, K. L., V. C. Bleich, T. R. Stephenson, B. M. Pierce, M. M. Connor, J. G. Kie, and R. T. Bowyer. 2014. Life-history characteristics of mule deer: Effects of nutrition in a variable environment. Wildlife Monographs 186:1–62.

Parker, K. L., P. S. Barboza, and M. P. Gillingham. 2009. Nutrition integrates environmental responses of ungulates. Functional Ecology 23:57–69.

Rawley, E. V. 1980. Species plan for Utah's big game resources. Publication number 80-14. Division of Wildlife Resources, Department of Natural Resources, Salt Lake City, Utah, USA.

Rawley, E. V. 1985. Early records of wildlife in Utah. Publication number 86-2. Division of Wildlife Resources, Department of Natural Resources, Salt Lake City, Utah, USA.

Robinette, W. L., N. V. Hancock, and D. A. Jones. 1977. The Oak Creek mule deer herd in Utah. Publication number 77-2. Division of Wildlife Resources, Department of Natural Resources, Salt Lake City, Utah, USA.

Sawyer, H., F. Lindzey, D. McWhirter, and K. Andrews. 2002. Potential effects of oil and gas development on mule deer and pronghorn populations in western Wyoming. Transactions of the 67th North American Wildlife and Natural Resources Conference 67:350–365.

Sawyer, H., A. D. Middleton, M. M. Hayes, M. J. Kauffman, and K. L. Monteith. 2016. The extra mile: ungulate migration distance alters the use of seasonal range and exposure to anthropogenic risk. Ecosphere 7(10):1–11.

Shields, A. V., R. T. Larsen, and J. C. Whiting. 2012. Summer watering patterns of mule deer in the Great Basin Desert, USA: Implications of differential use by individuals and the sexes for management of water resources. The Scientific World Journal 2012: Article ID 846218.

Smedley, D. C. 2016. Influence of release timing on survival and movements of translocated mule deer (*Odocoileus hemionus*) in Utah. Department of Plant and Wildlife Sciences, Brigham Young University, Provo, Utah, USA.

Smedley, D. C., M. van de Kerk, B. R. McMillan, K. R. Hersey, J. C. Whiting, and R. T. Larsen. 2019. Movements, space use and site fidelity of translocated and resident mule deer (*Odocoileus hemionus*). Wildlife Research, In Press.

Smith, J. W. 2008. Utah off-highway vehicle owners' specialization and its relationship to environmental attitudes and motivations. Thesis, Utah State University, Logan, Utah USA.

Smith, R. B. 1983. Mule deer reproduction and survival in the La Sal Mountains, Utah. Thesis, Utah State University, Logan, Utah, USA.

Stewart, K. M., R. T. Bowyer, J. G. Kie, N. J. Cimon, and B. K. Johnson. 2002. Temporospatial distributions of elk, mule deer, and cattle: Resource partitioning and competition displacement. Journal of Mammalogy 83:229–244.

Utah Division of Wildlife Resources. 2014–2018. Utah big game range trend studies. http://wildlife.utah.gov/range/Archive.htm.

Utah Division of Wildlife Resources. 2011*a*. Managing predatory wildlife species policy W1AG-4.

Utah Division of Wildlife Resources. 2011*b*. Emergency big game winter feeding policy W5Wld-02.

Utah Office of Energy Development. 2014. http://energy.utah.gov/resource-areas/energy-information/.

WAFWA. 2003. Mule Deer: Changing landscapes, changing perspectives. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies, USA.

WAFWA. 2013. Understanding mule deer and winter feeding, fact sheet #2. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies, USA.

Wallmo, O. C. 1978. Mule and black-tailed deer. Pages 31–41 *in* J. L. Schmidt and D. L. Gilbert, editors. Big Game of North America. Stackpole Books, Harrisburg, Pennsylvania, USA.

Wallmo, O. C. 1981. Mule and black-tailed deer of North American. University of Nebraska Press, Lincoln, Nebraska, USA.

Wasley, T., M. Fleming, B. Compton, T. Keegan, D. Lutz, D. Stroud, K. Gray, M. Cox, B. Johnson, C. McLaughlin, L. Carpenter, J. Carlson, and K. Urquhart. 2008. Habitat guidelines for mule deer: intermountain west ecoregion. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies, USA.

Watkins, B. E., C. J. Bishop, E. J. Bergman, A. Bronson, B. Hale, B. F. Wakeling, L. H. Carpenter, and D. W. Lutz. 2007. Habitat Guidelines for Mule Deer: Colorado Plateau Shrubland and Forest Ecoregion. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies, USA.

White, G. C. and R. M. Bartmann. 1998. Mule deer management – what should be monitored? Pages 102–116 *in* C. Vos, Jr., editor. Proceedings of the 1997 deer-elk workshop, Rio Rico, Arizona. Arizona Game and Fish Department, Phoenix, Arizona, USA.

Workman, G. W. and J. B. Low. 1976. Mule deer decline in the West—a symposium. Utah State University, Logan, Utah, USA.

Figure 1. Statewide trends in mule deer hunters afield and harvest, Utah 1925–2018.

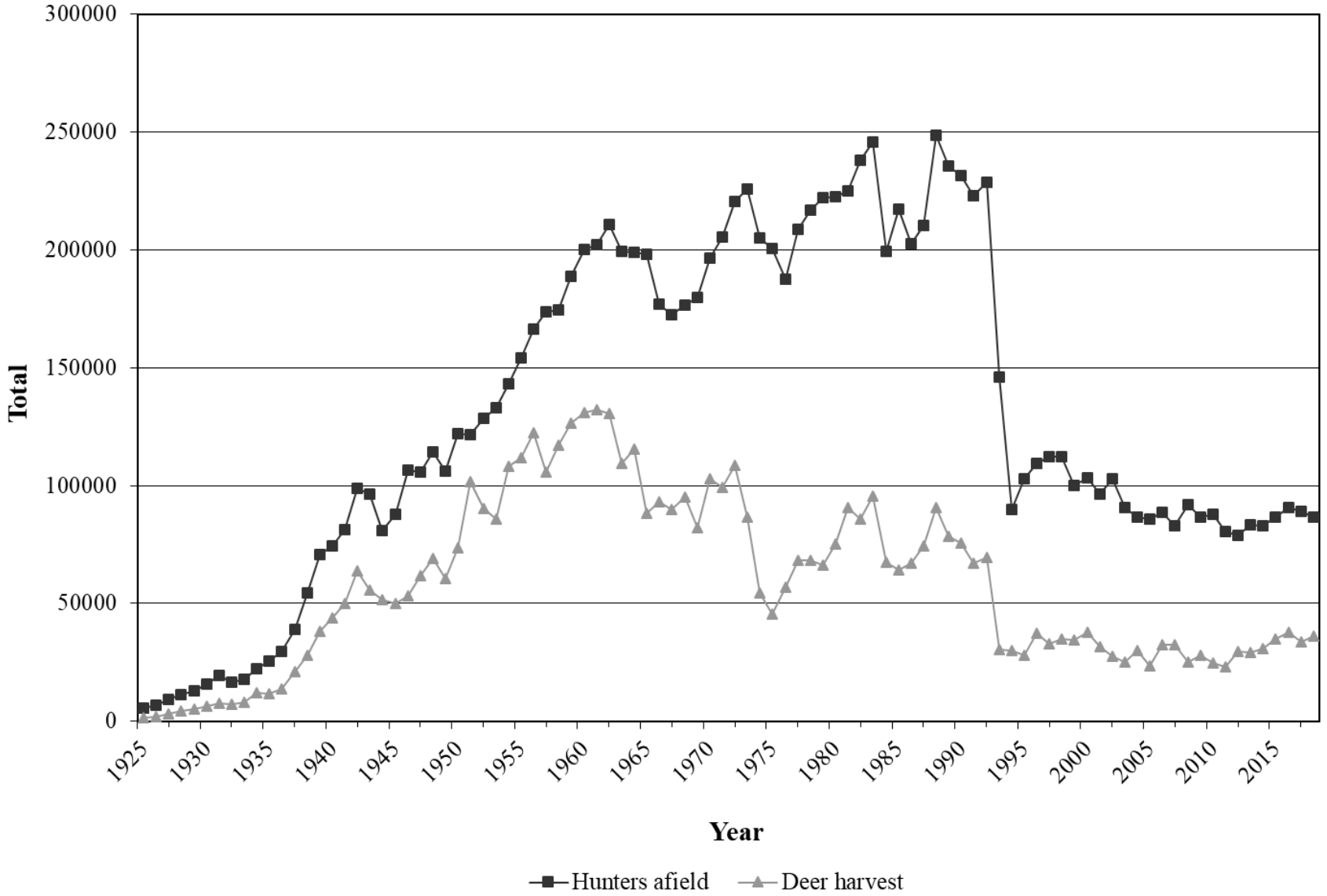


Figure 2. Statewide post-season buck to doe ratio estimates, Utah 1993–2018.

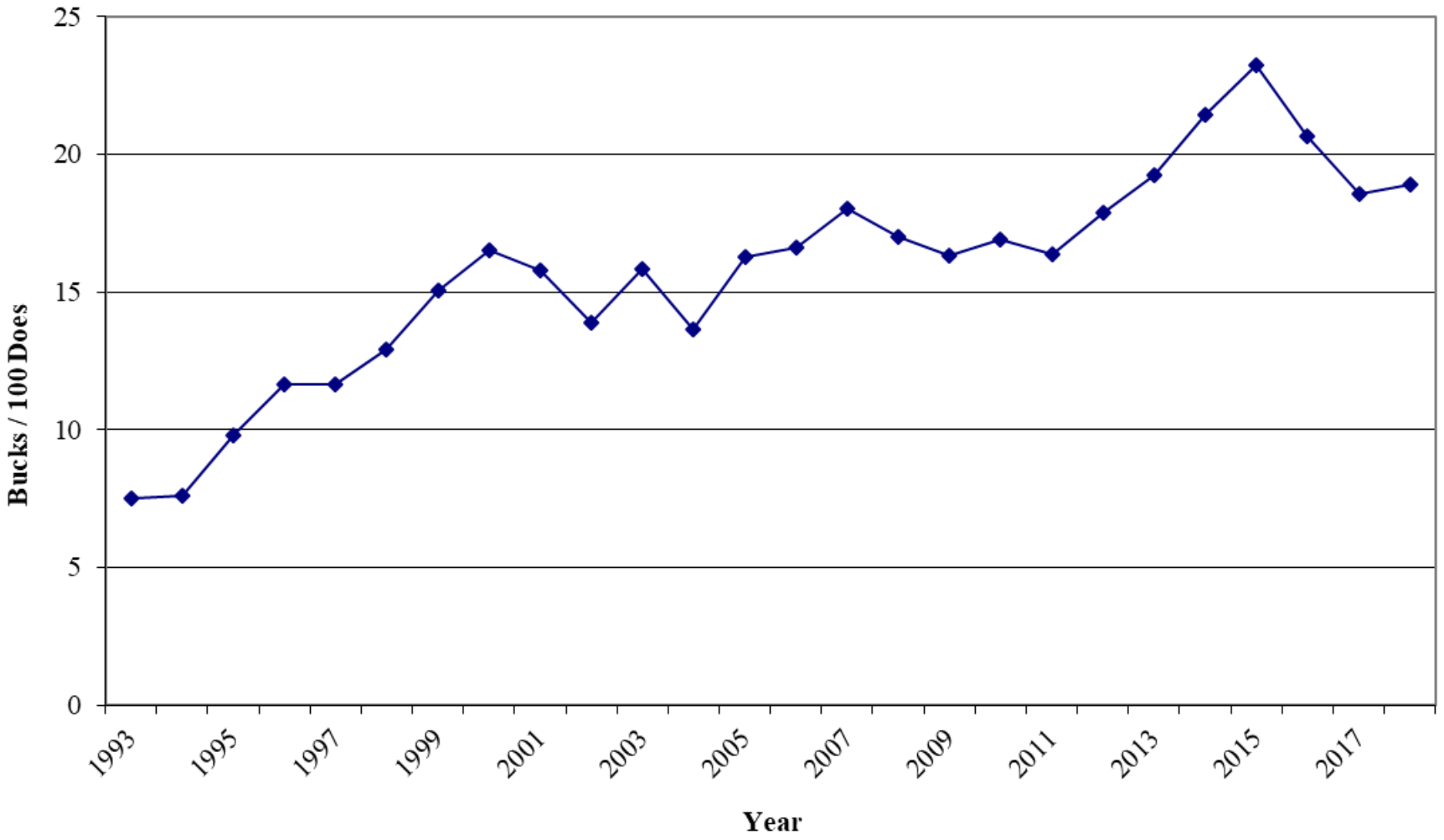


Figure 3. Statewide post-season mule deer population estimates, Utah 1992–2018.

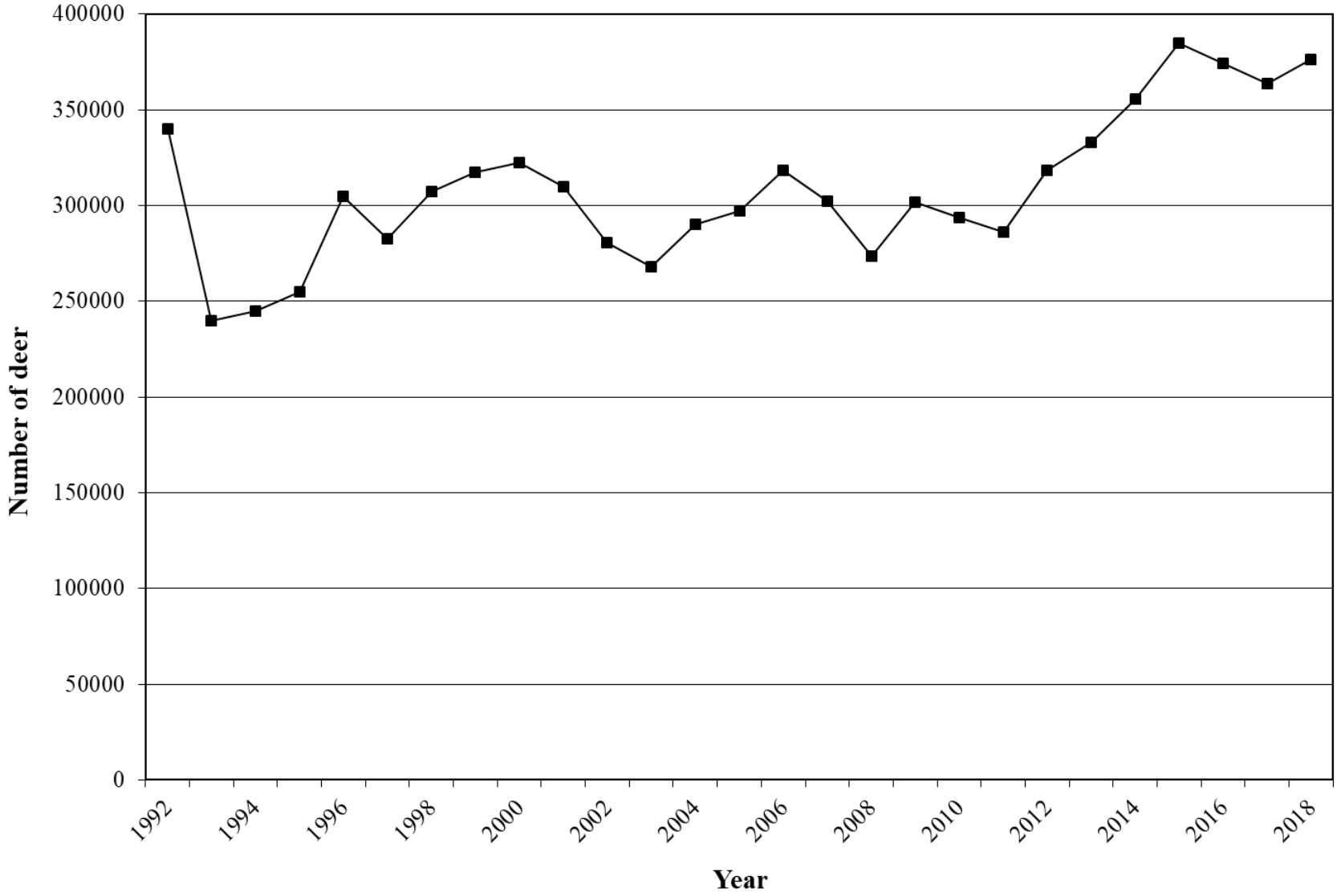


Figure 4. Statewide post-season fawn to doe ratio estimates, Utah 1993–2018.

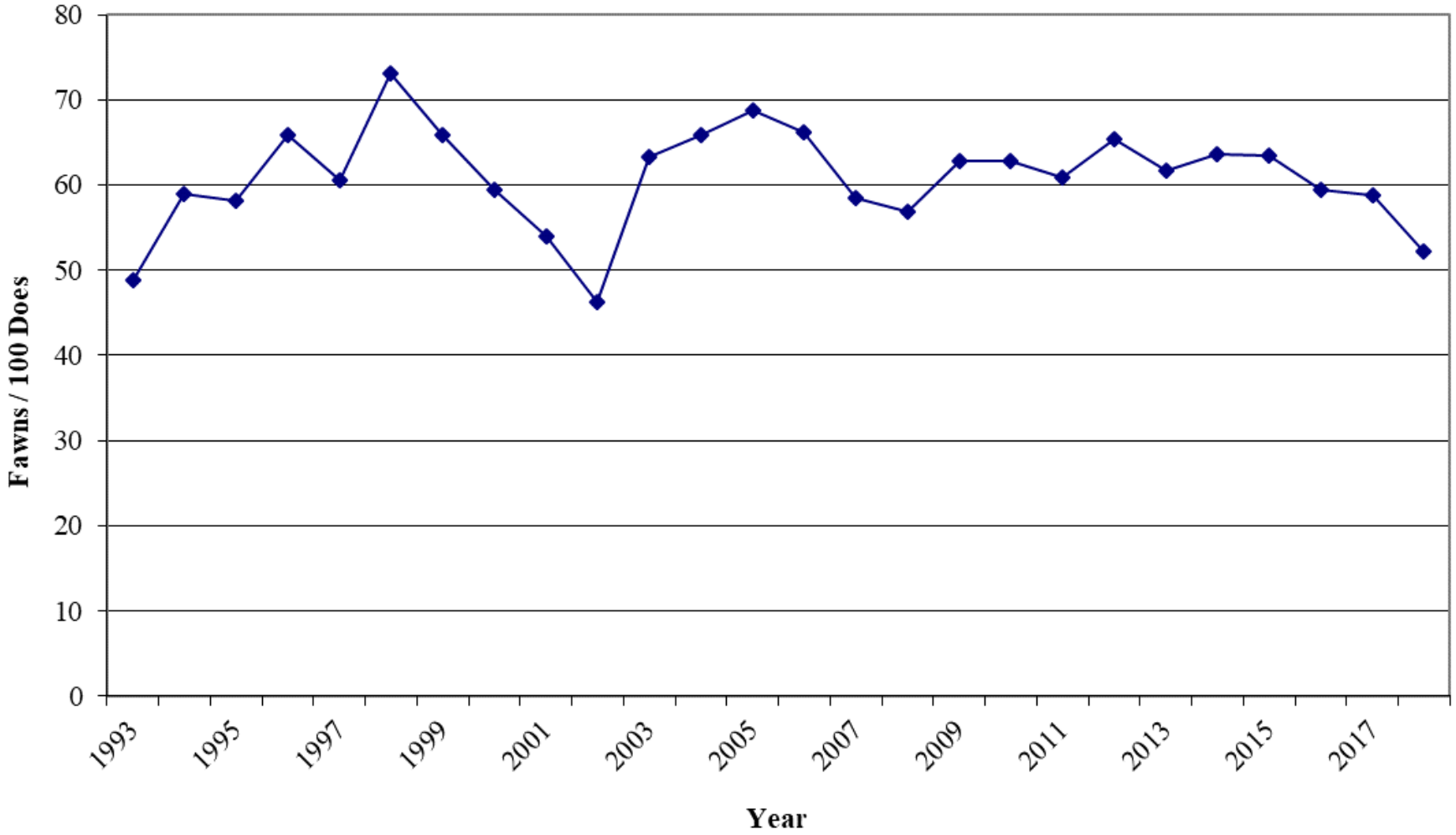


Figure 5. Mule deer habitat, Utah 2019.

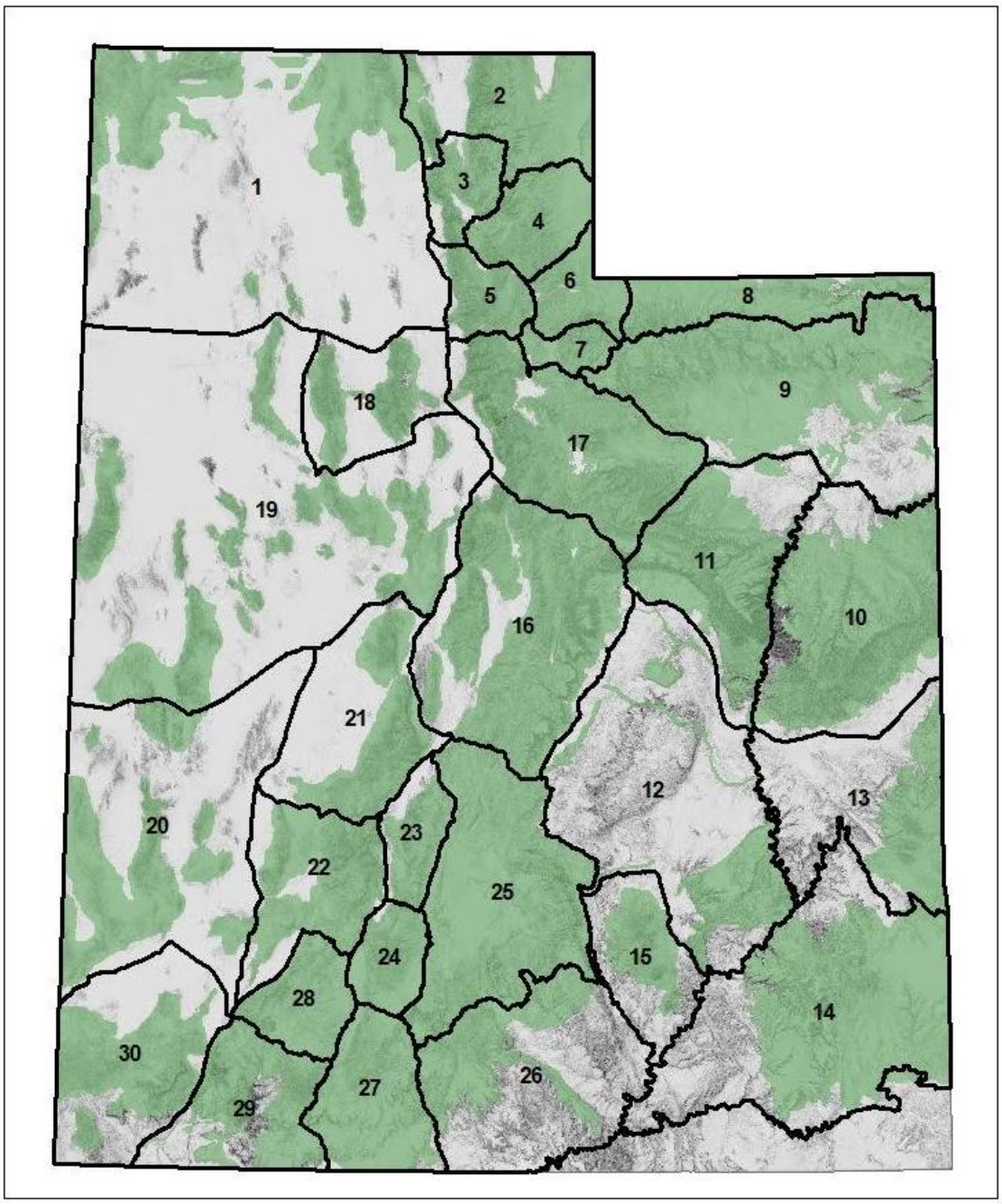


Figure 6. Crucial mule deer habitat restoration priority areas, Utah 2019.

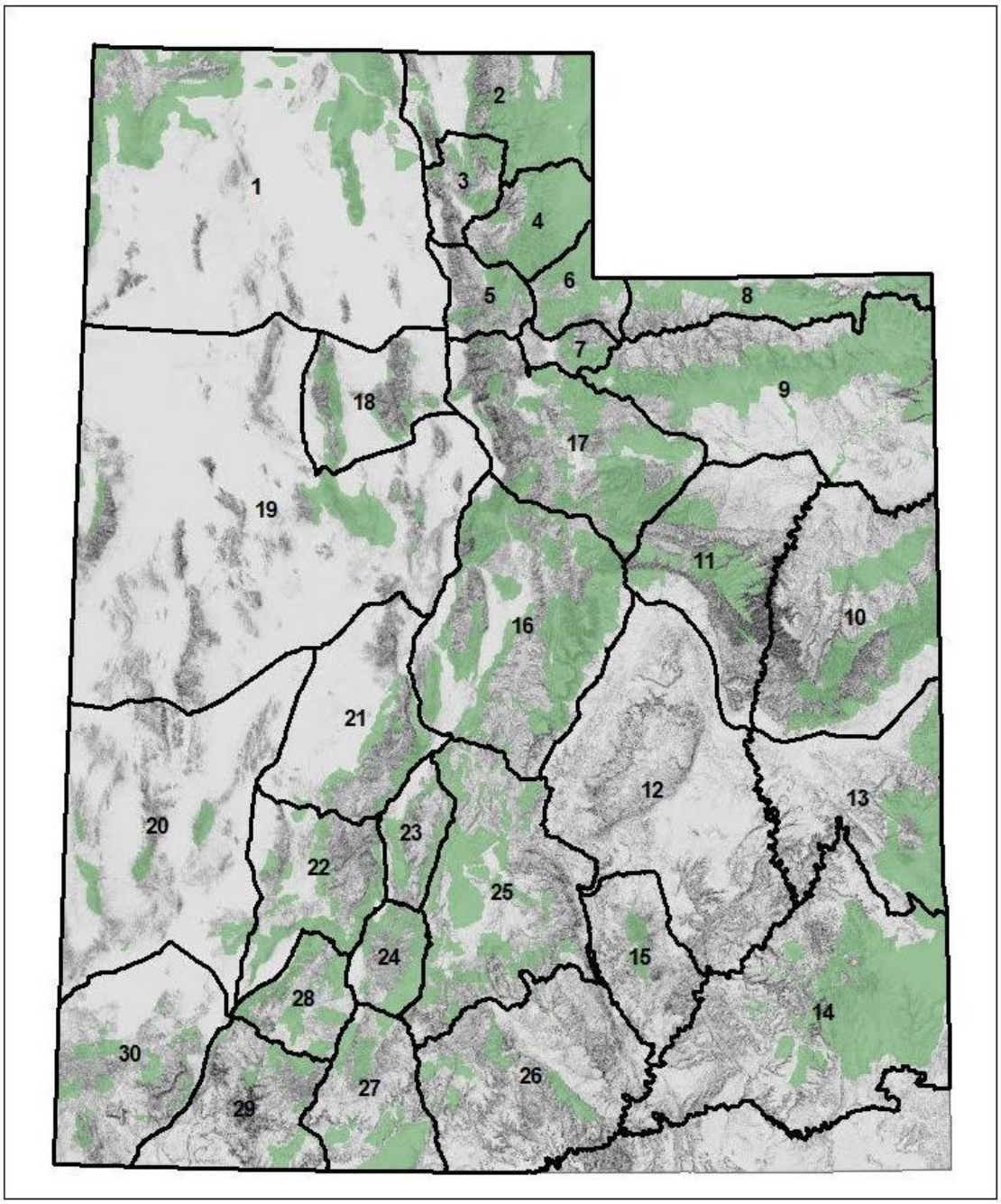


Figure 7. Locations of over 900 mule deer that were monitored with GPS tracking technology in 2019.

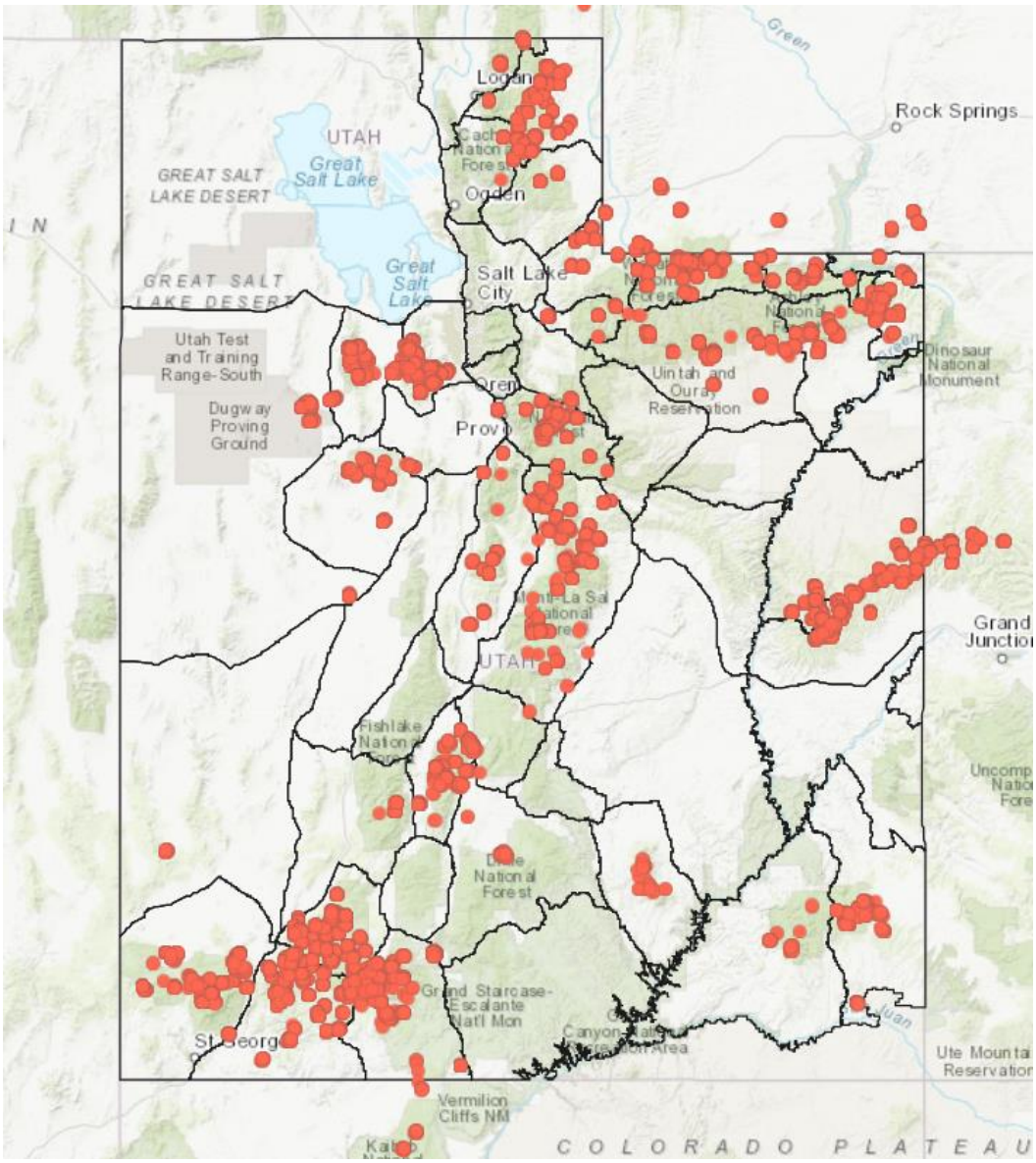


Figure 8. Mule deer migration corridors near the City of Eagle Mountain, UT

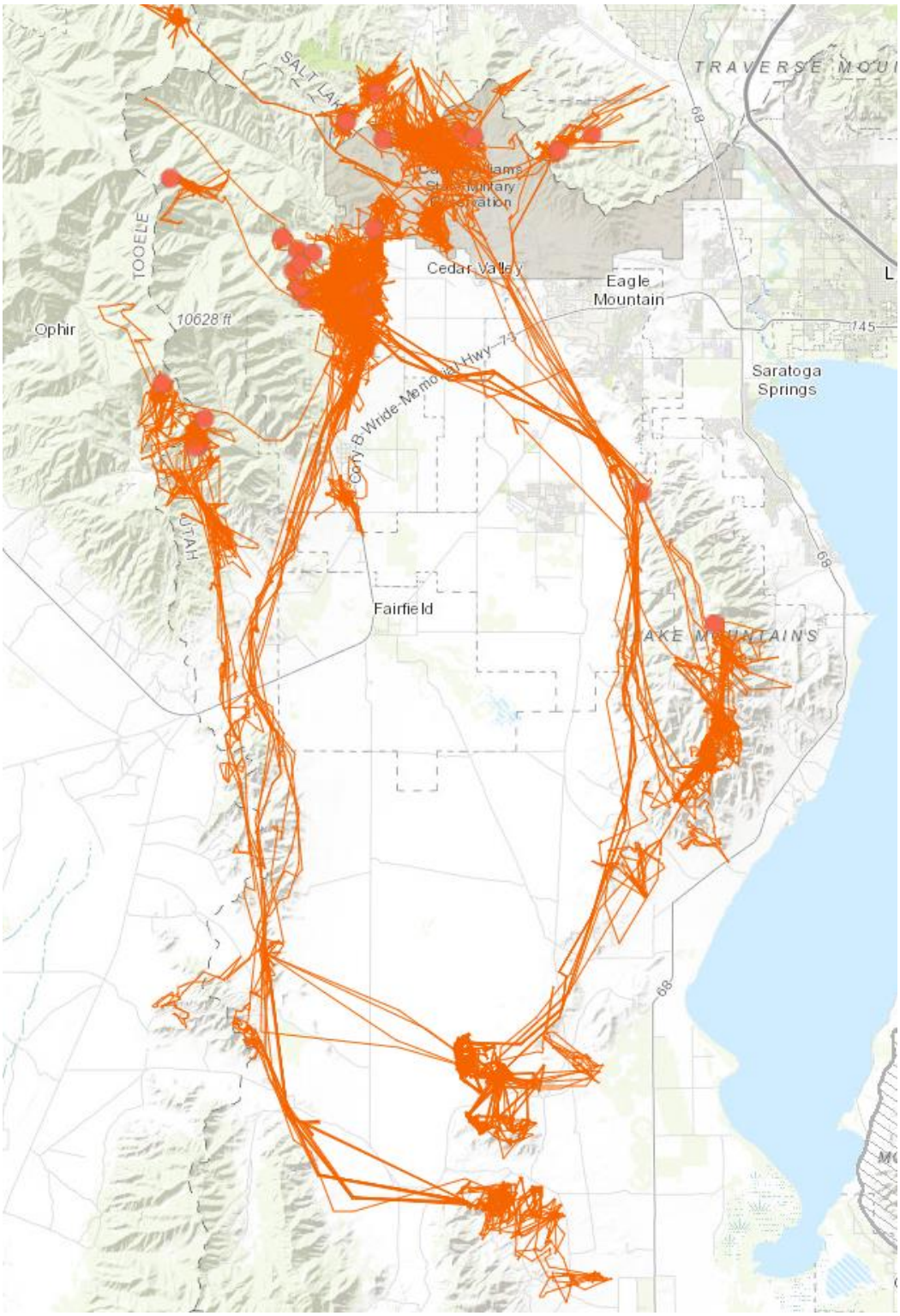


Table 1. General-season unit bucks per 100 does and objectives, Utah 2016–2018.

General season unit	Unit #	Objective	2016	2017	2018	3 year average
Beaver	22	18–20	24.8	17.7	15.1	19.2
Box Elder	1	15–17	19.3	18.8	16.0	18.0
Cache	2	15–17	15.1	15.4	19.6	16.7
Central Mtns, Manti/San Rafael	16B/12	15–17	15.6	13.3	16.7	15.2
Central Mtns, Nebo	16A	15–17	15.3	16.8	15.7	15.9
Chalk Creek/East Canyon/Morgan-South Rich	4/5/6	18–20	32.9	24.9	29.6	29.1
Fillmore	21	18–20	26.7	22.4	17.7	22.3
Kamas	7	18–20	31.0	22.5	23.7	25.7
La Sal, La Sal Mtns	13A	15–17	16.7	11.1	17.4	15.1
Monroe	23	18–20	19.1	13.6	17.4	16.7
Mt Dutton	24	18–20	20.8	18.2	16.5	18.5
Nine Mile	11	18–20	26.8	27.6	25.7	26.7
North Slope	8	18–20	20.6	17.9	19.7	19.4
Ogden	3	18–20	21.4	15.6	20.0	19.0
Oquirrh-Stansbury	18	15–17	23.1	18.7	19.1	20.3
Panguitch Lake	28	18–20	19.2	18.0	15.7	17.6
Pine Valley	30	18–20	24.2	23.9	23.8	24.0
Plateau, Boulder/Kaiparowits	25C/26	18–20	16.5	17.4	12.5	15.5
Plateau, Fishlake	25A	18–20	18.1	15.2	18.4	17.3
Plateau, Thousand Lakes	25B	18–20	21.2	32.0	25.9	26.4
San Juan, Abajo	14A	15–17	23.4	22.4	17.8	21.2
South Slope, Bonanza/Vernal	9BD	15–17	17.2	18.8	23.0	19.7
South Slope, Yellowstone	9A	18–20	23.0	18.2	22.2	21.1
Southwest Desert	20	18–20	25.0	23.5	20.6	23.0
Wasatch Mtns, Avintaquin/Currant Creek	17BC	18–20	22.6	18.6	18.7	20.0
Wasatch Mtns, West	17A	15–17	15.8	15.6	16.1	15.9
West Desert, Tintic	19C	15–17	—	12.7	13.0	12.9
West Desert, West	19A	15–17	—	12.7	13.0	12.9
Zion	29	18–20	24.1	22.8	22.6	23.2

Table 2. Premium limited-entry unit bucks per 100 does and objectives, Utah 2016–2018.

Premium limited-entry unit		Objective	2016	2017	2018	3 year average
Henry Mtns	Buck-to-doe ratio	40–50	46.7	40.7	44.2	43.9
	% ≥ 5 years old	40–55	70%	68%	46%	61%
Paunsaugunt	Buck-to-doe ratio	40–50	50.8	48.3	48.8	49.3
	% ≥ 5 years old	40–55	51%	57%	57%	55%

Table 3. Limited-entry unit bucks per 100 does and objectives, Utah 2016–2018.

Limited-entry unit	Objective	2016	2017	2018	3 year average
Cache, Crawford Mtn	25–35	30.4	17.9	27.3	25.2
South Slope, Diamond Mtn	25–35	34.1	33.8	33.9	34.0
Book Cliffs	25–35	32.4	33.9	39.6	35.3
La Sal, Dolores Triangle	25–35	24.1	41.7	28.3	31.3
San Juan, Elk Ridge	25–35	42.9	30.3	43.8	39.0
West Desert, Vernon	25–35	36.5	44.0	29.2	36.5
Fillmore, Oak Creek	25–35	29.0	28.9	49.0	35.7

Table 4. Estimated survival of adult and fawn mule deer monitored via radio telemetry along with population growth rates (lambda; values above 1 indicate a growing population while values below 1 suggest an annual decline) by management unit, Utah 2013–2018.

Unit	Year	Adult Survival	Fawn Survival	Lambda
Cache	2013–2014	0.82	0.77	1.04
	2014–2015	0.92	0.79	1.16
	2015–2016	0.84	0.27	0.92
	2016–2017	0.71	0.10	0.75
	2017–2018	0.91	0.59	1.10
Monroe	2013–2014	0.82	0.86	1.12
	2014–2015	0.82	0.75	1.07
	2015–2016	0.79	0.44	0.93
	2016–2017	0.75	0.38	0.84
	2017–2018	0.76	0.41	0.86
Oquirrh-Stansbury	2013–2014	0.80	0.78	1.07
	2014–2015	0.78	0.61	0.98
	2015–2016	0.72	0.27	0.81
	2016–2017	0.72	0.18	0.77
	2017–2018	0.82	0.81	1.05
Pine Valley	2013–2014	0.84	0.93	1.11
	2014–2015	0.86	0.90	1.12
	2015–2016	0.89	0.41	1.02
	2016–2017	0.84	0.50	0.98
	2017–2018	0.79	0.43	0.91
San Juan	2013–2014	0.86	0.79	1.10
	2014–2015	0.84	0.71	1.01
	2015–2016	0.80	0.71	1.00
	2016–2017	0.75	0.41	0.87
	2017–2018	0.73	0.00	0.73
South Slope	2013–2014	0.93	0.83	1.20
	2014–2015	0.82	0.93	1.15
	2015–2016	0.78	0.59	1.00
	2016–2017	0.71	0.18	0.77
	2017–2018	0.88	0.75	1.11
Wasatch-Manti	2013–2014	0.81	0.80	1.09
	2014–2015	0.82	0.69	1.06
	2015–2016	0.81	0.31	0.91
	2016–2017	0.88	0.37	1.00
	2017–2018	0.83	0.75	1.07
Statewide	2013–2014	0.84	0.82	1.10
	2014–2015	0.84	0.77	1.08
	2015–2016	0.80	0.43	0.94
	2016–2017	0.79	0.30	0.87
	2017–2018	0.79	0.53	0.95

Table 5. Probable causes of mortality for GPS collared deer, Utah 2014–2019.

Mortality Cause	n	%
Birth complication	2	<1
Depredation removal	2	<1
Disease	20	2
Fence	19	2
Hunter harvest	9	1
Injury/accident	5	<1
Malnutrition	165	19
Poaching	5	<1
Predation, bobcat	11	1
Predation, cougar	194	23
Predation, coyote	167	20
Predation, domestic dog	1	<1
Predation, golden eagle	1	<1
Roadkill	54	6
Train	1	<1
Unknown	197	23

Table 6. Limited-entry and general-season odds of obtaining a permit, Utah 1998–2018.

Permit type	Year	Resident odds	Nonresident odds	Overall odds
Limited entry	1998	1 in 7.5	1 in 19.7	1 in 8.3
	1999	1 in 7.9	1 in 16.3	1 in 8.5
	2000	1 in 8.9	1 in 14.4	1 in 9.3
	2001	1 in 9.9	1 in 18.1	1 in 10.6
	2002	1 in 12.8	1 in 24.8	1 in 13.8
	2003	1 in 15.2	1 in 34.0	1 in 16.7
	2004	1 in 17.2	1 in 40.4	1 in 19.1
	2005	1 in 19.5	1 in 48.3	1 in 21.7
	2006	1 in 19.9	1 in 49.7	1 in 22.1
	2007	1 in 21.0	1 in 62.2	1 in 23.7
	2008	1 in 20.6	1 in 48.2	1 in 22.5
	2009	1 in 19.8	1 in 74.1	1 in 23.8
	2010	1 in 20.3	1 in 72.1	1 in 24.3
	2011	1 in 21.3	1 in 76.5	1 in 25.5
	2012	1 in 23.5	1 in 79.0	1 in 27.9
	2013	1 in 27.1	1 in 98.4	1 in 32.5
	2014	1 in 28.7	1 in 108.8	1 in 34.8
	2015	1 in 26.8	1 in 92.9	1 in 32.4
	2016	1 in 24.9	1 in 91.1	1 in 30.4
	2017	1 in 26.1	1 in 98.3	1 in 32.5
	2018	1 in 26.0	1 in 111.5	1 in 33.1
General season	2000	—	—	1 in 1.1
	2001	1 in 1.2	1 in 1.6	1 in 1.2
	2002	1 in 1.3	1 in 1.7	1 in 1.3
	2003	1 in 1.3	1 in 1.9	1 in 1.3
	2004	1 in 1.3	1 in 1.7	1 in 1.3
	2005	1 in 1.4	1 in 1.7	1 in 1.4
	2006	1 in 1.3	1 in 1.7	1 in 1.4
	2007	1 in 1.4	1 in 1.7	1 in 1.5
	2008	1 in 1.4	1 in 1.5	1 in 1.4
	2009	1 in 1.4	1 in 1.5	1 in 1.4
	2010	1 in 1.3	1 in 1.4	1 in 1.3
	2011	1 in 1.4	1 in 1.5	1 in 1.4
	2012	1 in 1.5	1 in 1.8	1 in 1.5
	2013	1 in 1.6	1 in 1.8	1 in 1.6
	2014	1 in 1.7	1 in 2.1	1 in 1.7
	2015	1 in 1.8	1 in 2.1	1 in 1.8
	2016	1 in 1.8	1 in 2.1	1 in 1.8
	2017	1 in 1.9	1 in 2.2	1 in 1.9
	2018	1 in 1.9	1 in 2.3	1 in 1.9

Appendix A.

Utah Division of Wildlife Resources
Chronic Wasting Disease Management Plan

Goals of the plan:

The goals of this plan are to provide adaptable directions for management and prevention of spread of Chronic Wasting Disease (CWD) in free-ranging deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), and moose (*Alces alces*) in Utah. The disease has been present in Utah for at least two decades, and eradication, although desired, is likely not realistic at this point in time. Specific objectives addressed in this plan are to 1) reduce the rate of spread and prevalence of Chronic Wasting Disease in Utah; 2) provide guidelines for response to detection of new infection foci; 3) communicate with the public and participate in scientific research.

Background:

Chronic Wasting Disease (CWD) is a neurodegenerative disease of deer, elk, moose, and caribou caused by infectious proteinaceous particles called prions (Haley 2015). The disease is classified as a transmissible spongiforme encephalopathy (TSE) similarly to bovine spongiforme encephalopathy in cattle, scrapie in sheep, and kuru and Creutzfeld Jacob Disease in humans (Haley 2015). Incubation time from infection to clinical signs averages at approximately 16 months (Williams & Miller 2002). Clinical symptoms in affected animals can vary but can include progressive weight loss, behavioral changes, ataxia, excessive salivation, head tremor, aimless wandering, and always results in death of the affected animal (Williams 2005; Haley 2015). In infected animals, prions are predominantly present in nervous and lymphoid tissues, but have also been detected in antler velvet, muscle, saliva, blood, intestinal tract, bladder, urine, and feces (Henderson *et al.* 2015; Angers *et al.* 2006; Mathiason *et al.* 2006; Angers *et al.* 2009; Haley *et al.* 2011). Transmission can occur directly from animal to animal via contact with infectious body fluids (Haley 2015), however, prions are highly resistant in the environment and environmental contamination may contribute to the spread of the disease (Miller 2004; Miller *et al.* 2004; Haley 2015).

Chronic wasting disease can have consequences for both free ranging and captive populations. Studies have shown that CWD can cause declines in free-ranging deer populations, especially with high disease prevalence (Wasserberg *et al.* 2009; Edmunds *et al.* 2016) and environmental persistence (Almberg *et al.* 2011). Survival studies in deer and elk utilizing radio collars showed that CWD infected animals have lower survival, consequently leading to lower population growth rates (Miller *et al.* 2008; Monello *et al.* 2014; Geremia *et al.* 2015; DeVivo *et al.* 2017). Chronic wasting disease continues to be a major concern for the domestic cervid industry.

To date, CWD has been detected in multiple US states and Canadian provinces (for a map of the current distribution visit http://cwd-info.org/map-chronic-wasting-disease-in-north-america/), as well as in Norway (Benestad *et al.* 2016), Finland, and South Korea (Sohn *et al.* 2002; Kim *et al.* 2005). The disease has mainly spread to new areas via natural animal migrations, translocations of cervids, and escape of CWD infected cervids from captive facilities (Miller & Fischer 2016). Other risk factors may include transport of infected carcasses or animal products such as urine, saliva, feces etc., and artificially concentrating animals through baiting or feeding (Miller & Fischer 2016).

Chronic Wasting Disease in Utah:

The Utah Division of Wildlife Resources (UDWR) first began conducting CWD surveillance in 1998 upon the request of the Center for Disease Control and Prevention. The first case of CWD was found in a hunter-killed buck taken near Vernal in Uinta County in 2002. To date, 92 mule deer and two elk have tested positive for CWD in 6 Wildlife Management Units (WMU) statewide (Figure 1). The highest prevalence in Utah is found in WMU 13 in the La Sal Mountains where the proportion of CWD positive samples have varied between 0 – 8% since 2003 with an increasing trend (Table 1, Figure 2). The proportion of CWD positive samples have varied between 0 and 2% in the other positive WMU's (8, 9, 11, 14, 16) but also with an increasing trend (Table 1, Figure 2). The disease appears to be slowly spreading. In the fall of 2016 and 2017, two deer tested positive near Myton, which is located in the western part of unit 9 and approximately 40 miles west of previously positive animals, and in 2018, another deer tested positive within unit 11 near this area. In the fall of 2017, one deer tested positive near Kenilworth, also within unit 11. This deer was harvested close to CWD positive deer within unit 16. To date, only two elk and no moose have tested positive for CWD in Utah.

Domestic elk ranching is administered through the Utah Department of Agriculture and Food (UDAF). In 2014, a domestic bull elk killed on a hunting ranch in Liberty in northern Utah tested positive for CWD. This elk was traced back to a domestic elk facility near Blanding in southeastern Utah. The facility was depopulated, and 38% of the animals tested CWD positive. Spread of CWD from domestic to wild cervids and from free-ranging to captive populations continues to be a significant concern.

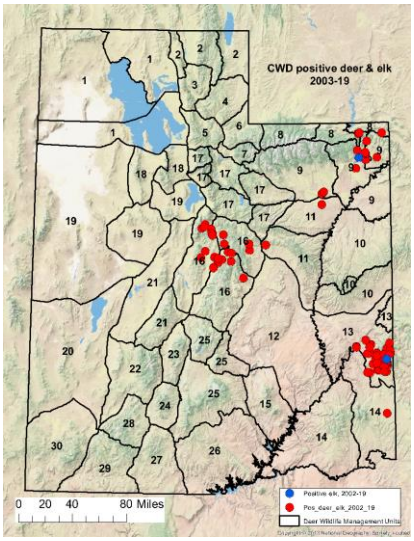
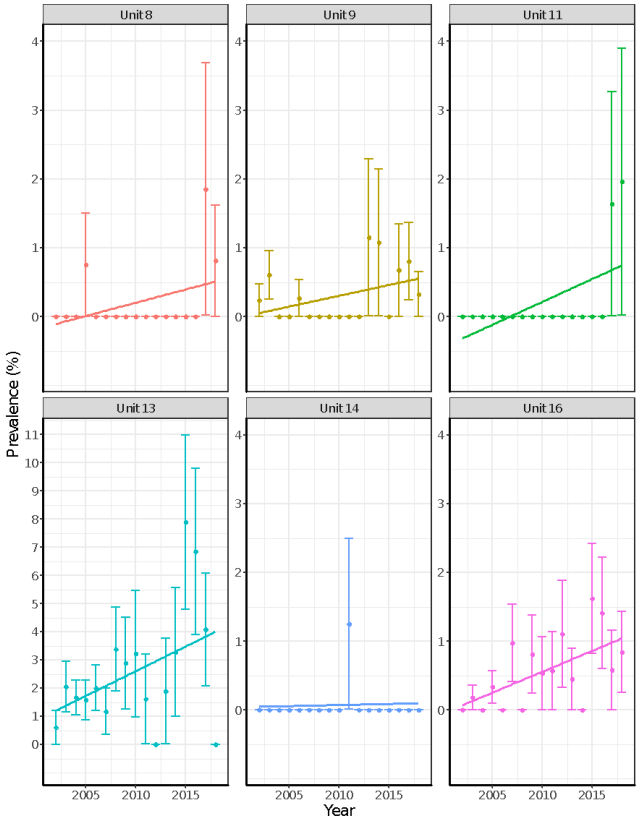


Figure 1: Locations of CWD positive deer and elk in Utah from 2002-2019.

Table 1. Total number of samples collected (Total) and number (Pos) and percent positive (%) mule deer in CWD positive units in Utah from 2002 – 2019. In addition to the data shown in the table, two elk have tested positive for CWD during this time period, one in Unit 9 and one in Unit 13.

	Unit 8			Unit 9			Unit 11			Unit 13			Unit 14			Unit 16		
Year	Total	Pos	%	Total	Pos	%	Total	Pos	%	Total	Pos	%	Total	Pos	%	Total	Pos	%
2002-03	138	0	0.00	423	1	0.24	18	0	0.00	166	1	0.60	136	0	0.00	16	0	0.00
2003-04	66	0	0.00	495	3	0.61	125	0	0.00	244	5	2.05	175	0	0.00	549	1	0.18
2004-05	102	0	0.00	563	0	0.00	85	0	0.00	420	7	1.67	226	0	0.00	549	0	0.00
2005-06	133	1	0.75	493	0	0.00	78	0	0.00	316	5	1.58	223	0	0.00	594	2	0.34
2006-07	94	0	0.00	375	1	0.27	71	0	0.00	300	6	2.00	72	0	0.00	392	0	0.00
2007-08	75	0	0.00	151	0	0.00	37	0	0.00	171	2	1.17	133	0	0.00	308	3	0.97
2008-09	62	0	0.00	251	0	0.00	32	0	0.00	148	5	3.38	93	0	0.00	210	0	0.00
2009-10	62	0	0.00	254	0	0.00	34	0	0.00	104	3*	0.03	87	0	0.00	247	2	0.81
2010-11	57	0	0.00	391	0	0.00	34	0	0.00	62	2	3.23	59	0	0.00	187	1	0.53
2011-12	56	0	0.00	304	0	0.00	52	0	0.00	62	1	1.61	80	1	1.25	175	1	0.57
2012-13	60	0	0.00	93	0	0.00	11	0	0.00	41	0	0.00	107	0	0.00	181	2	1.10
2013-14	73	0	0.00	87	1	1.15	21	0	0.00	53	1	1.89	55	0	0.00	223	1	0.45
2014-15	70	0	0.00	93	1	1.08	29	0	0.00	61	2	3.28	86	0	0.00	239	0	0.00
2015-16	74	0	0.00	179	0	0.00	28	0	0.00	76	6	7.89	63	0	0.00	247	4	1.62
2016-17	104	0	0.00	148	1	0.68	9	0	0.00	73	5	6.85	84	0	0.00	213	3	1.41
2017-18	54	1	1.85	249	2	0.80	61	1	1.64	98	4	4.08	97	0	0.00	172	1	0.58
2018-19	123	1	0.81	308	1	0.32	51	1	1.96	24	0	0.00	64	0	0.00	238	2	0.84
Total	1403	3	0.21	4857	11	0.23	776	2	0.26	2419	52	2.15	1840	1	0.05	4740	23	0.49

Figure 2: Trends of apparent CWD prevalences [(numbers positive/ numbers tested)*100] in mule deer in CWD positive units 2002–2018. Note the different scale in unit 13.



Risk factors for spread of CWD and options for management:

Once CWD is established in a population it is unlikely to be eradicated. Currently, there are no effective treatments or vaccines available for CWD. At the time of writing of this plan, Utah first detected CWD in its cervid population almost 2 decades ago. The goal of CWD management in Utah is therefore *to slow the spatial spread of the disease*, *to prevent further increase in CWD prevalences in affected areas*, and *detect new infection foci as early as possible*. As deer are more susceptible to CWD than elk and moose, CWD management actions and sampling efforts will therefore primarily target mule deer populations at this time, as a reduction in CWD prevalence in mule deer likely will reduce the spread of the disease to other cervid species as well.

Chronic wasting disease prions can persist in the environment (Almberg *et al.* 2011), and environmental contamination may contribute to transmission of the disease within infected areas. Deliberate, localized reduction of population densities ("hot-spot culling) has been utilized by multiple states and may be effective in reducing CWD prevalences locally. However, sustained actions are needed in order to achieve long term effects, and these efforts have therefore yielded mixed results (Miller & Fischer 2016; Wolfe 2018).

Male deer are more likely to be infected than females (Miller *et al.* 2000; Grear *et al.* 2006; Rees *et al.* 2012), and statistical modeling has shown that harvest management may be most effective when focused on antlered deer (Jennelle *et al.* 2014; Potapov *et al.* 2016). Bucks over 4 years of age are more likely to be infected with CWD (Miller & Conner 2005), and targeting older age bucks may therefore be a tool for reducing CWD prevalences. Hunts later in the hunting season and during the rut appear to be especially effective in increasing adult male harvest and may therefore be an effective tool for targeting this age group. Research is currently underway to better understand the effect of different harvest strategies on CWD prevalences and spread.

Other risk factors for spread of CWD include movements of animals and animal parts (Williams & Miller 2003), and artificial concentration of cervids through baiting and feeding (Fischer & Davidson 2005). Implementing and enforcing carcass import regulations, reducing artificial concentration of wild cervids by prohibiting baiting and feeding, and avoiding translocation of wild cervids are therefore management options that may reduce the risk of CWD transmission.

The Western Association of Fish and Wildlife Agencies (WAFWA) published Recommendations for adaptive management of Chronic Wasting Disease in the West (WAFWA 2017), which outlines possible CWD management strategies and recommendations for how to evaluate their effectiveness. Some of these recommendations have been incorporated in this plan.

Human health risks associated with CWD:

To date there has been no direct evidence that CWD is transmissible to humans (CDC 2018). A study investigated the occurrence of prion associated diseases over time in a CWD infected area of Colorado and did not find evidence of a higher incidence of prion associated diseases in residents (MaWhinney *et al.* 2006). Further, transgenic mice with human prion proteins, failed to develop the disease when exposed to elk CWD prions (Kong *et al.* 2005). Recently, a Canadian study successfully infected cynomolgus macaques by intracranial and oral routes (Czub 2017), however, a study by Race et al. 2018 reported no infection of the same species 11-13 years after experimental inoculation with CWD prions.
The UDWR maintains a website with information on CWD in the state and beyond and provides general advice on how to reduce the risk of exposure. Hunters are advised not to harvest animals that appear sick

or eat meat from suspect or positive animals. The following simple precautions are recommended when handling the carcass of any deer, elk, or moose:

- Do not handle or consume wild game animals that appear sick. Instead, contact your local DWR office and notify them of the location of the sick animal.
- Do not consume meat from animals known to be infected with CWD.
- Wear rubber or latex gloves when field dressing big game.
- On all deer, bone out the meat, and avoid consuming the brain, spinal cord, eyes, spleen and lymph nodes of harvested animals.
- Minimize handling of soft tissues and fluids. Wash hands with soap and warm water after handling any parts of the carcass.
- Knives, saws, and cutting table surfaces should be disinfected using a solution of 50 percent household bleach for at least an hour.
- Please contact the Utah Division of Wildlife Resources for additional information or if you see a sick animal while hunting.

Objectives of the plan:

1. Reduce the rate of spread of Chronic Wasting Disease in Utah and reduce the CWD prevalence in infected areas
2. Provide guidelines for response to detection of new infection foci
3. Communicate with the public and participate in scientific research

Objective 1) Reduce the rate of spread and prevalence of CWD:

This objective will be reached through the following strategies a) surveillance, b) harvest management, c) reducing risk of importing infected carcasses from other states by carcass import restrictions, d) restricting baiting and feeding of wildlife, e) limiting the translocation of wild cervids, f) prohibiting the rehabilitation of wild cervids, g) implementing clear requirements for disease testing of domestic cervids that are overseen by UDWR, and h) providing guidelines for proper carcass disposal.

Strategies to achieve objective 1:

a) Surveillance:

The UDWR has conducted CWD surveillance since 2002. To date, the surveillance has consisted of sampling hunter harvested animals in all wildlife management units across the state on a rotational schedule, sampling vehicle killed and other animals in areas with urban deer translocation programs, sample and test any symptomatic cervid, and test all cervids submitted for post mortem examination to the diagnostic laboratory for any reason. In addition, elk have been sampled opportunistically in areas where CWD has been confirmed. The sample efforts are designed to be able to detect ≥1% prevalence of CWD with 95% confidence and employs a weighted surveillance strategy (Walsh 2012). In this system, animals that are more likely to be infected (e.g. a symptomatic animal, vehicle killed animals, or adult bucks), are given a higher weight than animals considered at lower risk for being infected with CWD, (e.g. fawns or yearlings). An overview of the weights allocated to each sample type is shown in Table 2.

Table 2: Relative sample weights (points) associated with demographic groups of deer and elk for weighted surveillance of Chronic Wasting Disease. The weights were developed based on mule deer data from Colorado (Walsh 2012).

	Weight and species	
Demographic group	**Mule deer**	**Elk**
Symptomatic female	13.6	18.75
Symptomatic male	11.5	8.57
Road-killed male/female, all ages except fawns/calves	1.9	0.41
Other mortalities (predation, other unexplained in adults and yearlings)	1.9	0.41
Harvest, adult males	1	1.16
Harvest, adult females	0.56	1.00
Harvest, yearling males	0.19	N/A
Harvest, yearling females	0.33	0.23
Harvest, fawns/calves	0.001	N/A

The required sample size for determining a ≥1% prevalence of CWD with 95% confidence is 304 deer and 346 elk (due to lower test sensitivity in elk), using standard equations for determining freedom of disease (Dohoo 2010). Currently, the positive WMU's are sampled annually, whereas the WMU's considered free of CWD are sampled every 5 years on average in clusters of 2-3 units together. Table 3 is showing the sampling units that have been combined since 2006.

Hunter harvested samples are collected at check stations, meat processors, regional offices, and taxidermists. From each animal, the retropharyngeal lymph nodes will be collected. The obex may also be sampled if lymph nodes are not available. Samples will be screened for CWD with an Enzyme-Linked-Immunosorbent Assay (ELISA), and positives confirmed with Immunohistochemistry (IHC) at a National Animal Health Laboratory Network-accredited laboratory (Utah Veterinary Diagnostic Laboratory). Hunters who wish to have their animals tested from areas outside of the test zones can continue to do so at their own expense.

Test results are made available online for hunters to check. If an animal is positive, the hunter is contacted and, if the hunter agrees, the meat and antlers confiscated and incinerated. If the meat and antlers are surrendered, the hunter is issued a new tag for the following year in the same hunting unit.

Table 3: Wildlife management unit clusters sampled for CWD since 2006 in Utah.

Year	**Wildlife Management Units sampled (mainly hunter harvest)**								**Urban**
2006-07	2,3,4	5,6,7	10,11	17	21,23,25	8,9	16	13,14	*
2007-08	2,3,4	6-7	*	17	21,23,25	8,9	16	13,14	*
2008-09	2,3,4	5,6,7	*	17	23,24,25	8,9	16	13,14	*
2009-10	2,3,4	*	*	*	21,22	8,9	16	13,14	*
2010-11	2,3,4	*	*	*	27,28,29,30	8,9	16	13,14	*
2011-12	*	*	10,11	*	*	8,9	16	13,14	*
2012-13	*	*	*	*	*	8,9	16	13,14	*
2013-14	2,3,4	*	*	*	*	8,9	16	13,14	*
2014-15	*	5,6,7	*	17	*	8,9	16	13,14	*

2015-16	2,3,4	*	*	17	*	8,9	16	13,14	*
2016-17	2,3,4	*	*	*	23,24,25	8,9	16	13,14	*
2017-18	2,3,4	*	10,11	*	*	8,9	16	13,14	5, 17,18,19
2018-19	*	5,6,7	10,11	17	21,22	8,9	16	13,14	5, 17,18,19

Ongoing strategy for hunter harvest surveillance:

Rotational hunter harvest surveillance:

The rotational hunter harvest surveillance will continue by targeting a cluster of 2-3 units at least every 5 years using the weighted surveillance approach. Known positive units will also be included in the rotational surveillance instead of being sampled every year. A suggested 5- year rotational schedule is outlined in Table 4.

Compulsory testing and other strategies to increase sample size:

In Utah, it has become increasingly difficult to obtain adequate sample sizes to achieve statistically meaningful results. Beginning in the fall of 2020, compulsory testing may be introduced in units that are being surveyed in a given year. Compulsory testing could entail sampling a subset or all of harvested deer in a given unit and year. Additional strategies to increase the number of CWD samples may include sending letters to hunters to request their participation in the CWD surveillance program, providing freezers in convenient locations where hunters can leave the head of their harvested animal, hiring additional staff during the hunting season, and working with meat processors and taxidermist to obtain samples.

Table 4: Possible 5-year rotational schedule for sampling of hunter harvested mule deer across Utah.

Year	**Units**		
Year 1	1	23,24,25	12,15,16
Year 2	2,3,4	17	13,14
Year 3	5,6,7	10,11	8,9
Year 4	18,19	20,21,22	21,23,24
Year 5	22,24,28	27,28,29,30	-
Year 6	Rotation begins from the top		

b) Harvest management:

Hunting is an important tool to manage cervid populations in Utah and continues to be the most effective source of surveillance samples. Harvest management may also be the most effective tool to reduce spread and reduce or maintain low CWD prevalences. Research has also shown that that it may be most effective when focused on antlered deer (Jennelle *et al.* 2014; Potapov *et al.* 2016). To date, most of the CWD positive units in Utah have been managed at low buck to doe ratios, which may have contributed to the relatively low prevalence of CWD in Utah thus far. However, despite these efforts, the prevalence appears to be slowly rising, and as the disease spreads, changes to existing harvest management will likely be necessary in order to prevent further spread of disease in the state.

Bucks over 4 years of age are more likely to be infected with CWD (Miller & Conner 2005), and targeting older age bucks may therefore be a tool for reducing CWD prevalences (WAFWA, 2017). Hunts later in the hunting season and during and after the rut appear to be effective in increasing harvest of older aged bucks infected with CWD (Conner et al., 2000).

Further, CWD does not occur randomly distributed over the landscape, but CWD positive animals are often harvested from within smaller focal areas. This is known because hunters that harvest CWD positive animals are requested to provide an approximate GPS location of harvest. An increase in sample size of animals tested for CWD, e.g. through compulsory testing, may facilitate more effective identification of disease hotspots. More accurately locating disease hotspots could enable managers to increase harvest within those focal areas with the goal of removing more CWD positive animals.

Strategies to use harvest management as a tool to reduce the spread of CWD:

Data from Colorado suggests that after initial introduction of CWD into an area, CWD prevalence slowly increases but remains < 5 % for years. However, when an ~5% infection rate is reached, the increase in CWD prevalence becomes exponential and population impacts become detectable (Colorado Parks and Wildlife, 2018). In Colorado, a 5% prevalence is also the threshold for mandatory management action to reduce the prevalence of CWD (Colorado Parks and Wildlife, 2018). In Utah, a 5% prevalence of infection likely has been reached in Unit 13 (La Sal Mountains), whereas in other units, the prevalence is likely still below 2%, but also with an increasing trend. Because Utah still has a relatively low prevalence of CWD, setting the threshold for action at 5% would result in years of inaction while waiting for the prevalence to become higher. The consequence would not only be more disease in the populations, but also spread of CWD from its current infection foci to other areas. Potentially, valuable limited entry units bordering CWD positive areas could be infected if the prevalence is not kept at the lowest level possible.

Consequently, in order to reduce the risk of an increase in prevalence and spread of CWD, the threshold for implementation of CWD management actions in Utah should be set at detection of CWD. Currently, the CWD surveillance program is aimed at detecting a ?1% prevalence of CWD with 95% confidence. Based on this surveillance program, the threshold for taking action should therefore be set at the detection of the first CWD positive, which, if sample sizes are met, likely would mean that the CWD prevalence is ?1%. The type of action taken in a unit should be decided by the regional biologist, in consultation with the big game and wildlife health programs.

One or more of the following harvest management strategies can be implemented in units with ε1% prevalence of CWD:

- The buck to doe ratio of each unit is outlined in the unit management plans. If CWD is present in a unit, the buck to doe ratio should be kept at the lowest end of the range outlined in the plan. A ratio of 15-17 bucks per 100 does should be maintained in units that are already CWD positive. If CWD is found on a unit that is managed for 18-20 bucks per 100 does or higher, consider changing the management of the unit to 15-17 bucks per 100 does.
- Late season buck hunts can be implemented within focal hotspot areas within CWD positive units. The goal of such hunts is to target prime age class bucks that are more likely to be infected with CWD. The boundaries of such areas will be determined by the regional biologists and managers and be based on previous CWD surveillance, deer movement data, and location of winter ranges. These boundaries may be changed if CWD spread from the original infection foci.
- If CWD is detected in units with higher buck to doe ratios, a late season hunt can be implemented immediately to target prime age class bucks. The area in which the late season hunt is

implemented should be determined by the area biologist and wildlife managers based on knowledge of deer movements and location of winter ranges. In addition, change in hunt management to lower the buck to doe ratio across the unit should be considered.
- Issuance of more buck and doe hunting licenses to lower the population density.
- Shifting of the harvest to later in the season during and after the rut to target prime age class bucks that are more likely to be infected with CWD while maintaining the overall same number of tags.
- Adding a unit wide hunt later in the season during or after the rut to target prime age class bucks and increase overall harvest.
- Increasing harvest on private land and in urban areas by increasing collaboration with private land owners, wildlife management areas, cities, counties and other entities.

In order to reduce focal disease hot spots, managers could consider the following management options in addition to the late season hunt:
- Increase the overall number of tags within a focal hotspot area.
- Add doe hunts within focal hot spot areas.

The effectiveness of new management strategies should be evaluated over a period of at least 10-15 years (2-3 sampling rotations). Additionally, any implementation of targeted strategies (e.g. late season buck hunts within focal hotspot areas) should involve additional annual CWD monitoring to determine the prevalence of CWD within the focal area and longer term effectiveness of the strategy. As new science becomes available additional CWD management strategies may be added to this plan.

c) Carcass import restrictions:

The import of deer, elk and moose carcasses from known infection areas is prohibited. Only meat that is cut and wrapped either commercially or privately, quarters or other portion of meat with no part of the spinal column or head attached, meat that is boned out, hides with no heads attached, skulls or skull plates with antlers attached that have been cleaned of all brain matter and spinal column tissue, antlers with no meat or tissue attached, upper canine teeth known as buglers, whistlers or ivories, and finished taxidermy heads are allowed. The Division keeps a list of states, provinces, game management units, equivalent wildlife management units, or counties on their website, from which it is prohibited to import carcasses, except for the parts listed above. Prohibiting import from infected units or counties instead of from entire states that have CWD, significantly increases the risk of bringing in an infected carcass as finding CWD is very dependent on the quality of the surveillance.

Strategy to reduce risk of importing CWD infected carcasses through import restrictions:

It will be prohibited to import carcasses, except for the carcass parts listed below from any state where CWD has been detected. Additional states may be added as necessary.

Permitted parts: Only the following parts of wild deer, elk and moose may be imported from states with confirmed CWD:
- Meat that is cut and wrapped either commercially or privately
- Quarters or other portion of meat with no part of the spinal column or head attached
- Meat that is boned out
- Hides with no heads attached

- Skulls and skull plates with antlers attached that have been cleaned of all brain matter and spinal column matter
- Antlers with no meat or tissue attached
- Upper canine teeth known as buglers, whistlers or ivories
- Finished taxidermy heads

d) Baiting and feeding:

Baiting and feeding of wildlife in Utah is currently legal and unregulated. However, with the exception of the elk feeding ground at Hardware Ranch in northern Utah, state managed feeding of wildlife only occurs on a very limited basis during extreme winter conditions. Baiting and feeding by private individuals may occur but the extent is unknown.

Strategy to reduce the risk of CWD transmission through artificial concentration of cervids:

Artificial concentration of wild cervids can facilitate transmission of CWD and should be avoided. Even during emergency conditions such as extreme winters, UDWR will not feed cervids in areas where CWD has been detected, or in high risk areas where CWD is suspected. All intentional feeding of wild cervids by private individuals should be limited to the largest extent possible. The UDWR will educate the public about the disease risks associated with feeding of wildlife.

e) Translocation of cervids:

Import and translocation of cervids significantly increases the risk of spreading CWD, and has been the single most important factor in spreading CWD in North America (Miller & Fischer 2016).

Strategies to reduce risk of spread of CWD through translocation of cervids:

The UDWR should not allow for import of free-ranging or captive deer (*Odocoileus* sp.), free-ranging elk (*Cervus elaphus* sp.), or free-ranging or captive moose (*Alces alces*) into Utah. The UDWR has previously translocated free-ranging cervids within the state from areas considered free of CWD. Such translocations carry significant risk of spreading undetected infections and should be limited to the largest extent possible. Translocation of moose away from urban areas is permitted within the same unit.

f) Rehabilitation:

Rehabilitation can lead to an unnatural mixing and concentration of wild cervids with unknown background and infection status, and it increases the risk of moving cervids from one area of the state to the other. Further, rehabilitated deer don't always acclimate well to natural conditions when released back into the wild, and these animals often congregate in urban areas resulting in nuisance and public safety concerns.

Strategy to reduce risk of spreading CWD through wildlife rehabilitation:

The Utah DWR prohibits the rehabilitation of deer, moose, or elk of any age in order to prevent the mixing of potentially infected and non-infected animals.

g) Alternative livestock species:

Domesticated elk:

Captive elk ranching is overseen by the UDAF. The Division will continue to collaborate with UDAF on captive elk ranching, prevention of ingress and egress of wild cervids, and finding sustainable solutions to reduce the risk of CWD transmission between captive and wild cervids. If wild deer are found in captive elk facilities, owners may apply for certificate of registration (COR) to lethally remove wild deer, in accordance with R657-71.

Fallow deer and reindeer:

Keeping of fallow deer and reindeer in Utah requires the possession of a valid COR issued by the UDWR. Facilities must meet the standards for keeping fallow deer and reindeer as outlined in the COR, and no permit can be issued before a facility inspection has been conducted and the facility approved. Each fallow deer and reindeer must be identified with a unique identification, and a full herd inventory comprising of ID number, age, sex, disposition, place of origin, place to where the animal was sold (if sold) must be submitted annually. Any animal that dies for any reason must be tested for chronic wasting disease (retropharyngeal lymph nodes and/or obex) at a National Animal Health Laboratory Network (NAHLN) approved laboratory (such as the Utah Veterinary Diagnostic Laboratory) and the test results reported to the UDWR with the annual report. The Division has the right to conduct unannounced inspections at any time to determine whether the reported inventory is correct. Failure to comply with these regulations will lead to revocation of the COR.

h) Carcass disposal:

Disposal of infected carcasses is a concern for environmental contamination, and potentially could be a source of spread of CWD.

Strategy to avoid CWD spread through carcass disposal:

Incineration, alkaline hydrolysis tissue digestion, and burial in an approved, active landfill are considered suitable methods for carcass disposal (AFWA 2018). The DWR will continue to educate hunters, the public, meat processors, and taxidermists about the risk of CWD, and appropriate carcass disposal methods. Hunters and meat processors are encouraged to help prevent the spread of CWD by following management practices such as a) processing the carcass in the field and thereby not move it out of the area of origin, b) disposing carcasses by burial in a landfill, or c) disposing unused animal parts and wild game meat in double bagged plastic bags in the household trash for burial at the landfill.

Objective 2) Provide guidelines for response to detection of new infection foci

Strategy: Implement population reduction and sampling to determine prevalence

Aggressive sampling in focal areas was conducted early in the CWD epidemic in Utah but has not been used as a tool since then. If CWD is detected in new areas, strategies as outlined under objective 1 should be implemented, but in addition, an immediate response should also be considered on a case by case basis. A more aggressive approach should especially be considered especially in areas where CWD has previously not been detected, and that are located far from previous infection foci.

Factors that may determine the strength of a response:

- Distance to CWD positive areas
- Resident or migratory population
- Connectivity or isolation to other populations
- Size of the population
- Current hunt management of the population
- Presence of other cervid species
- Presence of domestic cervid facilities (elk, reindeer, fallow deer)
- Accessibility (private and public land)
- Hunting opportunity for the public
- Public perception of the proposed change or intervention
- Location with respect to another positive area out of the State of Utah or tribal ground

If CWD is detected within a new area, a feasible course of action should be determined by area biologist and wildlife managers based on factors listed above.

Strategies to consider may include:

- Immediate, localized reduction of population densities.
- Immediate, intensive sampling in areas around the positive animal in order to determine CWD prevalences.
- Immediate implementation of a late season hunt targeting older age class bucks.

Objective 3) Communicate with the public and participate in scientific research.

This objective will be reached through the following strategies: a) Communication with the public, and b) participation in relevant, applied research.

a) Communication with the public:

The UDWR is committed to providing the public with factual, timely and accurate information on the CWD prevalence, distribution, and management in the State. The Division will maintain an up to date website and release relevant information through other media outlets when necessary. The information provided will include where CWD has been found in the State, public health risks as determined by public health professionals, efforts to monitor the disease, links to laws and regulations pertaining to CWD, information on carcass import restrictions, and how the public can help minimize the spread of CWD. The UDWR will engage hunters in education about the disease transmission risks associated with baiting and feeding wildlife, using urine scents and lures, and harvest management to manage CWD prevalences in order to gain public support for any regulations and management actions that may be necessary. The location of hunter check stations, regional offices, and annual units for CWD surveillance will also be publicized on the CWD website and prior to the hunting season on social and other DWR media outlets.

b) Participation in relevant, applied research:

The Division will participate in applied research that is relevant for enhancing knowledge about CWD. Participation in relevant research project will be decided and approved by UDWR on a case by case basis.

Literature cited:

AFWA. 2018. Association of Fish and Wildlife Agencies. AFWA best management practices for surveillance, management, and cotrol of chronic wasting disease (CWD). Available at: https://www.fishwildlife.org/application/files/9615/3729/1513/AFWA_Technical_Report_on_CWD_BMPs_FINAL.pdf. Accessed June 1, 2019.

Almberg ES, Cross PC, Johnson CJ, Heisey DM, Richards BJ. 2011. Modeling routes of chronic wasting disease transmission: environmental prion persistence promotes deer population decline and extinction. *PLoS One* 6: e19896.

Angers RC, Browning SR, Seward TS, Sigurdson CJ, Miller MW, Hoover EA, Telling GC. 2006. Prions in skeletal muscles of deer with chronic wasting disease. *Science* 311: 1117.

Angers RC, Seward TS, Napier D, Green M, Hoover E, Spraker T, O'rourke K, Balachandran A, Telling GC. 2009. Chronic wasting disease prions in elk antler velvet. *Emerging Infectious Diseases* 15: 696.

Benestad SL, Mitchell G, Simmons M, Ytrehus B, Vikøren T. 2016. First case of chronic wasting disease in Europe in a Norwegian free-ranging reindeer. *Veterinary Research* 47: 88.

CDC. 2018. Centers for Disease Control and Prevention. Chronic Wasting Disease. Available at https://www.cdc.gov/prions/cwd/index.html. Accessed June 1, 2019.

Colorado Parks and Wildlife. 2018. Colorado Chronic Wasting Disease Response Plan. Available at: https://cpw.state.co.us/Documents/Commission/2018/Nov/Item_19-Chronic-Wasting-Disease-Response-Plan.pdf. Accessed May 31, 2019.

Conner, MM, McCarty CW, Miller MW. 2000. Detection of bias in harvest estimates of Chronic Wasting Disease prevalence in mule deer. *Journal of Wildlife Diseases* 36: 691-700.

Czub S, Schulz-Schaeffer W, Stahl-Hennig C, Beekes M, Schaetzl H, Motzkus D. 2017. First evidence of intracranial and peroral transmission of Chronic Wasting Disease (CWD) into *Cynomolgus macaques*: a work in progress. presentation at the PRION 2017 Conference, Edinborough, Scotland. https://www.youtube.com/embed/Vtt1kAVDhDQ.

DeVivo MT, Edmunds DR, Kauffman MJ, Schumaker BA, Binfet J, Kreeger TJ, Richards BJ, Schätzl HM, Cornish TE. 2017. Endemic chronic wasting disease causes mule deer population decline in Wyoming. *PLoS One* 12: e0186512.

Dohoo I, Martin W, Stryhn H. 2010. *Veterinary Epidemiologic Research*. VER Inc., Charlottetown, Prince Edward Island, Canada.

Edmunds DR, Kauffman MJ, Schumaker BA, Lindzey FG, Cook WE, Kreeger TJ, Grogan RG, Cornish TE. 2016. Chronic Wasting Disease drives population decline of white-tailed deer. *PLoS One* 11: e0161127.

Fischer JR, Davidson WR. 2005. Reducing risk factors for disease problems involving wildlife. In: *Transactions of the North American Wildlife and Natural Resources Conference* 81: 289.

Geremia C, Miller MW, Hoeting JA, Antolin MF, Hobbs NT. 2015. Bayesian modeling of prion disease dynamics in mule deer using population monitoring and capture-recapture data. *PLoS One* 10: e0140687.

Grear DA, Samuel MD, Langenberg JA, Keane D. 2006. Demographic patterns and harvest vulnerability of chronic wasting disease infected white-tailed deer in Wisconsin. *Journal of Wildlife Management* 70: 546-53.

Haley NJ, Hoover EA. 2015. Chronic wasting disese of cervids; Current knowledge and future perspectives. *The Annual Review of Animal Biosciences* 3: 305-25.

Haley NJ, Mathiason CK, Carver S, Zabel M, Telling GC, Hoover EA. 2011. Detection of chronic wasting disease prions in salivary, urinary, and intestinal tissues of deer: potential mechanisms of prion shedding and transmission. *Journal of virology* 85: 6309-18.

Henderson DM, Denkers ND, Hoover CE, Garbino N, Mathiason CK, Hoover EA. 2015. Longitudinal detection of prion shedding in saliva and urine by chronic wasting disease-infected deer by real-time quaking-induced conversion. *Journal of virology* 89: 9338-47.

Jennelle CS, Henaux V, Wasserberg G, Thiagarajan B, Rolley RE, Samuel MD. 2014. Transmission of chronic wasting disease in Wisconsin white-tailed deer: implications for disease spread and management. *PLoS One* 9: e91043.

John TR, Schätzl HM, Gilch S. 2013. Early detection of chronic wasting disease prions in urine of pre-symptomatic deer by real-time quaking-induced conversion assay. *Prion* 7: 253-8.

Kim TY, Shon HJ, Joo YS, Mun UK, Kang KS, Lee YS. 2005. Additional cases of chronic wasting disease in imported deer in Korea. *Journal of Veterinary Medical Science* 67: 753-9.

Kong Q, Huang S, Zou W, Vanegas D, Wang M, Wu D. Yuan J, Zheng M, Bai H, Deng H, Chen K, Jenny AL, Rourke K, Belay ED. Schonberger LB, Petersen RB, Sy MS, Chen SG, Gambetti P. 2005. Chronic wasting disease of elk: Transmissibility to humans examined by transgenic mouse Models. *The Journal of Neuroscience* 25: 7944.

Mathiason CK, Powers JG, Dahmes SJ, Osborn DA, Miller KV, Warren RJ, Mason GL, Hays SA, Hayes-Klug J, Seelig DM. 2006. Infectious prions in the saliva and blood of deer with chronic wasting disease. *Science* 314: 133-6.

MaWhinney S, Pape WJ, Forster JE, Anderson CA, Bosque P, Miller MW. 2006. Human prion disease and relative risk associated with chronic wasting disease. *Emerging Infectious Diseases* 12: 1527-35.

Miller M, Fischer J. 2016. The first five (or more) decades of chronic wasting disease. Transactions of the 81st North American Wildlife and Natural Resources Conference. Available at: http://cwd-info.org/wp-content/uploads/2018/12/81st-NAWNRC-Transactions_FINAL-CWD-Excerpt.pdf. Accessed June 1, 2019.

Miller MW, Swanson HM, Wolfe LL, Quartarone FG, Huwer SL, Southwick CH, Lukacs PM. 2008. Lions and prions and deer demise. *PLoS One* 3: e4019.

Miller MW, Conner MM. 2005. Epidemiology of chronic wasting disease in free-ranging mule deer: spatial, temporal, and demographic influences on observed prevalence patterns. *Journal of Wildlife Diseases* 41: 275–290.

Miller MW. Williams ES, Hobbs NT, Wolfe LL. 2004. Environmental sources of prion transmission in mule deer. *Emerging Infectious Diseases* 10: 1003.

Miller MW, Williams ES, McCarty CW, Spraker TR, Kreeger TJ, Larsen CT, Thorne ET. 2000. Epizootiology of chronic wasting disease in free-ranging cervids in Colorado and Wyoming. *Journal of Wildlife Diseases* 36: 676-90.

Miller MW, Williams ES. 2004. Chronic Wasting Disease of cervids. *Current Topics in Microbiology and Immunology* 284: 193 - 214.

Monello RJ, Powers JG, Hobbs NT, Spraker TR, Watry MK, Wild MA. 2014. Survival and population growth of a free-ranging elk population with a long history of exposure to chronic wasting disease. *The Journal of Wildlife Management* 78: 214-23.

Potapov A, Merrill E, Pybus M, Lewis MA. 2016. Chronic wasting disease: transmission mechanisms and the possibility of harvest management. *PLoS One* 11: e0151039.

Race B, Williams K, Orrú CD, Hughson AG, Lubke L, Chesebro B. 2018. *Journal of Virology* 92, e00550-18; DOI: 10.1128/JVI.00550-18.

Rees EE, Merrill EH, Bollinger TK, Ten Hwang Y, Pybus MJ, Coltman DW. 2012. Targeting the detection of chronic wasting disease using the hunter harvest during early phases of an outbreak in Saskatchewan, Canada. *Preventive Veterinary Medicine* 104: 149-59.

Sohn HJ, Kim JH, Choi KS, Nah JJ, Joo YS, Jean YH, Ahn SW, Kim OK, Kim DY, Bakachandran A. 2002. A case of chronic wasting disease in an elk imported to Korea from Canada. *Journal of Veterinary Medical Science* 64: 855-8.

WAFWA. 2017. Western Association of Fish and Wildlife Agencies. Recommendations for adaptive management of Chronic Wasting Disease in the west. WAFWA Wildlife Health Committee and Mule Deer Working Group. Edmonton, Alberta, Canada, and Fort Collins, Colorado, USA. Available at: https://www.wafwa.org/Documents%20and%20Settings/37/Site%20Documents/Committees/Wildlife%20Health/docs/CWDAdaptiveManagementRecommendations_WAFWAfinal_approved010618.pdf. Accessed June 1, 2019.

Walsh DP. 2012. Enhanced surveillance strategies for detecting and monitoring chronic wasting disease in free-ranging cervids: U.S. Geological Survey Open-File Report 2012–1036. Available at: https://pubs.er.usgs.gov/publication/ofr20121036. Accessed June 1, 2019.

Walsh DP, Miller MW. 2010. A weighted surveillance approach for detecting chronic wasting disease foci. *J Wildl Dis* 46: 118-35.

Wasserberg G, Osnas EE, Rolley RE, Samuel MD. 2009. Host culling as an adaptive management tool for chronic wasting disease in white-tailed deer: a modelling study. *Journal of Applied Ecology* 46: 457-66.

Williams E. 2005. Chronic wasting disease. *Veterinary Pathology* 42: 530-49.

Williams E, Miller M. 2002. Chronic wasting disease in deer and elk in North America. *Revue scientifique et technique-office international des épizooties* 21: 305-16.

Williams E, Miller M. 2003. Transmissible spongiform encephalopathies in non-domestic animals: origin, transmission and risk factors. *Revue scientifique et technique-Office international des épizooties* 22: 145-56.

Wolfe LL, Watry MK, Sirochman MA, Sirochman TM, Miller MW. 2018. Evaluation of a test and cull strategy for reducing prevalence of chronic wasting disease in mule deer (*Odocoileus hemionus*). *Journal of Wildlife Diseases* 54: 511-519.

Appendix B. Statewide mule deer transplant list, Utah 2019.

Region	Unit		County	Area (s)
Northern	1	Box Elder	Box Elder	Newfoundland Mountains
				Pilot Mountains
				Raft River Mountains
	2	Cache	Cache	Hardware Ranch
	7	Kamas	Summit	Cedar Hallow
Northeastern	11A	Nine Mile, Anthro	Duchesne	Big Wash
				Nutters Ridge
				Sowers Canyon
	17C	Wasatch Mtns, Avintaquin	Duchesne	Strawberry River
				Horse Ridge
				Lake Canyon
Southeastern	11B	Nine Mile, Range Creek	Carbon and Emery	Southern end of Tavaputs Plateau
	14B	San Juan, Elk Ridge	San Juan	Cedar Mesa
				Deer Flat
				Lower Lost Park
	16C	Central Mountains, Manti	Emery, Sanpete, and Sevier	Stump Flat
				Danish Bench
				North and South Horn Mountain
				Biddlecome Ridge
				Black Dragon
				Dry Mountain
				Sage Flat
				Muddy Creek Canyon
				Link Canyon McEwen Flat
				The Pines/Green Hollow/Wildcat Knolls
				Quichupah Canyon/Water Hollow/Saleratus Benches
				Trough and Mill Hollow/Gilson Valley
				Duncans

Central	19A	West Desert	Tooele and Juab	Deep Creek Mountains (Tom's Creek and Granite Creek) Dutch Mountain Gold Hill Northern end of Cedar Mountain
Southern	21A	Fillmore, Oak Creek	Millard	Oak Creek Mountains
	21B	Fillmore, Pahvant	Millard	Pahvant Mountains (North of Holden to South of Fillmore)
	24	Mt Dutton	Garfield and Piute	Deer Creek to Pine Creek East and West Forks of Hunt Creek Sanford Bench
	30	Pine Valley	Washington	Browse Area