Overview of the Management of Wild Horses and Burros

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A report presented to the National Academy of Sciences Committee to Review the Management of Wild Horses and Burros

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October 2012

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Introduction:

Despite the Wild Free-Roaming Horses and Burros Act (WFRHBA) providing protections to wild horses and burros on lands where they existed in 1971, the Bureau of Land Management (BLM) has permanently removed wild horses and/or burros from approximately 22.2 million acres (slightly less than the combined land-area of South Carolina and Connecticut). It has justified these decisions to "zero-out" herds based on checkerboard (private/public) land ownership, a lack of critical resources required to sustain wild horse and/or burro populations (i.e., water, food, space, cover), land transfers, substantial conflict with other resource values, legal decisions, or for other reasons.[1] Yet, the Animal Welfare Institute (AWI) still questions the legitimacy of these decisions.

Over the past 41 years, tens of thousands of wild horses and burros have been removed from western rangelands based on claims of "excess," concurrent concerns over impacts to rangeland conditions, or in response to "emergencies" linked to environmental circumstances (i.e., drought) or disasters (i.e., wildfire). While many were successfully adopted by private citizens, some ended up slaughtered for food, while the majority have been taken to long-term holding facilities. Indeed, as of August 2012, there are more horses in short- and long-term holding (or maintenance and contract facilities) (47,523) than are estimated to exist in the wild (37,294).

The capture, handling, and transportation process inherent to wild horse removals has destroyed wild horse bands, disrupted social dynamics of wild populations, and led to injuries and deaths of captured animals. While some amount of injuries/mortalities are, sadly, expected when handing wild animals, many of the incidents that have occurred are entirely preventable; the result of negligence, abusive capture techniques, or cruel handling practices employed by those contracted to conduct the roundups.

The BLM claims that such removals are required to restore the "thriving natural ecological balance"[2] and to permit "multiple-use" of the land, while AWI questions the very justification for the removals, criticizes the agency for manhandling the animals, and laments the loss of these animals from our public lands. AWI claims that the BLM has little to no credible data to justify its management actions, operates with little transparency, that wild horse and burro numbers pale in comparison to number of livestock, and that the BLM's relationship to industry and user groups compromises the

[1] See: http://www.blm.gov/wo/st/en/prog/whbprogram/history_and_facts/quick_facts.html

[2] AWI is unaware of any official definition of a "thriving natural ecological balance" (TNEB) or what measures are used by the BLM to assess whether a TNEB exists. Without a formal definition of and criteria, or standards to assess TNEB, the BLM has considerable discretion in determining if a TNEB exists or not which provides it with the opportunity to make claims that a TNEB does not exist which are then difficult to challenge. AWI has previously offered a definition of TNEB for inclusion in federal legislation. AWI proposed to define "TNEB" as "a condition that protects ecosystem health, the ecological processes that sustain ecosystem function and a diversity of life forms, including those species listed under the Endangered Species Act, and further ensures that wild horses and burros, livestock and/or wildlife species are given fair and equal consideration in the allocation of resources on those lands where said species are authorized and/or managed."

agency's integrity and corrupts its management of wild horses and burros. Protest campaigns against wild horse or burro roundups and lawsuits challenging BLM decisions are commonplace. The oft-divisive relationship between wild horse advocates and the BLM has created a level of distrust that is not conducive to dialogue, deliberations, or collaboration.

As the controversy over the management and treatment of wild horses and burros has escalated, so have the costs. In fiscal year 2011, wild horse and burro holding cost 35.7 million dollars, which was 47 percent of the total wild horse and burro program budget of 75.8 million dollars. As long as wild horses continue to be removed from the range and placed into long-term holding, these taxpayer-funded costs will increase.

The ongoing controversy that plagues the wild horse and burro management program has generated some needed reform, new strategies, and actions that have been welcomed by interest/user groups and advocates, but which remain inadequate to comprehensively reform the program.

For example, though the vast majority of BLM planning documents – including documents used to evaluate the environmental impacts of wild horse or burro roundups – remain woefully inadequate, the BLM finally published its wild horse and burro management handbook in June 2010. In addition, a new proposed strategy to reform wild horse and burro management was published in February 2011. This strategy ostensibly emphasizes management of wild horses and burros on the range by promoting immunocontraception as a method to control the growth in wild horse and burro populations, yet use of this promising technology on wild horse and burro populations remains woefully insufficient.

Many documents that should exist either don't or they are not readily accessible to the public. Herd Management Area Plans are not available via the BLM website; site-specific rangeland condition monitoring data, if it is collected, remains difficult to access; and the data ostensibly used to set AML for wild horses and burros – a critical decision that directly influences management decisions – cannot be readily accessed. Though many Resource Management Plans can be accessed online, these documents do not necessarily provide the data or analysis used to set AML, making it difficult to identify when or in which document this importance management issue is comprehensively addressed.

Recently, the BLM has made cursory attempts to improve its transparency by, for example, providing increased opportunities for the public to observe gather operations, tour roundup facilities, and visit short- and long-term wild horse and burro handling and holding facilities. It also provides daily reports on its website for roundup operations, including information on wild horse or burro injuries and mortalities and the causes of such incidents. Despite these efforts, transparency remains incomplete at roundup sites, horse handling and holding facilities, and in regard to decision-making processes. For example, while the BLM's decision to review its Standard Operating Procedures used at roundups was welcomed by wild horse and burro advocates, its decision to engage in this review without any opportunity for public input is inexcusable and potentially illegal.

AWI has prepared this report in order to provide information relevant to the tasks assigned to the NAS Committee for its consideration. The organization, founded in 1951 to reduce the suffering caused to animals by people, has actively advocated on behalf of wild horses and burros for more than half a century (including working towards passage of the WFRHBA), supporting their right to remain wild and free, with minimal intervention from the federal government. We have long sought to reduce the suffering caused these animals by people and to restore them to the range that is their home.

The report is separated into several sections. The first section addresses the questions or tasks under the consideration of the NAS Committee. In addition, this section includes a summary of previous NAS reports on wild horse and burro management and, at the end, AWI's recommendations to the NAS Committee for each question under its review. The second section contains additional information that may be of interest to NAS Committee members, including a summary of AWI's concerns about the management of wild horses and burros by the BLM, an abbreviated legal analysis, and a summary of current wild horse and burro management procedures. The third section contains a national and state-by-state analysis of wild horse and burro and livestock management based primarily on statistical data obtained from the BLM's website. The fourth and final section contains the appendices, which include a series of state maps identifying all wild horse and burro HMAs, more focused maps depicting the overlap between HMAs and public land grazing allotments, and a bibliography. The maps were prepared for AWI by Ms. Kerry Deneene McMahon, who is majoring in geography and environmental planning at Towson University in Maryland.

The NAS Study:

Pursuant to Section 1333 of the WFRHBA, which authorizes the BLM to consult with independent experts, the BLM requested the NAS to provide a review of its wild horse and burro management program.

The task assigned to the NAS Committee is to conduct an "independent, technical evaluation of the science, methodology, and technical decision-making approaches of the WH&B [wild horse and burro] Program." This review is to build upon findings of prior National Research Council reports published in 1980, 1982, and 1992 and to supplement those findings with "additional, relevant research completed since the three earlier reports were prepared." In addition, relying on "information about the program provided by the BLM and on field data collected by the BLM and others," the NAS Committee is asked to address eleven key scientific challenges and questions, including: estimates of the WH&B populations; population modeling; genetic diversity in WH&B populations; annual rates of WH&B population growth; predator impact on WH&B population growth; population control; immunocontraception of wild horse mares (porcine zona pellucida); managing a portion of a population as non-reproducing; AML establishment or adjustment; societal considerations; and additional research needs.

AWI applauds the efforts of all NAS Committee members for volunteering their time and expertise to prepare a report that comprehensively and objectively complies with the statement of task. AWI appreciates the opportunities provided for the public to participate in the process and to address the Committee. AWI thanks the NAS for providing the Committee and public opportunities to obtain information relevant to wild horse and burro management from invited experts during open meetings and via webinars.

Considering that the present report is to build from the previous NAS reports, the findings of those reports are summarized here.

<u>1980 NAS Report</u>: Wild and Free-Roaming Horses and Burros Current Knowledge and Recommended Research, Phase I, Final Report

In this first NAS report on wild horse and burro management, the NAS was asked to assess the "state of knowledge on wild horses and burros, recommend research to fill gaps in knowledge, oversee the research during its conducts, and compile all relevant information at the end of the 2-year research effort." In its response to this task, the NAS Committee compiled information relevant to wild horse biology, ecology, and impacts on other species, and evaluated sociopolitical and economic issues relevant to wild horse and burro management. It also recommended 18 research projects covering a wide range of wild horse and burro ecology, biology, and management issues.

Findings in the Committee's 1980 report include:

- Mainstream equid evolution occurred in North America with fossil evidence documenting the presence of a large horse and an ass, structurally indistinguishable from the modern horse and donkey, as recently as 11,000 years ago (Skinner 1972, Haynes 1967, Mawby 1967, Hemmings 1970, Havry 1975, Cole et al. 1979).
- A range of social organizations exists in wild equids, from the harem or stable family group commonly observed in wild horses (Feist 1971, Pelligrini 1971, Feist and McCullough 1975, Hall and Kirkpatrick 1975, Green and Green 1977, Rubenstein 1978, Salter 1978, Nelson 1979); to a "territorial form" with stable bonds only between the mother and offspring observed in some burro populations (Moehlman 1974, 1979; Woodward 1976, 1979), but rarely in horses (Rubenstein 1978) (though burros, depending on location, demonstrated variability in social organization) (Moehlman 1979).
- Demographic variables for wild horses include evidence of first year survival rates of 50-86 percent (Boyd 1980, Feist and McCullough 1975); annual adult survival rates between 75 and 95 percent (Wolfe 1980, Keiper 1979); herd age ratios with 40-45 percent of animals in the foal to two-year old range and progressively smaller percentage in the older age groups (data compiled from multiple authors); total herd sex ratio of 55 percent female (Feist and McCullough 1975, Nelson 1979) (though the ratio favors females in the younger age categories and males in older categories); annual growth rate from below 10 percent to as high as 20 percent (though these rates may be a product of improved census proficiency and/or changes in census methodologies) (Wolfe 1980, Conley 1979, Nelson 1979); a foaling rate that ranges from 11 percent in 3 year-old horses to 84 percent in horses five years of age and older (Boyd 1980, Welsh 1975); and virtually no evidence of breeding in two-year-old mares.
- Demographic variables for wild burros include evidence of both high and low first year survival rates (Ohmart et al. 1975, Seegmiller 1977, Douglas and Norment 1977); herd age composition similar to that found in wild horses; annual growth rates of up to 20 percent or higher (though such rates were considered to press the biotic potential of the species) (Douglas and Norment 1977, Ohmart et al. 1975, Morgart 1978); and an average of more than 60 percent of two-year and older jennies foaling per year (Moehlman 1974, Woodward 1976, Morgart 1978, Douglas and Norment 1977, Seegmiller 1977, McCort 1980).
- Nutrition data indicates that burros are highly opportunistic, broad-spectrum feeders, capable of surviving on high-fiber, low-nitrogen diets. Dietary preference studies document burro consumption of grasses ranging from 0 to 79.6 percent, forbs from 8.0 to 77.4 percent, and browse from 5.7 to 83.8 percent during different season and in different areas (Hansen and Martin 1973, Woodward and Ohmart 1976). For horses, which are more selective feeders, dietary preference for grasses ranges from 36 to 100 percent of total

diet (Hansen 1976, Vavra and Sneva 1978), averaging 89.4 percent with grasses and representing 85 percent of the diet in two dozen studies reviewed.

- Burros were identified as having impacts on other ecosystem components, with higher impacts when burros were within a radius of 2 to 2.5 kilometers from a water source. Impacts were reported from Death Valley National Monument (now Death Valley National Park), Grand Canyon National Park, Bandelier National Monument, and the Lake Mead National Recreation Area (Hanly and Brady 1977, Carothers et al. 1976, Koehler 1974, Moehlman 1974, O'Farrell 1978). For wild horses, little controlled research had been done to assess their impacts on other ecosystem components. Similarly, little research was available to assess horse competition with wildlife, though dietary overlap was reported for horses and cattle, elk, mule deer, pronghorn antelope, and bighorn sheep (Hansen 1976, Hubbard and Hansen 1976, Hansen et al. 1977, Thomas 1979). For burros, the primary concern in regard to competition was with bighorn sheep, though studies of alleged impacts often contained conflicting results (Thomas 1979, Golden and Ohmart 1976, Moehlman 1974, Woodward 1976).
- Though no empirical studies were reviewed to assess the impact of wild horses and burros on soil, anecdotal or localized reports suggested that equids, mostly burros, compacted soils, created trails that accelerated erosion, and polluted water sources (Koehler 1974, Woodward and Ohmart 1976, Stoddart et al. 1975, Carothers et al. 1976, Norment and Douglas 1977). The impacts of overgrazing on soils include increases in erosion rates, reduced infiltration rates, and impaired watershed function and water quality.
- The importance of sociopolitical and economic issues to the management of wild horses and burros was noted, along with a gap in knowledge and information on these issues to facilitate decision-making. Areas where there was a need for further evaluation were identified, and included the value and demand for wild horses and burros, adoption procedures, control and management techniques, optimal numbers for wild equids, management alternatives, and costs of existing legal regulations and restrictions.
- Animal census methodologies reviewed included indices, complete counts, and various kinds of estimates based on sampling. The Committee concluded that direct counts in open terrain are "reasonably accurate," but also identified a host of variables that could affect the accuracy of such counts, including vegetation type, topography, airspeed, altitude, and observer experience. Based on a preliminary analysis of BLM and U.S. Forest Service (USFS) census data, the Committee identified concerns about the lack of standardized timing of the season of the census, a significant difference in census numbers when helicopters replaced fixed-wing aircraft, and less variability when comparing helicopter counts.
- The Committee reviewed 10 BLM and joint BLM/USFS wild horse capture plans and accompanying environmental analyses and concluded that, though eight plans were proposed, because of perceived problems in range conditions, "few provided much information on range conditions and the techniques used

to determine it, or on which herbivores (horses, cattle, wildlife) caused the problem."

- Eighteen research projects were recommended, addressing many of the biological, ecological, and sociopolitical/economic gaps in knowledge identified by the Committee.

<u>1982 NAS Report</u>: Wild and Free-Roaming Horses and Burros Current Knowledge and Recommended Research Phase I Final Report

This final report was considered Phase III of the analysis initiated in 1979, which initially resulted in the 1980 Phase I report summarized above. Phase II of the report provided an evaluation of horse and burro research contracted by the BLM but is not summarized herein. This third Phase of the report contained recommendations for the management of wild horses and burros. Phase III report findings include:

- "Ecological niches to which Pleistocene equids related do not exist today, and no other animals in the contemporary North American fauna would have the same niche relationships as the modern-day equids, with or without the latter's presence."
- More "data are needed to gain a better sense of the range and typical magnitudes of the rates [of increase in wild horse and burro populations] given a range of estimates of 10 percent or less to 22 percent" (see e.g., Conley 1979, Wolfe 1980, Eberhardt 1982).
- Despite some evidence of density-dependent processes in wild equid populations, "they do not appear effective enough to self-limit populations below levels at which they significantly impact the vegetation" (compare Downer 1977, Ryden 1978 to Hall 1971, Welsh 1975).
- "'Excess' refers to that number of large herbivores exceeding the number that (a) allows a range ecosystem to exist at some condition approaching its potential productivity, or prevents it from becoming as productive as feasible; and (b) permits a plurality of resources and uses." Further, the "concept of excess" has a sociopolitical component in determining the combinations of herbivorous animals that can be grazed within the biological potential for a site.
- Proper management plans "require a strong information base," including data on the "(a) biological potential for the area; (b) numbers and combinations of herbivorous animals that can be safety carried on the area; (c) kinds and amounts of forage and habitat required by the animals; (d) effects of herbivores on vegetation and each other; (e) effects on soil and hydrology; and (f) an understanding of the economic and social values associated with the area."
- Primary production on a given area can be highly variable, necessitating the use of a conservative grazing policy "setting stock levels appropriate for average forage production, and, in the case of overused range, stocking in the range of 65 to 80 percent of average forage production" (Stoddart et al. 1975). The Committee also noted that "grazing capacities are not often determined,

and stocking decisions are more often made on the basis of a range trend" though using range trends to make management decisions can be problematic.

- "Horses are primarily grazing animals with considerable dietary overlap with cattle." Yet, there is increasing evidence that shrubs make up at least a quarter or more of horse dietary choices in some habitats (Smith et al. 1982, Hansen 1976, Krysl et al. 1982).
- A habitat preference and use study in Wyoming's Red Desert documented "horses occupying all areas used by cattle, but cattle distributed over only a small fraction of the areas used by horses" (Denniston et al. 1982). Competition for forage, if it occurs, is more likely in the spring and summer in the vicinity of watering areas (Denniston et al. 1982).
- A forage-impact study in the same areas revealed that winter stocking rates can be much higher than summer stocking rates, but that such rates can have variable impacts on plant community changes (Smith et al. 1982). The extrapolation of such findings is only applicable to areas with similar vegetation, soils, and climate. Otherwise, the correlation between stocking rates and impacts to plant communities must be established through site-specific studies. The Committee also reports, citing recent research, a mutual benefit to grazing animals and vegetation as a result of short, intensive grazing periods (Reiner 1982).
- There has been no formal research on the impacts of wild equids on hydrology, but anecdotal reports do exist (see, e.g., Koehler 1974, Fisher 1975, Stoddart et al. 1975, Woodward and Ohmart 1976, Carothers et al. 1977, Norment and Douglas 1977, Zarn et al. 1977, O'Farrell 1978, Jones 1980), so it is assumed that their effects are similar to those of livestock – that is, heavy, continuous grazing promotes soil erosion and accelerates runoff (Skovlin 1981, Blackburn et al. 1982).
- The impacts of wild equids on wild ungulates can be beneficial or harmful depending on complementarity of their food and habitat preferences, numbers, and intensity of resource use. Since horses are primarily grazers, the Committee held that "it is reasonable to expect them to have a beneficial effect on the primarily browsing and/or forb-feeding ungulates – deer, moose, pronghorn antelope, and elk – on ranges in reasonably good condition" (see e.g., Hubbard and Hansen 1976, Hansen and Clark 1977, Hansen et al. 1977) while "on severely degraded ranges, diets of different species tend to converge, and competition is possible" (see e.g., Miller 1980).
- Though far more evidence is available evaluating the impact of livestock on bighorn sheep, such evidence may indicate a susceptibility of bighorn sheep to competition with horses (Halloran and Deming 1958, Albrechtson and Reese 1970, McQuivey 1978, Jones 1980). More extensive research on interactions between burros and bighorn sheep suggest competition for water and forage (see, e.g., Sumner 1959, Russo 1956, Weaver 1959, St. John 1965, Thomas 1979, Jones 1980, Wishart 1975, Douglas 1977, Walters 1977, Hinks 1978) and that burros "have been a factor in sheep decline." Some researchers, however, haven't observed such adverse interactions (Moehlman 1974, Golden and Ohmart 1976).

- Census methodologies must continue to rely on aerial techniques, but the method used at present misses animals, with the percentage of misses dependent on terrain and vegetation. In open terrain about 93 percent of horses were counted, while in wooded, mountainous areas only 40 percent were counted. Census findings imply that there are more horses present in the western United States in 1982 than in 1971, but horses "and their forage demands, whatever the correct values, still comprise a minor fraction of the domestic livestock and/or wild ungulates." Annual censuses are not necessary, and censuses every 2 or 3 years should be sufficient.
- A significant proportion of pregnant mares – up to half in some cases – apparently abort their fetuses as a result of roundups, penning, transportation, and adoption (Boyd 1980). In addition, a small number of horse and burro foals are orphaned as a result of roundups.
- The use of chemosterilants in dominant stallions does not appear to be a promising means of fertility control due to evidence of breeding by non-dominant stallions, and because mares can move between bands (Miller 1979, 1980; Nelson 1980). The use of steroid compounds for long-term fertility control in mares may have potential but has not been sufficiently studied.
- Public opinion and biological considerations will continue to be a major force in shaping decisions on wild horse and burro management. An understanding of the nature and distribution of public attitudes, and consideration of such attitudes in developing management policies, are vital to the facilitation of management.
- Controversy will continue to plague land use planning systems due to data inadequacies.
- Sound and effect equid management programs require a firm base of scientific information.

<u>1991 NAS Report</u>: Wild Horse Populations: Field Studies in Genetics and Fertility

This report evaluated the design and results of BLM-funded research recommended by the Committee on Wild Horse and Burro Research that was established in 1985. That Committee, with input from the BLM, ultimately recommended three areas of research: wild horse population genetics, fertility control, and simulation modeling of alternative population-control strategies. Only two of these research recommendations – population genetics and fertility control – were funded, while the modeling project was not funded due to data limitations.

Key findings of the genetics research conducted in the Great Basin region include:

- The number of effective alleles for wild horses averaged 41.3 ± 2.8 (range 38.8 to 46.3) and for domestic breeds averaged 40.3 ± 4.0 (range 33.7 to 46.8).
- The average heterozygosity was 0.402 ± 0.0009 and 0.353 ± 0.011 for wild and domestic horses, respectively.

- The genetic data support the hypothesis that Great Basin horses originated from escaped or released domestic draft, saddle, and cavalry animals.
- Paternity data reveal that approximately one-third of the foals were not sired by the harem stallions. These findings did not change when data from horse herds disrupted by roundups were removed from the analysis.

Key findings of the fertility control research include:

- In captive mare fertility trials at the Lovelock Corrals, silastic rod implants containing sufficient dosages of progesterone, ethinylestradiol, and/or estradiol were successful in blocking ovulation over one or more breeding seasons in 60 to 90 percent of the mares treated depending on the combination of hormones contained in the implant.
- In wild mares from three herd management areas (Clan Alpine, Stone Cabin, Wassuks), treatment with implants containing ethinylestradiol or ethinylestradiol and progesterone versus a placebo resulted in foaling rates of 7 to 11 percent (treated mares) versus 49 percent (placebo treatment) in 1988 and 6 to 10 percent (treated mares) versus 57 percent (placebo treatment).
- The use of vasectomies to sterilize stallions may be effective in herds that occupy mountainous habitat where there may be little overlap among bands, have limited-to-no subordinate male breeding, and have limited harem-switching by mares. But its effectiveness as a long-term population control procedure is less certain in areas where wild horse bands regularly intermingle, especially considering the evidence that up to one-third of foals are not sired by the dominant harem stallion. Additional concerns were raised about the bioenergetic impacts to dominant vasectomized stallions if their mares continue to enter oestrus as a result of their failure to conceive.

Research concerns identified in the 1991 report include:

- Loss of Clan Alpine horses, including study animals, as a result of capture -related mortality, dehydration due to a fence obstructing wild horse movements, or negligence;
- Collar design resulting in moderate to severe injuries and some death among collared horses;
- Foal orphaning and death as a result of roundups and/or monitoring;
- Abortion due to the stress of capture; and
- Disappearance of research animals from the Lovelock Corrals.

<u>Review of Questions Posed to the NAS Committee:</u>

The remainder of this section of the report will address the eleven key scientific challenges and questions posed to the NAS Committee. The response to each question includes a summary of the relevant scientific findings, additional commentary as needed, and concludes with a set of recommendations. The scientific information relied on in this report is from both the primary and secondary literature, with the latter constituting information or data obtained from the BLM or other federal agency websites and/or published studies that may not have been subject to peer review. The primary literature is from published journals. Where noted, more detailed scientific analysis is available in an appendix to the report.

A. Estimates of the WH&B populations: *Given available information and methods, how accurately can WH&B populations in the West be estimated? What are the best methods to estimate WH&B herd numbers and what is the margin of error in those methods? Are there better techniques that the BLM currently uses to estimate populations numbers? For example, could genetics or remote sensing using unmanned aircraft be used to estimate WH&B population size and distribution?*

Accurately counting any species is important in developing responsible management strategies. Unfortunately, most species are difficult to accurately census, with some being far more difficult than others. For wild horses and burros, accurate, science-based population estimates are important for setting AML, maintaining herd health, protecting habitat conditions, calculating herd/population growth rates, and preserving genetic diversity. Wild horses and burros, given their relatively large size, can be counted more easily than many other species. In open (largely treeless) habitat, it is often easier to count wild horses and burros from the air compared to habitats that are forested and/or more geographically or topographically diverse. Since wild horses and burros occupy a variety of habitats, including open plains and deserts, forested areas, and/or remote and rugged terrain and will often seek out such areas to find refuge from heat, inclement weather, insects, or harassment by humans, methods are needed to accurately census wild horses and burros within a diversity of habitat types.

At present, the BLM's primary method for counting horses appears to be direct counts from the air. Though AWI is not aware of the actual methodology used, it assumes that fixed-wing aircraft with one or more observers fly set transect routes and all horses or burros seen are counted. The aircraft may divert from set transects in order to permit the observer(s) to obtain a more precise count and/or to permit the classification of the observed animals into adults and foals. It would appear, based on information contained in BLM wild horse and burro population reports, that inventory flights are conducted sporadically and not on a set schedule or even annually. Annual censuses of wild horse and burro population would be ideal but are likely cost-prohibitive and, for management purposes, the National Research Council has indicated that annual survey flights are not necessary (National Research Council 1982). Regardless of the frequency of such flights, direct counts of wild horses or burros without, at a minimum, the use of any correction factors generally results in an undercount of animals (Lubow and Ransom 2007).

Among the unknown factors relevant to the BLM's census methodology: the number of observers used to conduct aerial censuses, the experience of the observers, the type of aircraft used, the transect design, the distance between transects, the speed and altitude of the aircraft, the provisions made to avoid potential double-counting of animals, whether alternative methodologies are used depending on habitat type surveyed, and whether the methodologies used are consistent across all BLM field offices. These factors are critical in assessing the reliability of the estimates obtained via aerial surveys.

The BLM clearly recognizes that its census methodologies may not be providing accurate estimates, given its ongoing work with the USGS to develop and test new inventory techniques.[3] This collaboration is providing valuable results in regard to inventory techniques and other critical elements pertinent to the management of wild horses and burros. Census methods being evaluated through this collaboration are mark-resight (wild horses only), simultaneous double-count, sightability bias correction modeling, and distance sampling. As reported by the USGS, since each of these methods has drawbacks when applied to wild horses and burros due to the diversity of terrains they inhabit, scientists are experimenting with combinations of the methods to identify which combinations work best for wild horses and burros. This approach is supported by a number of scientists who have found that while any counting method, by itself, often has limitations, combining counting methods, can address many of the deficiencies of the individual techniques and ultimately will provide greater power and efficiency in the resulting population estimate (Manly et al. 1996, Borchers et al. 1998a, 1998b, Laake 1999).

An accurate census depends on the ability to detect the target animal. Numerous researchers have documented the difficulty in accurately counting ungulates (Williams et al. 2002). Indeed, up to one-third of ungulates are missed using standard aerial surveys (Pollock and Kendall 1987, Samuel et al. 1987, Ackerman 1988, Singer and Garton 1994, Bodie et al. 1995, Bowden and Kufeld 1995). Ransom (2012) and Lubow and Ransom (2008) identify a number of factors that can affect detection ability, including aircraft type (e.g., fixed wing or helicopter), observer experience and skill, observer fatigue, seat position on the aircraft, number and/or density of animals, animal behavior, animal distance from the aircraft, group size, percent snow cover, cloud cover, sun angle, percent vegetation cover, vegetation type, and topography (Pollock and Kendall 1987, Samuel et al. 1987, Unsworth et al. 1994, Bodie et al. 1995, Lubow and Ransom 2007, Fleming and Tracy 2008). Other potential biases include animal size, color, speed and height of aircraft, transect width, and pilot skill (Frei et al. 1979).

The impact of some of these factors on counting accuracy is obvious. For example, animals are more difficult to count in forested, rugged terrain than on the large open plains. Similarly, surveyors who have had years of experience counting, for instance, wild horses and have developed a "search image" for the animals will likely be more accurate in observing wild horses compared to a novice who has never previously

[3] See: http://www.fort.usgs.gov/WildHorsePopulations/ for information about the USGS collaboration with the BLM in regard to developing new census techniques for wild horses and burros and in the study of fertility control.

participated in a census. The impact of other factors may be more subtle, but can still affect the accuracy of counts. Furthermore, in any aerial census flight, each of these factors may come into play and, consequently, their cumulative impact on the accuracy of the count can be substantial.

In their study of the accuracy of aerial census estimates on the Dugway Proving Grounds in west-central Utah, Frei et al. (1979) used three different types of aircraft (two helicopters and one fixed-wing aircraft) and three observers; one with extensive census experiences, one with moderate experience, and one with no experience. The two helicopters were operated by the same pilot while the fixed-wing aircraft was operated by a different pilot. They found that, predictably, the least experienced surveyor observed far fewer horses when using the fixed-wing aircraft than the most experienced observer. Comparing the maximum (185) and minimum (71) counts across aircraft types, the most experienced observer (in the Bell Jet-Ranger helicopter) saw 160 percent more horses than the least experienced observer (in the fixed-wing Citabria aircraft). Counts by the most experienced and moderately experienced surveyors, depending on aircraft and mountain range, were more consistent, except when using the Bell Jet-Ranger helicopter when the counts by surveyors with different experience levels were less consistent. In the overflight of the Cedar Mountains, the moderately experienced surveyor sighted slightly more horses than his/her more experienced colleague, which was attributed to excellent versus poor light during their respective flights. The most experienced surveyor also spotted fewer horses during the survey of the Granite Mountain study sites compared to his/her moderately experienced colleague, which was attributed to the greater scatter of animals during his/her flight, which occurred on the same day but after previous study helicopter and fixed-wing aircraft flights.

Statistically, Frei et al. (1979) found that observer experience was the most significant factor influencing their count results. However, regardless of experience level, counts were more consistent among the three observers when using the Bell 47 helicopter, which offers greater visibility and flies at a slower speed than the other aircraft used in the study. Though Frei et al. didn’t try to control for all potential variables in their study, it is clear that observer experience, aircraft type, light conditions, previous disturbance of the subject animals, and speed of aircraft all, to varying degrees, affected the accuracy of their counts.

In a similar, but more recent study, Ransom (2012) compared census results from two different types of aircraft (helicopters and fixed-wing) using dual but independent observers to identify potential sources of bias. Observer skill, population location, and aircraft type were the key components of a model which also analyzed the effects of group size, sun angle, vegetation type, topography, cloud cover, percent snow cover, and observer fatigue on the ability to detect wild horse groups in 15 areas encompassing multiple HMAs in Wyoming, Nevada, Utah, and Colorado. The results of Ransom’s experiment demonstrate the difficulties associated with accurately counting animals, including large animals like horses, from the air.

Those factors that were determined to most influence census counts were horse group size, sun effect, and observer experience were the most important influences on wild horse detection probabilities. In fixed-wing aircraft flights under the best conditions, the most skilled and least skilled observers exhibited nearly 23 percent difference in detecting 3-horse groups. In helicopter surveys this differences range from a mere 1 percent under the best sighting conditions to 20 percent under the worst conditions. Other factors that also contributed to detection bias in helicopter surveys included vegetation type, topography and observer fatigue with a 31.7 percent different in detection of 3-horse groups in best versus worst conditions. In fixed wing aircraft, group size, sun effect, and observer experience contributed to an estimated 15.06 percent detection difference for 3-horse groups in the best compared to the worst sighting conditions. These findings make clear that, given the diversity of observation conditions encountered in the field, standard direct or raw aerial counts of wild horses and burros can lead to inaccurate and, particularly in forested or rugged terrain, negatively biased abundance estimates.

While there is ample evidence that inaccurate estimates can result from any number of variables (some of which are not under human control), the actual method or methods used have to be more reliable or more able to compensate for such variables compared to the standard direct or raw counts typically used by the BLM.

The collaboration between the USGS and BLM is resulting in a comparison of multiple techniques. Information obtained from the USGS website[4] about these efforts is summarized here, as is evidence from the published literature.

<u>Mark-resight techniques</u> work best on closed populations (i.e., animals that do not move into or out of the area being censused during the survey period), when natural or artificial marks are clearly visible to observers and are unlikely to be missed, when the marked animals are representative of the population, and when the mark does not enhance or reduce the sightability of the animal. Since radio collars have not proven to be effective for use on wild horses, natural markings (i.e., body color, face or leg markings), and/or band makeup can be used to identify specific wild horses. Once a statistically valid "marked" population is available, data comparing the number of marked animals observed or missed during a survey can then be used to develop estimates of population size. Because of the need for individual animals to be uniquely marked, this method cannot be used on burros. It may work with wild horses, particularly in herds with a high proportion of uniquely marked, colored, or patterned individuals, but may not be reliable in large, widely dispersed herds containing horses that may be difficult to reliably distinguish.

Lubow and Ransom (2008) examined the use of photographic mark-recapture techniques to determine the population size of wild horses. Wild horses are ideal for this type of sampling since they often have distinctive natural markings (i.e., pelage colors, face and leg patterns (Gower 2000, Green 2001)) that can be used to identify individuals. The

[4] See: http://www.fort.usgs.gov/WildHorsePopulations/

study was conducted on wild horse populations within the Little Book Cliffs Wild Horse Range (CO), McCollough Peaks Herd Management Area (WY), and Pryor Mountain Wild Horse Range (MT/WY) where population sizes were known. Despite rugged terrain and dense vegetation which influenced sighting probabilities, Lubow and Ransom were able to accurately estimate the size of these populations using the photographic mark-recapture technique. More specifically, their best population estimates for all three populations were within -6.7 percent, +2.6 percent, and -8.6 percent of the known population sizes for all three herds. Furthermore, the cost of the method tested was comparable to the cost of raw counts, which is the standard technique commonly applied to estimate wild horse populations in the west.

They used helicopters to conduct the aerial surveys due to the ruggedness of some of the terrain and to facilitate the acquisition of photographs of the wild horse groups. Other variables noted during the flights included group movement status, time of day, direction of sun, topography type, vegetation type, group size, and vegetation cover. Within the McCullough Peaks HMA, small groups of horses were easily observed due to excellent visibility and a lack of trees. In sites with cover, however, sighting probabilities for small groups was far less than 50 percent. As group size increased, however, so did sighting probability, with greater than 90 percent sightability of all groups of 27 horses or more. The ability to observe horses in subsequent flights increased in one case, but, decreased from 40.4 percent to 29.2 percent between flights on the Pryor Mountains. Uncorrected raw counts of horses were consistently less than known population sizes (by -7.5 to -32.0 percent), though the error was smallest at McCullough Peaks due to the excellent visibility. Based on the 90 percent prediction interval of raw counts, approximately 5 percent of raw counts resulted in undercounts of greater than 35 percent, with the majority of raw counts resulting in undercounts of some magnitude. This amount of error is consistent with the 39 percent undercount of wild horses on Assateague Island via aerial survey methods compared to ground counts (Bashore et al. 1990). Indeed, variability in sighting probability has been documented by other researchers (Bayliss and Yeomans 1989, Graham and Bell 1989, Walter and Hone 2003, Lubow and Ransom 2007).

Lubow and Ranson (2008) found that heterogeneity among groups of horses (i.e., the variability in observing groups of horses) was one of the more important factors affecting sighting probability, particularly when dealing with difficult sighting conditions. Indeed, even after six independent sighting opportunities, 16–20 percent of known groups of horses were not observed on any occasion, yet correction factors compensated for this deficiency. The relevant correction factors took into account terrain, vegetation types, horse group size, and the behavioral response of the horses. Consequently, with this number of variables, no single or constant correction factor or single-sightability model calibration could be used on all wild horse populations/herds. This raises concerns about the suitability of using simple sightability bias correction models (Samuel et al. 1987) to calculate unbiased population estimates.

To address the variability in correction factors, Lubow and Ransom (2008) recommend that future aerial surveys cover the entire range of all herds that may intermingle or exchange animals, even if this requires multiple planes or repeated days of flights to survey the entire area. This would facilitate inclusion of the implicit heterogeneity in every population for the purpose of calculating and employing the most accurate correction factors. Conversely, if a herd is determined through such surveys to not be particularly heterogeneous, then the use of such correction factors may be unnecessary or could be simplified.

Simultaneous double-count is a form of the mark-resight technique whereby two observers independently observe and record information about wild horse or burro herds seen from the air. Animals or groups of animals seen by one observer are considered "marked" and, if seen by the second observer, "resighted." The resulting data can be compared and sighting probabilities computed for both observers which then can be used to generate population estimates. This technique does not require the capture or handling of any animals and, if conducted properly, has provided promising results.

However, Lubow and Ransom (2008) cautioned that when only mark and recapture data are considered, this makes it impossible to correct for any biases due to unmodeled heterogeneity. Their study, employing the use of photo-identification in combination with the mark-resight methodology, allowed for an adjustment for potential sightability bias among wild horse groups where some groups are more or less likely to be observed.

The sightability bias correction model involves, as its name suggests, the development of a model to predict the sighting probability for groups of horses or burros. Surveys are conducted to determine the covariates that affect the probability of observing groups of animals. These covariates may include group size, percent tree cover, observer experience, survey intensity, survey timing, ambient temperature, or other variables. A model is then constructed that integrates these covariables with calculated correction factors to compensate for these sightability factors in order to generate population estimates. According to the USGS, this method is most useful when sighting rates for all groups are more than 60 percent and when populations within each count unit remain constant during the survey. Furthermore, the development of such models requires considerable time, cost, and effort so that the model will provide consistent and valid results over space, time, and with changing observers. The ability of the model to account for multiple sightability factors is, however, one of the advantages of using this technique though, as noted by Lubow and Ransom (2008), no single correction factor will be applicable to all population/herds given the multitude of variables influencing the detection probabilities of horses.

Lubow and Ransom (2007) examined the accuracy of using an aerial survey technique combining simultaneous double-count and sightability bias correction methodologies on wild horse populations in the Adobe Town and Salt Wells Creek HMAs in Wyoming. These two HMAs share a common, unobstructed border. The combination of these techniques improves the accuracy of the count by using the sighting covariates to model difference in sighting probability to correct for the visibility bias in the double-count method, which results in underestimates of true population size.

After five surveys conducted over four years, Lubow and Ransom (2007) found that the combined methodologies resulted in estimates consistent with the known number of horses based on modeled population projections, the number of horses removed between surveys, and an annual estimated population growth rate of 16.2 percent per year which fits within other observed annual growth rates measured in other herds (Eberhardt et al. 1982, Garrott and Taylor 1990, Garrott et al. 1991). For the entire set of surveys, average sighting rates ranged between 70.2 and 84.2 percent. The variables that they found to be most important in accurately counting horses including the skill of the individual observers, size of the horse group, and vegetation cover. For example, for a single horse the estimated sighting probability varied from as low as 13.2 percent to as high as 65.5 percent depending on the observers and sighting conditions. As group size increased, sighting probabilities predictably also increased. Yet, when looking toward the sun on a clear day, the presence of vegetation and rugged terrain all reduces sighting probabilities compared to opposite conditions.

<u>Distance sampling</u> uses the perpendicular distance from a transect line to the target animals to estimate population density from which total population estimates can be calculated. This method is based on the theory that the distance to animals in low-density populations will be higher, on average, than in high-density populations. Three assumptions underlie the technique: all animals new or on the transect line must be seen; distances are accurately measured; and animals are accurately located before they move in response to observer approach. This latter assumption is often the biggest challenge in using this technique. Advantages of the technique include the fact that only a single overflight is needed, double-counting of animals is not a concern, the technique is robust to variation in the visibility of animals between surveys, and the methodologies and associated statistical analyses have been extensively developed.

The value in combining methodologies is that the deficiencies or weaknesses in one technique can be overcome by the strengths of a separate technique. The USGS has tested combinations of these methodologies on wild horse populations of known sizes to assess their accuracy. For smaller populations or for horses occupying habitats consisting of considerable tree cover and rugged terrain, which affects the sightability of individual animals, encouraging results have been obtained by combining the mark-resight sampling technique with the sightability bias correction model. For larger HMAs more representative of typical wild horse HMAs, where population estimates are not known, the simultaneous double-count method and sightability bias correction model were used both before and after removal of horses to develop what the USGS deemed "a more statistically sound population estimate for each HMA," as well as to provide other information relevant to variables affecting modeling efforts.

Though their results were excellent, Lubow and Ransom (2008) cautioned about using the photographic mark-recapture technique on all wild horses populations, particularly larger populations, due to the difficulty of accurately matching groups in photographs to groups during multiple aerial surveys. Though many horses have unique distinguishing characteristics, some wild horse herds contain phenotypically similar animals, making individual identification difficult. This is of particular concern in dense herds or in herds with some atypical structure that could facilitate merging and splitting of groups, thereby complicating group identification efforts. This methodology, therefore, may be most appropriate for smaller herds and where sighting conditions may be more challenging.

Other techniques that may be worth investigating include the use of infrared technologies and non-invasive genetic sampling. According to the USGS, it has integrated the use of forward-looking infrared (FLIR) technologies into its ongoing studies on wild horse and burro inventory methodologies. FLIR has been used to survey a variety of wildlife species occupying diverse habitat types. The technique uses infrared technologies to detect the heat signatures of animals observed from the air. It may be of particular value in surveying animals in more rugged or forested habitats, though trials of FLIR, as attempted and reported by the USGS, have provided less satisfactory population estimates compared to the simultaneous double-count method. Nevertheless, additional experimentation with this technology may provide valuable insights into its suitability as a tool to census wild horses and burros.

The use of unmanned aircraft may also warrant study. This technology – generally associated with various military applications – is increasingly being used to for wildlife management science. While the cost of such unmanned drones is not known, presumably a handful of drones equipped with cameras and operated by experts could be used to quickly survey public land areas. The resulting photographs could then be analyzed to identify unique or specific wild horse and burro groups, identify habitat use patterns, conduct direct counts, or use with other statistical/mathematical techniques to develop population estimates.

Another technique that has been widely used to sample wildlife populations is non-invasive collection of fecal samples. Given significant advances in DNA and scat analysis technologies, a great deal of information can be obtained from fecal samples, including sex, dietary preferences, pedigree, genetic diversity, and even measures of stress. Since every individual has a unique genetic profile, DNA extracted from a fecal sample can, like the fingerprint of a human, be used to identify specific individuals. Once a proportion of animals within a herd or population are genetically identified or "marked," then standard mark-resight techniques can be used to estimate population numbers. Though the collection of fecal samples requires "boots on the ground," often in remote areas, it is an ideal citizen-science project whereby citizens can be recruited and provided basic training to identify, collect, and properly label and store fecal samples for subsequent analysis. While aerial survey techniques allow coverage of a larger geographic area, fecal sampling provides a suite of data that can't be obtained via aerial inventories.

Beyond accurately counting horses, obtaining accurate ages of wild horses is important for determining with greater precision age-specific foaling, survival, or mortality rates. In his analysis of 60,116 records of horses removed by the BLM from public lands in Nevada, Oregon, and Wyoming between 1975 and 1987, Garrott (1991) revealed an underestimation of 5-year-olds, over representation of 6- to 7-year-old horses, under representation of yearlings from Oregon, and higher than expected numbers of 15- to 20-

year-old horses. As explained by Garrott, in Oregon those responsible for aging captured horses were systematically misclassifying yearlings into adjacent age classes based on the eruption pattern of their third deciduous incisors. The standard used, however, was inaccurate and resulted in yearlings, captured in late autumn or winter, being classified as 2-year-olds. Similarly, the under or over representation of 5- to 7-year-old horses in the data set was a product of misclassification based on the natural variability in tooth wear among animals of these ages; incisor wear on some 5-year-olds may suggest that they are older while, for slightly older horses, incisor wear can appear to be less, suggesting that they are younger than their actual age. For the oldest horses, including those classified as up to 30 years of age, the age distribution from horses captured in Nevada and Oregon demonstrates that "aging older animals is quite speculative" (Garrott 1991). Garrott recommended that, for horses beyond the age of 4 years, animals should be grouped into age classes (e.g., 5–9, 10–14, 15–19) and suggested that future research could include comparing age estimates based on tooth eruption/wear with known age animals and ages determined using tooth cementum analysis.

Conclusion: The management of wild horses and burros would substantially benefit from improved accuracy in estimating population sizes and trends. This should be a priority for the BLM and its collaborators, given the importance of accurate population estimates to all aspects of wild horse and burro management.

Recommendations:

1. The collaboration between the BLM and USGS has provided valuable results and should be continued and expanded to incorporate new partners and the testing of alternative inventory methodologies (e.g., FLIR, unmanned aircraft, DNA analysis of fecal samples) and combinations of such methods to identify those techniques that provide the most accurate population estimates.

2. In its planning documents, including RMPs, HMAPs, roundup plans, and associated NEPA documents, the BLM should explain the specific methodologies used to estimate wild horse and burro population sizes, disclose the diversity of population estimates if multiple census methodologies have been used, and explain its rationale for selecting a particular population estimate if multiple estimates for the same region, area, HMA, or HMA complex are available.

3. The BLM should engage in outreach and education efforts to provide interest/user groups and concerned individuals with additional information about its current methodology used to census wild horses and burros, efforts being made to identify new and improved techniques, and to explain the strengths and weaknesses of all techniques. The BLM should host training sessions for interest/user groups and concerned individuals to enhance understanding of various inventory methodologies used by the BLM for the management of wild horses and burros.

B. Population Modeling: *Evaluate the strengths and limitations of the WinEquus population model for predicting impacts on wild horse populations given various stochastic factors and management alternatives. What types of decisions are most appropriately supported using the WinEquus model? Is there a better model (i.e., the HSUS model) the BLM should consider for future uses?*

The output from models is only as good as the scope of the model parameters and the data used to populate the model. The WinEquus model (Jenkins 1996) is intended to be predictive; allowing the BLM to predict how its management action may impact the size of a wild horse population over time.

The WinEquus model is a relatively simple model that uses basic biological data on wild horses (e.g., population size, survival probabilities, foaling rates, age at first reproduction, sex ratio) to predict the impact of management actions on herd survival and growth rates. Ideally, the data would include accurate HMA-specific population estimates, age and sex specific survival probabilities, age specific foaling rates, and sex ratio at birth. Unfortunately, these data are not always available, necessitating the use of less-than-ideal data to run the model. The model provides users flexibility to adjust parameters to observe how such alterations may impact herd survival and growth. Such adjustments, including for survival probabilities and foaling rates, can ostensibly be used to simulate demographic and/or environmental stochasticity, though a randomization function in the model also varies such parameters (from the user specified input) to simulate such stochastic events. The model results, as depicted in BLM planning documents, provide a low, median, and high estimate of the wild horse population size after ten years in response to proposed management actions.

Given its intended use, the design of the WinEquus model appears to be adequate. The model is deficient, however, in its application. The deficiency results from the inadequacy of the data used to populate the model, including a lack of age and sex specific survival probabilities, age-specific foaling rates, accurate population estimates, the frequent lack of HMA or site-specific data, little consideration of density-dependent impacts on population demographics, and a lack of clarity on the randomization function to accurately model stochastic events. Though, in general, the survival rates of wild horse adults and foals are high, there is evidence of lower rates in particular herds or as a result of stochastic or catastrophic events (i.e., severe snow storms, prolonged cold, extreme drought conditions). Such events can substantially impact survival rates, yet it is unclear if the WinEquus model incorporates this level of variability in its randomization function.

As used by the BLM in its planning documents, the WinEquus model nearly always is run using wild horse population characteristics from the Garfield Flat HMA in Nevada. While this is entirely appropriate for the Garfield Flat HMA and even for other HMAs that may be similar in terms of topography, geography, climatic patterns, vegetation, and wild horse characteristics, for those HMAs where such characteristics are different, the use of the Garfield Flat HMA population data is inappropriate and will likely provide results that are inaccurate. For predictive purposes, if the BLM desires to model the potential impacts of a management action on an HMA for which no population data is available, using population data from a similar HMA may offer some insight, though it should be made clear that such data should be interpreted with caution and/or that it may not provide an accurate prediction of the impacts of the management action.

Considering that the BLM has been rounding up horses for over forty years and, therefore, likely has data on population characteristics for nearly every HMA, it is unclear why that HMA-specific data is not used when running the WinEquus model to predict the impact of management actions. Though some of the population parameters (i.e., adult survival) may be similar across a diversity of HMAs, there is evidence that there can be substantial differences between HMAs in other respects – potentially resulting in considerable variability in modeling results.

The WinEquus model is also not sufficiently complex to consider other variables that may be of relevance in assessing the impact of management actions on other ecosystem resources, or to aid in making management decisions. For example, the WinEquus model does not take into consideration wild horse genetic health and diversity issues. Its assessment of immunocontraceptive impacts to any population cannot capture all of the inherent complexity, including the effects of immunocontraceptive vaccines beyond year three, decreased mortality rates in treated horses, and increased longevity. Furthermore, it is not sufficient for modeling the cost of proposed management action which, in these days of budget austerity, should be of critical concern to any BLM official.

Other models have been developed to try to address these deficiencies. Gross (2000) developed a model that is designed to evaluate wild horse genetics and management scenarios, while Hobbs et al. (2000) developed what's referred to as The Hobbs Model for evaluating contraceptive treatment options though, like the WinEquus model, it lacks sufficient detail to capture all of the direct, indirect, and cumulative impacts of the use of immunocontraceptives in wild horses.

The Humane Society of the United States (HSUS) attempted to address the economic deficiencies in the WinEquus model by developing a model that supplements or "stands on the shoulders" of the WinEquus model. (De Seve and Boyles-Griffin 2012). The HSUS model uses many of the same parameters as found in the WinEquus model (e.g., age and sex distributions, adult and foal survival rates, roundup and contraception efficacies) but adds economic or cost parameters in order to predict not only the impact of a management action on herd or population demographics but to also predict the costs inherent in taking action. By manipulating parameters in the model (e.g., frequency of contraceptive treatments, frequency of roundups) the variable costs of a management strategy can be assessed. In their assessment of the costs of a traditional roundup and removal strategy compared to a roundup, contracept, and release alternative, De Seve and Boyles-Griffin demonstrated that the BLM could save $204 million dollars over a 12-year period. The HSUS model, however, does not account for genetic health/variability and may not adequately capture the full range of impacts of immunocontraception, including reduced mortality and increased longevity of treated animals.

Each of the existing models is intended to assess a particular set of variables, each has its strengths and weaknesses, and each is subject to the quality of the data used to populate and run the model. Ideally, these models could be combined to create a single model that considers the full suite of relevant issues, including population demographics, roundup efficiency, contraceptive efficacy and impacts to individual and herd demographics, genetic health and variability, and economic costs. Such a model could predict how a proposed roundup will impact population size and growth rates for the next decade, assess the value and impact of contraceptive treatments, and provide a cost prediction for each alternative assessed. Nevertheless, it still would not predict how such changes may impact vegetation production on the range. In addition, the model would not be applicable for use in assessing the impact of management action on wild burro populations.

To predict impacts on rangeland conditions, there are other models or types of models that the BLM should consider. These models, like the SAVANNA landscape model, provide a more holistic ecosystem-wide view capable of predicting how a wide range of variables – including climatic patterns, vegetation production, and multi-species herbivory – will interact across a broader landscape in response to the impacts of different management actions. In this case, the predictions would extend beyond merely defining how management will impact population size, but would incorporate other limiting factors, changing environmental conditions, and how such conditions influence ecological health and rangeland condition. This would allow the BLM to model potential impacts to the wild horse population, other animals (domestic and wild), and to the habitat itself, which could prove valuable to its longer-range planning and decision-making processes and rangeland condition assessments.

Considering the shift away from species-specific management regimes to ecosystem-based management, the use of more complex models would provide benefits to the BLM, user/interest groups, and concerned citizens engaged in wild horse management efforts. To shift to such ecosystem-based models, however, the BLM would be compelled to use and disclose more of the range condition, status and management data that it may already collect, or else establish mechanisms to collect such data for use in the model. This would impose additional requirements on field office personnel, BLM scientists, and others. It may cost more but would improve the value of any modeling effort by making the results more mimetic of real world conditions and processes. Of course, combining the parameters of ecosystem-based models with the population demographic, contraceptive efficacy, gather efficiency, genetic health, and economic costs of the other models may not be technologically feasible, but endeavoring to model such a full complement of issues (whether in a single model or in multiple models) may improve management decisions and benefit all species and users of the rangelands.

<u>Conclusion</u>: Concerns with the WinEquus model are less a function of model design and more a product of the quality and specificity of the data used to populate and run the model. Though the model does not adequately address potential density dependent impacts to wild horse populations, there may not be sufficient data available to incorporate this element fully into the model. Furthermore, though the model permits the

adjustment of select variables to simulate demographic or environmental stochasticity and includes a randomization function to model such stochastic events, it is not clear if the model fully captures the potential severity of such events on wild horse herd demographics. The WinEquus model also doesn't consider other factors of relevance to wild horse management, including genetic health and economic costs. Also, it doesn't fully capture the potential impacts of immunocontraception on a population. Other models – with their own strengths and weaknesses – have been developed to fill those gaps. The BLM, however, is not using such alternative models in concert with the WinEquus model to more accurately predict the full range of potential impacts of its management alternatives on wild horse herds. Instead, the BLM continues to rely only on the WinEquus model. Other more holistic models could be utilized to obtain greater predictive knowledge on how management actions may affect the broader ecosystem, but such models involve far more parameters and, therefore, more data is necessary to run said models – data that the BLM may neither possess nor attempt to collect.

Recommendations:

1. The BLM should immediately initiate use of the WinEquus, Gross genetic models, Hobbs Model, and HSUS economic model in concert when evaluating the impact of wild horse management actions. In particular, the BLM should employ the HSUS economic model to examine the long-term economic impacts of its management options in order to ensure that economic considerations are considered in the management decision-making process. This is of particular importance, given federal budget limitations and increasing concerns about the costs of the BLM wild horse and burro management program. Just as the BLM includes an appendix providing the results of the WinEquus model in its roundup planning documents, it can similarly provide the results of the other models.

2. The BLM should consult with those responsible for the various models to determine if or how the different model parameters could be integrated into a single model to permit consideration of all such variables in a single assessment, in order to better predict the full range of impacts associated with management actions and improve decision-making.

3. The BLM should examine the potential for employing more holistic, ecosystem-based models that would allow it to better predict a fuller range of impacts to and from wild horses from a wider range of variables, including climate, vegetation production, and herbivory impacts of other animals (wild and domestic). Though such models require far more scientific data to run, the results would enable the BLM to better predict how a variety of variables may respond to changing environmental conditions and management actions. This, in turn, will aid in predicting how these changing conditions impact wild horses and other animals and how population sizes of wild horses and other animals are likely to impact habitat characteristics.

4. The BLM should consult with population modelers, equid biologists, and persons with expertise in burro population demographics and behavior to develop a burro

population model. At present, no model is available to predict the impact of management actions on burros.

C. Genetic diversity in WH&B herds: *What does information available on WH&B herds' genetic diversity indicate about long-term herd health, from a biological and genetic perspective? Is there an optimal level of genetic diversity within a herd to manage for? What management actions can be undertaken to achieve an optimal level of genetic diversity if it is too low?*

In recent decades the use of genetics to study wildlife populations has become increasingly commonplace. Advances in genetic sciences have been substantial and ongoing, providing scientists with tools to study wildlife populations, including through the use of non-invasive techniques, which did not previously exist. Indeed, so much genetic information can now be ascertained from a urine or fecal sample or from a strand of hair that many studies that used to require the capture and handling of wildlife can be done non-intrusively and non-invasively, eliminating most welfare issues and risk of injury or death.

AWI has often expressed concerns about the impact of BLM's management actions on the genetic health of wild horse and burro populations. Exceedingly low AMLs – well below any size that may be able to sustain the genetic health of a herd – are cited as evidence of the BLM's efforts to, in effect, manage wild horses and burros into extinction by promoting inbreeding and its deleterious impacts to herd production and survival. The BLM has largely ignored such concerns, apparently confident that its management actions are not threatening the genetic health of wild horse and burro herds, that it is adequately monitoring changes to the genetic diversity of wild herds, and that, if necessary, it can address any genetic concerns through manipulation of the existing population or via the introduction of one or more non-related individuals.

The BLM is required by law to manage for self-sustaining herds of wild horses and burros. It is also required to routinely inventory and monitor the herds and their habitat to ensure that its management is consistent with legal standards. This implies that the BLM must monitor the genetic diversity and health of its herds. This is done though establishing a genetic baseline for each HMA by collecting blood or hair samples during a roundup and submitting those samples for DNA analysis. Once a genetic baseline is established, the BLM is required to reassess the genetic health of the herd every 6–10 years.

In its roundup plans, the BLM routinely references its intent to collect blood or, more often, hair samples from captured horses and burros for DNA analysis. Presumably, this is accomplished if the roundup is conducted. In some roundup planning documents, the BLM concedes that it has obtained genetic samples from the herd in question before, but it often does not reveal the results of the analyses. The BLM has, for years, contracted with Dr. Gus Cothran of Texas A&M University to conduct the DNA analysis of samples obtained from wild horses and burros. Consequently, for those herds in HMAs that have been subject to capture and from which hair or blood samples have been attained, information about the herd's genetic diversity and health is available and, in some cases, multiple DNA datasets from the same herd may be available. Yet, the data is not reliably included in roundup planning documents nor is it readily accessible – as it should be – via the BLM website. Even when the BLM includes information about the genetic health of a herd in a roundup planning document, it is generally simply a statement asserting that DNA analyses of previously obtained samples indicate that the herd is genetically diverse and healthy or that it has a sufficient level of genetic heterozygosity. No further information, including any reference to the actual data, the results of the analysis, the number of samples on which the conclusion is based, is provided in the document.

Consequently, though it is generally reported that the majority of wild horse and burro herds are genetically healthy, without further disclosure of the information upon which such assertions are made and evidence regarding the genetic health and diversity of each herd within each HMA for which such data is available, it is impossible to assess or draw any conclusion about the long-term genetic health of these herds. Nevertheless, based solely on the high AMLs established for the 179 HMAs, the fact that the majority of HMAs (126 of 179 or 70.4 percent) are managed for less than 149 animals, and that the high AML for such herds has been set at such low numbers for decades, it is likely that many of these herds are undergoing some level of genetic loss as a result of the long-term impacts of inbreeding and genetic drift.

Preserving genetic diversity within a herd depends on protecting a sufficient number of breeding individuals – referred to as the effective population size (Ne) -- in order to limit, minimize, or prevent inbreeding (Hartl and Clark 1997). Effective population size is, however, notoriously difficult to estimate in real populations because it is affected by various population attributes such as sex ratio, age-specific breeding success, population size fluctuations (Harris and Allendorf 1989, Shull and Tipton 1987), and breeding patterns and behaviors (e.g., random versus non-random). Such is the case with wild horses due to their polygynous breeding behavior, and even the BLM concedes that there is no single, uniformly acceptable method for calculating the effective population size in wild horses (Coates-Markle 2000).

An effective population size of 50 breeding animals is considered by the BLM to be the minimum necessary to maintain an acceptable level of genetic diversity within reproducing wild horse and burro populations.[5] This number was developed in the study of domestic animals but has been applied to wild animals as well, with the presumption that populations with effective population sizes larger than 50 will avoid the deleterious effects of inbreeding (Franklin 1980, Soulé 1980). As reported by Meffe and Carroll (1995), populations with a genetically effective population size of 50 to 500 were considered secure, suggesting that the BLM's use of an effective population size of 50 should be considered, at best, a minimum to preserve genetic health and diversity in wild horses and burros. In bison, for example, Gross et al. (2006) report that populations containing fewer than 500 breeding individuals are believed to be especially vulnerable to harmful consequences of inbreeding depression and other impacts that can be directly traced to the genetic composition of the populations (Frankham 1995, Keller and Waller 2002). Yet, as reported by Wright (1977) and Frankham et al. (2002), the deleterious effects of inbreeding are anticipated to be directly proportional to the increase in

[5] Handbook at 22, citing Cothran (2009).

inbreeding, and are not present or absent relative to the threshold of an effective size of 50 (Ballou et al. 2008).

In 1991, Cothran suggested that to achieve an Ne of 50 individuals, a herd would have to easily exceed 100 animals (Cothran 1991). This assumes that the dominant stallion sires all or nearly all of the offspring from his harem group. Based on evidence that one-third of the offspring of a harem group are not sired by the dominant stallion (Bowling and Touchberry 1990), Ne will be higher since the ratio of reproducing females to males is reduced. Because of the overlapping generations in horses, unequal sex ratios, variance in reproductive success given the standard polygynous breeding structure, calculating Ne in horses is difficult. Only through genetic analysis (using either blood or hair samples) can it be confirmed how many herd members are contributing to the reproducing population.

Cothran (1991) also suggested that wild horse formation of harem groups is conducive to maintaining high levels of genetic variation. At that time, he reported, based on data "from most breeds and some feral herds," "horses naturally have high levels of genetic variation, both in terms of the number of identified allelic variants and individual heterozygosity." Yet, while some wild horse herds "have levels of genetic variation within the range expected for genetically healthy horse populations," "other herds are depauperate in genetic variation and may face imminent inbreeding problems."

Nine years later, Cothran (2000) conceded that "the majority of wild equid populations managed by the BLM are kept at population sizes that are small enough for the loss of genetic variation to be a real concern" Consequently, he concluded that "it is critical that genetic considerations be included in management plans for wild equid populations." Similarly, Singer and Zeigenfuss (2000) state that "genetic conservation will become a serious consideration over future decades in wild horse management since so many of the herds (referring to BLM herds) are not isolated and small." Yet they also conclude that "there is little imminent risk of inbreeding since most wild horse herds sampled have large amounts of genetic heterozygosity, genetic resources are lost slowly over periods of many generations, and wild horses are long-lived with long generation interval."

For species in which reproductively active male and female animals have equal opportunities to breed, the ratio between the effective population size and total population size can be low. For wild horses, as explained previously, the ratio is higher since a smaller proportion of animals capable of breeding (particularly males) actually engage in breeding in any year. Though the BLM concedes that it is difficult to accurately calculate an effective population size in wild horses (Coates-Markle 2000), the BLM generally assumes the effective population size to be 30–35 percent of the total estimated herd size. This is consistent with the findings of Singer and Zeigenfuss (2000), who found that the Ne of the Pryor Mountain wild horse herd was 27 percent of the census population until 1994 and 36 percent after 1994. The difference, they explained, was due to natural factors and artificial manipulations that resulted in more male horses on the range, which led to smaller average harem sizes. Berg (1986), however, concluded that, on average, the effective size of wild horse populations is 43 percent of the total population size.

Ultimately, it is not known if the 30–35 percent figure is sufficient to preserve an effective breeding population of 50 in wild horses. We do know that the effective breeding population percentage is herd specific. Herds that are skewed toward males (whether as a result of management action or natural factors) may have a lower effective population size compared to those with a more equal sex-ratio. Alternatively, when a herd is skewed toward males, it is anticipated that this will result in a larger number of smaller-sized harems which could, in turn, increase the effective population size because a larger proportion of male horses may be breeding. If the smaller-sized harems increase the ability of the dominant stallion to prevent sneak copulations by subordinate males or bachelor group stallions, whatever genetic benefit was obtained from the larger proportion of males in the herd may be lost.

By using the 30–35 percent conversion rate, the BLM recommends that wild horse herds should contain a minimum of 150–200 animals.[6] Yet, according to HMA-specific data from February 2012, the majority of BLM wild horse and burro herds are managed for a high AML below 150 animals. See Table 1. It must be emphasized that these statistics are based on high AML and that, consequently, when the BLM reduces a herd through roundup and removal to low AML, the genetic implications of doing so are larger and potentially more adverse than if the herd was consistently managed at high AML.

Table 1: Wild Horse and Burro High AML Numbers for all 179 HMAs (FY 2012):

Species	0-49 AML	50-99 AML	100-149 AML	150-200[7] AML	201-300 AML	≥300 AML
Horse only	34	37	20	15	19	19
Burro only	7	4	6	2	1	1
Mixed Horse	3	1	1	3	1	1
Mixed Burro	7	1	1	0	1	0
Zero	4					

Indeed, as revealed in Table 1, 24 percent (34 of 144) of all wild horse HMAs are managed for a high AML of 0–49 animals, 26 percent (37 of 144) for 50–99 animals, 14 percent (20 of 144) for 100–149 animals, 10 percent (15 of 144) for 150–200 animals, and 26 percent (38 of 144) for over 200 animals.

For HMAs only managed for wild burros, 33 percent (7 of 21) of all wild horse HMAs are managed for a high AML of 0–49 animals, 19 percent (4 of 21) for 50–99 animals,

[6] Handbook at 22.
[7] The range 150-200 is used in this table to correspond to the recommended herd size contained in BLM policies. The 2012 data used to compile this chart can be accessed at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

28.5 percent (6 of 21) for 100–149 animals, 9.5 percent (2 of 21) for 150–200 animals, and 9.5 percent (2 of 21) for over 200 animals.

In those ten HMAs[8] where wild horses and burros are both managed, 10 are managed for a high AML of 0–49 (3 horse, 7 burro), 2 are managed for a high AML of 50–99 (1 horse, 1 burro), 2 are managed for a high AML of 100–149 (1 horse, 1 burro), 3 are managed for a high AML of 150–200 (all horse), and 3 are managed for a high AML ≥201 (2 horse, 1 burro).

In total, 28 percent (50 of 179) are managed for a high AML of 0–49, 23 percent (42 of 179) are managed for a high AML of 50–99, 15 percent (27 of 179) are managed for a high AML of 100–149, 11 percent (20 of 179) are managed for a high AML of 150–200, 12 percent (21 of 179) are managed for a high AML of 201–300, and 12 percent (21 of 179) are managed for a high AML of ≥301 animals.

These data do not reflect those instances where there are two or more HMAs that form a complex within which the wild horses can intermix. In these so-called metapopulations, the total herd size is larger than what is depicted by examining HMA-specific data. The BLM, however, does not present the data at a metapopulation level and there is no mechanism, without accessing statewide HMA maps, through which HMAs may be isolated versus those that may be part of complex. Furthermore, even if HMAs share a common border, this does not necessarily mean that the animals occupying those HMAs intermix, due to potential topographical, physical (e.g., fences), habitat-related, or behavioral barriers or, if they do intermix, that they do so during the breeding season. Consequently, without HMA-specific data on wild horse or burro distribution and movement patterns, the mere existence of HMA complexes does not necessarily mean that the various herds of equids are intermixing. Indeed, as reported in the literature, even within single HMAs (e.g., Granite Range HMA and Garfield Flat HMA), there is evidence of two genetically distinct wild horse herds separated primarily by, in the case of the Garfield Flat herd, behaviors that may have been triggered by a massive roundup and removal and, for the Granite Range horses, by a fence splitting the horse population (Ashley 2004).

Within a species, genetic diversity provides the mechanism for evolutionary change and adaptation (Allendorf and Leary 1986, Meffe and Carroll 1994, Chambers 1998). A reduction in genetic diversity can cause a reduction in fitness, decreased growth, increased mortality, increased susceptibility to disease, and a reduction in the flexibility of individual animals to adapt to evolutionary changes (Ballou and Ralls 1982, Mitton and Grant 1984, Allendorf and Leary 1986, Berger and Cunningham 1994). Genetic diversity can be reduced as a product of inbreeding, founder effects, genetic drift, and as a consequence of domestication where purposeful selection will favor some morphological/behavioral/physiological traits over others.

[8] There are 10 HMAs that are managed for burros and horses. Since the high AML for horses and burros are separate, the sum of the mixed horse and mixed burro categories in Table 1 equals twenty.

Genetic diversity within a species or population is generally measured by examining heterozygosity (versus homozygosity) and/or by determining allelic diversity. Heterozygosity refers to the proportional amount of genetic variance at a locus while allelic diversity refers to the actual number of alleles at an individual locus. From an evolutionary perspective, heterozygosity is a good predictor of the potential of a population to evolve in the immediate future following a recent population bottleneck, while allelic diversity is important for the long-term response to selection and survival of populations and species (Allendorf 1986, Amos and Balmford 2001, Petit et al. 1998). This difference is also mentioned by Gross et al. (2006) who report that:

> "High allelic diversity will virtually always be correlated with the occurrence of many alleles that have a low frequency in the population. These rare alleles are unlikely to contribute substantially to short-term population responses to selection, but they can be a very important limit to the response to selection over many generations (James 1971, Allendorf 1986). Allelic diversity is thus considered important to the long-term survival of a species, especially where there may be substantial environmental changes, range expansions, or (re)introduction into new sites."[9]

The BLM has historically relied on observed heterozygosity to assess the genetic health and diversity of wild horse and burro herds. To assess whether a herd's level of heterozygosity is of concern, the BLM compares the herd-specific heterozygosity levels to the mean heterozygosity values for wild populations. Herds with observed heterozygosity values that are one standard deviation below the mean (which is 0.66 for DNA hair samples and 0.31 for blood samples) are considered at critical risk.[10] Using the mean value of heterozygosity for all wild horses combined and set criteria for what is deemed acceptable may not be credible given the herd- or HMA-specific factors that must be considered in evaluating genetic diversity.

Nevertheless, heterozygosity and allelic diversity can be relatively easily and inexpensively assessed via the collection of appropriate samples from individual animals and subsequent genetic analysis. Considering the lack of detailed population demographics, genetics, and individual animal histories for the majority of wild horse and burro herds on the range, these two measures may be the best tools available to the BLM to assess genetic health and diversity at this time.

Since heterozygosity is a relatively insensitive indicator of the loss of genetic variation, however, allelic diversity has been advocated as a more appropriate measure of genetic health because it is more sensitive to differences in population size and the number of populations, and therefore, will be affected first as herds or populations decline in size or as whole herds or populations are extirpated (Allendorf 1986, Neel and Cummings 2003). It is unknown whether the BLM has attempted to assess the allelic diversity of wild horse and burro herds and, if so, the results of such analyses.

[9] See also, Amos and Balmford (2001): "Perhaps the main consequence of reduced survivability (due to a loss of genetic diversity) is thought to lie in lowering a population's ability to react to novel changes."
[10] Handbook at 21.

More recently, kinship has become another tool used to evaluate genetic diversity within herds or populations. This technique requires population-specific data including demographic data, genetic data, and individual animal histories, which are used to create individual animal pedigrees that, in turn, can be used to model the impact of alternative management strategies within herds or populations. The use of pedigrees in the study of wild animal populations has become more common (Haig and Ballou 2002, Herbinger et al. 2006, Berger-Wolf et al. 2007, Pemberton 2008, Van Horn et al. 2008) and is used to provide "valuable data for the study of ecological and evolutionary processes, including mating systems, inheritance patterns of important traits, and behavior" (Eggert et al. 2010).

Eggert et al. (2010) employed pedigrees to study horses on Assateague Island National Seashore. The pedigrees could be developed due to the large amount of data collected over the years on individual horses (e.g., identification markers, group associations, home range use, life events) by the National Park Service (NPS). Models were developed to use the pedigrees, genetic data, and demographic data to assess the genetic and demographic status of the Assateague horses and to predict the impacts of efforts to reduce population size. Specifically, Eggert et al. (2010) evaluated the current age structure, contributions of individual founders to the genetic diversity of the present herd, differences in inbreeding over time, rate of loss of genetic diversity over several generations, and the overall levels of kinship among horses in the population. This latter assessment was done by examining the average mean kinship or MK, which is the "average of the pair-wise kinships of all pairs living in the population." Individuals with low MK are not closely related to other herd members and, therefore, may be important to the genetic legacy of the herd. Conversely, if animals with high MK values are selectively removed, this would increase estimates of retained genetic diversity in the herd by reducing average MK. As reported by Eggert et al. (2010) the use of MK "has outperformed other measures in terms of heterozygosity and allelic diversity retention and inbreeding minimization, as shown theoretically through simulations" (citing Ballou and Lacy 1995, Fernandez and Toro 1999, Toro et al. 1999, Toro 2000).

This analysis resulted in some interesting findings regarding the Assateague horses, including that: (1) the herd's mitochondrial DNA diversity was low compared to that seen in established horse breeds and wild ungulate populations, but its nuclear genetic diversity was higher; (2) of the 144 horses living in 2006, 21 were inbred (resulting in inbreeding coefficients ranging from 0.0156 to 0.2813) and inbreeding levels are likely increasing in the population; (3) the population retained 95.8 percent of the genetic diversity of the founder population; (4) the eigenvalue effective population size (i.e., the effective population size associated with the loss of genetic diversity) (Templeton and Read 1994) was 23, or approximately 16 percent of the census number – similar to the 11 percent determined by Frankham (1995) for various wildlife populations; and (5) Assateague horses can be expected to retain 80 percent of the diversity of the founders.

The tool was also used to evaluate the impact of management alternatives to kinship values and herd demographics. For example, an alternative that would selectively remove individual horses with the highest mean kinship values was determined to increase retained diversity of the founders and decrease average kinship between individual animals, but would substantially and disproportionately impact the size of the youngest wild horse age classes. This could not only limit the future reproductive potential of the herd but, as the number of breeding age females declines, put the population at greater genetic and demographic risk over the long term – particularly if some unexpected event results in increased mare mortality. Eggert et al (2010) concluded that a "combined strategy of controlled breeding and immunocontraception would be more effective than removing individuals with high mean kinships in preserving the long-term health and viability of the herd." Yet, they cautioned that once the population declines to a size that addresses concerns regarding impacts on the ecosystem, breeding among wild horses will need to resume to protect the demographics of the herd and that wild horses may need to be introduced to the island to maintain genetic diversity.

While the use of this tool may be limited to those herds or HMAs where there is sufficient data or where sufficient data can be obtained to develop pedigrees, the value of the tool is clearly demonstrated by the results obtained for the horses on Assateague Island.

Ballou et al. (2008) also used the wild horses of Assateague Island to develop an individual-based stochastic simulation model using Vortex software to evaluate the effects of different management strategies on the horse population. The origins of this work were based on a need by the NPS to develop a model that could simulate its goal of reducing and maintaining the wild horse population at a lower target size that would still be demographically and genetically viable (Zimmerman et al. 2006). Instead of using other population projection models that had previously been developed for wild horses, Ballou et al. (2008) were able – based on the significant amount of demographic, genetic, and other data available from years of study of the Assateague horses – to develop, populate, and test a more realistic model to assess the impact of contraception on the population, including on its genetic health. Their model results suggested that the ongoing use of immunocontraception to control herd growth would result in a linear drop in the population of an average of eight horses per year for 10–12 years (an average of approximately 6 percent per year), with the rate of decrease rising after year 12, to 16 percent per year. This result is a product of the long-term use and efficacy of immunocontraception in this population, which has skewed the age structure toward older animals.

In terms of the impacts to the genetic health of the population, Ballou et al. (2008) determined that the accumulation of inbreeding is similar for populations of more than 60 horses over the short term, but that inbreeding rates accumulate rapidly when the population was simulated to be reduced to approximately 20 animals. They also found that the effective population sizes of a herd containing 100, 80, 60, 40, and 20 horses are approximately 60, 50, 40, 30 and 15, respectively at the end of the 50-year simulation period. Consequently, for this herd, a population size of 100 or even 80 may be sufficient to avoid inbreeding problems, which is a smaller ratio between effective population size and total population size than that used by the BLM. However, Ballou et al. (2008) caution that these types of models are known to underestimate inbreeding, that a population of 80 to 100 animals may still exhibit inbreeding depression (though it is likely to be less severe than a smaller population), and that, therefore, the effects of inbreeding must be carefully monitored.

Gross (2000) developed an individual-based model to simulate population dynamics and genetic variation of horses in the Pryor Mountains in Montana under different management alternatives. Though the amount of data for individual horses in the Pryor Mountains is higher than what is available for many BLM HMAs, it is not nearly as extensive as the data available for horses on Assateague Island. He found that when the herds were managed via contraception alone, the average size of the herd was approximately 25 percent less than those herds managed through simulated removals. Consequently, the use of contraceptives allows the objectives for population control to be increased in number, further enhancing the retention of genetic variation. In regard to the impact of management alternatives on genetic diversity, Gross (2000) found that management targeting the removal of older animals to achieve a population objective of 90 animals resulted in a 70 percent reduction in heterozygosity after 200 years compared to the initial level of heterozygosity (0.301 compared to 0.433). In contrast, when populations were controlled by contraception along with the removal of only younger mares, with a population objective of 180, heterozygosity only declines to 0.413, or 95 percent of the initial level. Consequently, management strategies targeting older animals consistently resulted in more rapid loss of heterozygosity.

Gross (2000) also considered allelic diversity in his model of the Pryor Mountain horses and found that allelic diversity was a "much more sensitive indicator of changes in genetic variation" compared to heterozygosity. For example, Gross (2000) concluded that to have a 90 percent probability of retaining 90 percent of alleles, the population size would have to be approximately 500 animals. A population size of 250 animals would be sufficient to achieve a 90 percent probability of retaining 90 percent of the initial heterozygosity in the population. Even under the best management options, however, both measures revealed a high probability of losing more than 10 percent of the initial genetic variation in the population over time.

Population Viability Assessment (PVA) is another tool that includes the consideration of genetic health and diversity in assessing the full suite of factors that may cause a species to go extinct or, alternatively, to persist for a particular period of time (often 100 years). To utilize PVA to estimate a species persistence or risk or extinction, careful evaluation of demographic data (e.g., age specific survival/mortality rates, age specific reproductive rates), genetic characteristics, and geographic range requirements) is required (Noon et al. 2000). While it would be useful if PVAs could be performed on every wild horse and burro herd, for some herds or HMAs data may not yet be sufficient for such analyses. Nevertheless, one of the benefits of employing PVA is that it compels the consolidation of existing knowledge, evaluates alternative management scenarios, and identifies weaknesses in existing data that could influence the interpretation or inferences from the analysis (Underwood 2000).

Coates-Markle (2000) provides a valuable summary of the recommendations from the BLM wild horse and burro population viability forum conducted on April 21, 1999. Many of the recommendations from the forum addressed genetic management of wild horses and burros. The relevant recommendations and associated analyses included:

1. The BLM should carefully consider its mandate provided by the WFRHBA with respect to long-term genetic viability of populations of wild horses and burros. In general, the higher the genetic diversity in the herd, the greater the herd's long-term reproductive capacity. Conversely, inbreeding, random matings (genetic drift), and /or environmental catastrophes can all lead to the loss of genetic diversity within the populations. The negative consequences of such a reduction in diversity may include reduced foal production and survival, reduced adult fitness, and physical deformities. Such potential negative impacts are more a concern for smaller, isolated populations (<200 total size) particularly when the number of animals participating in breeding drops below a minimum level. If necessary, however, either naturally occurring or management-induced ingress and egress of wild horses can be used to maintain sufficient genetic diversity within such smaller populations.

2. The BLM should establish baseline genetic diversity information for each population over which it has management responsibility. Establishing baseline genetic diversity requires the collection and DNA analysis of samples from individual animals. For horses these samples can be blood, hair, or feces but for burros, hair or fecal samples are preferred due to the limited variation in blood protein genes. These samples are relatively easy to gather and are not prohibitively costly to analyze.

3. The BLM should establish a realistic management goal for maintenance of genetic diversity within all management populations that should be sufficient to ensure a self-sustaining reproductive capacity within the herd. "Genetic diversity" refers to the entire complement of genetic materials representative of all individuals (or a sample of individuals) from within the populations. Higher genetic diversity will minimize the effects of genetic drift or the random loss of genetic materials due to mating processes. Previous studies on other wildlife species and current efforts for wild horses indicated that management "should allow for a 90 percent probability of maintaining at least 90 percent of the existing population diversity over the next 200 years." Establishing a genetic goal for each herd requires the re-assessment of the herd-specific genetic diversity at least every five years.

4. The BLM should estimate the genetic Ne of all populations or metapopulations with a total size of 200 animals or fewer. The BLM does not have a standard goal for Ne for wild horses and burro herds, but an Ne of 50 (from domestic animal breeding guidelines) can be used. Populations where the Ne is less than 50 may have a higher rate of genetic diversity loss than what is likely acceptable. Based on the limited research conducted on wild horse herd, the Ne for a herd with a

natural age structure is approximately 30–35 percent of the total census population size. Ne, however, is difficult to determine for wild horses because of the polygynous breeding system, which greatly limits male participation in breeding and results in an uneven ratio of the sex of breeding animals, thereby reducing Ne. Substantial fluctuations in population size (as a result of captures and removals, for example) can also reduce Ne.

5. The BLM should evaluate viable management alternatives for conserving or enhancing genetic diversity within wild horse and burro populations (or within metapopulations) with a known limited level of diversity, a total size of less than 200 animals and/or an estimated Ne of less than 50. Alternatives can include: altering population age structure to promote higher numbers of reproductively successful animals; altering breeding sex ratios to encourage more even participation in breeding by males and females; increasing generation intervals by removing (or contracepting) younger instead of older mares; and/or introducing breeding animals (specifically females) from other genetically similar herds to help in conservation efforts.

6. The BLM should continue to evaluate the incidence of club foot, parrot mouth, and other physical defects in individual wild horse and burro populations. Despite such physical defects, the animals in question may otherwise be healthy, in acceptable condition, and fit enough to contribute socially and genetically to the herd. Consequently, there would seem to be little reason to remove the animals on the grounds of physical imperfection as determined by human standards. Indeed, since multiple genes are likely responsible of the expression of such traits, it is likely that the genetic predisposition for these traits will remain in the herd even with removals. Though BLM policy permits it to euthanize animals with such defects to prevent the furtherance of the defect through mating, there "is not solid evidence that these physical conditions are purely genetically-based and that they may contribute to a long-term loss of genetic health in the herd" (Coates-Markle 2000).

Regardless of the method used to measure genetic diversity (i.e., heterozygosity, allelic diversity, kinship), there is not a single optimum size to preserve the genetic health and diversity of a wild horse or burro herd. Ideally, management should strive to maximize herd sizes on the range – in excess of most of the current high AMLs – in order to preserve as much genetic diversity as possible, at least until additional studies are conducted to evaluate the values of heterozygosity, allelic diversity, and/or kinship as genetic management measures. Furthermore, studies are necessary to more accurately determine the ratio of the effective population size to the total estimated herd size to ensure that, at a minimum, a sufficient number of breeding individuals are retained in each population to protect and preserve long-term genetic health.

In reality, however, unless more habitat is provided to wild horses and burros, the WFRHBA creates restrictions on when, where, and how wild horses and burros are managed. Unlike many wildlife species that are free to roam with few legal restrictions, wild horses and burros are not afforded that luxury. This is not to suggest that roundups and removals are inevitable, as there are alternatives – namely immunocontraception – which can in time, if fully implemented, achieve management objectives and allow some breeding while reducing the need for captures and removals. Inevitably, as discussed elsewhere in this report, this will affect the genetic health of the treated herds but, if done responsibly and using, as necessary, other management strategies, the genetic diversity and health of these herds can be maintained at a level that, at a minimum, can slow the loss of genetic diversity.

Consequently, genetic management of any wild horse or burro herd must be done on a herd-by-herd basis. For example, Goodloe et al. (1991) calculated the number of animals that would need to exist on Assateague Island, Cumberland Island, and Chincoteague National Wildlife Refuge to maintain an effective breeding size of 50 animals. The results indicate that 72, 122, and 155 horses on Assateague, Cumberland, and Chincoteague, respectively, would be sufficient to maintain an effective breeding size of 50 while limiting the loss of genetic diversity to <1 percent per generation. Goodloe et al. (1991) reported that the difference in numbers pertains to the differences in the size of the populations on each island, management actions used to control population growth, proportion of males breeding, harem size, and survival rates.

In addition, factors such as the existing genetic diversity in the herd, number of animals, effective population size, species (i.e., horse or burro), age-structure, sex-ratio, evidence of any genetically inherited defects, and physical characteristics (e.g., size, coat color), and ancestry all must be considered in determining the herd-specific or HMA-specific genetic management strategy. In burro herds, given that the ratio between the effective population size and total herd size is smaller, management for a smaller herd size may not unduly compromise genetic diversity. In wild horses, the opposite is true – small herd size reduces the size of the effective population size, compromising the genetic health of individual animals and the herd.

A one-size-fits-all number to maintain or improve genetic diversity and health of wild horses and burros is not realistic or feasible. Nevertheless, the ongoing use of an effective population size of 50 by the BLM is not likely sufficient to prevent the long-term herd-specific decline in genetic health. Even if the BLM would manage every herd to ensure a minimum of 50 adult animals actively breeding and contributing to the herd's gene pool, this still won't likely be sufficient to maintain long-term genetic health, since there is little credible science to suggest that this level can preserve genetic diversity. Of course, considering that the vast majority of existing wild horse and burro herds have an effective population size below – and in many cases, well below – 50, there can be little dispute that, at present, management strategies are not preserving sufficient amounts of genetic diversity to ensure long-term genetic health. It could be that attaining and maintaining sufficient genetic diversity to protect long-term genetic health is not possible, given existing legal constraints on management. But far more consideration, study and analysis of this issue is urgently needed to ensure that future management actions do not exacerbate any impacts to the genetic diversity of wild horse and burro herds.

In regard to other management strategies that can be employed to increase the genetic diversity within herds where it is low, the obvious strategy is to manage existing wild horses and burro population to retain as much genetic diversity as possible. This may require adjusting AMLs upward to provide for an Ne of at least 50 is present or ensuring that wild horses that live within HMA complexes do intermix and interbreed and are not prevented from doing so by human-constructed impediments (e.g., fences). Yet, instead, there is evidence that the BLM ignores the genetic data and recommendations that it receives from Dr. Cothran by proceeding with roundups and removals even if inconsistent with the need to preserve genetic diversity. For example, in the Little Humboldt HMA in Nevada, which has an AML range of 48-80, Cothran (2010) advised the BLM that if it allowed the herd size to increase, it would stop the loss of genetic variation. Instead the BLM reduced the herd from 72 in 2010 to 66 in 2011 and again to 22 in 2012.

In addition, a common strategy to address low genetic diversity is to introduce new breeding-age horses or burros into the population. This cannot be done haphazardly, however, to avoid unintentionally diluting a gene pool that may be particularly rare or significant to equid populations. Perhaps there is an ancestry or physical characteristic unique to a particular horse or burro herd for which there are compelling reasons to preserve. Furthermore, particularly for wild horses, it cannot be ignored that the introduction of new horses – stallions or mares – into an existing herd is likely to result in disruption to the herd's social structure (especially if the herd has not been disturbed, disrupted, or subject to capture and removals in the recent past). Also, the introduction of new horses or burros into existing herds, even if done infrequently, may not be in compliance with the BLM's legal mandate to manage for self-sustaining populations.

It has been suggested (including by the BLM) that manipulating the sex ratio of wild horse herds to favor stallions can aid in increasing the proportion of males breeding in a herd and, hence, improve genetic diversity (Coates-Markle 2000). Whether this actually increases genetic diversity over the short- or long-term, however, has not been proven. In addition, the removal of younger animals from the breeding population can increase the effective population size, benefiting the genetic diversity and health of the herd (Coates-Markle 2000). Whether this strategy does, in fact, increase a herd's genetic diversity over time has also not been proven.

Conclusion: Despite claims that the genetic diversity within most wild horse and burro herds is sufficient to protect genetic health, the numbers indicate otherwise. The fact that so many wild horse and burro herds are managed at so low an AML is antithetical to the long-term preservation of herd-specific genetic health. What information or evidence that the BLM has in regard to the genetic health of those herds that have been sampled has not been disclosed. Therefore, a true understanding of herd-specific genetic health is not possible and conclusions cannot be drawn. In addition, though it concedes that there is no standard, uniformly accepted method to calculate the effective population size for wild horses, the BLM continues to utilize the lowest recommended size (50) for management purposes. Yet, despite recommending this number, the majority of its wild horse and burro herds have an effective population size of less than 50.

Mean kinship values would provide a more valuable assessment of individual and herd genetic health and be of greater value in informing management decisions. Unfortunately, the BLM does not have the amount of herd-specific data on individual paternity/maternity, demographics, or genetic diversity to utilize this tool on a broad scale at this time. The fact that the BLM continues to rely on capture and removals, often of large numbers of animals, also makes it difficult to use this tool. With its existing sampling and testing protocol the BLM should, at a minimum, examine the allelic diversity of its herds.

Finally, there is no single ideal number of wild horses or burro that will ensure the preservation of sufficient genetic diversity to maintain long-term genetic health. Instead, that assessment must be done on a case-by-case basis. Even then, given legal constraints and other management realities, it may not be possible to maximize genetic diversity in these herds, regardless of the available management alternatives. Instead, a more realistic goal may be to minimize the loss of genetic diversity over the long-term. While there are various strategies that can be used to introduce new genetic material into herds where genetic diversity is low, ideally (and given its legal mandate to manage for self-sustaining populations of wild horses and burros), the BLM should identify management strategies that maximize the number of wild horses and burros on the range even if that requires an adjustment in AML, a reduction in domestic livestock stocking rates, or other changes to the management of the range.

Recommendations:

1. The BLM should immediately make available all herd-specific or HMA-specific genetic data available via a specific link on its website. All of this data should be public and should not require specific requests to obtain the information. If the BLM needs to include a genetic primer to aid the public in interpreting the data, it should create such a primer and also make that available.

2. The BLM should immediately expand its genetic testing to include an assessment of allelic diversity. To the extent previous samples can be reevaluated to assess allelic diversity, this should be done. Or, if such assessments have been completed for one or more herds or HMAs, the results should be disclosed to the public via the BLM website.

3. The BLM should collect all of the demographic, genetic and other data available for as many herds/HMAs as is possible, and initiate an effort to conduct Population Viability Assessments of each HMA with a priority given to those HMAs for which the high AML is set at 200 animals or fewer. As needed, it should host a series of PVA workshops with relevant experts from both within and outside the agency to conduct these assessments. If it is determined that sufficient data is not available to conclude such assessments, the BLM should immediately strive to attain that information through new surveys, assessments, or studies conducted in-house or through cooperation with academic institutions, other agencies, or independent scientists.

4. The BLM should retain the assistance of experienced and credible large animal population biologists and geneticists to: (1) study the available herd or HMA-specific genetic data; (2) determine the adequacy of an effective population size of 50 to preserve genetic diversity and health long-term; (3) more accurately predict the effective population size of existing herds (using site and herd specific characteristic, genetic data, and scientifically accepted genetic management standards); and (4) identify any potential studies needed to inform and improve genetic management of wild horses and burros.

5. The BLM should revisit the recommendations made by Coates-Markle (2000) to determine whether any of those recommendations have been pursued and, if not, initiate efforts to implement those recommendations.

D. Annual rates of WH&B population growth: *Evaluate estimates of the annual rates of increase in WH&B herds, including factors affecting the accuracy of and uncertainty related to the estimates. Is there compensatory reproduction as a result of gathers to remove excess WH&B or application of PZP-22 over a 4-year gather cycle, and if so, what is the level of compensatory reproduction occurring? Would WH&B populations self-limit if they were not controlled, and if so, what indicators (rangeland condition, animal condition, health, etc.) would be present at the point of self-limitation?*

A number of studies have included information on the annual growth rates of wild horse populations. In its 1980 report, the National Research Council (NRC) cited a host of studies that pegged this rate of increase between 10 and 20 percent. Given the difficulties inherent in counting wild animals, the NRC and some scientists questioned the accuracy of annual growth rate estimates of 20 percent or more, given improvements in census methodologies, changes in census techniques, and particularly when growth rates predicted from modeling exercises were much smaller. The accuracy of these early models, however, may also have been an issue, given the lack of knowledge of a number of key population demographic variables (e.g., age-specific survival, age-specific fecundity, birth interval). If the data used to populate the models were not accurate, then the model output would similarly be in error. In the past several decades, since the publication of the NRC's initial report, other reported estimates of herd growth rates, disclosed by the BLM or in the literature, have ranged from 10 to 25 percent.

Understanding the annual rate of increase is critical for the management of wild horses and burros as it, in combination with scientifically-justified AML and relevant rangeland monitoring data, can be used to predict when a wild horse or burro population may be in need of direct or active management to meet legal requirements and management objectives. Accurate determination of the annual rate of increase depends on the ability to accurately count wild horses and burros or estimate their population size. As previously indicated, though the BLM is engaged in efforts to improve its ability to accurately count wild horses and burros, many of its current counts are likely inaccurate due to deficiencies in its census methodologies. Furthermore, given the biological and ecological variance among wild horse and burro herds and the lands they inhabit, using models to predict annual growth rates are unlikely to be accurate unless herd or site-specific data are used to populate the model.

In many of its planning documents (i.e., roundup NEPA documents), the BLM often claims that the annual rate of increase in wild horse herds ranges from 18 to 25 percent, though in other planning documents, the rate of increase claimed is as low as 10 percent. In many cases, the BLM relies on the growth rate calculated based on aerial surveys of the herd, despite the potential deficiencies in the survey methodology. The difference in herd growth rates reported by the BLM, however, reflects the diversity of the herd characteristics and the lands they inhabit. In addition to often using a generic growth rate (i.e., 20 percent) in its planning document, a review of the BLM's wild horse and burro population data suggests that, if no recent herd census has been conducted, the BLM appears to automatically increase a herd's size by 20 percent each year – a practice that may be under or overestimating herd size and that fails to consider the potential for annual variability in herd growth rates. At present, the accuracy of the majority of BLM's population estimates is suspect.

Since the veracity of annual growth rate estimates depends on accuracy in counting animals, the factors identified previously that influence such counts are also relevant to the determination of a herd or population's growth rate. These include wild horse and burro sightability, timing (by season and by day), conditions, intensity of effort, methodology, experience of observers, type of aircraft, weather conditions, speed and altitude of aircraft, and habitat type. Simply put, as the ability of BLM to accurately count wild horses and burros improves, so will its estimates of annual growth rates.

Without the collection of (or access to) population herd or HMA-specific demographic data over an extended time period by the BLM or its collaborators, it is difficult to prove that compensatory reproduction is occurring in wild horse or burro populations after removals or in response to PZP-22 treatments. In theory, as is the case for most species, unless a species is well in excess of its "ecological carrying capacity," the removal of a large number of animals will increases the resources (i.e., forage, water, space) available to surviving species, improving their physical condition and health, and increasing their productivity. The extent of the impact or effect would depend on a host of biological and ecological variables (e.g., habitat condition, density of wild horses or burros pre- and post-removal, health/condition of individual animals, climatic/environmental conditions). While there may be specific HMAs for which extensive data are available, it is unclear if anyone has analyzed that data to seek a causal relationship between roundups and removals on wild horse and burro survival and productivity.

In its planning documents, the BLM assumes that roundups will improve conditions for the remaining wild horses and burros (as well as for other wildlife and domestic livestock) and that, with access to more forage and less competition, their physical condition and health will improve and foal survival will increase. Hence, the BLM itself suggests that wild horse and burro populations will compensate for the removal of animals from their herds through improved condition, better health, and increased production.

Though the issue of compensatory reproduction in wild horses or burros does not appear to have been subject to extensive study, there is some evidence from the published literature that it does occur. Garrott and Taylor (1990), reviewed sixteen years of data (1970-1986) collected from the isolated horses on the Pryor Mountain Wild Horse Range in southwestern Montana to develop a better understanding of wild horse population dynamics. Their analysis of this long-term data set revealed that the highest foaling rates of 60 percent were documented in 1979-1981 after a 51 percent reduction in the wild horse populations as a result of a particularly severe winter in 1977-78. During the 1979-1981 period the increase in foaling rates was 2.5 times higher among 3-5 year-old mares while the foaling rate in other-aged mares was 1.5 times higher. Prior to this period, foaling rates for the 1976-78 period was 39 percent while, in 1982, once the population recovered to pre-winter mortality levels, foaling rates steadily declined until reaching the low rates documented in the 1976-1978 period. This analysis suggests that this population demonstrated a compensatory reproduction response to the reduction in population size.

Kirkpatrick and Turner (1991) compared foaling rates between wild horse mares on Assateague Island National Seashore and Chincoteague National Wildlife Refuge. Though both groups of horses share the same island, they are separated into a Maryland herd (Assateague Island) and a Virginia herd (Chincoteague herd). Their management is also substantially different with the Chincoteague horses subject to decades of intensive management with upward of 80 percent of foals removed annually while the Assateague horses, at the time, were subject to minimal management consistent with the policies of the National Park Service. These populations, therefore, provide an ideal scenario to study the issue of compensatory reproduction.

Kirkpatrick and Turner (1991) found a 32.5 percent foaling rate for 40 horses on Assateague compared to a 62.5 percent rate for 48 mares on Chincoteague. This difference in foaling rates was consistent to that measured by Keiper and Houpt (1984) who found an annual foaling rate of 74.4 percent among sexually mature Chincoteague mares compared to a rate of only 57.1 percent for unmanaged Assateague wild horses. Kirkpatrick and Turner (1991) hypothesized that the different foaling rates between the two populations could be due to the physiological stresses of concurrent pregnancy and lactation among the Assateague horses. Though this could lead to greater fetal loss among the Assateague mares, Kirkpatrick and Turner (1991) found that the fetal loss rate between the two groups was comparable with 7.1 and 6.2 percent for the Assateague and Chincoteague horses, respectively. What was different was the lactational status of the mares in the study, with the annual foal removal from the Chincoteague horses resulting in a significant difference in lactating mares with only 2 lactating Chincoteague horses compared to 10 lactating Assateague horses. Based on these data, Kirkpatrick and Turner (1991) concluded that the differential foaling rates were not the result of fetal loss, that lactational anestrous is a contributing factor, and that the annual removal of foals from Chincoteague NWR triggers compensatory reproductive mechanisms and higher foaling rates. More specifically, they found that the removal of unweaned horses trigger a compensatory reproduction response while the removal of weaned horses will likely not have any significant effects on the fecundity of the mothers.

Unlike management removals that may result in compensatory reproduction, the use of a removal plus immunocontraception, or an immunocontraception-only strategy should limit compensatory effects among the remaining wild horses or burros. The extent and duration of this effect, however, is dependent on a host of variables (e.g., proportion of target population contracepted, efficacy of contraceptive agent, extent of immigration of non-contracepted animals, longevity of vaccine effect, duration of treatment). The only wild horses or burros that could demonstrate a compensatory effect of immunocontraception would be those who are not treated or who don’t respond to the treatment, as they could theoretically be more productive over time in response to the contraceptive effects on their conspecifics. Again, a number of variables would influence the extent of a compensatory reproductive effect, including the duration of treatments, longevity of vaccine efficacy, proportion of mares treated, condition of non-treated or non-responsive animals, and habitat conditions.

If a removal plus immunocontraception strategy was used, habitat conditions could improve, but this would not trigger a compensatory response by the remaining horses or burros, depending on the variables previously mentioned. If an immunocontraception-only strategy was employed, assuming other variables remained the same, habitat conditions would improve, but over a more prolonged period of time. However, reproduction, including any compensatory reproduction, may not be possible – depending, again, on the same suite of variables. Though not a form of compensatory reproduction per se, evidence of improvement in the condition and increase in the life span of treated animals must be factored into management plans.

Also, even if wild horses or burros don't demonstrate a compensatory effect due to the impacts of immunocontraception, other species may increase in number, taking advantage of the extra resources not being utilized by wild horses or burros. If a removal plus immunocontraception strategy was used, the impact would be rapid, as the extra resources would be available to other species immediately. If an immunocontraception-only strategy was used with the intent of reducing a herd's size, the same benefits could be accrued by other species, though over a longer time period. This assumes that all other conditions affecting rangeland health remain largely static. Conversely, if an immunocontraception strategy was used only to manage a herd at a particular size (as appears to be the objective of the BLM in managing a herd within an AML range), the compensatory benefit for other species would be less.

As with other wildlife species, particularly large ungulates, if wild horse and burro populations were allowed to increase in size without any human-initiated control, they would inevitably reach a size where density-dependent effects would be triggered and the herd could become self-limiting – when mortality rates would exceed growth rates. There is no known wild horse or burro herd that has been allowed to increase to the point of potentially becoming self-limiting. Management mandates, articulated by the WFRHBA, prevent such an outcome – ostensibly to protect wild horses and burros, other wildlife, multiple use opportunities, and habitat conditions. There may be evidence of density-dependent effects in wild horse or burro herds that have greatly exceeded AML (e.g., declining foaling rates, reduction in survival rates – particularly for foals, decline in physical condition), though detailed site-specific demographic data collected consistently over time would be needed to demonstrate cause and effect. This also would be contingent on an accurate AML, as well as a lack of variability in other factors (e.g., livestock AUMs, wildlife numbers, rangeland conditions) that also can influence when density-dependent effects are triggered. Indeed, evidence that wild horse herds continue to increase at 18 percent or more annually even when herd population estimates are four or more times over AML suggests that AML is low, that recent environmental conditions have increased the productivity of the range, or that other competing factors (e.g., livestock AUMs) have declined so that wild horses benefit by utilizing rangeland resources previously allocated to livestock.

If no controls were imposed on one or more wild horse or burro herds, it is unknown at what size self-limiting factors would be triggered. This threshold would depend on a number of variables, including climate, habitat condition, predator type and density, overlap in wild horse or burro and predator range, livestock AUMs, wildlife numbers and density, health and condition of horses or burros, availability and accessibility of habitat, and other disturbance factors. Though density-dependent effects are not triggered overnight, but rather increase gradually to influence or alter herd demographics, if a wild horse or burro herd were allowed to grow without restraint it would likely reach a level where there would be significant over-utilization of the habitat, a decline in herd condition, and potential impacts to wildlife. Unlike other wildlife species which (unless constrained by particular habitat needs) can attempt to expand their range in response to an increase in population density, if wild horses and burros leave their HMAs they are subject to capture and removal. The management constraints imposed by the WFRHBA, therefore, act as a barrier to prevent a wild horse or burro herd from likely ever reaching or exceeding the so-called ecological carrying capacity (a constantly changing number due to a host of biotic and abiotic variables) of their habitat where density-dependent effects may become more noticeable.

If a wild horse or burro herd were allowed to expand in number without restraint, density-dependent factors could eventually be triggered if the herd's ability to expand its range was constrained. Hypothetically, if the herd were not so constrained, density-dependent effects may never commence to alter herd demographics. If they did, then in time the herd size could stabilize or even decline – through a declining foaling rate, increased foal and adult mortality, declining health and condition, increase in disease susceptibility, and the potential for catastrophic mortality due to a severe winter or drought. If the decline were substantial enough, the herd would likely begin to increase in number again and the cycle would recommence. At such levels there would be both positive and negative consequences for other species and their habitats.

Conclusion: The BLM supports wild horse and burro roundups by claiming that the remaining animals will benefit though increased access to forage, less competition for forage and water, improved condition and health, increased survival rates, and greater productivity. Though the BLM offers no data to substantiate these claims, such claims are consistent with what would be expected to happen if a large number of conspecifics are suddenly removed from a habitat. It is not conclusive proof, however, that this can be considered a compensatory effect from removals, given the host of other variables influencing population demographics. Proving such compensatory effects is more difficult for those horse and burro herds under the management of the BLM, due to a lack of sufficient HMA-specific demographic data. While wild horse and burro captures and removals have prevented any herd from reaching the level where density-dependent effects may be clearly apparent, if a herd were allowed to grow without restraint it is possible, depending on a host of other variables, that the herd could become self-limiting – though, at such numbers, there would be consequences for other species. Unlike other wild species who can generally attempt to expand their range in response to increases in numbers or density, if wild horses or burros expand their range outside of HMAs, they are then subject to capture and removal. Unlike the impact of management by removals, the use of immunocontraception would substantially reduce if not eliminate any compensatory reproduction effect, depending on the proportion of the herd that is treated, duration of the treatment program, and efficacy of the vaccine.

<u>Recommendations</u>:

1. Continue efforts, including through collaboration with the USGS, to improve the ability to accurately census wild horse and burro populations, as the development and consistent utilization of more accurate counting methods at the HMA or HMA-complex level will improve estimates of annual growth rates.

2. Initiate studies to collect and analyze credible data to determine whether there is compensatory reproduction as a result of captures and removals of wild horses and burro or in response to immunocontraception. This could be done by reexamining any existing long-term data sets that may be available on select herds (e.g., Garfield Flat HMA, Pryor Mountains Wild Horse Range) or by initiating new studies on select herds throughout the current ranges of wild horses and burros. Alternatively, time and money are likely better spent expanding the use of immunocontraception on wild horse and burro herds and studying the physical, behavioral, social, genetic, and reproductive impacts of those treatments.

E. Predator impact on WH&B population growth: *Evaluate information relative to the abundance of predators and their impact on WH&B populations. Although predator management is the responsibility of the USFWS or State wildlife agencies and given the constraints in existing federal law, is there evidence that predators alone could effectively control WH&B population size in the West?*

As an initial matter, the USFWS has little management responsibility over predators. With the exception of predators listed under the Endangered Species Act (e.g., Florida panthers, grizzly bears, some gray wolf populations), the USFWS does not possess management authority over the predators most likely to kill wild horses or burros (i.e., mountain lions). Even on national wildlife refuges, though the USFWS can implement hunting policies more restrictive than those of the relevant state wildlife agency, it nearly always defers to the management standards adopted by the state agency. State wildlife agencies, therefore, assume the primary management responsibility for predators – including those species most likely to depredate wild horses and burros.

Those predators potentially capable of killing wild horses and burros are mountain lions, wolves, bears (grizzly and black bears), coyotes, and bobcats. Of these, mountain lions are likely the key predator of wild horses and burros. Lions are highly adaptable and, though their densities differ depending on habitat type, their known range overlaps that of a number of wild horse and burro HMAs.

Concerning other potential predators: While wolves may occupy range that overlaps with a small number of wild horse HMAs, AWI is unaware of any documented wolf kills of wild horses in recent years – though this may be a product of diminished numbers and range. If wolf populations were allowed to expand, wolves could, in time, become a predation threat to wild horses. Black bears are omnivores and widely distributed, with black bear range overlapping some wild horse HMAs. As with wolves, however, AWI is unaware of any documented evidence of black bears killing wild horses or burros. For grizzly bears, though more than physically capable of killing wild horses, there are few if any areas where current grizzly bear range and wild horse habitat overlap. As for coyotes and bobcats, it is unlikely that these animals could kill any horse or burro except for foals. Even then, given the protective instincts of mares and the harem unit, any predation by coyotes or bobcats may be limited to foals that are diseased, disabled, orphaned, or near death.

Though not well studied, there is evidence in the published literature that mountain lions do kill wild horses and that they can have a substantial impact on wild horse herd population growth and demographics. Turner et al. (1992) found that a minimum of four adult mountain lions in their study area within the Montgomery Pass Wild Horse Territory on the central California-Nevada border were responsible for at least 82 percent of the foals killed, based on an examination of carcasses found from May to mid-July (consistent with the peak parturition period for wild horses). Not surprisingly, the mean first year survival rate for foals in that population was only 0.27 – less than one-third the rate documented in other wild horse populations. Based on eleven years of data collected in the same area, Turner and Morrison (2001) found that lions killed, on average, 45.1

percent of all foals produced. Overall, 82 to 89 percent of the foals found dead within the study area were determined to have been killed by lions. While lions preferentially killed mainly foals less than 2 months old, older foals (up to 6 months of age) were also killed, as were 3 adult horses (2, 3, and 4 years old). The foal survival rate averaged 0.32 over the 11-year study, ranging from a low of 0.23 in 1987–1988 to a high of 0.48 in 1996–1997, when lion numbers were thought to have declined.[11] Greger and Romney (1999) reported similar foal survival rates within their study area in southern Nevada, and hypothesized lion predation as the cause. Turner et al. (1992) concluded that the growth of the Montgomery Pass Wild Horse Territory horse herd was limited by lion predation.

In their study of mountain lion kill rate and prey composition in a multiprey system in west-central Alberta, Canada, Knopf et al. (2010) documented lion predation of feral horses even though a variety of other prey species (e.g., white-tailed deer, mule deer, moose, bighorn sheep, elk, mountain goat, coyote, red fox, lynx, black bears, marten, beaver, porcupine, snowshoe hares, red squirrels, marmots, and several bird species) were available. Indeed, among adult male lions, 13 and 10.5 percent of their summer and winter diet, respectively, consisted of wild horses, while adult females killed some wild horses in summer. Subadult lions killed no wild horses. The increase in summer consumption of wild horses is consistent with the wild horse foaling season, when juvenile horses are available. In general, most of the wild horses killed were younger animals (less than 2 years old), and young wild horses and moose were the most common lion prey in the study area. Knopf et al. (2010) suggested that the preponderance of documented large ungulates in the male lion diet may be due to the larger size of male lions, which reduces the risks associated with attacking larger prey (Sunquist and Sunquist 1989, Iriarte et al. 1990).

In the Virginia Mountain Range in western Nevada, Gray et al. (2008) found that a single collared female adult lion was responsible for 17 wild horse kills, all less than 9 months of age, over a 10 month period. In total, 22 animals were killed by the lion over 10 months, including 17 wild horses, 3 mule deer, and 2 coyotes. These kill figures were deemed to be minimum estimates, given operational problems with the radio-collar that may have prevented documentation of all kills, including potential kills of other species.

A more in-depth study of lion predation on wild horses encompassing the portions of the Virginia Mountain Range, Carson Range, and Pine Nut Mountains in western Nevada is being conducted by Alyson Andreasen of the University of Nevada at Reno. Though not yet published, preliminary results of her study (as disclosed in several presentations)[12] indicate that lions were responsible for more predation events on wild horses than would have been expected. In her study, a total of 32 lions have been collared and their kill sites (determined by a clustering of GPS signals) have been investigated. Approximately 13 of

[11] Turner and Morrison (2001) reported that the decline in lions at the end of their study period may have been due to, in part, a decline in wintering deer numbers. They did not attribute the decline to hunting as lion hunting was reported to be low to non-existent within the study area.

[12] Ms. Andreasen made similar presentations of her data on lion predation of wild horses to the Society for Range Management's symposium on wild horses (February 2012) and to the NAS Committee at its public meeting on May 14, 2012.

the collared lions have access to wild horses as prey. Of those, 77 percent (10 of 13, including both males and females), regularly consume horses as prey, and predation events have been documented year-round. Based on the results of dietary composition analysis, several lions clearly prefer wild horses as prey, with over 70 percent of their diet consisting of wild horses. Overall, of a total of 160 ungulate kills located and inspected, 126 were wild horses and 34 were mule deer. In addition, when wild horses are killed, the kill rate on other species appears to decline – presumably due to the large amount of meat provided by wild horses.

The physical capacity to kill wild horses and burros and the shared geography between mountain lions and wild horses and burros does not correlate to actual predation, however. Other factors that are relevant to predicting predation include habitat type, sport-hunting mortalities, lion density, lion experience killing horses or burros, horse/burro densities, anti-predator behaviors and strategies, and wild horse or burro condition. Mountain lions generally use ambush as their preferred predation strategy. Consequently, in more open habitat, even if occupied by both wild horses/burros and lions, the ability of lions to predate wild horses or burros is severely compromised. Conversely, where mountain lion and wild horse or burro range overlap on lands more suitable to the lion's ambush style of attack (i.e., forested, rocky, extensive areas of cover), predation is more likely.

The density of lions and wild horses or burros may also affect predation rates. A high density of horses or burros could make each animal more susceptible to predation based solely on numerical risk. Alternatively, larger population sizes could result in larger band or group sizes, increasing the potential that the lion may be detected before an attack can occur.

The density of lions may influence predation rates. At high densities – recognizing that lions are territorial and therefore cannot become overpopulated in a biological/ecological sense – there may be a greater competition between lions resulting in more lions that may predate horses or burros and a higher proportion of lions skilled in killing these equid species. Even at lower densities, however, if a lion has skill at killing wild horses or burros and assuming such prey is available, a single lion may be capable of maintaining a high predation rate on these animals. Scientists have determined that lions can learn to specialize on bighorn sheep, and there is little reason that lions could not similarly learn to specialize in killing wild horses or burros.

For a lion or any predator, killing or attempting to kill wild horses or burros is not without risk. These are large and powerful animals (particularly adult horses) capable of severely injuring or killing a predator. If smaller, alternative prey are available (such as deer), lions may prefer those less dangerous species. Alternatively, if lions do kill horses or burros, they may target the old, young, weak, or sick.

The impact of predation on wild horse and burro populations is complex and does not lend itself to a definitive answer. Indeed, despite the evidence that lions can and do predate wild horses and can, under certain circumstances, effectively dampen or limit wild horse population growth, if lion density is low or if lion range does not overlap with that of wild horses and burros, predation will not provide an effective natural control on wild horse and burro populations.

To evaluate information relative to the abundance of predators and their impact on wild horse and burro populations, as the NAS Committee has been asked to do, requires accurate estimates of predator abundance. Except in rare instances, such accurate estimates simply don't exist. Predators are far more difficult to census than are wild horses and burros due to their more secretive behaviors and more cryptic appearance. Though many state wildlife agencies estimate lion population sizes and densities, few of those estimates are likely to be accurate.

In addition, thousands of lions are killed by hunters in nine of the ten states (sport hunting of lions is illegal in California) that possess wild horse and/or burro populations, and hundreds more are removed annually by state or federal agents in response to public safety, livestock depredation, or "nuisance" concerns. Such removals may diminish the potential impact of lion predation on wild horses/burros – by removing animals that may preferentially predate wild horses or burros, removing the larger-sized lions that may be more physically capable of killing horses or burros, or by reducing lion densities.

Though lions are territorial – which aids in controlling lion densities and distribution – if not for lethal removals and provided that sufficient prey populations exist, lions might survive at higher densities, or could expand their range and maintain higher density populations throughout a larger area, including wild horse and/or burro ranges. This could, in turn, increase potential predation rates on wild horses and burros. Alternatively, the age-structure of unhunted lion populations is weighted toward older animals – animals that due to their size and experience may be more likely to predate wild horses and/or burros compared to transient juveniles dispersing from their mothers' range. At present, with many state wildlife agencies expanding predator hunting opportunities, the potential role of natural predation in controlling wild horse and burro population numbers where lion and wild horse or burro ranges overlap is likely limited.

Conclusion: Though not subject to extensive study, there is evidence that mountain lions can and do kill wild horses and burros and that, under some circumstances, the predation rate may be sufficient to control wild horse and burro population growth. At a minimum, predation can dampen population growth rates in select areas. The relationship between predators and wild horses and burros is complex, is dependent on a host of variables, and may best be evaluated on a case-by-case basis versus rendering broad conclusions about predator impacts on wild horse and burro herds. The available evidence supports additional analysis and study of the potential role of predators in providing natural control of wild horse and burro populations where the ranges of the species overlap. To be useful, however, this analysis must incorporate an assessment of current hunting/management statistics and policies and ascertain how wild horse and burro predation rates may change if predator management strategies were altered.

Recommendation:

The BLM should contract with an independent, third party to engage in a comprehensive review of predator impacts on wild horse and burro populations to, among other goals: (1) identify where predator and wild horse and/or burro ranges overlap and where there is sufficient habitat to permit ambush predation of wild horses or burros; (2) correlate species densities to predation rates; (3) determine how the availability of alternative prey may influence predation rates; (4) examine existing management standards for predators and all potential prey species in such areas; and (5) assess if changes to management standards could influence predation rates on wild horses and/or burros. If such an analysis were to demonstrate that predators could provide a more significant natural tool to limit or dampen wild horse or burro herd growth rates, the BLM should consult with the relevant state wildlife agencies seeking any needed changes to lion management strategies to achieve the maximum predation impact on wild horses and burros.

F. Population control: *What scientific factors should be considered when making population control decisions (roundups, fertility control, sterilization of either males or females, sex-ratio adjustments to favor males and other population control measures) relative to the effectiveness of control approach, herd health, genetic diversity, social behavior, and animal well-being?*

Any type of management, lethal or non-lethal, temporary or permanent, will impact animal well-being, social behaviors, herd health, and genetic diversity. For wild horses and burros all of the management strategies used by the BLM have consequences to the animals as individuals, their herds, and their individual social groups. A balancing of impacts must be struck to maximize efforts to achieve herd health, preserve normal social behavior to the extent possible, and protect animal well-being.

Recognizing these complexities, AWI provides the following input on the factors that should be considered when making wild horse and/or burro management decisions. In addition to the population control methods identified in the "other population control measures" category, AWI includes managing wild horses and burros in non-reproducing populations, given increasing attention to this as a management option. The bulk of this analysis is focused on wild horses, though some input is provided, as needed, relevant to wild burros.

<u>Roundups</u>: By law, wild horses and burros are subject to roundups when there are "excess" animals on the range and when the excess animals are preventing achievement of a thriving natural ecological balance (TNEB) and/or when they are on private lands outside of existing HMA boundaries. There are a number of scientific issues that ostensibly contribute to the decision to conduct a roundup. Prior to addressing the specific components identified in this question (e.g., effectiveness, herd health, genetic diversity, animal well-being), a brief discussion of the roundup decision-making process is warranted.

The BLM considers wild horses and burros to be excess when their population size is above the high AML set for the HMA. The high AML is ostensibly based on what maximum number of wild horses and/or burros can be retained on the range and still achieve a TNEB and allow for multiple uses of the range. When determining excess, the BLM is required, by law, to look beyond mere AML (many of which are outdated or of questionable veracity) and population estimates (which are also often inaccurate) to consider rangeland condition as a litmus test for evaluating whether a TNEB exists. Yet few BLM roundup analyses contain more than speculative assertions over what impacts are attributable to wild horses and burros, without site-specific evidence that such impacts are real. Similarly, the BLM assumes that by removing the "excess" animals, it will achieve a TNEB even if the AML is out-of-date and despite potential changes to ecosystem conditions.

Consequently, to legitimately determine if an excess exists, the relevant scientific factors include: (1) an accurate population estimate of wild horses and/or burros; (2) an AML based on scientifically credible rangeland condition and other data (e.g., vegetation production, abundance, vigor, and composition; climatic data and trends; species-specific forage preferences, distribution and movement patterns, and foraging ecologies) collected using scientifically sound methodologies; (3) a baseline measure of what constitutes TNEB; and (4) the mechanism and data used to allocate forage to wild horses and burros, livestock, and wildlife.

Other sections of this report address wild horse and burro population census methodologies and the establishment of AML. Suffice it to say, the accuracy of BLM wild horse and burro population estimates remain highly dubious and the scientific credibility of AML is suspect. It is also unclear as to what constitutes a TNEB, what factors or elements are considered in making this determination, how those factors are prioritized if management strategies are needed to improve rangeland conditions, and the spatial scale of this measure. For example, is achieving an area's land health standards (which are generally set at a watershed level) consistent with achieving TNEB?

Though the BLM is required, by regulation, to consider wild horses and burros comparably with other resource values in the formulation of land use plans, it is unclear what this means, if it is being done, or, if so, how it is being accomplished. According to BLM policy, wild horses and burros constitute a resource value like mining, cultural resources, and recreation, while livestock grazing represents a range use. Does this distinction, whether justified or not, prioritize livestock use over the value of wild horses and burros on BLM-administered public lands?

The reality is that if the mandate to consider wild horses and burros comparably with other resource values required a balancing of interests, wild horse and burro AMLs would be set far higher, while livestock AUMs, in those allotments wholly or partially within HMAs, would be substantially lower. This would not alter the need for management interventions under the WFRHBA, though it could reduce damage to rangeland conditions (if livestock were the primary cause of said damage) and could remedy concerns over preserving the long-term health of specific wild horse and burro populations. Furthermore, domestic livestock would still substantially outnumber wild horses and burros due to the vast areas open to grazing compared to the HMA lands available to wild horses and burros.

Even if the BLM had or could attain the scientific evidence necessary to fully inform roundup decisions, that evidence is not sufficient in justifying a management action unless disclosed to the public as required by law. Unfortunately, in its roundup decision-making documents, the BLM rarely discloses any evidence relevant to the establishment of AML, objective measures of what constitutes a TNEB, how it considered wild horses and burros comparably with other resource values, site-specific data substantiating wild horse and burro impacts to rangeland condition, or its evaluation of the impact of other factors on the range. Instead, the BLM lists the multitude of adverse impacts wild horses and burros are having within the HMA (e.g., overgrazing rangeland vegetation, damaging riparian areas, facilitating soil erosion, degrading water quality, diminishing habitat value for other species) without providing any concrete evidence to support such assertions.

Whether a roundup is justified or not, if conducted it will impact herd health, social behavior, genetic diversity, and animal well-being.

Effectiveness: Roundups are highly effective in removing large numbers of wild horses and/or burros from the rangeland.

Herd health: The BLM justifies roundups by claiming that those wild horses or burros that remain on the range will benefit by having access to additional forage, water, and space and that there would be less intra-specific competition for such resources. In turn, the BLM claims that the remaining wild horses or burros would experience improved condition, health, and increased production. Theoretically, such claims may have merit but there is no credible scientific evidence suggesting that wild horse or burro herds attain such benefits as a result of removals. Considering the number of variables that influence rangeland health (e.g., climatic conditions, existing rangeland conditions, other uses of the range, land management practices), it is possible that roundups may not provide the extent of benefits to wild horses and burros as suggested by the BLM. Moreover, roundups can have deleterious impacts on wild horses and burros is harassed but not captured or if captured, handled and released. Such impacts can include an increase in stress, injuries, and even death.

Genetic diversity: Roundups with removals can adversely impact genetic diversity merely as a result of removing a potentially large proportion of a population or herd. The impact depends on a number of factors, including the total herd size (within the HMA or complex of HMAs), the total number of animals being removed, the effective population size both pre- and post-roundup, and the existing level of genetic diversity (i.e., heterozygosity, allelic diversity, or kinship measures). It has been reported that management alternatives such as sex-ratio manipulation to favor males can benefit the genetic health of a wild horse herd by increasing the proportion of males on the range, resulting in a larger number of smaller harems and thereby increasing the number of males participating in breeding (Coates-Markle 2000). Whether this impact is real or only speculative has not been adequately studied.

As a herd or population is reduced in size, the potential for inbreeding increases. This can have deleterious impacts on genetic diversity and herd and individual health. While both wild horses and wild burros, at small population sizes, can experience a loss in genetic diversity, the traditional polygynous breeding behavior of wild horses makes them particularly susceptible to such impacts, given their lower proportion of breeding individuals within a herd. For wild horses, the BLM recommends a total herd size of 150–200 in order to provide for an effective breeding population size of 50. This is based on evidence that, in wild horses, the effective breeding population is 30–35 percent of the total herd size (Coates-Markle 2000), though whether this rate is accurate has not been sufficiently studied. Furthermore, whether this “rule of thumb” is protective of herd genetic diversity depends on the specific herd characteristics. For burros, since a larger proportion of animals in a herd breed, the ratio between the effective population size and total herd size is smaller.

At present, of the 179 HMAs managed for wild horses and burros by the BLM, 144 are managed exclusively for wild horses, 21 exclusively for wild burros, and 10 contain both wild horses and burros. Of those 138 HMAs managed only for wild horses, 34, 37, 20, 15, and 38 have the high AML set at 0–49, 50–99, 100–149, 150–200, or ≥201, respectively. For those HMAs in which only burros are found, 7, 4, 6, 2, 1, and 1 have high AML set at 0–49, 50–99, 100–149, 150–200, and ≥201, respectively. For the HMAs in which both wild horses and wild burros are found, 10 are managed for a high AML of 0–49 (3 horse, 7 burro), 2 are managed for a high AML of 50–99 (1 horse, 1 burro), two are managed for a high AML of 100–149 (1 horse, 1 burro), three are managed for a high AML of 150–200 (all horse), and 3 are managed for a high AML of ≥201 animals (2 horse, 1 burro).

<u>Social behavior</u>: There is great variability in the social systems of wild equids. In general, however, wild horses tend to form harem groups (a stallion, several mares and their offspring) and bachelor groups (all male animals) (Berger 1977, Goodwin 2007). Alternative groupings include multi-stallion harem groups (containing a dominant and one or more subordinate stallions), bachelor groups that can contain juvenile females, and solitary animals (Rubenstein 1982, 1986, Feh 1999, Linklater and Cameron 2000a, 2000b). Harem groups are often relatively stable, though dominant stallions can be challenged and replaced or be replaced upon death, harem mares can switch harems (intentionally or forced), juveniles will eventually disperse from harems, and new mares can be recruited into harem groups.

A wealth of studies have attempted to find the evolutionary or practical benefit of harem groups – for mares and stallions – yet any variety of factors (singly or in combination) may be relevant depending on the herd (e.g., access to quality habitat, mate selection, increase in well-being, increase in breeding opportunities, improved fecundity and foal survival, reduction in male-mare and mare-mare aggression, predator avoidance, environmental conditions).

Based on a preponderance of the evidence, it would appear that a fundamental benefit of living in a stable harem group is a reduction in agonistic incidents, which is of significant benefit to mares in terms of providing additional time for forage, improving their physical condition, increasing their productivity, and improving foal survival (Rubenstein 1986, 1994, Keiper and Sambraus 1986). For stallions, though there are costs to defending a harem group from bachelor males or other harem stallions in terms of physical exertion, loss of energetic reserves, and the potential for injury or – though rare – death, the ability to maximize breeding opportunities outweighs such costs. In addition, though aggressive conflict between stallions can occur, conflicts are often resolved through visual or olfactory strategies that avoid physical contact (Salter and Hudson 1982, Rubenstein and Hack 1992).

Multi-stallion harem groups are generally less stable than single-stallion groups due to both intra-group competition between stallions and, as is the case with all groups, competition from other harem stallions and bachelor males (Linklater et al. 1999). In multi-stallion groups, mares are generally in poorer condition, are subject to increased agonistic incidents, have a lower fecundity rate, and foal mortality is increased (Cameron et al. 2003, Linklater et al. 1999).

When stable bands are disrupted, broken, or destroyed as a result of management actions, including roundups and removals, this can lead to impacts on individual animals who came from the broken band and to other bands or groups that may not have been targeted by the management action. For dominant stallions, if they survive, they will likely desire to form a new harem, leading to a potential increase in conflicts with other stallions and aggression toward mares. For mares, the loss of a stable harem group could result in them living as solitary animals (subject to high rates of harassment and aggression by bachelor males, stallions, and other mares) or they may try to join (or be forced into) a new harem where, at least initially, they may be subject to increased agonistic interactions impairing their well-being, contributing to a decline in fecundity, and/or causing the loss of their foal (Cameron et al. 1999, Linklater et al. 1999, Rubenstein 1994, Rutberg 1990, Monard and Duncan 1996, Parker 2001, Rubenstein and Nunez 2008). Some may attempt to escape from such groups if the harassment/aggression is intolerable but will then be subject to aggression anyway as solitary females or if they attempt to join another harem group.

For burros, given that most live in more arid environments, the primary social group is a jenny with her foal (Moehlman 1974, Klingel 1979, Rudman 1998). With few exceptions, burros don't form harem or bachelor groups. Instead, male burros create territories that will provide them with access to females potentially in estrus (Moehlman 1998, 2005). Since female burros are asynchronous in their estrus cycles, male burros can potentially access females in estrous throughout the year. These territories are not necessarily defended year-round, but the male burro may exhibit territory defense behavior (physical, visual, and/or olfactory) when a female in estrous is in his territory (Moehlman 1974, 1998, 2005). In addition, multiple territories can be overlapping, with boundaries that change seasonally. In the winter, when cooler temperatures reduce burro need to remain close to water, territories can increase in size while, in the warmer and dryer months, territories can be smaller as burros tend to concentrate near sources of water.

If roundups remove entire bands, the impact to the individual members of the band in regard to their social relationships will be significant and adverse, but the impact to other bands not captured or removed will be less. If roundups result in the disruption of a stable harem group as a result of the capture and removal of group members or even mere dispersal of the group as they attempt to escape the harassment, the impacts to the surviving group members and other bands not targeted by the roundup could be substantial, as explained previously. The loss of select harem group members (e.g., subordinate males or juveniles), though significant to those individuals, mothers (in the case of juveniles), and to those with whom they have formed affiliative relationships, may have less of an impact on the groups' and herds' social dynamics than the loss of a dominant stallion or mares.

For individuals, the behavioral, social, and psychological impact of being removed from a harem group, a dominant stallion, another mare, or a foal is likely substantial, though such individualized impacts have not been well studied. Anecdotal reports of a dominant stallion chasing a trailer containing one or more of his mares or a mare following a trailer containing her foal suggest that these events can harm individuals and such impacts should not be ignored or downplayed. Indeed, the relationship between band/group members has been described by some as affiliative or, in other words, a friendship. (Cameron et al. 2009, VanDierendonck et al. 2009) As our understanding of the intelligence, consciousness, social dynamics, and relationship of animals improves, there is an increasing recognition that the psychological, behavioral, and social health of an individual animal is as important as his/her physical health.

Animal well-being: In addition to the impacts on an individual animal's psychological, social, and behavioral health inherent to a roundup, there are physical consequences as well. In addition to the old, lame, and sick wild horses or burros who may be subject to euthanasia upon capture pursuant to BLM policy, horses and burros subject to the rigors and stress of a roundup and the aftermath (i.e., handling, transportation, testing/vaccination and branding, and the gentling process) can be harmed or even die as a result of injuries sustained during a roundup. The BLM claims that, statistically, only approximately .5 percent of all wild horses or burros captured in any one year will die as a result of some aspect of the capture operation. For horses in short-term holding, the annual mortality rate is reported as 5 percent while, for long-term holding it is 8 percent.

There are, of course, potential adverse implications associated with the capture of any wild animal even if great care is taken to avoid injuries or mortalities. Even if the BLM's reported .5 percent roundup mortality rate is accurate, there have been numerous reported incidents where wild horses or burros were injured or killed as a clear result of negligence, carelessness and/or outright cruelty on the part of the roundup contractor. Though the BLM has procedures in place to ensure that such operations are as humane as possible, it is not clear that the procedures are adhered to fully or whether the procedures themselves permit activities that are not humane. For example, the procedures and BLM policy specify that the distance animals are chased and the pace of the chase must be at levels commensurate with the well-being and humane treatment of the animals. There is no specified limit on the distance or speed during a roundup, as this determination is intended to be made on site after an initial survey of the area and in consideration of weather, topography, location of the trap site, and condition of the animals.

Based on eyewitness reports of a number of roundup operations and as evidenced by some of the injuries sustained by captured animals (e.g., hoof sloughing in captured foals) this would suggest that restrictions placed on roundup operations are not sufficient and, importantly, not consistent with the well-being and humane treatment of the animals. In addition, the capture procedures, among other questionable provisions, permit wild horses to be tied down or hobbled for 30 minutes to one hour – an act that cannot be considered humane.

Beyond injuries and mortality, the stress inherent to roundups can have adverse impacts on wild horses. Whether acute or chronic, stress triggers the release of cortisol and other adrenocorticoids in mammals (Yates and Urquhart 1962). Both natural and anthropogenic factors can cause stress in wildlife including animal condition (linked to forage/prey quantity, quality, and availability), predation threat or risk, human harassment, trapping or capture and handling.

In their study of wild horses on the Granite Range and Garfield Flat HMAs in Nevada, Ashley and Holcombe (2001) compared the impact of stress caused by roundups on the reproductive success of both groups of wild horses. Stress is a critical factor influencing wild animal survival, reproductive success, behavior, and ecology. Ashley and Holcombe (2001) found that for mares captured, marked and released without delay, foaling rates were close to those observed in non-captured horses. For horses captured and either released after 3 to 4 days in captivity or permanently removed and adopted within ≥21 days after capture, the foaling rate was 45.9 for the mares captured and released and 55.6 percent for the mares captured and removed, respectively, compared to rates of 82.4 and 74.1 percent for non-captured mares from the Garfield Flat and Granite Range HMA, respectively. In addition, at the short-term holding facility, Ashley and Holcombe (2001) report 15 to 18 spontaneous miscarriages based on evidence of shed fetuses among the Garfield Flat HMA horses, the death of a single mare with a well-developed fetus in utero, and the death of two pregnant mares at interim locations prior to adoption.

Ashley and Holcombe (2001) reported that "it likely is that severe and chronic reduction of serum progesterone (which has been linked to acute stress (van Niekerk and Morgenthal 1982)) due to prolonged removal stress was responsible for spontaneous abortions at PVC (the short term holding facility for Garfield Flat horses) and overall decrease in reproductive success." Furthermore, Kirkpatrick et al. (1977) concluded that "the wild horse lives in an almost constant state of stress year round as a result of competition during the breeding season, competition for the limited available forage and miscellaneous forms of harassment" suggesting that any additional harassment of these animals (e.g., via a roundup and removal operation) would add to the stress burden with potential adverse consequences for individual animals.

The removal of wild horses as the result of a roundup may provide (depending on ecosystem health, rangeland condition, climatic conditions and trends, and other ecosystem stressors) benefits to the remaining animals by providing greater access to higher quantities of forage and reduced competition for water. However, given the structure and social dynamics within a wild horse population, it will harm wild horse herd health – of which behavior must be considered a component – by removing related individuals, bands, and bachelor groups. Even if entire bands are removed together, this may still result in an adverse impact to herd behavioral health as a result of changes to intra-herd and inter-band relationships.

Though there have been numerous published studies on a wide range of wild horse behaviors, AWI is unaware of any studies that have explicitly examined the short and long-term impacts to individual wild horses, herds, and bands as a result of roundups. The BLM frequently reports that, with the exception of an increased skittishness in response to humans for those horses remaining after a roundup, those animals experience no further behavioral impacts but benefit from the reduced competition resulting from the removal of conspecifics. The basis for such conclusions is unknown. Considering the evidence of the behavioral impact on survivors when matriarch elephants are killed or when the alpha wolf pair is removed, to cite just two examples, it is difficult to believe that the removal of wild horses from the range would not result in some impact, likely adverse, on surviving band-mates, on the social dynamics of surviving bands, or on herd dynamics. Unless the BLM has credible scientific evidence to document the extent, or lack thereof, of behavioral impacts to wild horses as a result of roundups, this would appear to be a suitable and important subject for additional research.

Burros: Since wild burros generally do not form or live in social groups (e.g., harem groups or bachelor groups) as do wild horses, roundup impacts to harem groups and to the dynamics between such groups are nonexistent. Jennies and their foals remain together until the foal is weaned. Consequently, roundup operations can have deleterious impacts on these mother-foal groups. Other impacts inherent to roundups to herd health, genetic diversity, social behavior, and animal well-being, however, should be the same for wild burros herds and/or individual animals as they are for wild horses.

Fertility control: For the purpose of this analysis, AWI assumes that fertility control refers primarily to the use of immunocontraceptive agents, since the question explicitly distinguishes between fertility control and sterilization (i.e., surgical or chemical). Furthermore, as a preface to this analysis, it is imperative to place any behavioral or social impact of fertility control (as well as any other methods of control) in the proper context and to ensure that any comparisons between the impacts of control options are valid. In other words, any impacts of fertility control treatments on behavior or social dynamics of a horse or burro herd cannot be examined without the consideration of or comparison to the same impacts related to the other control methods. All too often, the behavioral impacts of fertility control are alleged without comparing or contrasting them to the behavioral or social impacts attributable to roundup and removal operations, sterilization procedures, or the development of non-reproducing groups of animals. Each control method will result in impacts to herd health, social behavior, genetic diversity, and animal well-being and, before a management decision is made, those impacts, including impacts documented by the BLM and contained in the scientific literature, should be compared so that the best or most informed decision is possible. Currently this is not done by the BLM when it elects to proceed with its roundups and removal operations. Instead, it assures the public that for those wild horses or burros captured and released or those never captured, with the exception of being more skittish around humans, there will be no other significant impacts to their behavior or group/band/herd social dynamics.

In recent years, the BLM has purportedly emphasized the use of fertility control strategies to reduce wild horse and burro herd growth rates in order to reduce the frequency of roundups and the removal of animals; many of whom will likely be relegated to a lifetime in long-term holding facilities at significant expense to the taxpayer. Indeed, in its new wild horse and burro management strategy, the BLM explicitly calls for an expansion in on-the-range management of wild horses and burros by increasing the use of immunocontraceptive vaccines. Nevertheless, with the exception of its role in various fertility control experiments conducted in the field, the actual number of wild horses or burros contracepted for management purposes is small. This is a product of the BLM's efforts to reduce herds with "excess" animals to low AML, the efficiency of the typical roundup operation, and proposals only to contracept those animals who are captured but don't require removal to meet low AML. The result is often a small number of mares, if any, who qualify for treatment and release.

This is unfortunate, considering the efficacy of immunocontraceptive vaccines in reducing pregnancy rates, their safety (including to unborn fetuses), the duration of effectiveness, the availability (if needed) of remote delivery mechanisms, proven success of a one-shot or inoculation technology, and ongoing efforts to improve this valuable management tool. At present, PZP-22 is the only immuncontraceptive vaccine registered (under the name Zonastat H) by the Environmental Protection Agency for use in wild horses.

Any vaccine intended to prevent pregnancy may affect the behavior, social dynamics, and well-being of both treated and untreated animals. Depending on the vaccine these affects may be beneficial or, in limited instances, adverse. The vast majority of the literature, however, suggests that the benefits of immunocontraception far outweigh any reported consequences and, overall, any adverse impacts inherent to immunocontraceptive use in wild horses and burros are substantially less than the severe and permanent impacts of other management alternatives and, particularly, roundups and removal.

In addition to the information provided below, additional discussion of the safety, efficacy, and affects of immunocontraceptive vaccines is provided in response to task G in this report.

Effectiveness: Immunocontraception has proven to be remarkably effective in a variety of wild and domestic species. In free-roaming wild horses and burros, PZP has been proven to effectively control fertility. For example, on Assateague Island National Seashore, PZP has not only stopped the growth of the population but, over time, it has directly contributed to the population's decline and improved both the condition and longevity of treated mares. In addition, administration of PZP to wild horses in Nevada and elsewhere has also demonstrated that the vaccine is safe, efficacious and reversible. While various dosages, emulsion mixtures (using different adjuvants), use of booster vaccines, and delivery methods have been tested, all such experiments have resulted in a reduction in pregnancy and foaling rates without any significant harm, physical or behavioral, documented in the treated population (Kirkpatrick et al. 2011). While the reduction in foaling rates has varied in such experiments, foaling among treated animals has consistently been well below that of untreated or control animals. More recently, the use of the vaccine in an injectable form combined with the delivery of microspheres containing the vaccine has extended the duration of effectiveness of the vaccine to 2+ years while avoiding the need for a booster vaccine 30 days or 1 year after the initial dose (Turner et al. 1997, 2005).

SpayVac and GonaCon or GnRH have also shown promise in experiments involving captive wild horses and, for GnRH, in wild horses, though the efficacy of GnRH in wild horses was less than that reported for GnRH in captive horses or for PZP in wild horses.

Herd health: The vast majority of fertility control impacts on herd health are positive. Assuming that fertility control is used alone and not in combination with, for example, capture and removals, the impacts to herd health are different than if roundups and removals are a component of the fertility control strategy.

Successful application of immunocontraception should slow or stop, depending on management objectives, herd growth and, in time, result in a decline in herd size. If a herd is near, at, or over its management objective (e.g., high AML, assuming AML is based on credible scientific data), slowing or stopping herd growth will reduce or eliminate an increase in the population, thereby reducing herd impacts on rangeland vegetation, riparian areas, soils, water quality, and other species. If range condition is compromised solely as a result of impacts attributable to wild horses or burros, reducing or stopping population growth will, assuming other variables (e.g., climatic conditions) remain constant, improve conditions. If wild horses or burros are only one of many stressors on public lands, slowing or stopping their population growth may aid, but will not remedy all threats to rangeland condition.

Physically, both individual horses and entire herds could benefit from fertility control. As has been proven, PZP-treated mares are often in better condition and live longer lives than untreated mares, likely due to the savings, energetically and physically, inherent to pregnancy, foaling, and lactation. These affects, which include evidence that mares in better condition are more likely to give birth to male foals, must be taken into consideration in management planning as they will impact whole-herd demographics. Furthermore, if the overall body condition of a horse or burro herd is poor, minimizing or preventing the addition of new animals could benefit the existing herd members.

Behaviorally, the vast majority of studies have found that PZP has not resulted in any significant behavioral impacts to treated horses or burros or their herds. Some have suggested that PZP can increase harem-switching behaviors (Nunez et al. 2009, Madosky 2011) but these findings have been questioned (see e.g., Kirkpatrick et al. 2011) and have not been observed in other herds. Furthermore, while harem switching can behaviorally impact individual animals, harem groups, and whole herds, compared to the behavioral/social impacts of capture and removal, such affects are relatively benign.

Genetic diversity: Depending on how fertility control is administered, it could promote, maintain, or reduce herd genetic diversity. If care and caution is taken in administering fertility control, baseline data on the genetic composition of individual herd members is known, individual herd members can be differentiated from each other, and the management objective is to maintain or promote genetic diversity, this can be accomplished through the selective and planned use of immunocontraceptives.

Immunocontraceptive vaccines are generally reversible even after several consecutive years of treatment (Kirkpatrick et al. 1995). Consequently, managers can, through decisions as to who is vaccinated and when, ensure that all mares or select mares are allowed to breed at some time in their lives in order to pass on their genes to future generations to protect the herd's genetic diversity. How much diversity is preserved depends on the available genetic baseline data available for each herd, the level of diversity in the herd pre-treatment, and the management decisions made. Since the BLM is required to collect genetic data from horses and burros subject to roundups, it should have baseline data for a number of herds through the west, though this data has never been fully disclosed and it is unknown if the type of genetic data available is sufficient for making fertility control decisions to protect genetic diversity.

Social behavior: Fertility control is intended to prevent conception and, hence, to reduce if not eliminate foal production. As such, it will inevitably have some affect on the social behavior of individual animals, harem and bachelor bands, and entire herds. For individuals, the majority of mares subject to fertility control will not conceive. Thus, any behaviors inherent to gestation, foaling, lactation, and development of their offspring will be lost.

Aside from the findings related to contraception in horses on Shackleford Banks (see Madosky 2011, Nunez et al. 2009) which have been called into question (see Kirkpatrick et al. 2011), there have been no studies demonstrating any meaningful behavioral problems in PZP-treated horses. On Assateague Island National Seashore, for example, decades of study of PZP-treated horses has not produced evidence of any significant behavioral effect attributable to PZP-use (Kirkpatrick et al. 1992, Kirkpatrick et al. 1995, Powell, 1999, Powell and Monfort 2001, Kirkpatrick et al. 2011). Nevertheless, in response to concerns raised about the lack of quantitative behavioral studies, behavioral data on the use of immunocontraceptive vaccines should be collected in the field as vaccine use is expanded. The results of this information gathering can help further shape its use in the future. Furthermore, data to evaluate behavior/social interactions between and among horse groups and also for burros should be collected irrespective of the management method used, and such data should be compared between the different management methods.

At the harem group or herd level, the impact of fertility control on social behaviors depends, in part, on the vaccine agent used. Among the most prominent agents, PZP and SpayVac allow treated mares to cycle naturally allowing normal breeding behaviors to continue. While the duration of the breeding season may be extended, there is little if any credible data from any wild horse herd suggesting that this impact has compromised wild horse (stallion or mare) fitness or foal survival.

GnRH treated mares – though they can demonstrate some estrous behaviors – are generally considered to be anestrous. In GnRH treated mares, breeding behaviors may substantially decline which could result in behavioral impacts; the significance of which is unclear.

Animal well-being: Fertility control treatments, as previously indicated, have been proven to increase the physical condition, health, and longevity of treated mares. For mares and stallions that may be in generally poor condition due to a potential excess of wild horse or burro numbers on the range, the use of fertility control treatments would, relatively quickly, reduce herd growth rates, reduce intra-specific competitions, and potentially provide the animals with access to a higher quality and quantity of forage resources compared to if fertility control treatments were not used. How much of a benefit this would provide to wild horses and burros would depend on other biotic and abiotic factors.

Burros: Fertility control treatments, specifically PZP, are safe, efficacious, and reversible in wild burros, though they have not been studied as extensively in burros compared to wild horses. Potential impacts of fertility control on herd health, social behaviors of individual animals, genetic diversity and animal well-being would likely be similar between wild horses and burros though, due to different social structure, impacts to harem groups would not be relevant to burros. The potential impacts of fertility control on genetic diversity of burro herds should be carefully monitored, however, given the small size of many of the remaining herds, with 45 percent managed for a high AML of only 0–49 animals.

Ultimately, the impacts, including any alleged negative consequences, of fertility control treatments indisputably pale in comparison to the significant and permanent impacts inherent to roundup and removal operations. By limiting breeding while ensuring the integrity of herd and band social dynamics, immunocontraception can remove much of the adverse physical, behavioral, social, and psychological impacts of roundup and removal operations while reducing the economic costs of caring for an increasing number of wild horses in short and long-term holding facilities.

Sterilization: The WFRHBA explicitly references sterilization as a management option for wild horses and burros. For this analysis, sterilization is considered to be permanent and either accomplished chemically or through surgical procedures (i.e., gelding, vasectomies, or spays) and includes the establishment of non-reproducing populations. The creation of non-reproducing populations of wild horses or burros, either as stand-alone populations or by creating a portion of an intact population that is non-reproducing has recently been subject to various BLM proposals. Legally, given the mandate to ensure that wild horse and burro herds are self-sustaining, the creation of whole, non-reproducing herds is illegal and won’t be subject to any further discussion. The legality of the concept of adding non-reproducing animals (i.e., gelding, vasectomized stallions, and/or spayed mares) to an intact, self-sustaining herd is less clear, though it would appear to be permissible as long as the intact population is self-sustaining and its long-term health, including its genetic diversity, is preserved.

To date, although the BLM has engaged in or permitted experiments that have included vasectomizing stallions in the wild and geldings all stallions that are captured and removed from the range, it has not employed the broad-scale use of sterilization as a management strategy for wild horses and burros.

Effectiveness: If the objective is to control reproduction and either slow, stop, or reverse a herd's growth rate, sterilization via gelding, vasectomies, or spays is highly efficacious and permanent.

Herd health: As previously mentioned, if a wild horse or burro herd is at a size that is triggering density-dependent effects, the use of sterilization procedures to slow, stop or reverse herd growth could, in time, benefit the herd and overall herd health by reducing the number of animals in the herd and intra-specific competition for forage, water, cover and space. However, such procedures may not provide a benefit to the herd at all if habitat conditions are poor and continue to deteriorate, the area is affected by a severe drought or large fire, or if the number and density of other animals – wild or domestic – is so high or increases in size to prevent rangeland recovery. Assuming no significant changes in these other variables, sterilization like the use of fertility control will, in time, provide benefits to herd health by creating the conditions that will likely improve the physical condition of herd members, reduce intra- and inter-specific competition, and aid in restoring range condition (if diminished or deteriorated).

The WFRHBA would prevent the BLM from sterilizing an entire herd of wild horses or burros since, if it were to do so, that herd would no longer meet the statutory mandate of being self-sustaining. Consequently, if sterilization procedures were used as a management alternative, sufficient breeding would have to be allowed to sustain the population long-term within the scientifically justified AML range. For some animals, those who are not sterilized, breeding behaviors, gestation, foaling and all of the behaviors and inherent psychological benefits to individual animals and bands or groups would continue.

Genetic diversity: Any wild horse or burro who is gelded, vasectomized or spayed cannot and will not ever contribute to the genetic diversity of the herd after they have been altered. If they have already bred and are responsible for one or more offspring raised to independence, the loss of their genetic contribution to the herd may not be of importance, depending on their genetic uniqueness, the herd's characteristics, and the herd's genetic health.

If the herd is genetically homozygous yet one or more horses have a high level of genetic diversity, their loss as a result of sterilization would generally be of more importance than the loss of an inbred or highly homozygous individual. If the individual animal has a high level of allelic diversity, then his or her loss to the population as a consequence of sterilization would generally be greater than the loss of an individual horse or burro demonstrating minimal allelic diversity. Or, if the animal has a low kinship value, his or her loss would be more critical than an animal with a high kinship value (Eggert et al. 2010).

The reality is that, depending on the measure of genetic health or diversity used (i.e., heterozygosity, allelic diversity, or kinship value) different individual animals and different herds would have different values to the genetic health and diversity of a harem group, herd, or metapopulation. In addition, phenotypic variables, including color, pattern, and any evidence of deformities, would be other considerations that must be evaluated when determining how sterilization could impact the genetic diversity of a herd.

Herd size is also a critical consideration. In general, the smaller the herd size the larger the potential impact of sterilization on genetic diversity. The BLM reports that herd sizes of 150–200 are necessary to attain a genetic effective population size of 50. This assumes that the reports of the effective population size being 30–35 percent of the total herd population size are accurate. Yet, as previously explained, the majority of wild horse and burro herds are managed at numbers below this "ideal" as identified by the BLM.

If a herd of wild horses managed for a high AML of 100 animals had 25 animals removed and replaced with 25 sterilized/non-reproducing animals, the impact to the genetic diversity of the herd would, under most circumstances, be far greater than if this were done to a herd with a total estimated census size of 400 animals. This is because such a manipulation would further reduce an already low effective population size in the smaller herd. However, if the herd size was retained at 100 intact individuals but 25 non-reproducing animals were added to the herd, the impact on the genetic diversity of the herd would likely be negligible or non-existent, assuming that the breeding behaviors and social dynamics of the reproducing component of the herd remained intact. Consequently, while creating mixed herds with both reproducing and non-reproducing animals may be consistent with the law, the non-reproducing component must not be counted toward AML (particularly in smaller populations) to avoid further compromising the genetic diversity of the herds.

Social behavior: The impact of sterilization on the social behavior of horses or burros is dependent on the procedure used. Gelded horses may still attempt to obtain and defend harems but their drive and ability to breed will be diminished if not entirely eliminated while, in time, they are likely to lose the traits and behaviors necessary to defend a harem. Vasectomized stallions have been proven to be able to successfully create and defend harem groups for at least two years, but it is less clear whether they will be able to retain their harem groups over a longer time period (Asa 1999). While they still will be able to copulate, they will not be able to impregnate mares. Some breeding will still occur in the herd unless all males are gelded or vasectomized (an unacceptable scenario) indicating that some amount of "normal" reproductive behaviors by mares and between mares and non-sterilized stallions will continue.

Though spaying of mares would seemingly be less likely given the invasiveness of the procedure, the procedure used (i.e., ovariohysterectomy, hysterectomy, or tubal ligation) would likely affect the impacts to the treated animal's behavior. Procedures that impact hormone productions and levels in the mare all influence behavior. Indeed, any sterilization procedure on a stallion or mare that affects hormones will inevitably result in behavioral changes.

While fertility control will inevitably cause some behavioral impacts, because of the reversibility of such treatments, the behavioral impacts will likely be less than those associated with the more permanent behavioral impacts inherent to sterilization. The more relevant question is not whether such treatment options will result in behavioral impacts but whether the benefits that the treatments provide to individual horses and burros, wild horse bands, and entire herds outweigh the potential behavioral effects. Considering the option of remaining on the range versus being captured and removed from the wild, treatment, preferentially using fertility control, would appear to have the most benefits with the fewest short- and long-term consequences for wild horses and burros.

Animal well-being: Sterilization is likely to improve animal well-being, both at the herd level (by reducing herd growth rates) and at the individual level (by reducing the energetic costs of breeding and, for mares, the additional costs of lactation and offspring defense). The individual benefit to a vasectomized horse is probably less since he will continue to try to create and/or defend harems at least over the short term and will continue to copulate with mares as if he were an intact animal. For geldings, they will likely demonstrate far less, if any, interest in breeding, which may result in energy savings that can translate into improved condition. For mares, if spayed or if not successfully impregnated by a stallion (i.e., if stallions were sterilized), reducing the costs of pregnancy, lactation, and offspring care and defense will likely, as has been documented in mares treated with immunocontraceptives, improve their condition and increase their longevity.

Burros: The use of sterilization techniques on burros (jacks or jennies) will entail some of the same impacts as discussed with wild horses. The disruption of hormonal production, for example, would trigger behavioral changes in burros just as it would in wild horses. Overall, the behavioral impacts of sterilization to individual burros or burro herds would depend on the procedures used (i.e., gelding, vasectomy, spaying) and the proportion of animals treated. Whether such changes would caution against employing such procedures depend, again, on a full assessments of the potential benefits and costs of sterilization and other management options to individual animals and the overall herd.

In regard to genetic diversity, since burros utilize a different breeding strategy compared to wild horses – whereby more reproductively active burros are able to breed – the ratio between total herd size and effective breeding population size is smaller. Nevertheless, sterilization can adversely impact burro genetic diversity depending on the proportion of the animals in the herd sterilized and, consequently, the number and genetic makeup of the intact animals remaining to breed. Considering that the majority of remaining burro herds in HMAs are managed for a high AML of 149 or less, significant caution must be taken if sterilization procedures were to ever be employed on burros to avoid adverse impacts to genetic diversity. A breakdown of existing high AML numbers for wild burro herds indicates that of the only 31 HMAs that are managed for wild burros, 26 (84 percent) are managed at a high AML of 149 animals or fewer. More specifically, 45 percent (14 of 31) are managed for a high AML of 0–49, 16 percent for a high AML of

50–99, 22.5 percent for a high AML of 100–149, 6.5 percent for a high AML of 150–200, 6.5 percent for a high AML of 201–300, and 3.2 percent for a high AML of ≥301.

Since burros, with one notable herd exception, don't form harem groups, sterilizing male burros may be more likely to result in a reduction in the herd's growth rate, depending on the proportion of the male burros sterilized and assuming that sterilized burros continue to defend territories at least when female burros in estrous are in the territory. Unless all the male burros were sterilized, breeding would still occur but it would require an intact male gaining access to a female in estrous traversing his territory. Since one intact male burro can impregnate any number of females, the herd growth rate would depend on how many female burros in estrous traverse the territories of intact male burros. If female burros were spayed, then they likely would benefit in regard to their fitness, condition, and potentially longevity by eliminating the costs of pregnancy, lactation, and offspring care and defense.

Sex-ratio adjustment: In nearly every BLM roundup plan, the BLM includes as part of its proposed action the manipulation of a herd's sex ratio to favor males over females. Whether the manipulation actually occurs depends on the number of horses that the BLM proposes to remove to achieve low AML and gather efficiency. If not enough horses are gathered to achieve low AML, then presumably few to no animals are released back into the wild. If more than enough wild horses are captured in order to achieve low AML, additional animals can be selectively released to skew the sex ratio in favor of males. Though the BLM always promotes sex-ratio manipulation as part of a package that includes the proposed use of immunocontraception, this analysis evaluates sex-ratio manipulation as a separate, stand-alone management tool and it is important to do so. If fertility control and sex-ratio manipulation were evaluated together, the effectiveness, impact to herd health, genetic diversity, social behaviors, and animal well-being would be far different than in evaluating either management option separately.

Effectiveness: The BLM utilizes sex-ratio manipulation to theoretically reduce the annual growth rate of a wild horse herd by reducing the proportion of females in the population. Even with the polygynous breeding system of wild horses, the fewer the number of reproductively active females in the population (particularly since twinning is very rare in horses) the smaller the number of foals produced each year. Consequently, the manipulation of sex ratios to favor males is likely to reduce herd annual growth rates. Nevertheless, even the BLM is not convinced that sex-ratio manipulation will achieve the desired results (considering that, in its own Handbook, it claims that the affect of such manipulations should be monitored to assess effectiveness). In addition, since the sex-ratio at birth is generally 1:1, efforts to manipulate the population must be ongoing to retain the desired sex-ratio.

Herd health: As with fertility control and sterilization, if a wild horse herd is so large as to compromise the health of its habitat and the individual animals themselves, and if the manipulation of a herd's sex ratio to favor males reduces the annual growth rate of the population, the potential benefits to herd health are positive. However, it is unclear how sex-ratio manipulation may influence the level of agnostic interactions between stallions and mares. If the larger number of stallions with harem groups reduced inter-band aggression, this would seemingly benefit individual animals, group health and the health of the larger herd. If, however, the larger overall number of stallions in the herd increases intra- or inter-group agonistic events or such events between dominant stallions and bachelor males attempting to take over a harem or engage in breeding, this could have adverse consequences for individual animals, group stability and structure, and social dynamics of the entire herd.

Genetic diversity: With more stallions in the population it is anticipated that this will result in a larger number of harems groups containing a smaller number of animals (Coates-Markle 2000). This is a product of a larger number of stallions competing over a smaller pool of mares. If this occurs, then the effective population size may increase, as a larger proportion of stallions in the population may have breeding opportunities which – depending on the genetic pedigree of those breeding and the overall herd – could increase the herd's genetic diversity. The actual level of benefit depends, however, on the actual proportion of stallions who are successfully impregnating receptive mares.

In stable harem groups, the dominant stallions may sire all foals. Or, as has been documented, he may sire only 65 percent of the foals born to his mares with the remaining foals sired by other subordinate stallions (who are part of the harem group) or by bachelor group males. From a genetics management perspective, in general it is preferred if subordinate and bachelor males are contributing their genes to the population by copulating with mares. Presumably, given the limits of a stallion's ability to defend his harem, the larger the harem group the more likely it is that sneak copulations can be achieved by bachelor or subordinate stallions or that mares can move (by force or voluntarily) from one harem group to another. Consequently, though a larger number of smaller harem groups would theoretically benefit the genetic diversity of the herd, if the dominant stallion is better able to defend the mares in the smaller harem groups from sneak copulations from his subordinates, it is not clear if sex-ratio manipulation to favor males will actually increase the herd's genetic diversity.

Social behavior: As previously indicated, the anticipated result of skewing a herd's sex ratio to favor males is a larger number of smaller-sized harem groups. As a stand-alone management strategy, while manipulating the sex-ratio of a herd will not entail all of the same potential behavioral impacts as would sterilization or fertility control – since no animals would be rendered permanently or temporarily infertile – effects to individual, group or band, and herd social behaviors are still likely. The frequency and severity of agonistic interactions, for example, may change with more stallions competing for mares and controlling harems. If such interactions, in turn, cause mares to engage in harem-switching behaviors, this could result in an increase in mare-on-mare aggression as the composition of harem groups change. Any increase in aggression – intra- or inter-band – can result in adverse consequences to individual animals, groups or bands, and an entire herd's social dynamics.

Animal well-being: As indicated above, the primary concern for animal well-being in regard to sex-ratio manipulation is the potential of an increase in aggressive or agnostic interactions among wild horses and burros. Such interactions can occur between stallions, between stallions and mares, or between mares, and can have adverse consequences for those involved.

Burros: The use of sex-ratio manipulation in the control of burro populations is not commonly promoted by the BLM. While, theoretically, using this method will result in a lower proportion of females or jennies on the range and will reduce annual herd growth rates, some of the impacts that could occur to wild horses may or may not occur in wild burros. For example, since wild burros, with one notable herd exception, don't form social groups (i.e., harem groups) and tend to live alone (with the exception of mother-offspring pairs and when seasonal conditions compel burros to concentrate near water), the potential for increased agonistic interactions if sex-ratio manipulation were used would be less compared to wild horses. This is not to suggest that there could not be impacts, but only that the impacts would not necessarily be the same for both species.

Conclusion: Each of the management strategies addressed in this section can result in impacts, beneficial or adverse, to herd health, genetic diversity, social behavior and animal well-being. While many of these potential impacts have not been adequately studied or sufficiently quantified, it is clear that some management options (i.e., roundups and removals) impose more significant impacts on wild horse and burro populations than do other options (i.e., fertility control). When assessing such impacts, it is imperative that the collective impacts of all management options be evaluated so that the benefits and consequences of each option can be compared versus assessing the impacts of only one management alternative and making management decisions based on that limited analysis.

Recommendation:

The BLM should, in cooperation with academic institutions, other federal agencies, or independent scientists, engage in more substantial and quantitative studies of the impact of these various management alternatives on wild horse and burro herd health, genetic diversity, social behavior, and animal well-being. The need for such research, however, should not delay the implementation of the use of fertility control to begin to slow herd growth rates, reduce or eliminate the need for roundup and removal operations, and ultimately reduce the number of animals being sent to short- and long-term holding facilities and the associated costs thereof. While it may be perceived as risky to implement fertility control while there remains some question about the impacts of such treatments on certain aspects of wild horse and burro behaviors and/or demographics, the reality is that fertility control must be implemented urgently on a broad scale to reduce the numbers of animals being removed from the range and the costs of the short- and long-term care programs.

G. Immunocontraception of wild horse mares (porcine zona pellucida): *Evaluate information related to the effectiveness of immunocontraception in preventing pregnancies and reducing herd populations. Are there other fertility control agents or population control methods the BLM should consider (for either mares or stallions)?*

Various methods of fertility control have been subject to extensive study for potential use in a number of animal species, including an ark of captive animals in zoological parks, white-tailed deer, elk, seals, wild horses, and wild burros. For some, the side effects, delivery systems, or costs were not conducive to field application, while others have been used effectively by scientists worldwide.

The need for an efficacious and safe fertility control agent is particularly urgent for species such as wild horses and burros, that can exceed management or cultural carrying capacities and/or for which lethal forms of management are unavailable, controversial, or unsafe. Furthermore, in wild horses and burros, given the vagaries in the adoption demand for these animals, alternative methods are needed to reduce or reverse herd growth rates on the range in order to reduce the need for roundups, maintain social dynamics/relationships on the range, and to ultimately reduce the number, and cost of maintaining, animals in short- and long-term holding facilities.

For the purpose of this analysis, the focus is on fertility control studies involving wild horses and/or burros. Though there is extensive literature published on the use of fertility control agents, including immunocontraception, in other wild species, few of those studies are cited herein.

Fagerstone et al. (2010) provides a summary of a number of types of fertility control agents, regulation of their use in the United States, the economics of fertility control, potential implications of such use, and public perception of the technology. The EPA is responsible for wildlife contraceptives in the United States. Given the limitations of the Federal Insecticide, Fungicide, and Rodenticide Act, wildlife immunocontraceptives are categorized as “pesticides” even though they clearly are not intended for such use. The EPA registration process requires submission of studies on product chemistry, toxicity, non-target hazards, environmental fate of the product, and its efficacy (Fagerstone et al. 2010). At present, there are three contraceptive products registered by the EPA for use on wildlife, including OvoControl G for use on Canada geese and pigeons, GonaCon or GnRH for use on white-tailed deer, and Zonastat H or PZP-22 for application to wild horses. Other immunocontraceptive agents can continue to be used on an experimental basis on free-ranging wildlife, though authorization is required from the EPA and, in many cases, from state authorities.

All forms of fertility control, from vasectomy to immunocontraception, are considered herein, though the focus is on immunocontraceptive vaccines given their safety, efficacy, use, and reversability in wild horses and burros. For the purpose of this analysis, each type of fertility control tool or agent is evaluated, with immunocontraception being evaluated first. As discussed in more detail below, any alleged or potential negative consequences of each fertility control strategy must be weighed against the benefits in comparison to other management alternatives. Finally, a brief summary of some of the models developed to evaluate the impact of contraceptive treatments on wild horses and burros is provided.

The use of any fertility control or immunocontraceptive agent is not without potential impacts, positive and negative. Though a number of studies have concluded that immunocontraceptive vaccines have resulted in little to no meaningful adverse impact on wild horse health or behaviors, fundamentally any effort to prevent breeding or successful conception in any species will have potential behavioral, psychological, physiological, and other impacts (Garrott 1995). Given the complexity of the social structure of wild horse herds, any and all management actions can have implications, including positive affects, on the individual, band, or entire herd. Such affects should be objectively and equally evaluated and compared in any management strategy (Ransom et al. 2010).

If assessments on the animals' welfare (behavioral, psychological, physiological and pathological) were done as a routine part of any decision-making process, there is little question that fertility control would consistently be deemed the least disruptive of all existing management alternatives. For example, when comparing immunocontraception treatments to roundups and removals, the likelihood of mortalities or injury to wild horses or burros is far less with immunocontraception (even if the animals have to be gathered to administer the vaccine since the animals would be treated and released and not subject to transport and repeated handling), the disruption to the herds' social structures would be substantially less, the variability or fluctuations in herd size would be less, the frequency of any needed roundups would be less, and the direct, indirect, and cumulative costs would be less.

In this particular case – the management of wild horses and burros – such equitable evaluations are even more critical since these species, unlike nearly all other wild species, are not allowed to freely roam across an ecosystem and because other forms of management (i.e., hunting) are not (and should not ever be) permitted as a form of management.

Potential side effects of immunocontraception include physiological effects, behavioral effects, population impacts, and evolutionary impacts (Nettles 1997, Magiafoglou et al. 2003, Cooper and Larsen 2006). Though many studies documented changes in physiology or behavior, most studies found no changes to activity, movements or rank of treated females, suggesting that such changes may not have welfare implication to individual animals and that any welfare impacts are likely far less than such impacts inherent to other management alternatives (Kirkpatrick 2007).

Immunocontraception:

Kirkpatrick and Turner (1991) identify the characteristics of the ideal contraceptive to include: a high degree of effectiveness; a lack of toxicity and harmful side effects, particularly to pregnant animals; reversibility and a flexible duration of action, to preserve the reproductive and genetic integrity of the target animals; low cost; minimal or no effect on social organization or behaviors; remote delivery, preferably with a single administration; and an inability of the contraceptive agent to be passed from treated animals to predators, scavengers, or humans through the food chain.

There are three primary immunocontraceptive agents that have been tested on captive and/or wild horses. They are gonadotropin-releasing hormone (GnRH) (marketed as GonaCon), SpayVac, and porcine zona pellucida (PZP). SpayVac is a PZP based vaccine that incorporates PZP into a multilamellar liposome. The following provides evidence about the safety and efficacy of the use of these vaccines on wild horses and, where applicable, wild burros. Information about how each of the vaccines specifically function to reduce fecundity is not provided here.

In general, when considering the use of contraceptives in wild, free-roaming animals, there are three factors that limit what level of treatment can be achieved: the proportion of animals that can be detected, the proportion of detected animals that can be treated, and the efficacy of the contraceptive agent (Garrott 1995). In an ideal scenario described by Garrott (1995), 90 percent of target animals can be detected, 90 percent of those can be successfully treated, and the vaccine is 95 percent efficacious. Even at those high levels, however, approximately 23 percent of the population remains reproductively active. For wild horses, given their polygynous breeding behavior and since contraceptives targeting male animals are not realistic for a variety of reasons addressed previously, the effectiveness of a contraceptive agent in stopping or slowing the annual growth rate depends on the proportion of mares accessible and treatable, the efficacy of the vaccine, and the duration of the vaccine's effectiveness.

PZP:

Wild horses were the first species to be subject to experiments using immunocontraceptive vaccines, specifically PZP. PZP's success as an immunocontraceptive agent has since been documented in a variety of species. As a reversible contraceptive agent, Barber et al. (2000) suggested that PZP would have advantages if it had high efficacy, lacked harmful side effects, could be remotely delivered, required minimal number of treatments, provided at least 12 months of activity, and was cost effective. PZP satisfies each of these criteria though, to reduce costs, longer-lasting vaccine treatments have become available.[13]

The use of PZP as a management tool for wild horses on Assateague Island National Seashore has been remarkably successful and subject to considerable study. In this case, not only has PZP use slowed and stopped the growth of the herd but, over time, herd sizes have declined due to natural attrition of the population. While this has required time and patience to achieve the current results, this is a case where

[13] PZP use in a variety of species including wild horses and burros has been subject to extensive study and, consequently, there is more published literature on the safety, efficacy, and affects of PZP on wild horses and burros than exist for the other immunocontraceptive vaccines. This should be taken into consideration when reviewing the following information.

immunocontraception (PZP) alone is contributing to the achievement of management objectives for the wild horse herd and, simultaneously, reducing the impact of the horses on the island ecosystem. As indicated below, however, PZP has been utilized in a variety of herds beyond Assateague Island with success – in all such trials.

As reported by Kirkpatrick et al. (1997), a foaling rate of 3.8 percent was found in 14 of 26 Assateague Island mares vaccinated with PZP emulsified with Freund's Complete Adjuvant (FCA) and then treated several weeks later with a booster vaccine containing PZP combined with Freund's Incomplete Adjuvant (FIA). Twelve horses given the initial treatment were not treated with the booster vaccine. Two years prior to treatment, 53.8 percent of the treated mares had foaled. For comparison, the foaling rate was 50 percent in control mares (n=6) and 45.4 percent in untreated mares (n=11) (Kirkpatrick et al. 1990, Kirkpatrick et al. 1995a). Subsequent vaccine booster treatments extended the duration of contraceptive effect without altering social organization and behaviors (Kirkpatrick et al. 1991; Kirkpatrick et al. 1992). The vaccine was also found to have no impact on the birth of healthy foals among mares treated during the third trimester of pregnancy. Treated horses did, however, show a marked improvement in overall health condition due to the lack of stress associated with pregnancy and lactation (Kirkpatrick 1995). Furthermore, reversibility was demonstrated in mares treated over three consecutive years (Kirkpatrick et al. 1997), though prolonged PZP treatments can cause an alteration in estrous cycles in horses (Kirkpatrick et al. 1992) as well as in other species.

In their experiment administering PZP treatments to free-roaming wild horses in Nevada, Turner et al. (1997) documented 4.5 percent (2 injection protocol; n=60), 20 percent (1 injection protocol; n=21) and 28.6 percent (1 injection with microspheres protocol; n=22) reproductive success in treated mares in year one, compared to 55 percent and 53.9 percent in placebo (n=19) and untreated mares (n=63), respectively. For the twice-injected group of horses, in year two with no further treatment, reproductive success was 44 percent for the twice-injected mares compared to 50 and 54.5 percent in the placebo and untreated mares, respectively. In a related study, 20 wild mares were captured in Nevada and vaccinated (via hand injection) with a single dose containing 65 mg of PZP emulsified with FCA together with another 65 mg dose contained in microspheres. In 1994, 14 of the 20 mares were relocated and four (28.6 percent) had foals compared to >50 percent of control mares with foals (Turner et al. 1996b, Kirkpatrick et al. 1997). In that same year, 14 mares on Assateague Island were vaccinated using the same dosages via darts. Only 2 of the 14 mares subsequently had foals, though for one of these, this was due to the failure of the dart to inject the vaccine (Kirkpatrick et al. 1997).

In another study involving the use of microspheres, Turner et al. (2005) experimented with a one-inoculation vaccine that was intended to extend the duration of efficacy of the vaccine. In this experiment, 96 wild horse mares were treated with a single inoculation of PZP emulsified with FCA along with controlled release pellets containing variable doses of PZP (70, 90, and 250 mg) along with the QS-21 adjuvant. The variable doses of PZP were linked to the expected release delay (by month) of the vaccine, with the doses corresponding to an expected 1-month (70 mg), 3-month (90 mg), and 12-month (250 mg) delay. The fertility rates for treated and untreated mares from 2001 through 2004 were 5.2 versus 53.6 percent (2001), 14.9 versus 58.5 percent (2002), 31.6 versus 55 percent (2003), and 46.2 versus 51.8 percent (2004).

Due to concerns associated with the use of FCA as an adjuvant (Warren et al. 1993), Willis et al. (1994) tested a PZP formulation that used a synthetic adjuvant (trehalose dicorynomycolate glycolipid) in place of FCA. Three captive mares were administered the vaccine via biobullet in two doses – an initial dose and a booster separated by one month. Four control mares were treated with biobullets containing the synthetic adjuvant only. Among the three treated mares, one of seven breeding attempts resulted in pregnancy (14.3 percent) while, for the control mares, 75 percent (3 of 4) became pregnant. In year two (though the experimental treatment was only delivered once at the beginning of the experiment) none of the treated mares became pregnant despite 12 breeding attempts, while all of the control mares were impregnated. These results are consistent with the results of other studies that delivered PZP using other mechanisms (Liu et al. 1989, Kirkpatrick et al. 1990, Kirkpatrick et al. 1991, Kirkpatrick et al. 1992). Willis et al. (1994) also found that the use of biobullets resulted in no abscess formation or any other clinical problems and, therefore, concluded that this technology (i.e., delivery of PZP via biobullet) meets many of the characteristics of an ideal vaccine: need for only periodic treatments, lack of expense, remote delivery, safety for target and non-target species, and no hazard to the environment since biobullets are biodegradable.

PZP has also been used successfully in wild burros. Turner et al. (1996) successfully contracepted burros with PZP in Virgin Island National Park, on St. John in the Lesser Antilles. In this study, 16 burros were remotely vaccinated with PZP using either a single-injection protocol (n=3) employing a vaccine and microspheres, or a two-injection protocol (n=13) with an initial injection followed by a second injection a few weeks later. Both groups of treated burros received booster vaccines 10-12 months later. Eleven burros were used as untreated controls. In the treated burros, none produced foals during the one-year period after receiving the booster vaccine, though one tested positive for pregnancy based on fecal analysis but was never subsequently observed with a foal. Among untreated controls, 54.4 percent (6 of 11) tested pregnant and four were subsequently observed with foals. Within the 12-24 month period after the booster vaccinations, pregnancy rates were similar among PZP-treated (6 of 13, or 46.1 percent), untreated (3 of 6, or 50 percent), and randomly sampled jennies (15 of 33, or 45.5 percent), demonstrating contraceptive reversibility. In addition, Turner et al. (1996) found no discernible difference in reproductive behaviors between the treatment and control groups.

Kirkpatrick et al. (2011) provide a comprehensive summary of the safety, efficacy, and other characteristics of immunocontraceptive vaccines when used on wildlife (see also Gray and Cameron 2010). For PZP, Kirkpatrick et al. report that the lack of cross-reactivity between the zona proteins and other tissues and protein hormones is an advantage. In addition, the fact that the action of the PZP vaccine is so far "downstream" in the reproductive process (i.e., preventing sperm binding with egg), the "sequelae of reproductive events that are disrupted are inconsequential." PZP impact on ovarian endocrine function and estrous cyclicity showed no permanent or significant changes even after long term-treatment (Kirkpatrick et al. 1992, Kirkpatrick et al. 1995, Powell and Monfort 2001, Kirkpatrick et al. 2011).[14]

Furthermore, PZP's contraceptive effect is safe in pregnant mares (Kirkpatrick et al. 2002, Kirkpatrick et al. 2003), is reversible as least through five consecutive years of treatment (Kirkpatrick et al. 1992, Kirkpatrick et al. 1995, Kirkpatrick et al. 2002), improves body condition and longevity in mares treated chronically (Turner and Kirkpatrick 2002, Kirkpatrick and Turner 2007), and demonstrated no significant changes in fundamental wild horse social organization or behaviors (Powell 1999). Indeed, on Assateague the benefits of PZP on wild horse longevity resulted in the creation of a wild horse age class (>25 years) that did not previously exist.

Consequently, Kirkpatrick et al. (1997) concluded that PZP has "great potential" as an immunocontraception agent in many wildlife species because of its efficacy (>90 percent), remote delivery capability, reversible effects after short-term use, an apparent lack of debilitating side effects on horse health even after long-term treatment, minimal impact on social behaviors, and the vaccine or antibodies it produces can't be passed through food chains.

In his study of the effects of PZP vaccination on the behavior of wild horses on Assateague Island National Seashore, Powell (1999) concluded that there were "no significant differences between treated and untreated mares in general activity budget, aggression given or received, and spatial relationships relative to the stallion," demonstrating that PZP contraception "seems to have no acute behavioral effects on the behavior of individuals."

Ransom et al. (2010) examined the impact of immunocontraception (PZP) on wild horse individual and social behaviors in three discrete populations: Little Book Cliffs Wild Horse Range, McCullough Peaks HMA, and Pryor Mountain Wild Horse Range. They found that treated and control mares allocated a similar amount of time for feeding, resting, moving, and maintenance behaviors. While no difference was seen in the body condition between treated and control mares, mares with foals were, as expected, in poorer body condition. The high-condition mares spent 11.4 percent less time feeding, 6 percent more time resting, nearly 1 percent more time in maintenance activities, and showed a 1.8 percent increase in social behaviors compared to the low-condition mares.

In contrast, Madosky (2011) and Nunez et al. (2009) concluded that PZP treatments of wild horses on Shackleford Banks led to an increase rate of harem-switching behaviors and an increase in reproductive behaviors during the breeding and non-breeding season. Numerous other studies have failed to observe such impacts and these conclusions have been criticized. Kirkpatrick et a. (2011), reports that the band fidelity study by Nunez et

[14] Kirkpatrick et al. (1992) did find that after three years of treatment, effects on ovarian function included lower ovulation rates and depressed estrogen levels. This decline in estrogen production and ovulation rate continued in mares treated with PZP for up to seven years, although most mares continued to cycle at least intermittently (Kirkpatrick et al. 1995, Powell and Monfort 2001).

al. (2009) “was not controlled for pregnant animals or mares that had foals removed annually” while the conclusions regarding time budgets are not entirely unexpected given changes in body condition among treated animals. Ransom et al. (2010) also found evidence of increased incidents of reproductive behaviors from stallions, but explained that such differences should be expected due to the higher rates of estrous reported in PZP-treated females of other species as compared to control females (Mahi-Brown et al. 1985, Shumake and Wilhelm 1995, Heilmann et al. 1998, Curtis et al. 2002). Furthermore, any differences in the activity budgets of horses subject to immunocontraceptive treatments are expected, based on the pregnant/lactating or barren condition of mares and the correlative impacts to body condition (Boyd 1988, Henneke et al. 1984, National Research Council 2007, Ransom et al. 2010, Kirkpatrick et al. 2011).

In terms of herding behavior, Ransom et al (2010) found no difference in the rate of herding behavior of control versus treated females, though harem mares without a dependent foal were herded approximately 50.9 percent more than resident females with a foal. Treated and control mares received harem-tending and agonistic behaviors from stallions equally (though at a low rate of only 0.04 incidents/hour) while treated mares received 54.5 percent more reproductive behaviors from stallions than control mares. Ultimately, Ransom et al. (2010) concluded that the “direct effects of PZP treatment on the behavior of feral horses appear to be limited primarily to reproductive behaviors and most other differences detected were attributed to the effect of body condition, band fidelity, or foal presence” and that “PZP is a promising alternative to traditional hormone-based contraceptives and appears to contribute few short-term behavioral modifications in feral horses.”

Injection site reactions with PZP are uncommon, particularly when the vaccine is injected into the rump or hip. Concern has been expressed about the use of FCA as an adjuvant (Warren et al. 1983, Lyda et al. 2005) due to the potential of false tuberculosis-positive tests in some treated species (not equids) and potentially adverse injection site reactions. However, since 1998 Freund’s Modified Adjuvant (FMA) has become the adjuvant of choice (Lyda et al. 2005). While injection site reactions remain possible with FMA or FIA, they seldom occur in more than 1 percent of animals treated (Lyda et al. 2005).

In their study of injection site reactions in three populations of wild horses treated with PZP emulsified with FCA, FMA, or FIA, Roelle and Ransom (2009) found “a single nodule, two instances of swelling, and no other reactions,” in over 100 hand injections to horses at all three study sites. In the two herds where the vaccine was delivered remotely by dart, reactions were documented as 1 and 6 percent for abscesses, 25 percent for nodules (both herds), 11 and 33 percent for swelling, and 1 and 12 percent for stiffness. Though nodules were the most frequent reaction observed, there was no evidence that they altered the animal’s range of movement or locomotion pattern in any way different than naturally occurring injuries or scars. Nodules persisted the longest (up to 1,337 days), while swelling subsided within 30 days post-injection and most incidences of stiffness disappeared within 24 hours. A total of only eight abscesses (out of 306 total injections) were observed, with six of the eight appearing within 39 days post-injection and with most resolved within 90 days of treatment.

The minimal reactions observed by Roelle and Ransom (2009) are consistent with the evidence presented in other studies. Turner et al. (1997) hand-injected 60 mares with PZP and FCA and found no evidence of abscesses within the first 30 days post-treatment. Turner et al. (2001) hand-injected 95 mares with the same vaccine emulsion and another 60 mares with the emulsion mixed with a carbomer adjuvant, and no abscesses were observed during 13–17 days of captivity. Lyda et al. (2005) treated 15 mares (7 with PZP and FCA and 8 with PZP and FMA), as well as a booster of PZP and FIA 27 days later, and observed a single abscess in one horse after the booster vaccine. Similarly, in their work on Assateague Island, Kirkpatrick et al. (1990) documented three abscesses (among 70 injections) after administering a booster of PZP and FIA; abscesses that appeared within 48 hours post-treatment but healed within 14 days. Following several additional years of treatment, only two (Turner and Kirkpatrick 2002) or three (Lyda et al. 2005) were reported out of a total of 381 injections (Roelle and Ransom 2009).

Another common concern relevant to the use of immunocontraceptive vaccines is the impact on estrus behavior in treated animals. Though different immunocontraceptive agents such as PZP and GnRH are designed to operate differently in target animals, any vaccine that prevents conception may lead to repeated estrous cycles and/or extended duration of the estrus period. Even for GnRH, which is intended to prevent estrus entirely, there is evidence of some estrus activity among treated animals. Such repetitive estrous behavior can affect both treated mares and their stallions (by e.g., harassment of treated mares, increased bioenergetic expenditures, disruption in reproductive behaviors, increase in agnostic interactions, and the potential for births outside the typical foaling season) (Ransom et al. 2010).

Yet, in their study of estrus cycle characteristics in wild horses on Assateague Island, Powell and Monfort (2001) found no difference in estrus phase duration between currently treated and untreated mares over two years, though they lacked true controls (i.e., wild horses who had never been treated). Morevoer, in another study of the Assateague horses, Kirkpatrick and Turner (2003) examined past foaling records for individual horses and found that 69 of 91 (75.8 percent) of mares never treated with PZP had foals in April, May, and June (considered in season); 50 of 77 (64.9 percent) PZP-treated mares had foals in season; 20 of 29 (68.9 percent) mares that experienced contraception failures had foals in season; and 30 of 48 mares (62.5 percent) withdrawn from treatment after receiving treatment for more than two years had foals in season. In untreated mares, they noted that out-of-season births had increased from 12 percent in 1984 to 26 percent in 2001, which reflected an increase in variability as the wild horse population increased from 80 in 1984 to 173 in the early 2000s.

These findings are consistent with other studies of foaling periods. For example, also on Assateague Island, Keiper and Houpt (1984) reported that 88 percent of foals were born in season. For the Pryor Mountains, Feist and McCullough (1975) reported no births out of season, while on Sable Island in Canada, 77 percent of foals were born in season (Welsh 1975), with similar results reported by Boyd (1979) for horses in Wyoming's Red Desert and by Berger (1986) for horses in the Great Basin.

In addition, in examining foal survival records, Kirkpatrick and Turner (2003) concluded that survival rates did not differ for foals born in or out of season on Assateague Island. Of the foals born in season, 104 of 119 (92.9 percent) survived to age 1 while, for foals born out of season, 42 of 49 (85.7 percent) survived. Similarly, for foals born to mares never treated with PZP, 77 of 91 (84.6 percent) survived, which was not significantly different than the 67 of 77 (87 percent) survival for foals born to mares treated sometime before the foal's birth. These results, however, may only be applicable to horses occupying barrier islands and may not be valid or predictive for horses that occupy more mountainous terrain with harsher climatic patterns (Kirkpatrick and Turner 2003).

GnRH:

GnRH has been successfully applied as a contraceptive agent in a number of mammalian species, including domestic cats (Levy et al. 2004), domestic and feral swine (Killian et al. 2003, 2006c; Miller et al. 2003), wild horses (Killian et al. 2004, 2006a), bison (Miller et al. 2004a), and white-tailed deer (Miller et al. 2000c). It is currently registered by the EPA as a contraceptive for use in adult female white-tailed deer (Fagerstone et al. 2010).

Both GnRH and PZP (discussed below) are proteins and are rapidly digested in the stomach if administered orally. This also, contrary to claims made by opponents of immunocontraception, renders these vaccines and the antibodies that they produce in treated animals entirely harmless to any organism (including humans) that eats them (Miller et al. 1993).

One of the first attempts at using immunocontraception in wild horses occurred in 1986 on Cumberland Island, Georgia (Goodloe et al. 1996) though the results of this GnRH vaccine trial were not promising (Kirkpatrick et al. 2011). Goodloe (1991) reported that the use of GnRH with different adjuvants delayed but did not prevent ovulation. Warren et al. (1993) suggested that the difference between these study results could be caused by the type of adjuvant or conjugate used, or may be related to the number of booster vaccinations applied. Regardless, they concluded that the limited duration of effectiveness for this treatment option diminishes the practicality of using this method in wild horse population management. Conversely, Safir et al. (1987) tested GnRH on captive mares and demonstrated 60 percent efficacy in preventing ovulation for the five month duration of the study.

Killian et al. (2004, 2006, and 2008) reported on the results of a study that examined the efficacy of three fertility control treatments (GnRH, SpayVac, and IUDs) in wild mares provided by the State of Nevada.[15] The study included 8 control mares, 12 mares treated with SpayVac, 16 mares treated with GnRH, and 15 mares subject to IUD use, all of

[15] Though all three publications reported on the same study there were some differences in the reported results. Killian et al. (2004), for example, suggested that the number of horses used in the GnRH trial was 18 not 16 and that none of the GnRH horses became pregnant in year one versus one pregnancy in a GnRH-treated mare reported by Killian et al. (2006 and 2008). In addition, Killian et al. (2006) reported that in year three of the experiment, GnRH provided contraception of 8 of the 15 GnRH-treated mares in the study, not 9 of 15 as reported in Killian et al. (2004).

whom were maintained in captivity during the study. At the time, Killian et al. (2008) reported that little was known about the efficacy of GnRH to control fertility in mares or how the vaccine would impact ovarian function or behaviors (Dalin et al. 2002, Killian et al. 2004, 2006b; Imboden et al. 2006; Elhay et al. 2007).

For those horses treated with GnRH, efficacy of 94 percent (15 of 16), 60 percent (9 of 15), 60 percent (9 of 15), and 40 percent (6 of 15) was measured over the four years of the study. Comparatively, for the 8 control mares, 75 percent (6 of 8), 75 percent (6 of 8), 88 percent (7 of 8) and 100 percent (8 of 8) successfully foaled in years one through four, respectively. In addition, the incidence of uterine edema (a condition seen in healthy mares indicating that she is in heat and under the influence of estrogen produced by ovarian follicles (Sample 1997)) in GnRH-treated mares was similar to normal cycling mares, suggesting that the treated mares may have experienced some level of estrus activity.

Gray et al. (2010) tested SpayVac and GnRH in a population of wild horses in the Virginia Range in Nevada. They treated 24 horses with GnRH, 20 horses with SpayVac, 22 horses received the adjuvant only (AdjuVac), and 18 received no injection. GnRH treatments resulted in significant reductions in fertility for three years, with rates of 39, 42, and 31 percent per year.

In a study of the effects of GnRH on free ranging horses at Theodore Roosevelt National Park, Baker et al. (2012) vaccinated 29 adult mares with GnRH while 28 control mares received vaccinations of a placebo. There was no impact of the treatment in the first breeding season post-treatment (consistent with the safety of GnRH for pregnant animals), while in the second breeding season, treated mares were three times less likely to have foals compared to control mares. In the third birthing season post-treatment, 74 percent of control mares foaled while 48 percent of treated mares foaled. Furthermore, no treatment-related effects were observed on mare activity budgets and, though 80 percent of treated mares showed some visible swelling at the injection site 25 to 280 days post-treatment, by 380 days after treatment approximately half of these swellings were no longer visually detectable.

Kirkpatrick et al. (2011) identify a number of concerns associated with the use of GnRH as an immunocontraceptive vaccine. In wild horses, since wild horse social behavior is largely driven by reproductive steroids, the use of GnRH which essentially, albeit temporarily, results in a non-surgical castration, may consequently impact such behaviors. This could, in turn, result in disruption to group or band structure and subsequent impacts to individuals animals, harem groups, and potentially the entire herd. Though GnRH is known to cause abortions in select species, this does not include the horse. However, GnRH is recognized as a form of neurotransmitter and with GnRH receptors on a variety of tissues in mammals including the cerebellum (Lopez et al. 2007), bladder (Bahk et al. 2008), and cerebrospinal fluid (Skinner et al. 1995), its use can have physiological effects throughout the central nervous system (Kirkpatrick et al. 2011). Other potential impacts identified by Kirkpatrick et al. (2011) including impacts to the hippocampus which has been linked to Alzheimer-like syndrome, alteration in olfactory function, depressed activity in the cerebral cortex, and potential links to the genetically based disorders of Gordon-Holmes Syndrome and Boucher-Neuhauser Syndrome. Two studies have also documented GnRH impacts to cardiac tissue which is extremely rich in GnRH receptors leading to a greater risk for cardiac infarction (McCoy 1994, Schofield 2002).

It is not yet know if these documented impacts have any relevance to free-roaming or captive wildlife (Kirkpatrick et al. 2011). Yet, as explained by Kirkpatrick et al. (2011), "it becomes intuitive that vaccines that exert their influence further 'upstream' in the reproductive process and which have interactions with non-reproductive tissues will be more problematic than those with target tissue specificity and that exert their effects further 'downstream' in the reproductive process."

SpayVac:

As reported by Killian et al. (2008) in 12 captive mares treated with SpayVac, contraception rates over four years were 100 percent (12 of 12), 83 percent (10 of 12), 83 percent (10 of 12), and 83 percent (10 of 12), respectively. Based on titer analyses, there was evidence of a self-boosting effect in SpayVac treated mares in year four of the study. While these data indicate that the duration of effect of SpayVac may be longer than other immunocontraceptive agents, the limited number of horses returning to fertility even four-years post treatment and the potential self-boostering effect of the vaccine is disconcerting if reversal of vaccine effects is desired. Unfortunately, the reproductive status of these SpayVac treated mares was not monitored past four years post treatment.

Other studies had previously demonstrated the effectiveness of SpayVac in white-tailed deer and wild horses with a single shot vaccine (Fraker et al. 2002, Killian et al. 2004, 2006b). Killian et al. (2006 and 2008) concluded that mares vaccinated with SpayVac, based on high titer levels, may have remained infertile into a fourth year, for several additional years, or indefinitely. These results led Killian et al. (2008) to report that long-term contraception of mares is possible with the SpayVac PZP vaccine.

For mares treated with SpayVac, Gray et al. (2010) found fertility reduction rates of 37, 50, and 44 percent per year over the course of the three-year study. For comparison, during the same three-year period, 61, 67, and 76 percent of control females were fertile.

In addition, regardless of contraceptive used (SpayVac or GnRH), they did not observe any abscesses or evidence of inflammation at the injection sites in the mares after receiving the vaccine treatments. Nor were any impacts observed to the length of the foaling period. With the exception of two foals born in July, all other foals were born in April and May, which is consistent with other horse populations (Feist and McCullough 1975, Keiper and Houpt 1984, Berger 1986, Kirkpatrick and Turner 2003).

Gray et al. (2010) suggested that the higher fertility rates observed in their study compared to previous studies of contraception in wild horses (Kirkpatrick et al. 1990, Turner et al. 2002, 2007) could have been due, in part, to their more intensive monitoring of the horse population, thus permitting more accurate estimates of pregnancy and foal production. Since horses may abort fetuses throughout the year or may lose foals shortly after birth (Keiper and Houpt 1984, Lucas et al. 1991), Gray et al. (2010) report that if individual horses are not monitored closely, abortions or foal loss can be missed, resulting in the appearance of increased contraceptive efficacy. Another potential explanation for their findings is due to the inter-individual differences in responsiveness to the fertility control treatments (Garrott et al. 1998, Fayrer-Hosken et al. 2002, Frank et al. 2005). Finally, differences between the reduction in fertility rates among wild mares (Gray et al. 2010) and captive mares treated with GonaCon and SpayVac (Killian et al. 2008) were attributed to the likelihood of better nutrition among the captive mares, which may have increased the vitality of their immune systems compared to animals in poorer condition (Houston et al. 2007).

While SpayVac may provide a longer duration of effectiveness (i.e., at least three years following a single treatment) compared to the other vaccines, its efficacy when used in wild horses is less than that obtained using PZP. Furthermore, drawbacks to SpayVac, as identified by Kirkpatrick et al. (2011) include the high viscosity of the vaccine and the inability to deliver it remotely along with potential side effects on reproductive tissues (Killian et al. 2008). More specifically, in their study, uterine oedema was observed in 82 (9 of 11), 91 (10 of 11), 100 (10 of 10) and 70 (7 of 10) percent of treated horses in each year of the four year study (Killian et al. 2008). This incidence of uterine oedema was greater than what would be predicted for normal cycling mares. Furthermore, while repeated estrous cycles during the breeding season have been reported for PZP treated mares (Turner and Kirkpatrick 2002), those cycles were of normal length. In contrast, for mares treated with SpayVac, the high incidence of uterine oedema indicates abnormal estrous cycles (Killian et al. 2006). While Killian et al. (2004, 2006) ultimately concluded that the high incidence of uterine oedema did not adversely affect the treated mares, others have questioned whether this condition could contribute to an increase in uterine infections. Kirkpatrick et al. (2011) and Killian et al. (2006) recommend more extensive testing to assess the significance and implications of this high incidence of uterine oedema and to better characterize the estrous cycle of SpayVac treated mares.

Surgical procedures:

Early fertility control research tested standard surgical vasectomies of dominant stallions to determine the effect on foaling rates. Asa (1999) examined the ability to vasectomize wild stallions from the Beaty Butte HMA in southeastern Oregon and the Flanigan Herd Management Area in northwestern Nevada to control reproduction in their harems (see also Eagle et al. 1993). Her results indicated that, at least for up to three years post-treatment, vasectomized dominant male horses can reduce fecundity among their harem mares. Of the harems led by vasectomized males, 17 and 33 percent contained foals in years two and three, respectively, post-treatment. For non-vasectomized stallions who led harem groups, 86 and 80 percent of their mares foaled in those years. No effect of the treatment was measured in year one, since the vasectomies were conducted after the breeding season and, hence, the mares were already pregnant. These results were consistent with those of Kirkpatrick et al. (1982), who documented an 80 percent reduction in foaling for one year.

Asa (1999) suggested that the presence of foals in the harems led by a single vasectomized male horse appeared to be more likely the result of pregnant mares being added to the harem group instead of sneak copulation by bachelor stallions. Indeed, the majority of foals were observed in multi-stallion bands, suggesting that these foals were likely sired by subordinate males in the band. The breeding season also was longer in the groups containing the vasectomized stallion (breeding season extended into August) compared to non-vasectomized stallions (breeding season ended in May), as would be expected given the repeated cycling of mares who are not impregnated. Whether vasectomized or not, an extended breeding season would likely hinder the ability of a dominant stallion to consistently fend off competitors for harem mares.

Ultimately, the lack of stable bands and breeding by subordinate males are the fundamental elements that determine the success or failure of male sterilization in managing wild horse population growth (Natl. Res. Council 1982, Boyd 1979, Miller 1979, Nelson 1980, Wolfe 1982, Warren et al. 1997).
Though stable bands have been reported to be common (Kirkpatrick and Turner 1986), instability in bands has been documented in rapidly expanding populations (Berger 1986), when conditions are harsh (Miller 1981), and in response to management actions that disrupt wild horse herd or band social dynamics. In addition, though the dominant males in a harem are responsible for the bulk of the breeding, it is not uncommon for subordinate harem males or males from bachelor bands to mate with harem females. Bowling and Touchberry (1990), for example, determined that nearly 33 percent of the 121 foals they studied from 69 intact bands were sired by males who were not affiliated with the band at the time of capture.

Garrott and Siniff (1992) concluded that even if a high proportion of males are sterilized, repeated cycling of females provides many mating opportunities and reproduction is not curtailed as highly as expected (Garrott and Siniff 1992). Furthermore, this could also lead to a delay in the foaling period, which could result in increased foal mortality if foals are born late in the season and forced to enter winter without access to sufficient forage for themselves or their lactating mothers, or adequate body reserves to survive extended periods of nutritional stress (Garrott 1995). Consequently, even if this technique were used, either a large proportion of stallions would have to be sterilized due to mating by subordinate males or, whenever a stallion takes over a harem, that particular animal would have to be captured and sterilized (Slade and Godfrey 1982).

Steroidal contraceptives:

Kirkpatrick et al. (1982) found that a microencapsulated form of testosterone propionate (MTP) on wild stallions was effective in inhibiting fertility. The number of foals/mare was .371 in the control group and .066 in the treated bands, while the number of foals/band was.62 in the control and .28 in the treatment groups. Furthermore, for those behaviors monitored (i.e., elimination marking, mounting, copulation, herding, and aggression) no differences were found in the treated versus control groups in 1980 or 1981. In addition, Kirkpatrick et al. (1982) did not observe either harem switching or breeding by subordinate males in their study.

On Assateague Island, wild stallions were treated with MTP through the use of barbless darts. This resulted in a 28.9 percent fertility rate for mares accompanying the treated stallions compared to 45 percent for control mares (Kirkpatrick and Turner 1987, Turner and Kirkpatrick 1991).

Concerns relevant to this method of fertility control include the need to immobilize stallions in order to deliver MTP (Kirkpatrick et al. 1982), the need for multiple doses to deliver a sufficient quantity of the fertility control agent (Kirkpatrick and Turner 1987, Turner and Kirkpatrick 1991, Kirkpatrick et al. 1993), the high cost of the immobilizing drugs, the need for annual treatments, and the likelihood that this treatment regime would have lower efficacy in wild horse bands with subordinate stallions or high movement of mares between harem groups (Warren et al. 1993). For microencapsulated steroids, potential problems include the clumping of the suspension if not used shortly after mixing (Turner and Kirkpatrick 1991), potential for environment contamination if darts used to deliver the steroid suspension remotely are not found (Warren et al. 1993), and the need to carefully calculate dart velocity and trajectory to avoid dart rebound (Turner and Kirkpatrick 1991).

In response to some of these concerns, fertility control efforts were directed at mares. On Assateague Island, six mares were administered microencapsulated northisterone (or mNET) remotely using barbless darts (Kirkpatrick and Turner 1987, Turner and Kirkpatrick 1991), but all six mares produced a foal a year later. This was unexpected considering that the foaling rate of island horses seldom exceeded 55 percent (Keiper and Houpt 1984) and suggested that steroid treatment did not suppress but enhanced the fertility rate of the mares (Kirkpatrick and Turner 1991). In another study in Nevada, 30 captive wild mares were implanted with Silastic rods containing a combination of estradiol, progesterone, various amounts of "estradiol-plus," or no hormone (Vevea et al. 1987, Plotka et al. 1988) with all treated animals displaying estrus, regardless of treatment, and ovulating (Kirkpatrick et al. 1993). The failure of this treatment was due to a rapid decline in plasma steroid concentrations, suggesting increase metabolic clearance of the steroid.

Plotka et al. (1989) demonstrated contraceptive efficacy of 88 to 100 percent through two breeding seasons (and 75 percent for a third season) in captive wild mares using Silastic implants containing synthetic estrogen ethinylestradiol (EE2) or EE2 plus progesterone. In a similar study, intraperitoneal implants of variable doses of EE2 resulted in a reduction in fertility rates of 75 to 100 percent through two breeding seasons with rates of EE2 decline, suggesting a contraceptive duration of 16, 26, and 48-60 months for the 1.5, 3, and 8 gram doses, respectively (Plotka and Vevea 1990, Eagle et al. 1992).

Eagle et al. (1992) examined the potential for the chemical contraception of feral mares in three wild horse herds in central and western Nevada implanted with silastic rods containing ethinylestradiol alone (EE) or in combination with 36 g of progesterone (EE+PP) (Plotka et al. 1992). In year one of the study, 1988, foaling rates of mares receiving placebo treatments in the Wassuk Mountains and Clan Alpine Mountains were 45 and 42 percent, respectively. For treated mares in the Clan Alpine Mountains, the foaling rate was 53 percent, while in Stone Cabin Valley mares treated with EE alone had a foaling rate of 11 percent and those treated with EE+PP had a foaling rate of 7 percent. The lack of efficacy of the treatment in the Clan Alpine Mountains horses was not unexpected for year one, since the hormone implants had been shown to not end existing pregnancies (Plotka et al. 1992).

In the second year of the study, foaling rates for EE treated horses in Stone Cabin Valley and Clan Alpine Mountains were 3 and 9 percent, respectively. For EE+PP treated horses in the same areas, the foaling rates were 16 and 6 percent. In contrast, control horses in the Wassuk Mountains and Clan Alpine Mountains had foaling rates of 70 and 45 percent, respectively. In the third and fourth years post implantation, the combined data for both treatment groups in the Stone Cabin Valley horses indicate foaling rates of 16 and 23 percent, respectively.

The differing efficacies of natural (i.e., estradiol, progesterone) versus synthetic (i.e., ethinylestradiol) steroids in providing a contraceptive effect in wild horses suggested that natural steroids degraded rapidly, thereby requiring contraceptive doses so large as to be impossible to administer (Kirkpatrick et al. 1993). Conversely, with synthetic steroids, though the small risk of transmission of these steroids to humans or other wildlife (if they were to consume a treated horse) made registration of the product unlikely with government agencies (i.e., Food and Drug Administration, U.S. Department of Agriculture, or the Environmental Protection Agency) (Kirkpatrick et al. 1993).

Physical devices:

Daels and Hughes (1995) examined the potential use of intrauterine devices as a means of fertility control in wild horses, given deficiencies or concerns with other forms of control, including dominant stallion vasectomy, hormonal treatments, and immunocontraception. Among the six treated mares, none became pregnant in year one post-treatment, but all quickly conceived in year two after the IUD had been removed prior to placement in pastures with a stallion. All untreated mares (12) became pregnant in year one. Despite this success, there was cytological and histopathological evidence of endometritis in the treated mares that failed to conceive, though these conditions subsided after removal of the IUD and fertility was restored.

Killian (2006, 2008) found that among their 15 IUD-treated mares, 80 percent (12 of 15), 29 percent (4 of 14), 14 percent (2 of 14), and 0 percent (0 of 14) were successfully contracepted during each year of the study, respectively.

Comparatively, for the 8 control mares, 75 percent (6 of 8), 75 percent (6 of 8), 88 percent (7 of 8), and 100 percent (8 of 8) successfully foaled in years one through four, respectively. The declining success of the contraceptive as the study progressed was assumed by Killian et al. (2008) to be due to failed retention of the IUD. In addition to these less-than-stellar results, another complication with the use of IUDs is that delivery requires capture and handling of every treated mare.

Killian et al. (2004, 2006) concluded that there were no ill effects or no indication of adverse treatment effects on body condition and general health of the mares. Even for the IUD-treated mares, ultrasonography of their uteri did not reveal evidence of uterine infection or fluid accumulation as a result of the IUD. Behaviorally, while Killian et al. (2008) did not include an observational element in their study design, Argo and Turnbull (2010) in their study of captive Welsh mountain ponies treated with IUDs observed no modification of endocrine, ovarian, uterine, or behavioral functions associated with the estrus cycle in pony mares.

Contraception modeling:

Modeling efforts have been undertaken to predict the impact of fertility control on wild horses and other species. The efficacy, practicality, and cost-effectiveness of fertility control is contingent on a number of factors, including whether the target population is open or closed, the number of animals in the population, sex ratios, age structure, rate of population increase, and mortality rates.

In one of the earliest models developed on wild horses, Garrott (1991) predicted that the maximum effectiveness of a contraceptive treatment for wild horses in the field would range between 64 and 81 percent using a contraceptive agent with 85–95 percent efficacy and assuming a gather efficiency of 75–85 percent. While he questioned whether immunocontraception alone could suppress populations that may increase at an annual rate of 15 to 20 percent (Berger 1986, Wolfe 1986, Eberhardt et al. 1982), Garrott (1991) recommended that the use of immunocontraception would still be of benefit by minimizing the numbers that need to be removed and reducing the frequency of such removals.

The limited data on wild horse demographics constrains the ability to construct models to accurately simulate wild horse population response to contraception and other management actions (Garrott (1991b). Existing models also don't consider the cost of contraceptive programs.

Garrott et al. (1992) – armed with new information on wild horse population dynamics and demographics (Wolfe et al. 1989, Garrott and Taylor 1990, Garrott et al. 1991a, Garrott et al. 1991b), hormone implant and PZP vaccine duration, efficacy, and costs (Eagle et al. 1992, Plotka et al. 1992, Kirkpatrick et al. 1990) – developed a new wild horse model to both simulate the impacts of contraceptive treatments on wild horses as well as the costs of such actions.

In this new model, simulations were run to evaluate five management alternatives, including nonselective removals (NSRs), NSRs and implants, NSRs and PZP, NSRs and steroids, and selective removals (SRs). All alternatives were determined to be able to maintain the wild horse population within the management objective of 300–600 animals, with the three alternatives incorporating some form of fertility control treatment to slow population growth rates, thereby reducing frequency of roundups and, hence, limiting the number of horses subject to maintenance and placement (Garrott et al. 1992). For the NSR alternatives, the population doubled every four years. For the NSR+ fertility control options, population doubled every 10 years. The fertility control options required treatments annually (PZP), every five years (hormonal implants), or every 10 years (steroids), with the percent of animals treated varying from 52 percent (PZP), 82 percent (steroids), and 86 percent (hormonal implants).

Garrott and Siniff (1992) created a computer program to simulate feral horse population dynamics in order to investigate the potential efficacy of male-oriented contraception as a population management tool and to assess how such a tool would affect seasonal foaling patterns. Specifically, they simulated the impacts of sterilizing only the dominant harem stallions and sterilizing male horses regardless of their social status.
Likely success of the first alternative (sterilizing only dominant stallions) depends on the ability of the dominant stallions to maintain exclusive breeding access to their mares. In some populations this may be possible (Berger 1986) but other studies of wild horses have provided evidence that not all mares in a harem group are exclusively bred by the harem's dominant stallions (Nelson 1978, Miller 1979, Bowling and Touchberry 1990). Based on modeling results, Garrott and Siniff (1992) reported that the sterilization of only dominant stallions resulted in relatively modest reductions in population growth since reproduction can still occur by subordinate, unsterilized males. Since unbred mares will continue to cycle if not successfully bred, this provides multiple breeding opportunities for unsterilized males. As a result, only if a large proportion of all males in a population are sterilized can adequate suppression of population growth be achieved.

Gross (2000) developed a dynamic simulation model to evaluate the effects of wild horse removal and contraception on the genetic variation and demographic characteristics in wild horses of the Pryor Mountains in Montana. In his model, Gross considered the relationship between both removals and contraceptive treatments, the sex and age of horses subject to such treatments, and how the removals, contraception, or a combination of treatments influenced herd genetic health. He determined that management by removals led to populations that experienced rapid increases and precipitous declines, with an average size 18–27 percent greater than AML. Conversely, when contraception was used, populations were relatively stable, remaining within 3 percent of AML. Populations controlled by both removals and contraceptives were, on average, 18 to 5 percent above AML for populations of 90 and 180 animals, respectively. Based on his analysis, Gross (2000) concluded that approximately 70 percent of all reproductively active mares in a population would have to be maintained in an infertile state to achieve population stabilization.

Ballou et al. (2008) used the wild horses of Assateague Island to develop an individual-based stochastic simulation model using Vortex software to evaluate the effects of different management strategies on the horse population. Instead of using other population projection models that had previously been developed for wild horses, Ballou et al. (2008) were able – based on the significant amount of demographic, genetic, and other data available from years of study of the Assateague horses – to develop, populate, and test a more realistic model to assess the impact of contraception on the population, including on its genetic health. Their model results suggested that the ongoing use of immunocontraception to control herd growth would result in a linear drop in the population of an average of eight horses per year for 10–12 years (an average of approximately 6 percent per year), with the rate of decrease rising after year 12, to 16 percent per year. This result is a product of the long-term use and efficacy of immunocontraception in this population, which has skewed the age structure toward older animals.

Eggert et al. (2010) employed pedigrees to study horses on Assateague Island National Seashore. Models were developed to use the pedigrees, genetic data, and demographic data to assess the genetic and demographic status of the Assateague horses and to predict the impacts of efforts to reduce population size. They concluded that a "combined strategy of controlled breeding and immunocontraception would be more effective than removing individuals with high mean kinships in preserving the long-term health and viability of the herd."

<u>Conclusion</u>: Based on the best available scientific evidence, while PZP, GnRH, and SpayVac are all, to different degrees, efficacious in reducing wild horse and, for PZP, burro fertility rates, neither GnRH nor SpayVac are presently registered for use in wild horses or burros and neither has been subject to the same level of field testing compared to PZP. Consequently, further captive and field testing of these agents are needed to more fully demonstrate field efficacy and to assess their potential physiological, pathological, and behavioral impacts. This is not to suggest that further study of PZP is not warranted but that, at present, PZP is registered, is known to be safe and efficacious for wild horses and burros, is reversible, can be remotely delivered, has successfully stopped, slowed, and even reversed wild horse population growth rates and population sizes, and its impacts to wild horse or burro behavior are not significant – particularly when compared with alternative management actions (i.e., roundups and removals). Furthermore, at present, the BLM has a contract with the Humane Society of the United States providing for their collaborative efforts to utilize and study the impacts of PZP vaccination on wild horse populations in the West, and has expressed a desire to expand the use of PZP to better control wild horse and burro populations.

Though other methods of population control are available (e.g., sex-ratio manipulation, permanent sterilization), reversible immunocontraception would appear to be the ideal option at this time to reduce wild horse and burro population growth rates, maximize management of wild horses and burros on the range, preserve genetic diversity, and achieve and/or maintain AML – while reducing wild horse and burro roundups and thereby avoiding the myriad adverse impacts of roundups.

Recommendations:

1. The BLM should maximize it use of immunocontraception (i.e., PZP-22 or other PZP -based vaccines that may be developed with a longer duration of efficacy) to manage wild horse and burro herds. It should utilize this methodology as a primary tool to slow, stop and eventually reverse herd/population growth rates even when a herd is over AML so that it can begin to reduce the number and cost of wild horses subject to capture, handling, and short- and long-term holding. With patience, an adequate budget, and sufficient agency, contract, and volunteer personnel, this technology – if implemented responsibly yet on a large scale and aggressively – could allow the BLM to achieve its HMA-specific management objectives within 10–20 years. Even if there is reluctance to use this technology on herds that are presently in excess of AML without first conducting a roundup, there is no rational excuse for not immediately employing this tool on those herds that are under, at, or near high AML.

2. Utilize immunocontraceptive treatments as part of adaptive management experiments so that, as more is learned, the experimental protocol can be manipulated if necessary to maximize the effectiveness of the program. Such studies, which should only be conducted in the field, utilizing PZP and alternative immunocontraceptive agents, and which should evaluate behavioral and genetic impacts of fertility control, could be conducted by academic institutions, other federal agencies, state agencies, and/or private parties, and paid for by the BLM or via a private/public partnership. The BLM should also fund studies intended to develop and test new potential immunocontraception agents, including new formulations of PZP, and to evaluate new vaccine delivery mechanisms.

H. Managing a portion of a population as non-reproducing: *What factors should the BLM consider when managing for WH&B herds with a reproducing and non-reproducing population of animals (i.e., a portion of the population is a breeding population and the remainder is non-reproducing males or females)? When implementing non-reproducing populations, which tools should be considered (geldings (castration), sterilized (spayed) mares or vasectomized stallions or other chemical sterilants)? Is there credible evidence to indicate vasectomized stallions in a herd would be effective in decreasing annual population growth rates, or are there other methods the BLM should consider for managing stallions in a herd that would be effective in tangibly suppressing population growth?*

The WFRHBA includes "sterilization" as an option that the BLM can consider in its management of wild horses and burros. At the time the Act was passed, "sterilization" was likely limited to permanent means of preventing pregnancies through surgical procedures (i.e., spays of mares, gelding or vasectomy of stallions) or via chemical sterilants. Immunocontraceptions, though a type of sterilant – albeit temporary and reversible – was not a technology available at the time. However, the Act also defines a "herd" to consist of "one or more stallions and his mares." Despite the inclusion of sterilization as an option in the Act, regulations implementing the WFRHBA require that wild horse and burro populations be self-sustaining and make no reference to the use of sterilization as a management tool, or to the creation of non-reproducing herds or mixed herds (combining reproducing and non-reproducing animals) on the range as a management alternative. Yet, additional BLM policy and guidance for wild horse and burro management reference non-reproducing herds as a management alternative.

The inconsistency in the legal standards regarding sterilization of wild horses or burros creates confusion in interpreting what is and is not permissible. Since a statute trumps any regulation or policy, there is no question that, legally, sterilization is a tool that the BLM can employ to manage wild horses and burros. Nevertheless, the creation of herds of only non-reproducing horses (e.g., a geldings-only herd) while it could have value in reducing the number of gelded horses in long-term holding, may not be legal, as it may not conform to the legal definition of "herd" in the statute. Creating mixed herds, however, though perhaps objectionable to some interests, would appear to be consistent with all relevant legal standards.

The creation of such mixed herds would involve behavioral impacts that, to date, have not been adequately studied. As previously indicated, wild equids exhibit a range of variability in their individual and herd social dynamics and relationships. Among wild horses, with some notable exceptions, harem and bachelor bands are the fundamental social groups. Harem groups are composed of one or, in some cases, more than one stallion along with several mares and their juvenile offspring (Berger 1977, Goodwin 2007). Harem groups are often stable, but harem-switching by mares, replacement of the dominant stallion, and acquisition of new mares can disrupt harem stability. A harem stallion, though not always the most dominant horse in a harem (Houpt and Keiper 1982, Keiper and Sambraus 1986), will defend his harem and does the majority of the breeding with harem mares. Subordinate males and males from bachelor groups can also, however, breed with harem mares (Bowling and Touchberry 1990). While there are costs for the stallion in defending a harem group, there are benefits for both stallions and mares who are members of stable harem groups including, but not limited to, access to breeding opportunities, reduction in male-to-female and female-to-female incidents of aggression (Keiper and Sambraus 1986), expanded foraging opportunities (Rubenstein 1986, Rubenstein 1986a, Rubenstein and Nunez 2009), and increased rates of foal survival (Rubenstein 1994, Linklater et al. 1999.

In burros, mother and offspring groups are the primary social group (Klingel 1979, Moehlman 1974, Rudman 1998). Adult male burros, instead of forming harem groups, establish and seasonally defend territories that will be traversed by female burro in search of required forage or water resources (Moehlman 1974). Male burros will use scent (Moehlman 1974, 1985, Klingel 1975, 1977, McCort 1980), visual, and physical cues to defend these territories, particularly when a female burro who is in estrus enters the territory. With the exception of one island burro population that utilizes a harem social structure, nearly all other burros utilize a territorial social dynamic – a product of the more arid and less productive habitats that burros often occupy compared to horses (Rudman 1998, Moehlman 1974). Even in such arid environments, social dynamics of burro herds will shift seasonally based on availability of forage and water, with larger concentrations of burros found in the summer when access to water is limited.

Though this particular question would appear to be directed more toward horses than burros, the creation of mixed reproducing and non-reproducing herds of both species will entail some potential behavioral impacts that have not been sufficiently studied. In wild horses, for example, if intact and sterilized males coexisted, how would this affect the composition of harem groups, bachelor groups, harem-switching behaviors by mares, levels of male-to-male or male-to-female aggression, or other elements of the wild horse social system? Does a sterilized male have the same hormonal makeup as an intact male that would drive the attempt to create and defend a harem group? If so, since the mares in such a group would repeatedly cycle until impregnated, would the non-reproducing male have the ability to successfully deter intact males from breeding with his females? If so, what would be the likely impacts or welfare implications to the non-reproducing dominant male, due to the effort that would be required to prevent breeding by subordinate or bachelor stallions?

If the non-reproducing male could not defend his harem mares, the reproductive potential of the harem group would likely be the same compared to harems controlled by a dominant stallion. If a non-reproducing (i.e., sterilized) male did not attempt to create and defend a harem, would he live alone, in bachelor groups that are either mixed (intact stallions and non-reproducing males) or separate, or would non-reproducing males be accepted as subordinate males within a traditional harem group? If the latter, would the dominant stallion or the harem mares benefit from allowing a non-reproducing male into their group? Would doing so increase or reduce the stability of the group? These are only a few of a number of questions that should be considered before the creation of mixed herds of reproducing and non-reproducing wild horses is considered as a viable management option.

The BLM cares for a substantial number of geldings as all stallions are gelded upon capture and prior to either adoption or placement into long-term holding. Ideally, BLM will determine a mechanism by which geldings can be released back onto the range within one or more of the ten states that provide habitat for wild horses. BLM has a large pool of gelded horses to use to assess behavior, herd structure, and effect on growth rate of the herd.

In addition, though captured mares are not spayed, to avoid any possibility of mares breeding (unless a domestic stallion was able to access long-term holding facilities for mares), mares and geldings are not maintained together at long-term holding facilities, with the exception of one facility where they are allowed to intermingle. The basis for this separation policy, unless preferable for behavioral purposes, is unclear since geldings can't breed. In fact, behavioral studies should dictate how the horses should be maintained in the holding facilities, so as to provide an environment that permits species-typical behaviors, including social interactions/relationships.

More recently, the BLM has proposed the possibility of combining a self-sustaining, reproducing herd with geldings. If this were implemented, an intact herd (mares and stallions) would continue to occupy the range along with a select number of geldings. The geldings would be from the same herd but would have been captured, castrated, and then released back on to the range. This proposal meets the regulatory requirement of ensuring herds are self-sustaining but allows geldings to be returned to their native range instead of being subject to adoption or placement into long-term holding, thereby ostensibly benefiting the individual animals and reducing short- and long-term costs associated with the long-term care. Presumably, this option could be used to return geldings currently in long-term holding to the wild, though this process would entail additional ecological, biological, and humane concerns.

First, would the non-reproducing horses (i.e., geldings, vasectomized males, spayed females, horses chemically sterilized) count toward AML? At present, in its proposal to combine geldings with intact herds, the BLM would count the geldings toward AML. Presumably this is because AML (i.e., high AML) ostensibly represents the total number of horses that a range can support while achieving a TNEB. However, by doing so, the BLM is effectively reducing the size of the reproductive component of the herd that is permitted to remain on the range, with potential impacts on the effective population size and, ultimately, the genetic health of the population. For example, if a combined herd contained 100 intact horses and 50 geldings, the effective population size is smaller than if the herd contained 150 intact horses. This is of particular concern for those herds that have high AML set at 200 or fewer animals, particularly if the BLM's recommendation of managing for 150–200 intact horses to maintain an effective breeding size of 50 horses to preserve genetic diversity is correct – which it may not be. For herds where high AML is set higher, in excess of 200, if sufficient intact animals are present to sustain an effective breeding population of 50 horses, then adding non-reproducing animals and counting them toward AML may be more reasonable from a genetic health perspective, though it may be controversial. Simply put, from reproduction and genetic health perspectives, a sterilized wild horse or burro provides as little benefit to his or her herd as an animal that has been captured and removed from the range.

If sterilized horses are not counted toward AML, this would defeat the BLM's purpose for creating combined herds – to reduce the herd's growth rate, assuming no additional measures are taken (e.g., immunocontraception and/or sex-ratio manipulation) on the same herd. It would, however, still provide an alternative to adding to the populations in long-term holding, or an option for placing some of the long-term holding animals back on the range.

The BLM may find its proposal to create combined herds of intact and sterilized horses more acceptable to user/interest groups if the sterilized animals did not count toward AML, as this would allow more animals to remain on the range while not compromising the genetic health and diversity of the remaining animals (dependent on herd size and AML). This would require allocating additional forage for wild horses to compensate for the additional horses in the herd. While this could theoretically impact livestock stocking rates/AUMs and/or forage available for wildlife, depending on the number of sterilized horses, there may be sufficient flexibility in the system to compensate for the extra animals without any substantive harm (except potentially under a prolonged drought or severe drought conditions) to livestock or wildlife.

Second, what would be the behavioral impacts of creating combined herds? The impacts may differ depending on whether the combined herds were created with geldings, vasectomized stallions, or spayed mares.

For geldings, regardless of which stallions are selected for gelding (i.e., dominant, subordinate, or bachelor) breeding by intact stallions would continue. For geldings, interest in breeding and the ability to breed would be significantly reduced or entirely extinguished. In addition, considering that gelding is a management technique used on domestic stallions to make them more "manageable," gelded wild horses might be expected to lose some of the very characteristics that make them wild, allow them to survive in the wild, and acquire and defend mares – a core component of wild stallion behavior.

Even if a gelded horse was able to acquire and defend a harem, his dominance would likely be quickly and successfully challenged by intact stallions and/or his mares may be more likely to switch harems in order to successfully breed. Furthermore, if castrated horses become more "tame" over time, or if they are not accepted as part of a harem or bachelor group, they may be more susceptible to mortality inherent to losing wild instincts or due to the rigors of living alone.

Finally, as a social species, if castration has behavioral implications that result in castrated animals living alone or being more susceptible to mortality, would this be humane? It is possible, of course, that geldings could be retained within harem groups (i.e., the dominant stallion may not see them as a threat), or could form bachelor groups with intact horses or other geldings.

If stallions were vasectomized this would, as is the case for geldings, remove them from the breeding pool in the wild and many of the behavioral impacts could be similar. Nevertheless, a vasectomy, though an invasive procedure, retains the testicles and their function and would result in fewer physical, physiological or behavioral impacts to the treated stallions as individuals – though their role in herd behavior could be altered. While vasectomized stallions will retain much more of their wild nature, instincts, survival skills, and harem creation and defense behaviors than would geldings, their harems could still disintegrate in time if mares switch harems in order to produce a foal. This may be less likely if subordinates are engaged in breeding and if the dominant, vasectomized stallions accepts what would be unrelated foals in his harem group.

As with geldings, even if all dominant stallions in a herd were vasectomized, breeding by subordinate males and bachelors would still occur. There is evidence that, for at least two years, production in harems controlled by vasectomized stallions was lower than that in herds led by non-vasectomized stallions (Asa et al. 1999), though it is unclear for how long such a reduction in pregnancy/foaling rates would continue. The actual rate of growth will depend on the number of stallions in the herd that are vasectomized, whether there is ingress of intact stallions from adjacent wild horse herds, the frequency of inter-band interactions during the breeding season, and/or the proportion of males born into the herd. However, though the polygynous breeding system employed by horses would ensure that foaling would continue – though potentially at a reduced rate – if a large number of herd stallions were to be vasectomized, this could substantially affect the effective breeding population size, potentially contributing to a loss of genetic variability, diversity, and ultimately a decline in herd genetic health.

For spayed mares, given the invasiveness of the sterilization procedures, there would be additional risks to any proposal calling for the introduction of spayed mares compared to geldings. This alone should provide sufficient reason to reject this option as a management tool. Nevertheless, if spayed mares were released, many of the same questions as to the behavioral impacts of combining sterilized males with intact horses would be relevant. Would they be accepted as part of harem groups? If they never come into estrous, the dominant stallion may push them out of the harem since they provide no mechanism for him to sire offspring. If not allowed to be part of harem groups, would they be accepted within other groups of wild horses (such as bachelor herds)? Form sterilized mare groups? Find companionship with another single mare or non-dominant stallion? Survive as individuals? How would group structure affect their ecology, behavior, and survival?

Though specialists in wild horse behavior may be able to predict how sterilized horses will fare within intact herds, with the exception of studies examining the potential value of dominant stallion vasectomies to control herd growth, AWI is aware of no behavioral studies of wild horses that can answer these and other questions. There are dozens of published studies on wild horse and burro behavior, but most attempt to address questions pertaining to the evolutionary, practical, or ecological benefits of the different social/behavioral strategies used by horses and burros to survive in the wild.

While the relationships between gelding and intact mares could be studied at the BLM long-term facility that allows these animals to intermingle (as well as within private sanctuaries that permit intermingling of mares and geldings), these circumstances cannot replicate conditions in the field, since there are no stallions present within these herds. Consequently, while the prospect of the large-scale creation of combined herds may be premature at the moment, this issue would lend itself to adaptive management studies to begin to understand the implications – ecologically, biologically, behaviorally, and genetically – of creating combined herds. Prerequisites to such studies would be to establish a baseline of behavioral data in an existing herd, and to address the implications to AML – in particular, whether non-reproducing animals would be counted toward AML.

For burros, nearly all of the issues or concerns articulated above would be applicable to the consideration of the use of gelding, vasectomies, or spaying to create non-reproducing burros for release into the wild. Like horses, sterilized burros will not be able to contribute to the genetic variability, diversity, or health of their wild herds though, since burros don't engage in a polygynous breeding system, the impact of non-reproducing animals on the effective breeding population size is less. Nevertheless, the issue of whether non-reproducing burros should count toward AML would need to be addressed in any research proposal or management plan. As with wild horses, though there are a number of published studies on the behavior of burros, donkeys, and wild asses throughout the world, none reviewed by AWI address the behavioral impacts of mixing reproducing and non-reproducing animals into wild herds.

If combined herds are considered, from an individual health (physical, psychological, and behavioral) and herd health (behavioral and genetic) perspective, the order of preference of management options (from least to most invasive or impactful) would include chemical sterilant (delivered by hand injection or remotely), vasectomies, gelding and spays – though the latter two options can have such significant impacts (to the individual and herd) that they should not be considered.[16]

From a humane perspective, if a chemical sterilant can be administered remotely or while a wild horse is restrained post-capture without the need for anesthesia or surgery, this would be the least invasive of the procedures. The remaining procedures are all invasive, require anesthesia, and, therefore, can result in complications that may impact the animal's well-being and even survival. While gelding is the least invasive of the remaining three procedures and is commonly used on domestic horses, with most quickly recovering without serious consequences, there can be complications. Furthermore, for wild horses or burros, the behavioral impacts to the individual and potentially cascading through the herd are substantial. Though more invasive, the benefits of a vasectomy in wild horses is that it does not affect the stallion's hormone levels, allowing him to continue to copulate with receptive mares but preventing conception. A vasectomy will be more expensive than a castration and, if not done correctly, the stallion may remain

[16] This does not include the use of immunocontraceptive agents, which is the ideal approach, since they are considered reversible and, hence, treated animals would not qualify as permanently "non-reproducing" unless consistently retreated or repeatedly administered a booster vaccine over time.

fertile or regain fertility. Spaying is the most invasive of the procedures and will render the mare anestrous year-round. The mare remains physiologically capable of copulating, but will not provide the behavioral cues that would trigger a stallion to engage in reproductive behaviors.

Conclusion: There are legal, ecological, biological, behavioral, and management impacts inherent to creating combined herds of breeding and sterilized wild horses. Many of the potential behavioral impacts have not been studied or have not been sufficiently examined to provide guidance as to the short and long-term behavioral implications, whether there are ways to mitigate such impacts, and what, if any, ecological, biological, or genetic impacts may stem from sterilization. Among the potential methods of achieving sterilization, there are physiological, behavioral, genetic, economic, humane, and practical considerations for each. From a welfare perspective, not including immunocontraception, the order of preference would be administration of chemical sterilant (if no anesthesia or surgery is required), castration, vasectomy, and spay. Whether vasectomizing stallions will aid in achieving a reduction in population growth depends on a number of variables. If all stallions in a closed herd were vasectomized, breeding would cease (until any male foals born into the population reached reproductive maturity), though this would entail significant genetic implications for these horses and therefore would be unacceptable. If only dominant stallions were vasectomized, breeding by non-dominant stallions would continue, given the polygamous breeding system of wild horses. Although this could result in a temporary reduction in the pregnancy rate, this rate would ultimately increase.

Recommendation:

1. Since many of the behavioral impacts of creating combined herds of intact and sterilized horses remain unanswered, large-scale development of such combined herds would be premature. The BLM should engage in adaptive management experiments to assess the scope and severity of behavioral impacts and to determine if such impacts affect the ecology and biology of wild horses and burros. Such adaptive experiments must be properly planned, based on credible scientific methodologies, fully funded, and transparently developed with involvement from the public. During the experiment, any non-reproducing horses or burros introduced into a sexually intact herd should not be counted toward AML, in order to not degrade the genetic health of the existing population. If creating combined herds is ultimately deemed to be an acceptable option for management, the BLM should determine through a public planning process if sterilized horses will count toward AML.

I. AML Establishment of Adjustment: *Evaluate the BLM's approach to establishing or adjusting AML as described in the 4700-1 Wild Horses and Burros Management Handbook. Are there other approaches to establishing or adjusting AML the BLM should consider? How might BLM improve its ability to validate AML?*

The establishment of wild horse or burro AML is the cornerstone of wild horse and burro management. An AML is generally set as a range and applies to an HMA or HMA complex (though, historically, AMLs had been set as single numbers). The low AML is "normally … established at a number that allows the population to grow ... to the upper limit over a 4-5 year period, without any interim gathers to remove excess WH&B."[17] The high AML is "established as the maximum number of WH&B which results in a TNEB and avoids a deterioration of the range."[18] AML refers to the number of adult wild horses or burros within the population but does not include the current year's foals until January 1 following the year of the foals' births. For the purpose of establishing AML, all horses or burros in a population as of January 1 are counted toward AML.

The scientific literature is replete with studies regarding the impact of a host of species, domestic and wild, on rangeland conditions, including: vegetation production, composition, abundance, and health; riparian area condition and function; soil conditions and loss; and water quality. Every species, including wild horses and burros, have an impact on range conditions. These impacts can be small or large, direct or indirect, and potentially cumulative. AWI does not dispute that wild horses and burros impact their habitat – both beneficially and adversely – but it is also indisputable that domestic livestock far outnumber wild horses and burros on public lands and that their impacts, both historically and currently, are far in excess of the impacts attributable to wild horses and burros.

Science is integral to establishing AML as specified in BLM policy and guidelines. Indeed, as discussed in more detail below, a wealth of scientific information is required to be collected and analyzed to set or reevaluate AML. While the specific scientific data necessary to properly and credibly establish AML is debatable, the fundamental issue here is whether the BLM complies with its own policies, to rely on science to set AML.

If the BLM had and disclosed all data used to establish current AML, the data itself could be subject to scientific analysis to determine if the BLM's use and interpretation of the data is defensible. Without such data, the only possible scientific analysis of AML is to assess the credibility of the laundry-list of data that is supposed to be collected to set or reset AML, and the credibility of the collection procedures. As to the latter, although procedures are delineated, there are significant questions regarding their actual use in the field. While it is unclear if the data needed to set or adjust AML is collected, if it is collected, there are credible concerns about the veracity and completeness of the data, whether the data is up-to-date, and whether or how the data is used by the BLM to set or reevaluate AML.

[17] BLM Wild Horse and Burro Management Handbook (Handbook) H-4700-1 at 17.
[18] Handbook at 17.

AML establishment or adjustment must be subject to an interdisciplinary and site-specific environmental analysis and decision-making process (i.e., NEPA) with the required public involvement.[19] AML establishment or adjustments, which the BLM refers to as "implementation decisions," can be made in any one of several BLM decision-making processes: the Land Use Plan (LUP) or Resource Management Plan (RMP), single-use wild horse and burro decisions, multiple-use decisions, the Herd Management Area Plan, or as part of a gather/removal plan.[20] The BLM Handbook makes clear, however, that AML decisions are not generally established or adjusted as part of the "gather planning process" due to the complexity of the analysis. When establishing AML, the site-specific and interdisciplinary analysis should include an in-depth evaluation of intensive monitoring data or land health assessment, population inventories, habitat use patterns, animal distribution data, and progress toward attainment of other site-specific and landscape-level management objectives.[21] "Intensive monitoring data" must include "studies of grazing utilization, range ecological condition and trend, actual use, and climate (weather) data."[22] Preferably, a minimum of "three to five years of data" should be assessed when establishing or adjusting AML.[23]

Once established, AML should be evaluated when "review of resource monitoring and population inventory data indicates the AML may no longer be appropriate."[24] In addition, AML evaluations should consider:

- Changes in environmental conditions which may have occurred since the AML was established. Condition changes may include drought, wildfires, noxious weed infestations, effect of varying numbers of wild horses and burros on forage utilization or range ecological condition/trend, and increase or decrease in the available forage, changes in livestock management, etc.;
- Presence of any newly listed Threatened, Endangered or Sensitive Species; and
- Any additional resource monitoring, population inventory or other relevant data collected since AML was established.[25]

In addition to these basic definitions and guidelines, the Handbook provides a blueprint on the process that the BLM allegedly uses to establish and adjust AMLs.[26] A multi-tiered process is outlined. Tier 1 assesses "whether the four essential habitat components (forage, water, cover, and space) are present in sufficient amounts to sustain healthy populations and healthy rangelands over the long-term."[27] Tier 2 determines the "amount of sustainable forage available for WH&B use."[28] The final Tier evaluates "whether or

[19] Ibid. at 18.
[20] Ibid. at 10, 46, 47.
[21] Ibid.
[22] Ibid.
[23] Ibid.
[24] Ibid.
[25] Ibid.
[26] Ibid. at Appendix 3.
[27] Ibid. at 67.
[28] Ibid.

not the projected WH&B herd size is sufficient to maintain genetically diverse WH&B populations (i.e., avoid inbreeding depression)."[29]

In implementing Tier 1 of the process, the amount of forage is expressed as animal unit months or AUMs. For the purpose of this analysis, one AUM is the amount of forage necessary to sustain one adult horse or two adult burros for one month. This equates to approximately 800 pounds of air dry forage. The Handbook indicates that "the amount of sustainable forage available for WH&B use may be determined based on the results of utilization monitoring and use pattern mapping for the years evaluated."[30] A minimum of three to five years of monitoring data is preferred since forage production can vary by year, in some cases substantially, due in part to the amount and timing of precipitation. The type of forage (i.e., perennial vs. annual) should also be considered, though "annual forage is not typically used to support or justify WH&B numbers within an HMA" due to low availability in below-average precipitation years.[31] Other issues, including the comparison of whether land health standards have or have not been attained, and wild horse or burro inventory numbers, can also be used to assess forage availability for wild horses and burros, wildlife, or livestock.

To determine if the amount of forage is sufficient to sustain long-term use by wild horses and burros, the BLM Handbook identifies three steps. The first is to "analyze [forage] utilization data, use pattern mapping, and/or production, ecological site conditions, trend, frequency, precipitation, and indicators of land health."[32] Second, the BLM determines the AUMs of actual use by wild horses and burros for each of the evaluation years, based on population estimates derived from aerial surveys or through projections of population growth using previous population estimates and the herd's annual growth rate. Finally, the third step involves identifying key wild horse and burro use areas and using this "primary range" to calculate carrying capacity.[33]

In assessing the water available for wild horses and burros, the BLM is to conduct a thorough inventory of available natural water on public lands, and developed and man-made water sources if they are available and accessible for use by wild horses and burros.[34] Water sources occurring on private lands are not considered available to wild horses and burros unless a written agreement is obtained from the private landowner.[35] The water inventory "should include the name, location, and flow (in gallons per minute or cube feet per second)."[36] The availability of water should be assessed based on the most limiting season of the year (i.e., summer) and should be evaluated based on the minimum daily water requirements of 10 and 5 gallons for wild horses and burros, respectively.

[29] Ibid.
[30] Ibid. at 68.
[31] Ibid. at 68.
[32] Ibid. at 68.
[33] Ibid. at 68/69.
[34] Ibid. at 69.
[35] Ibid. at 69.
[36] Ibid. at 69.

Cover and space availability is based on an assessment of wild horse and burro movements. If movement data suggest that the animals are exiting the HMA to access forage, water, or thermal or hiding cover, this may indicate that cover is inadequate. This could provide grounds for amending the relevant LUP to remove the area's designation as an HMA. No specific guidance is provided in the Handbook for assessing whether space requirements for wild horses and burros are sufficient within an HMA.

Tier 2 determines the number of AUMs of sustainable forage available to wild horses and burros. To do so, the BLM is to conduct an "in-depth analysis of rangeland monitoring data" to determine if "Land Health Standards or other site-specific vegetation management objectives are being met."[37] If the standards are being met, wild horse and burro population inventory data are then examined to determine the range of population sizes using the HMA during the evaluation years. If land health standards or objectives are not being met, a determination is made as to whether wild horse and/or burro numbers contributed to or was the causal factor in not meeting the standards or objectives. If so, then AML is to be set at a number below that estimate of wild horses and/or burros that have prevented the standards from being met. Ultimately, the BLM Handbook specifies that "the sustainable forage (carrying capacity) available for WH&B use within an HMA is determined pending detailed analysis of utilization data and use pattern mapping for all users."[38] In doing so, the BLM, for each evaluation year, is to determine the weighted average utilization, potential carrying capacity, and the proposed carrying capacity.[39] To aide in understanding the Tier 2 review process, the Handbook contains an example of the Tier 2 analysis for the Mojave Desert Ecosystem.

To satisfy the Tier 3 requirement to ensure that the proposed wild horse or burro AML is sufficient to maintain genetically diverse populations, the Handbook recommends the use of "a minimum herd size of 50 effective breeding animals," which is equated to a total herd size of 150-200 animals.[40] An effective breeding size for burro herds "has not yet been determined."[41] If the proposed AML is not sufficient to maintain genetic diversity, the BLM should assess the potential for interchange between wild horses (or burros) within the HMA and adjacent HMAs or wild horse (or burro) territories managed by the USFS. If the proposed herd size is less than 150 animals, the HMA is isolated, and there is little potential for wild horse or burro ingress or egress, the BLM considers, in a site-specific NEPA analysis, removing the site's designation as an HMA, manipulating the animals in the HMA to maximize the numbers within the primary breeding ages (6-10 years of age), manipulating the sex ratio to favor male horses in order to promote the establishment of more harems, and/or introducing 1 or 2 young mares from outside the HMA every generation (approximately every 10 years).

[37] Ibid. at 70.
[38] Ibid.
[39] Ibid.
[40] Ibid. at 74.
[41] Ibid.

At the conclusion of the internal evaluation process, the "multi-tiered analysis should be documented in an HMA (AML) Evaluation Report."[42] The completed Evaluation Report is to be provided to the interested public for a 30-day review and comment period referred to as "public scoping."[43] This scoping process is to be followed by a "site-specific environmental analysis" to "analyze the environmental impacts associated with the Proposed AML and any alternatives."[44] This analysis will then either conclude with the issuance of a Finding of No Significant Impact (FONSI) or a decision to prepare an EIS and, subsequently, a Record of Decision (RoD).

As indicated above, the BLM has set forth a multi-tiered process to establish or adjust AMLs. While the process itself is confusing and could be substantially improved, the fundamental problem is that, to AWI's knowledge, there is little evidence that this process is used to set or adjust AMLs. AWI also questions whether the BLM actually has the necessary data, including intensive monitoring data, habitat use patterns, and distribution data, to conduct the analysis to set or adjust AMLs. If such data is available, it is often old and not, therefore, sufficient to set or reassess AMLs, given the requirement – specified in the Handbook concerning the process for AML determination – that data must be up-to-date.

AWI, has reviewed many roundup EAs, but has never reviewed one that included an analysis of AML. Indeed, when the public criticizes the EA for failing to consider an adjustment in AML, the BLM reports that such a determination is beyond the scope of the roundup EA. AWI has never seen or been provided the opportunity to comment on a draft HMAP or multiple-use decision. Likewise, as it is unclear what constitutes a "single-use" wild horse and burro management decision document, AWI is unable to comment on whether such documents exists and whether they contain the required AML analysis. In its past review of several draft Resource Management Plans, AWI found evidence that past AMLs were renewed without any novel analysis, that the BLM deferred analysis of AMLs due to a lack of up-to-date rangeland inventory data, and that BLM indicated that AML was set in a separate analysis (which was not available online for review for this report). While the BLM may have complied with this AML setting process in other LUPs or RMPs, AWI cannot provide an example where this has been done. Regardless of what decision-making process the BLM may use to set or adjust AMLs, its own Handbook specifies that the results of the AML multi-tiered analysis are to be disclosed in an HMA (AML) Evaluation Report subject to public review, NEPA analysis (including another opportunity for public input), and ultimately a final decision. AWI has never seen an Evaluation Report, let alone been offered an opportunity to comment on such a review.

Independent of the validity of the AML-setting process, the process is meaningless unless it is followed. Admittedly, though many existing AMLs were set prior to the publication of the Handbook, to be consistent in its determination of AMLs and, consequently, to aid in defining if wild horse and burro roundups are necessary, the BLM has an obligation to

[42] Ibid. at 75.
[43] Ibid.
[44] Ibid.

ensure that all AMLs are reevaluated consistent with this process. Moreover, considering the criteria for reevaluating AMLs (e.g., changes in environmental conditions, listings of protected species, and the availability of any new resource data available since the AML was established), it is incomprehensible that those criteria have not been met in the majority of HMAs. Consequently, though the NAS Committee has been asked to offer guidance on improving the validity of the AML process, a prerequisite to that determination may be that the process, as articulated in the Handbook, has to first be implemented to determine its strengths and weaknesses.

As indicated above, even a cursory review of the process in the Handbook raises a number of questions. Such questions include:

- How does the BLM conduct grazing utilization studies? Are the studies done on a regular basis to assess utilization trends over time given variability in environmental conditions and stochastic events? Does the BLM utilize randomly placed vegetation transects and/or grazing exclosures to assess forage utilizations rates? For forage species that may be preferred by livestock, wild horses, wild burros, or wildlife, how can the BLM distinguish between species-specific utilization rates? If the BLM uses a key plant system to assess utilization rates, how were the key species selected? Are the sampling areas selected randomly, and what specific methods are used to sample the species?
- How does the BLM determine range ecological conditions and trends? What methods are used to make such determinations? Are sampling plots permanent, randomly established each year, or are sites pre-selected to achieve a certain outcome? Does the BLM monitor such conditions over time? If so, how frequently are ecological conditions assessed?
- Where does the BLM obtain its climate data? Does it operate its own weather stations or does it attain weather data from existing monitoring devices established by other federal or state agencies? How accurate is the station data in determining climate data for the HMA under evaluation?
- How does the BLM perform use-pattern mapping? Is it done using GIS software? Are actual HMA maps produced depicting use patterns? Are patterns based on grazing use, or can the BLM distinguish between species-specific grazing use in order to produce species-specific maps?
- What land health standards or other vegetative management objectives exist for each HMA or HMA complex? Where are such standards delineated? How are such standards measured?
- How does the BLM determine the flow rate of water sources available to wild horses and burros on public lands? When are such flow rates determined – in each season, randomly throughout the year, in the season when flows are likely to be low? What proportion of developed and/or man-made waters can wild horses and burros access on public lands? What proportion of such waters can they not access and why?

- Are there additional criteria used to determine the sufficiency of cover on HMAs? Is evidence of horse movements beyond HMA boundaries necessarily a function of deficient cover?
- Why does the BLM provide no criteria for assessing the sufficiency of space for wild horses and/or burros in its Handbook?
- Why does the BLM determine carrying capacity "pending detailed analysis of utilization data and pattern mapping for all users"? Should carrying capacity not be determined based on the evaluation of utilization data and use mapping for all users?
- Is a total population size of 150-200 animals sufficient to achieve an effective population size of 50 reproducing animals, given the polygynous breeding system of wild horses?

As indicated in this report, the laws and regulations governing BLM management of public lands require it to create and maintain an inventory of public lands, including data relevant to the condition of such lands. In addition, BLM has various handbooks, manuals, and technical references that provide further guidance on how to monitor range condition, including assessment of forage condition, utilization rate, riparian health, and water quality. Consequently, if the BLM is complying with existing mandates, then the up-to-date data required to set or reset AML should be readily accessible. Yet, if this data exists it is unclear how or when it has been used to evaluate AML. If it has been used to set or readjust AML, those processes have not, to AWI's knowledge, included opportunities for public review and comments as required by BLM policy.

There may be other approaches to calculating AMLs or another measure similar to AML that could be used by the BLM. However, any strategy likely includes core components similar to what is included in the BLM process for determining AML. Such components must include inventories of population for all species of concern (including wildlife), species-specific forage utilization data, species-specific distribution and movement patterns, species-specific habitat use data, and climate data (including precipitation amounts and timing). Considering the likely impact of climate change and other long-term stressors on public lands, particularly in the arid west, there likely would be value in utilizing range condition data collected over a more extended period of time, such as 10-15 years rather than the recommended 3-5 years, in order to address longer-term trends that may not be immediately evident. Currently, the BLM process does not incorporate as much species-specific data as suggested here – data which could be incorporated into a new, more detailed, process.

Ultimately, since setting and reevaluating AML is such a critical cog in wild horse and burro management, it is imperative that this process be as accurate and informative as possible. High AML is not only a trigger for wild horse or burro removals, but is intended also to achieve TNED and prevent deterioration of the range, and facilitate multiple uses of the land.

<u>Conclusion</u>: The BLM Handbook contains specific guidance and instructions on determining AMLs. While the guidance could be more clear and the criteria improved,

there is no evidence that the existing criteria are used at all to establish or adjust AMLs. Rather, it appears that the BLM continues to rely on old AMLs, for which the scientific credibility of the underlying data is unknown. Furthermore, environmental changes and other factors should have already triggered new AML analyses. If such analyses are not being performed, updated, or if they are being conducted in secret, this is not compliant with federal law and the public is being prevented from participating in these important decision-making processes.

Recommendations:

1. The BLM should establish a single document that will be used consistently for the setting, reevaluation, or adjustment of AML. This can be a document that is part of an existing decision-making process (e.g., an RMP, HMAP, HMA (AML) Evaluation Report) or the BLM can create a new decision-making process specific to the assessment or reassessment of AML.

2. The BLM should, within no more than five years, reassess all current AML using the direction provided in BLM policy established to ensure that all rangeland condition, climate, and other data required for assessment of AML is disclosed, methodologies are fully explained, and that data interpretation is objective for the purpose of determining the adequacy of current AML ranges for each HMA. Consistent with its own policy, such assessment must all be subject to public review and comment.

3. The BLM should create a single website on which is posted the most recent decision-making document which contains the requisite analysis of rangeland conditions and other factors that serves as the basis for the current AML for all existing HMAs. This website could also be used to provide links to the relevant BLM handbooks, manuals, technical references, and other relevant documents that describe, summarize, direct, or report on the methodologies used by the BLM to collect the data required to set AML.

4. The BLM should provide classroom and field training opportunities for the public – including academics and other members of the scientific community as well as advocacy organizations for wild horses and burros, livestock, rangeland, and others – to learn about the principles, practices, and methodologies used by the BLM to formulate and set AML – including how it collects rangeland condition data.

J. Societal Considerations: *What options are available to BLM to address the widely divergent and conflicting perspectives about WH&B management and consider stakeholder concerns while using the best available science to protect land and animal health?*

The social dynamics or human dimensions of wild horse and burro management is a critical piece of the management dynamic that has never received sufficient consideration or study. Unlike many wildlife management issues (e.g., the management of urban white-tailed deer, management of Yellowstone bison, whaling, trapping, hunting, non-consumptive use of wildlife, and the economics of wildlife management) where sociologists or experts in human dimensions have engaged in comprehensive studies to understand the social concerns and parameters of these issues, very few sociological surveys or studies have been done with regard to the management of wild horses and burros in the United States.[45] Like many issues, there is little black and white in regard to the human social dynamics of wild horse and burro management. Instead, there are many shades of gray.

The management of wild horses has been subject to fierce debate in North America and elsewhere (see Wright 1989, Coddington 1991, Symanski 1996, Rinnick 1998). Often, the problems underlying the debate are, as Linklater et al. (2002) concluded, "largely political, economic, and cultural, not biological" pitting those who see wild horses as exotic pests against those who assert that they are culturally important and iconic animals. Similarly, Kirkpatrick (1986) has suggested that often, what appears to be a biological question or problem (e.g., the overpopulation of wild horses) is in reality a policy problem. This is, as Kirkpatrick notes, precisely the case with the management of wild horses and burros. For example, a fundamental issue inherent to this complex management challenge is defining what constitutes "overpopulation" in a manner that satisfies various interests, including range biologists, wildlife biologists, sportsmen, stockmen, humane organizations, and wild horse and burro enthusiasts. The emotions that wild horses and burros evoke among these disparate groups make this question difficult to answer.

In New Zealand, research to determine the best methods for population and vegetation monitoring was done only after controversy erupted over flaws found in the methods used (Linklater et al. 2001, Linklater et al. 2000a). This information compromised public trust in New Zealand's Department of Conservation, which had been defending the old, inaccurate methods for a decade. As Linklater et al. (2002) point out, even if there had not been a controversy, conducting the research first would have provided better quality information to make more informed management choices.

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[45] The BLM does, as is required by law, solicit public comment on many of its planning decisions including draft Resource Management Plans and roundup plans and has actively solicited public comment on new strategies for wild horse and burro management. See e.g., http://www.blm.gov/wo/st/en/info/newsroom/2010/june/NR_06_03_2010.html. These are not, however, sociological surveys to assess public attitudes about wild horses and burros, their value, and management.

The controversy surrounding wild horse management in the United States parallels, in many ways, the debate in New Zealand. Common areas of dispute include accuracy of population census methods, interpretation of vegetation monitoring results from exclosure studies (though in the United States, many question whether vegetation monitoring is done at all), and whether populations of wild horses were, as the government claims, in poor condition and deteriorating (Department of Conservation 1995, Hutching 1990, Bateman 2000).

In New Zealand and Australia, another country with a large wild horse population and where wild horse management is intensely controversial due to horses being portrayed in poetry, literature, and film as culturally significant and iconic animals (e.g., *The Man from Snowy River*), sociological surveys have been undertaken to assess the public's attitudes toward wild horses. These surveys revealed that the public had varying opinions as to whether wild horses were "pests," whether they enjoyed or desired to observe wild horses, and what management methods they preferred be used to control wild horse populations. In most surveys, no more than 21 percent of respondents viewed wild horses as pests (Johnston and Marks 1997, Fraser 2001, Nimmo 2005), 80 and approximately 40 percent expressed a desire to see wild horses in New Zealand's bush or high country or in national parks in New South Wales, Australia, respectively (Fraser 2001, Ballard 2005), and approximately 50 percent deemed aerial culling of wild horses (a technique used in Australia) to be "unacceptable" or "never acceptable" (Nimmo 2005, Ballard 2005). AWI is unaware of similar surveys conducted in the United States, though it notes that Kellert and Berry (1980) conducted a survey and found that horses were identified as the second favorite animals among Americans who responded.

In the United States, those who advocate for wild horses and burros and those citizens sympathetic to the plight of wild horses and burros are, nearly always, adopting a defensive posture, trying to protect wild horses and burros from the BLM – an agency they view as being in the pocket of the livestock industry. When the advocates seek a particular solution to a management issue and generate public support for that solution, only for the BLM to reject the solution and proceed with actions against the wishes of the public and antithetical to the interests of the wild horses and burros, this creates distrust and disdain toward the agency – all the more so when the BLM fails to substantiate its decisions using sound science and little or no credible data.

As wild horses and burros qualify, like all wildlife, as a "public trust resource," there is an expectation and obligation that the BLM will make management decisions in consideration of the interests of all citizens, not just a select or influential few. Even if the BLM believes that it is making decisions consistent with the law, by ignoring those who advocate for the horses and burros, the BLM directly contributes to the controversy that has plagued wild horses and burro management for decades. Repairing the damage will require a substantial commitment by the BLM to a more open and inclusive process.

This particular question asks how the BLM can best address the conflicting and divergent perspectives of its varied stakeholders while using the best available science to manage wild horses and burros. A first step would be for the BLM to articulate and disclose what it believes constitutes the "best available science" for the management of wild horses and burros. At present, wild horse and burro advocates, including AWI, are unclear as to what "science," if any, is used, how any data used to inform management decisions is collected, how it is interpreted, how it can be assessed, and whether its analysis is subject to any type of objective review.

In addition, the BLM must become more transparent with all stakeholders respecting the diversity of values that it represents (even if it disagrees with said values) and genuinely welcoming and legitimately considering all ideas and input into all aspects of wild horse and burro management. This goes beyond simply offering, as required by law, comment opportunities on decision-making documents. Rather, the BLM should provide science-based responses to such comments (even if not required by law); establish opportunities for direct dialogue with the varied interest groups; facilitate meetings between field level wild horse and burro specialists, managers, directors and wild horse and burro advocates; provide opportunities (classroom and field) to learn about BLM rangeland monitoring practices and procedures; and reform its wild horse advisory board to ensure that those who may challenge the BLM and the status quo have opportunities to serve.

Furthermore, the BLM must make all information relevant to wild horse and burro management nationally, at the state level, and within individual HMA or HMA complexes easily accessible to the public. There should, for example, never be a question about the origins of an AML in a particular HMA that cannot be answered by quickly finding the relevant data on a BLM website. There should be a one-stop wild horse and burro management page where the public can easily find all relevant information and data about Resource Management Plans and associated NEPA documents, completed and pending roundups and associated NEPA documents, statistical information, range monitoring reports, allotment management plans and associated NEPA documents, data used to set or adjust AML, injury and mortality statistics, upcoming public comment opportunities, and other information relevant to the BLM's management program. Though some of this information can be currently found on the Internet, it is often spread among multiple websites and not easily accessible, while other information appears to be only available via request. Such a high level of disclosure and transparency will aid in remedying some of the distrust among interest/user groups/concerned citizens and the BLM, while also providing access to information that would aid in better understanding how the BLM conducts elements of its management program. This, in turn, would facilitate more informed public input and comment on BLM management proposals.

Conclusion: The human dimensions of wild horse and burro management has not received sufficient attention or study in the United States. While such surveys, if conducted, are not likely to resolve the controversy inherent to this management issue, it will provide the BLM with, among other data, greater information about how American's perceive wild horses and burros, why they value or dislike them, and how they would prefer to see them managed (if at all). Ideally, such data – along with the input already provided by the public to the BLM during various public comment opportunities – would be carefully considered when making management decisions and not ignored. Those who advocate for wild horses and burros often feel that their interests, though required to be considered equally with other interests under the law, are ignored or downplayed because they don't match the management objectives or interests of the BLM or its allied organizations. This has contributed to the controversy, distrust, disdain, and litigiousness that have surrounded wild horse and burro management. Despite the damage that has been done, these difficulties can be overcome if the BLM would be more transparent, fully disclose all relevant information, and equally respect the diversity of values and attitudes that are pertinent to the management of wild horses and burros.

Recommendations:

1. Collaborate with social scientists to develop and implement sociological surveys to gather data on American's value and attitudes regarding wild horses and burros nationally, at a state level, and locally. Conduct surveys of the varied user/interest groups and citizens advocates to develop a more concrete understanding of their particular motivations, values and attitudes. Integrate the results of such surveys into management decision-making processes.

2. Develop opportunities to provide any and all user/interest groups and citizen advocates greater access to BLM field office personnel, managers, directors, and decision-makers to engage in dialogue, obtain information, and learn about the procedures and practices that the BLM uses in regard to wild horse and burro management. Such opportunities should include not only continued ability to observe roundups and visit short and long-term holding facilities, but also opportunities to learn about rangeland condition monitoring methods and meet with wild horse and burro program staff formally and informally to discuss concerns, ask questions, and collaborate on potential solutions.

3. Develop a single wild horse and burro management web page to provide a single source for all relevant information pertinent to the management of wild horses and burros and their habitat. This page should enable the public to easily find all relevant information and data about Resource Management Plans and associated NEPA documents, completed and pending roundups and associated NEPA documents, statistical information, range monitoring reports, allotment management plans and associated NEPA documents, data used to set or adjust AML, injury and mortality statistics, upcoming public comment opportunities, and other information relevant to the BLM's management program.

K. Additional Research Needs: *Identify research needs and opportunities related to the topics listed above. What research should be the highest priority for the BLM to fill information and data gaps, reduce uncertainty, and improve decision-making and management?*

Further research on all elements inherent to the management of wild horses and burros is, of course, beneficial. The pursuit of new studies, however, must not be used as an excuse to prevent or delay active, humane management. Instead, an adaptive management strategy must be employed so that appropriate, responsible, humane, and fiscally coherent management is implemented concurrently with new research efforts, with research results continually informing and altering management.

A significant shift in management is required to address the many deficiencies in the current program. There are too many wild horses in short- and long-term holding facilities usurping a substantial proportion of the BLM's budget. While such care must continue for the duration of the lives of those horses maintained in such facilities, the BLM must stop making the problem worse by constantly adding horses to these facilities or opening new facilities to address the continual stream of horses being removed from public lands.

AWI acknowledges that the BLM has a responsibility to manage wild horses and burros to protect a TNEB. Although we often disagree with roundup and removal decisions, our dispute is nearly always related to a lack of evidence disclosed to justify the action; not to whether the BLM has the authority to act. The WFRHBA and its implementing regulations and policies require wild horses and burros to be managed within HMAs.

While wholesale changes are needed within the BLM to address the many deficiencies in its management of wild horses and burros, to reduce or eliminate the roundups and removals while meeting management requirements, the only feasible solution is to implement a rigorous and far-reaching immunocontraception program. The responsible and scientific employment of fertility control to reduce or stop herd growth rates would, in time, achieve population reduction in a manner that is both cost effective and would involve minimal trauma to wild horses. If done with care, primarily to ensure sufficient genetic diversity is retained within the herds, the extensive use of this technology – on herds that are currently within AML range or even those that exceed high AML – will permit the BLM to minimize if not entirely eliminate roundups and removals. This would cut off the flow of horses to short- and long-term holding facilities, and, in time allow the BLM to maintain horse and burro populations on the range at desired management levels and reduce the number (and cost) of wild horses in holding through natural rates of attrition. There is no significant obstacle to implementation of such a program.

While such an effort is underway, the BLM, USGS, other federal and state partner agencies, and academic institutions should engage in research to fill information and data gaps, reduce uncertainty, and improve decision-making and management. Recommended areas for further research are as follows:

- Continue the collaboration with USGS to develop more accurate wild horse and burro census methodologies, and implement those new techniques to improve wild horse and burro population estimates, increase the accuracy of estimated annual growth rates, and inform management decisions.
- Collaborate with population biologists, mathematicians, population modelers, and university scientists to develop and implement more accurate, reliable, and comprehensive models for predicting the impacts and costs of management actions on wild horse and burro herds and their habitats.
- Develop and implement scientifically credible studies to advance understanding of the physical, behavioral, and social impacts associated with the use of immunocontraceptive agents for the humane control of wild horse and burro herds. These studies, which should include quantitative measures of behavioral or social impacts, should be done in concert with the recommended wide-scale use of the vaccines as a direct and immediate management action (recognizing that for scientific study, portions of some herds may need to remain untreated to represent a control group).
- Engage in a credible reassessment of all HAs from which wild horses and burros have been permanently removed, and all HA acreage within which wild horses and burros are not presently managed, in order to determine if conditions would permit a return of wild horses or burros to these lands. If so, wild horses and/or burros should be returned – including, potentially, the mares and geldings (as a component of a mixed herd of reproducing and non-reproducing animals) from holding facilities.
- Collaborate with academic institutions and state wildlife agencies to expand research into the role of natural predation as a control on wild horses and burros, including through the creation of areas where there is no sport-hunting of lions to assess how this may alter lion densities and predation rates on wild horses and burros.
- Continue to collaborate with Dr. Gus Cothran and develop new relationships with other geneticists to expand research into preserving the genetic health of wild horses and burros using all relevant tools (e.g., hair, blood, fecal samples) and measures (e.g., heterozygosity, allelic diversity, kinship relations) to assess, compare, and measure genetic health.
- Engage population biologists, animal behaviorists, and others with relevant expertise to study the physical, psychological, social and behavioral impacts of establishing mixed herds of reproducing and non-reproducing animals, recognizing that solely non-reproducing herds are not consistent with the intent of the WFRHBA and that, to preserve genetic diversity, any non-reproducing animals within a mixed herd must not count toward AML – particularly for those herds smaller than 200 animals.
- Collaborate with range scientists, ecologists, naturalists, and others with relevant expertise to engage in an HMA-wide reassessment of AML, with a goal to potentially adjust each AML through a standardized existing or newly developed procedure within five years, with the required level of public transparency and review.

- Engage sociologists, specialists in human dimensions of wild management, and others with relevant expertise to comprehensively evaluate the sociological components of wild horse and burro management to better understand the existing perspectives and identify management strategies that seek to accommodate as many of those perspectives as possible.
- Develop a classroom and field training program to provide wild horse and burro advocates, livestock industry officials, state and federal agency personnel, and interested members of the public with an opportunity to learn about the tools, techniques, responsibilities, obstacles, and dilemmas that are part of BLM's management of wild horses and burros.
- Collaborate with NEPA specialists from other agencies, public interest legal specialists, representatives from interest/user/advocacy organizations, and other with relevant expertise to define the components of a legally sufficient NEPA analysis (to be used for all levels of decision-making within the BLM's wild horse and burro management program) and implement those components in any future NEPA documents including roundup and removal plans.

While such research efforts are being implemented, to urgently improve transparency with the public and provide a platform to disclose and evaluate all components of its wild horse and burro management program, the BLM should immediately initiate a programmatic Environmental Impact Statement on its wild horse and burro management program. Such an EIS should include, but not be limited to, a site-specific analysis of all HAs from which wild horses and burros have been permanently removed, a description of the methods used to assess rangeland condition, disclosure of the relevant rangeland inventory and monitoring data for all HMAs, and disclosure and explanation of the data used to justify current AMLs.

The management of wild horses and burros is not too complex nor does it cover too great a geographic range to be adequately addressed in a programmatic EIS. Other agencies have utilized such documents to provide a platform to explain and evaluate their broad scale programs (see, e.g., U.S. Department of Agriculture, Wildlife Services (Animal Damage Control) programmatic EIS on its program, U.S. Fish and Wildlife Service EIS on migratory waterfowl management). The BLM should do the same. While such a document would not end the controversy associated with wild horse and burro management, it would provide everyone with a consistent explanation of how and why the BLM manages these animals, thereby improving the public's understanding of the program and providing a greater opportunity to participate in the process.

General Overview of the BLM Wild Horse and Burro Management Program:

Management of wild horse, burros and cattle on BLM lands is governed by multiple federal statutes, regulations, and policies. The BLM prepares Land Use Plans or Resource Management Plans (LUPs or RMPs) to determine how its lands will be managed; including what uses will be allowed. RMPs are applicable to large land areas under the specific jurisdiction of BLM field offices. They provide, in effect, a blueprint for how the lands will be used. Uses include, but are not limited to, livestock grazing, logging, oil and gas development, mining, recreation, and wild horses and burros. Congressionally designated wilderness areas, wild and scenic rivers, and critical habitat for federally listed threatened and endangered species can all be found within those lands covered in an RMP.

The BLM authorizes livestock use of grazing allotments via a permitting process. Public land grazing permits are generally valid for at least ten years, at which time they are subject to a renewal process. This process, which generally includes the preparation of a NEPA analysis, is intended to determine if the permit should be renewed. Nearly always the permit is renewed unless the permittee has grossly violated the terms of his or her permit and/or is engaged in some nefarious or other illegal act that would give the BLM the basis to reject the renewal. Even if not renewed, the allotment would remain open to grazing (i.e., once a new permittee is awarded the permit) unless the BLM elected, after completing an analysis, to alter the LUP and to close the specific area to livestock for any number of potential reasons. This rarely occurs, though there have been instances where permittees have given up their permit, voluntarily or through incentives, and the BLM has then closed the area to grazing to achieve an important conservation benefit.

Grazing permits identify the type of stock that can be grazed, establish when the allotment is open to grazing, and delineate other conditions that the permittee must follow. In addition to grazing permits, the BLM and permittee can develop allotment management plans (AMPs) that incorporate additional standards, provisions, or recommendations to guide the permittees use, management, and improvements to the allotment for the duration of the permit. AMPs are not required but, if not prepared, the standards applicable to the allotment (i.e., type of stock allowed, season of use, AUMs) are to be included in the permit itself.

Wild horses and burros are managed within HMAs. Upon passage of the WFRHBA, the federal government surveyed wild horse and burro populations to identify those areas where, as Congress directed, they were to be protected and managed. These areas were designated as HAs. It is not clear exactly when each area was surveyed and whether such surveys were conducted once or multiple times over the course of a year or two. Hence, it is not known if the areas originally designated as HAs for wild horses and burros encompassed sufficient range to meet the needs of the animals throughout the year. At that time, very few studies had been undertaken to understand wild horse and/or burro biology, ecology, behaviors, or habitat needs. It is probable, therefore, that the efforts made to establish wild horse and burro range were ill-informed as to the biological and ecological needs of the species.

HMAs were not designated in the 1971 law. It is not clear how the BLM delineates the boundaries of HMAs. Presumably it considers geography, topography, presence of private lands, land use patterns, water availability, forage production, space, cover, and economic and political factors when establishing such boundaries. In some cases, adjoining HMAs are considered as an HMA complex and managed accordingly. Each HMA, as articulated in the BLM Handbook, is to have a Herd Management Area Plan (HMAP) to provide additional guidance on how each HMA is to be managed. It is not clear how many HMAs have corresponding HMAPs at present.

For each HMA, the BLM establishes an AML for wild horses and/or burros. Though historically, AML had been set as a single number, today AML is set as a range (i.e., a low AML and high AML) to provide management flexibility. The high AML is set below the ecological carrying capacity of the habitat while the low AML is intended to represent a sufficient number of horses or burros needed to preserve a sustainable population and herd health (including genetic health), and permit approximately four to five years of population growth before meeting or exceeding high AML. Within HMA complexes, the individual AMLs for each HMA can be combined to develop an AML for management of the entire complex.

The establishment of the AML is a cornerstone of wild horse and burro management, as the BLM uses the high AML – rightly or wrongly – as a basis for determining whether an "excess" of wild horses and burros exist and, therefore, as a trigger for potential management action (i.e., roundups). As previously indicated, the BLM Handbook provides guidance on when and how AML is to be set or adjusted. In either case, as discussed in more detail below, one prerequisite for determining AML is to have three to five years of intensive rangeland monitoring data. Such data, however, is only a fraction of what is needed to adequately assess AML.

Considering the importance of establishing AML for the management of wild horses and burros (and indirectly for the management of livestock and wildlife) on BLM lands, the AMLs designated by the BLM have been the subject of considerable controversy. Many of the current AMLs were originally set decades ago and either they have not been reviewed or, if reviewed, the AML has not been adjusted to reflect new data or no new data is available to reassess AML. Retaining the same AML for decades, and failing to recognize the dynamic nature of ecosystems and the suite of factors that affect ecosystem processes is a serious flaw in the AML process.

Though the BLM indicates that AMLs can be reset in HMAPs or roundup plans, AWI is unaware of the existence of an HMAP and has never seen BLM adjust an AML as the result of a roundup plan. Similarly, in at least two RMPs that AWI has reviewed, the AMLs for the relevant HMAs have either not been reevaluated or were retained without change. In neither case did the BLM disclose the data it is required to gather or engage in the analysis mandated pursuant to the AML process articulated in the BLM Handbook. AWI continues to seek information to document the origins of each AML, and to understand how each was originally calculated and the basis for any amendment. Such efforts, however, have been thwarted by the BLM's apparent failure to comply with the required process to set or adjust AMLs.

Wild horse and burro roundups are triggered when the BLM determines that an "excess" of wild horses and/or burros are present on the rangeland and/or if there is evidence that wild horses and/or burros are present on private lands. Whether a particular herd is at a level that is considered excess is generally based on whether the herd numbers have exceeded high AML. A mere finding of excess, however, is not sufficient to justify a roundup, as the BLM also must conclude that the excess is preventing attainment of a "thriving natural ecological balance" (TNEB) on the rangeland. Presumably this is done by evaluating range condition and monitoring data. If so, however, the BLM rarely discloses the data or its interpretation of the data in its roundup plans. Instead, it often attributes a decline in rangeland condition to wild horses or burros without any supporting evidence. Furthermore, even if these data existed, the BLM would, to be fully consistent with the relevant laws, need to demonstrate that wild horses and/or burros were largely responsible for not achieving TNEB in order to justify a roundup.

Given the lack of evidence disclosed by the BLM to prove that the TNEB standard is not being met, it would appear that the BLM uses high AML as an ecological litmus test arguing that, if wild horse and burro numbers are in excess of high AML, then they are adversely impacting the TNEB on the range and, therefore, must be removed. The phrase TNEB is not defined in statute, regulation, or policy. As such, it is unclear what effort, if any, is made or what methods or measures are used to determine if the TNEB is actually being harmed by the number of wild horses and burros on the range. Considering that range conditions can change over time as a result of a variety of factors (i.e., precipitation quantity and timing, ambient air temperature, fire, hydrological changes), the monitoring of a full suite of biotic and abiotic factors that influence rangeland condition is essential for meeting the TNEB test.

The practical realities of planning and conducting roundups limit them to once every four to five years, except when the BLM acts in response to an emergency (i.e., severe drought, fire). With the exception of emergency roundups, all roundup operations are required to be preceded by NEPA analysis to evaluate the impact of the proposed roundup on the environment. These analyses are not conducted to determine if a roundup should proceed but only to examine possible roundup methods (i.e., bait trapping, helicopter trapping) and strategies (i.e., use of immunocontraception on released mares, sex-ratio manipulation, releasing geldings) and to evaluate the impact each may cause to the environment. Though BLM policy specifies that roundup decisions should be issued at least 30 days before the roundup is set to begin in order to accommodate the appeals process, roundups have often commenced within days of roundup decisions.

Roundups are conducted throughout the year except for March through June, which is the peak of the foaling season for wild horses. In general, only emergency roundups can be conducted during those months. The vast majority of roundups are conducted with helicopters used to locate, herd, or stampede wild horses and burros to trap sites established on public or private lands, usually within the HMA. Other techniques that can be used to capture horses and burros include bait or water trapping or roping. To aid in the capture, "Judas" horses and/or personnel on horseback or all-terrain vehicles can be used to lure or push horses the final distance into a trap. Depending on the total number of wild horses and/or burros to be captured, roundups can last from days to weeks. The operations are normally conducted by contractors hired by the BLM. The roundups are overseen by BLM personnel and both the BLM and contractors are required to conduct the operations in a manner consistent with relevant federal laws and BLM procedures which, ostensibly, are intended to ensure the humane care and treatment of the wild horses and/or burros through all phases of the capture operation. BLM policy and procedure is to afford the public an opportunity to observe roundups, though the location (public versus private lands), topography, and geography of the landscape can affect the proximity of the public viewing location to the capture or trap site, or whether such opportunities are provided at all.

BLM policy and procedures are intended to reduce the stress incurred by targeted horses and burros by limiting the time, distance, and/or pace that they can be chased or herded by the helicopter to the capture facilities.[46] It is not clear, however, how or even if the contractor hired to conduct the roundup and BLM personnel engage in an assessment of what distance or pace animals can safely be moved prior to the commencement of a roundup. AWI is not aware of any records kept by the BLM or its contractors regarding the distance, time, or pace of travel of wild horses or burros subject to capture. Nonetheless, based on eyewitness reports from individual roundups, the condition of the horses suggests that often the horses or burros have been pushed extended distances at a high rate of speed, a factor which can contribute to suffering, injury or even death.

Throughout the capture, handling, and transportation process, wild horses and burros can and do suffer, with some sustaining serious injuries or dying as a consequence of the process. During roundups, BLM policy specifies that it will provide daily reports on the status of the operations. These report include the number of wild horses or burros captured per day, their disposition, and information about any injuries, illnesses, or mortalities that were documented and, if known, the cause of such incidents. Overall, according to information contained in roundup plans, the rate of serious injury or mortality in all captured horses is 0.5 percent. In short-term holding facilities the mortality rate is approximately 5 percent per year, but this includes wild horses or burros euthanized at the discretion of the BLM or its contracting veterinarian. At long-term holding facilities, the reported annual mortality rate is 8 percent per annum.

Though the BLM has the legal authority to kill or euthanize old, lame, or sick wild horses or burros in the field, it is more common for the BLM to exercise this authority once animals have been captured. To achieve AML and consistent with BLM legal mandates, BLM removes horses preferentially based on age, with foals to 5-year olds (those animals considered to be the most adoptable) removed first, followed by horses that are 10-20 years old, and finally the 5-10 year old animals. Horse who are 20+ years of age, if

[46] The relevant procedures are the BLM's Standard Operating Procedures for roundup operations. These procedures are presently undergoing internal review and amendment by the BLM and selected outside experts. The BLM is not providing the public with an opportunity to participate in this process.

captured, are often returned to the range as they are likely to have the most difficult time dealing with the stress of handling and transport, will be the most difficult to gentle, and will not readily adjust to confinement. These standards, by potentially removing the majority of wild horses in their reproductive prime and leaving only older horses, can adversely impact long-term herd sustainability (depending on the age of reproductive senescence in horses and the sex and age composition of the remaining animals). In reality, these standards are often ignored; the majority of roundups are considered "gate-cuts," whereby all horses, regardless of age, are permanently removed in order to attain low AML.

If the BLM captures a sufficient number of horses or burros so that it becomes possible to return some to the range, it will often favor the release of male horses in order to manipulate the sex ratio of the herd to reduce growth rates. This is very likely to produce adverse impacts in the behavior of individual animals and the herd's social dynamic. A herd that has a 60/40 male-to-female sex ratio may form more, but smaller, harem groups. With more dominant stallions, there may be greater conflict between them which can, in turn, influence the well-being and productivity of harem mares and the survival of their foals. While the smaller number of mares will, numerically, limit production, the increased proportion of males could contribute to a larger proportion of mares being impregnated and foaling each year than would have occurred if the sex ratio had not been manipulated. This may defeat the purpose and intent of manipulating the sex ratio to reduce herd production.

In most BLM roundup plans, the BLM proposes to treat any mares returned to the range with an immunocontraceptive vaccine. The BLM has ostensibly embraced this technology in its new strategic plan and purports to emphasize its use to maintain as many horses on the range as possible. However, given the number of animals who must be removed to achieve AML and the efficiency of the capture operations, unless an immunocontraception research project is underway, the actual number of wild horses vaccinated annually has, to date, been quite small.

Upon capture, wild horses are sorted to separate stallions from mares and foals and to try to maintain mare and foal groups. The capture facilities are not designed to hold horses, so captured animals are, after sorting, generally loaded into trailers and transported to temporary holding facilities. At these facilities, the horses are provided access to food and water and prepared for transport to short-term holding facilities. BLM procedures provide guidance on the handling and transportation of wild horses and burros, ostensibly to reduce the potential for debilitating stress, injury, or mortality. The BLM is authorized to kill or euthanize wild horses who may be clearly sick, severely injured, in distress, old, or that demonstrate a genetic condition (i.e., swayback, club foot) at any stage during the capture and handling process. Though the BLM has the discretion to have a veterinarian at the capture or temporary holding facilities, often the horses arrive at the short-term holding facilities before they are subject to a veterinary examination.

Depending on age and condition, the BLM has the discretion to place foals found orphaned during capture operations (i.e., mother is not captured or is killed during the operation) in foster homes or rescue facilities to nurse the foal to better health or until he or she is mature enough to transition to a vegetation-based diet, at which time the foals are reclaimed by the BLM and placed into the adoption process.

Short-term holding facilities can include alternative facilities, like prisons. At short-term facilities, wild horses are prepared for the adoption process and/or long-term holding. This includes freeze branding, administration of routine vaccinations, and, for males, gelding. For those animals to be placed into the adoption program, they may be subject to training or procedures intended to make them more gentle and manageable. As of 2008, horses remained in short-term holding facilities for an average of 280 days far longer than the 90 days predicted by the BLM in 2001 and the 45-60 days documented in the late 1990s (GAO 2008). The cost of short term holding has also increased from $3/horse/day in 2001 to $5.08/horse/day in 2008 (GAO 2008).

The adoption process is guided by BLM policy, which articulates the entire process used to adopt a wild horse or burro, including the relevant adoption forms, costs, pre-adoption interview, care standards, post-adoption compliance checks, and procedures for returning horses or burros to the BLM. As part of the adoption process, adopters must verify, verbally and in writing, that they have no intent to use the adopted animals for commercial purposes, including for slaughter. The BLM has the right to deny an adoption application for any number of reasons or to cease a post-adoption transfer of title if the relevant requirements are not being fulfilled. One year after adoption, the adopter can request title for the animal from the BLM. Once title is transferred, the BLM no longer has any authority over the animal or the animal's care.

Pursuant to a rider attached to a bill passed in 2004, the BLM has sale authority for wild horses. This authority is triggered for any horse 10+ years of age or who has been put up for adoption at least three times without success. This authority allows the BLM to sell wild horses (and presumably burros) to anyone at a negotiated price. For these animals, title is immediately transferred at the time of purchase. Those purchasing wild horses are required to sign an attestation that they have no intention of selling the horse for slaughter or other prohibited purpose. Once title is passed the BLM has no further responsibility for that animal. With little or no oversight to govern the behavior of buyers following the attestation (along with the added difficulty of proving there existed intent to sell *at the time of attestation*), unscrupulous buyers can purchase horses at reduced rates and sell them at a profit for slaughter or other commercial uses.

Horses who are not adopted or sold, or never placed into the adoption process are transported to long-term, contract holding facilities. These facilities, located primarily in the Midwest, are on private lands. Though horses in long-term holding remain available for adoption or sale, the vast majority will likely live out the remainder of their lives in these facilities. With the exception of one facility with a herd of combined mares and geldings, all such facilities house geldings or mares separately. The cost of long-term holding is $1.27/horse/day based on 2008 data (GAO 2008).

It is the total number of wild horses in short and long-term holding and the costs to the taxpayers of such operations that is the focus of so much attention and controversy inherent to the BLM's management program. As numbers in short and long-term holding increase, the cost of caring for these animals also increases. For Fiscal Year 2012, Congress appropriated $74.9 million for the BLM's wild horse and burro management program of which $43 million was spent on the maintenance of wild horses and burros in short- and long-term holding facilities. There is a legitimate concern that the ongoing addition of wild horses to holding facilities is economically unsustainable. Since the mass euthanasia or slaughter of healthy animals is unlikely to be accepted by the public, implementing management strategies to maximize the number of wild horses and burros being managed on the range is clearly an essential component of program reform.

Legal Analysis:

Wild free-roaming horses and burros on public lands are deemed living symbols of the pioneer spirit of the West and considered a national aesthetic resource. At one time, estimating to number in the millions, by the late 1960s and early 1970s, the wild horse population was believed to have declined to as low as seventeen thousand. In 1971, concerned with this decline and recognizing the need for their protection, Congress enacted the Wild and Free-Roaming Horses and Burros Act (WFRHBA).

Under the Act and its implementing regulations, the Departments of the Interior and Agriculture manage and protect wild and free-roaming horses and burros on public lands. Over the course of the past forty years, the Act has been amended and subject to litigation (with respect to both the management of these animals and their protection).

This overview focuses on the relevant statutes that mandate and inform the management of wild horses and burros. The intent of this analysis is to aid in understanding the legal boundaries governing wild horse and burro management, recognizing that future lawsuits and amendments to the WFRHBA or relevant land management statutes may alter this legal landscape. Because the overwhelming majority of wild horses and burros live on lands managed by the Department of the Interior, this analysis focuses on the Bureau of Land Management.

In addition to these statutes, there are other laws (i.e., the National Environmental Policy Act, Administrative Procedures Act, Endangered Species Act), a series of regulations, and a smorgasbord of policies that also pertain to or influence wild horse and burro management. BLM policies are contained within BLM Handbooks, Manuals, Instruction Memoranda, and Information Bulletins.[47] The agency's Handbook on wild horse and burro management which, among other things, provides more detailed guidance on how the BLM creates and removes HMAs, considers genetics in the management of wild horses and burros, and establishes and adjusts AML, is referred to throughout this report. Other Handbooks and Manuals address rangeland inventory, monitoring, and vegetation management among many other items. In addition, the BLM also has a series of Technical References that provide, for example, more detailed guidance on the methodologies its personnel are required to use to monitor rangeland vegetation conditions and trends and riparian area health and function.[48] Given the sheer number and complexity of these policies, this report does not summarize or critique these documents here.

<u>Wild Free-Roaming Horses and Burros Act & Legislative History</u>

With the enactment of the WFRHBA, Congress declared that wild horses are "living symbols of the historic and pioneer spirit of the West [and] are fast disappearing from the American scene" and established a policy to protect horses from "capture, branding and

[47] BLM regulations, Handbooks, Manuals, Instruction Memoranda, and Information Bulletins can be accessed at: http://www.blm.gov/wo/st/en/info/regulations.html
[48] BLM Technical References can be accessed at: http://www.blm.gov/nstc/library/techref.htm

harassment, or death."[49] Horses were to be considered "an integral part of the natural system of the public lands."[50] As amended, the Act brings "[a]ll wild free-roaming horses and burros" under the jurisdiction of the Department of the Interior, through the Bureau of Land Management (BLM), and the Department of Agriculture, through the Forest Service (USFS), "for the purpose of management and protection."[51]

Under the WFHBA, the Secretary of the Interior is authorized and directed to protect wild free-roaming horses and burros "as components of the public lands."[52] In doing so, the Secretary may "designate and maintain specific ranges on public lands as sanctuaries for their protection and preservation"[53] after consultation with state wildlife agencies and advisory boards established under the Act.[54] The Act defines "range" to mean "the amount of land necessary to sustain an existing herd or herds of wild free-roaming horses and burros, which does not exceed their known territorial limits, and which is devoted principally but not necessarily exclusively to their welfare in keeping with the multiple-use management concept for the public lands."[55] Consequently, while wild horses and burros are commonly referred to as occupying rangelands, the BLM has the authority to designate specific ranges for the species where the interests of wild horses and burros are to take precedence over domestic livestock and/or wildlife. To date, after forty years of implementing the Act, the BLM has established only three wild horse or burro "ranges": the Pryor Mountain Wild Horse Range,[56] the Little Book Cliffs Wild Horse Range, and the Marietta Wild Burro Range.

Through the land use planning process, regulations implementing the Act specify that the BLM is to manage horses and burros within herd management areas[57] while the USFS does so within wild horse territories.[58] The establishment and use of HMAs, however, are not included in any of the relevant statutes, including the WFRHBA, which raises

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[49] 16 U.S.C. § 1331 (1994).
[50] *Ibid.*
[51] The Act was amended by the Federal Land Policy and Management Act of 1976, 43 U.S.C. §§ 1701-1785, the Public Rangelands Improvement Act of 1978, 43 U.S.C. §§ 1901-1908, and most recently in 2004, by the Consolidated Appropriations Act of 2005, Pub. L. No. 108-477, §142, 118 Stat. 2809, 3070-71. Bureau of Land Management National Wild Horse and Burro Program, History of the Program, http://www.wildhorseandburro.blm.gov/history.htm (last visited Nov. 20, 2005) (summarizing the history of the WFRHBA). 16 U.S.C. § 1333(a) (2000).
[52] § 1333(a).
[53] A designated range is the "amount of land necessary to sustain an existing herd or herds of wild free-roaming horses and burros, which does not exceed their known territorial limits, and which is devoted principally but not necessarily exclusively to their welfare in keeping with the multiple-use management concept for public lands." Id. § 1332(c).
[54] § 1333(a). For a discussion of the policy of regulations affecting protection, management, and control of wild horses and burros by the Bureau of Land Management, see 43 C.F.R. § 4700.0-6 (2004), and by the Forest Service, see 36 C.F.R. § 222.21 (2005). The Act authorizes the Secretaries "to appoint a joint advisory board of not more than nine members to advise them on any matter relating to wild free-roaming horses and burros and their management and protection." 16 U.S.C. § 1337.
[55] 16 U.S.C. §1332(c).
[56] The Pryor Mountain Wild Horse Range was established by Secretary of the Interior Udall in 1968, three years before passage of the WFRHBA.
[57] 43 C.F.R. § 4710.3-1 (2004).
[58] 36 C.F.R. §§ 222.20(15), 222.21(a)(1) (2005).

questions as to the legality of such designations. Instead, the WFRHBA, as amended, establishes protection and management standards for wild horses and burros "in the area where presently found" – a reference to HAs which, in most states, encompass a larger geographic area compared to HMAs and, therefore, can theoretically support a larger number of wild horses and burros.

Notwithstanding questions about the legality of HMAs, both the BLM and USFS are responsible for managing wild horses and burros "in a manner that is designed to achieve and maintain a thriving natural ecological balance on the public lands."[59] All management activities are to be conducted "at the minimal feasible level" and in consultation with state wildlife agencies "in order to protect the natural ecological balance of all wildlife species which inhabit such lands, particularly endangered wildlife species."[60]

In support of the WFRHBA, legislators expressed that the purpose of the bill was to "emphasize protection rather than intensive management."[61] The agency's goal was to "protect the range from deterioration associated with overpopulation of wild horses and burros."[62] Congress noted that "the management of wild free-roaming horses and burros [should] be kept to a minimum…. An intensive management program of breeding, branding, and physical care would destroy the very concept that this legislation seeks to preserve."[63] The Act did not authorize the maintenance of wild horses in long-term holding facilities.

<u>1978 Amendments & Appropriate Management Levels</u>

1978 amendments to the Act directed the BLM to keep an updated count or inventory of the wild horse populations on public lands.[64] This was required to enable the agency to determine when overpopulation exists, to establish "appropriate management levels" (AMLs) of wild horses, and to decide when to remove or destroy excess animals to

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[59] 16 U.S.C. § 1333(a) (2000). See U.S. Dep't of the Interior, The 10th and 11th Report to Congress on the Administration of the Wild Free-Roaming Horses and Burros Act for Fiscal Years 1992-1995, at 7 (1997) [hereinafter Report to Congress] (describing how the Department utilizes land-use planning, census techniques, and herd management to maintain a "thriving natural ecological balance").
[60] 16 U.S.C. § 1333(a).
[61] H.R. Res. 9890, 117 Cong. Rec. 34780 (1971).
[62] H.R. Rep. No. 95-1737, at 4131 (1978).
[63] S. Rep. No. 92-242, at 3 (1971).
[64] 16 U.S.C. § 1333(b)(1). See 43 C.F.R. § 4710.2 (2004) ("The authorized officer shall maintain... a current inventory of the numbers of animals and their areas of use."); 36 C.F.R. §§222.21(a)(5)-(6) (2005) (requiring the USFS to "[m]aintain a current inventory of wild free-roaming horses and burros" to determine appropriate management levels). With respect to inventories, the Board in Craig C. Downer, 111 I.B.L.A. 332, 337 (1989), 1989 IBLA LEXIS 292, explained: Inventory numbers chosen for administrative convenience as a starting point for monitoring purposes are not [appropriate management levels] within the statutory meaning of the term.... The inventory is to provide information which, along with other information gathered from monitoring and studies... will allow the Secretary to determine the optimum number of wild horses and burros that will allow a thriving natural ecological balance and protect the range from deterioration. The inventory itself does not constitute that determination.

achieve this optimal level[65] in the most humane manner possible or to implement other management options (e.g., sterilization, allowing natural control).[66] An AML is defined as "the median number of adult wild horses or burros determined through [the Bureau's] planning process to be consistent with the objective of achieving and maintaining a thriving ecological balance and multiple-use relationship in a particular herd area."[67]

"Excess animals" refers to wild horses and burros that "have been removed from an area by the Secretary pursuant to application (of) law or which must be removed from an area in order to preserve and maintain a thriving natural ecological balance and multiple-use relationship in that area."[68] Despite this statutory language, under regulations implementing the WFRHBA, the BLM has the authority to "[i]f necessary to provide habitat for wild horses . . . close appropriate areas of the public lands to grazing use by all or a particular kind of livestock."[69] The BLM has claimed that this regulatory authority is only pertinent in the event of emergency or catastrophic circumstances (i.e., severe drought, fire) but this is not reflected in the regulatory language.

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[65] The appropriate management level is based on the number of animals that a particular area can support. 16 U.S.C. § 1333(b)(1) (1994). See Cody, supra note 1, at 4 (noting that horses in excess of the appropriate management level are removed). A BLM regulation authorizing field officers to decide when excess animals must be removed was upheld as the most effective means of implementing the goal of "immediate" removal. Blake v. Babbitt, 837 F. Supp. 458, 459 (D.D.C. 1993) (upholding 43 C.F.R. § 4770.3(c)). The Act specifically authorizes the BLM to issue necessary rules and regulations. 16 U.S.C. § 1336 (1994); see also 43 C.F.R. §§ 4700-4770 (1999) (listing regulations issued by the agency under the Act's grant of authority).

[66] 16 U.S.C.§ 1333(b)(2)(A). For definitions of humane and inhumane treatment, see 43 C.F.R. § 4700.0-5(e)-(f) (2004) and 36 C.F.R. § 222.20(b)(5)-(6) (2005). Interpreting 43 C.F.R. § 4700.0-5(e), the IBLA found that "[i]nhumane treatment may result as much from neglect as from design." Nikki Lippert, 160 I.B.L.A. 149, 156 n.5 (2003), 2003 IBLA LEXIS 56. Humane treatment means handling compatible with animal husbandry practices accepted in the veterinary community, without causing unnecessary stress or suffering to a wild horse or burro. Inhumane treatment means any intentional or negligent action or failure to act that causes stress, injury, or undue suffering to a wild horse or burro and is not compatible with animal husbandry practices accepted in the veterinary community. 43 C.F.R. §4700.0-5.

[67] *Fund For Animals v. BLM*, 460 F.3d at 16 (2006). There is no set formula for calculating an appropriate management level, because each Bureau office has "significant discretion to determine their own methods of computing [appropriate management level] for the herds they manage." *Id*. The discretion in determination among local offices ranges from finding a level that reflects "the midpoint of a sustainable range" or as a "single number." *Id*. Note: the court distinguished this decision when it decided *In Defense of Animals v. U. S. Dept. of Interior,* 808 F.Supp.2d 1254 (E.D.Cal., 2011): "*Fund for Animals*, however, was particularly unique in that BLM set out to achieve nationwide AML; BLM presented the plan to Congress as a Presidential Budget Initiative, and so individual field offices were acting pursuant to a nationwide initiative. *Id* at 16-17. The court in that case had determined it was a unique enough situation that it was very unlikely to recur stating, 'If there are to be more roundups in the future – itself an open question – it remains to be seen whether they will be of the same magnitude as those which have come before, and whether the same criteria are applied.' *Id.* at 23. Because the roundup at issue in that case was a one-off sweeping initiative to reduce herd rates nationwide, it was indeed difficult to say that situation would recur."

[68] 16 U.S.C. § 1332(f)(1-2).

[69] 43 C.F.R. § 4710.5(a) (1999) ("If necessary to provide habitat for wild horses ... the authorized officer may close appropriate areas of the public lands to grazing use by all or a particular kind of livestock."); see also 43 § 4710.5(c) (1999) (authorizing either temporary or permanent exclusion of livestock).

In making AML and "excess animal" determinations, the BLM must consult with the United States Fish and Wildlife Service, state wildlife agencies, and individuals with particular expertise and/or special knowledge of "wild horse and burro protection, wild-life management and animal husbandry as related to rangeland management." [70] It is not apparent that the BLM regularly complies with this requirement in its management planning decision-making processes.

In addition to the required inventories, the Secretary may consider various sources to determine whether overpopulation exists, including the inventory of federal public lands, land-use plans, court-ordered environmental impact statements, and other information that becomes available or is attained through research mandated by the Act.[71] If an overpopulation is identified, the Secretary must "immediately remove excess animals from the range so as to achieve appropriate management levels."[72] When removing "excess animals" the Secretary must do so in a particular order, with old, sick, or lame animals humanely destroyed first; followed by the humane capture and removal of additional excess wild horses and burros for which there exists an adoption demand; and finally any additional animals removed for which an adoption demand does not exist must be destroyed in the most humane and cost efficient manner possible.[73] Congress, however, has consistently prevented the killing or euthanasia of healthy wild horses and burros and the BLM has, with some exceptions, expressed opposition to such killing due to public opposition.

Wild horses or burros that are adopted out to qualified individuals retain their status as wild horses and burros until title is passed after a year of competent and humane care, if the animal dies on the range or in captivity before title is transferred, or if destroyed consistent with the Act's standards.[74] The so-called sale authority for wild horses and burros was promulgated in 2004 as a result of passage of the Consolidated Appropriations Act of 2005. [75] This authority permits the sale of excess animals who are more than 10 years old or have been offered unsuccessfully for adoption at least three times. Title is immediately transferred for animals who are sold under the Act. Those who adopt or purchase wild horses or burros, however, have to attest that it is not their intent to sell, transfer, donate, or otherwise cause the adopted or purchased animals to be slaughtered.

Finally, private landowners can maintain wild horses and burros on their private lands or on lands leased from the government provided that this is done "in a manner that protects them from harassment, and if the animals were not willfully removed or enticed from the

[70] 16 U.S.C. § 1333(b)(1).
[71] *Ibid.* at § 1333(b)(2).
[72] *Ibid.* at § 1333(b)(2)(iv).
[73] *Ibid*. at § 1333(b)(2)(iv)(A-C).
[74] *Ibid*. at § 1333(c) and (d).
[75] See Pub. L. No. 108-447, § 142(a)(2),118 Stat. 2809, 3070 (to be codified at 16 U.S.C. § 1333(e)). Of the 22,500 burros and horses BLM has in holding facilities, approximately one-third of them are eligible for sale. Tom Kenworthy, U.S. Will Resume Selling Wild Horses, U.S.A. Today, May 18, 2005, at 03A, available at 2005 WLNR 7902645.

public lands."[76] If the landowner does not want the wild horses and/or burros on his or her lands, the BLM must arrange to have the animals removed.[77]

Other Land Management Laws & Regulations:

Congress considered a score of bills to reduce overgrazing and bring a more systematic approach to management of the unreserved public lands, which had not yet been removed from the disposal laws facilitating privatization.

<u>Taylor Grazing Act</u>

Pursuant to the BLM's authority under the Taylor Grazing Act of 1934, the BLM has adopted regulations that implement its grazing management responsibilities.[78] BLM authorizes grazing within a grazing district by issuing permits pursuant to section 3 of the Taylor Grazing Act,[79] which requires that "preference" in issuing grazing permits be given "to those within or near a district who are landowners engaged in the livestock business, bona fide occupants or settlers, or owners of water or water rights, as may be necessary to permit the proper use of lands, water or water rights owned, occupied or leased by them . . . ." BLM's regulations define "preference" as a superior or priority position against others for the purpose of receiving a grazing permit, and this priority is attached to base property owned or controlled by the permittee. One who owns or controls base property does not have an absolute right to graze livestock on the public land; such grazing is subject to the reasonable discretion of BLM.

A severe reduction or cancellation of a permittee's grazing privileges is appropriate where (1) the permittee's trespasses were both willful and repeated;[80] (2) they involve fairly large numbers of animals; (3) they occurred over a fairly long period of time; and (4) they involve a failure to take prompt remedial action upon notification of the trespass. Cancellation is appropriate where all of those factors are present and no lesser sanctions would be sufficient to reform a permittee's behavior, such as where the permittee takes the position that BLM has no authority to regulate grazing in the allotment where the trespasses are occurring.[81]

The court in *Fallini v. Hodel*[82] (1992) upheld the District Court for Nevada's decision that cattle ranchers did not violate a federal range improvement permit when they installed guardrails at one of their water holes to discourage wild horses from grazing the surrounding land because when the permit was issued, "wildlife" did not include wild

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[76] 16 U.S.C. § 1334.
[77] *Ibid.*
[78] *See* 43 C.F.R. § 4100 *et seq.*
[79] 43 U.S.C. § 315b (2000).
[80] Damages due for repeated willful grazing trespass include all reasonable expenses incurred by the United States in detecting, investigating, and resolving violations, and impounding livestock, as well as three times the value of the forage consumed.
[81] *See* 2008 IBLA 2007-79.
[82] 963 F.2d 275 (1992 U.S. App.)

horses and the purpose of the Taylor Grazing Act authorizing the grazing permit and protecting cattle growers from interference.

In addition, although water rights on Federal land had been put to the beneficial use of watering livestock before the Taylor Grazing Act was enacted in 1934, the holders of those water rights did not have an appurtenant right to graze livestock.

The Multiple-Use Sustained Yield Act of 1960[83] (MUSY)

The Multiple-Use Sustained Yield Act of 1960 broadened the USFS's mission to include fish and wildlife, recreation, grazing, timber, and minerals.[84] The Act gave clear instructions to manage the National Forest System so that desired yields of the multiple uses, in combination, could be sustained over time. MUSY directs the Secretary of Agriculture, through the USFS, to "develop and administer the renewable surface resources of the national forests for multiple use and sustained yield of the several products and services obtained therefrom."[85]

For example, the USFS must decide what percentage of forestland will be used as parkland and what percentage will be used for lumber, but the Act conveys broad discretion to the USFS to decide the "proper mix of uses."[86] The Act requires the USFS to give due consideration to the various competing uses.[87] Once a court is satisfied that the USFS had considered all competing uses, MUSY forbids the court to take any further action and thus substitute the court's decision for the Secretary's determination of the best use for the land.[88] For example, in *National Wildlife Federation v. United States Forest Service,*[89] a federal district court held that the USFS's decision to approve timber harvesting in the Siuslaw National Forest, despite damaged soil, watershed and fish habitats from prior timber harvests, had not violated, and was in keeping with, the Multiple-Use Sustained-Yield Act of 1960.[90]

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[83] 16 U.S.C. §§ 528-531 (2006).
[84] *Ibid*. §§ 528-531.
[85] *Ibid*. § 529 (1982).
[86] *Ibid*. §§ 529, 531 (1982). *See also Sierra Club v. Hardin*, 325 F. Supp. 99, 123 (D. Alaska 1971). The case involved an action by the Sierra Club to enjoin the sale of timber from the Tongass National Forest and the issuance of a patent of the land for timber harvesting. Plaintiffs argued, *inter alia,* that the Secretary of the Department of Agriculture and the other federal defendants failed to consider and to balance non-economic uses of the land, such as 'outdoor recreation, watershed, wildlife and fish uses . . ..' *Id.* at 106. In *dicta*, the district court stated that the Forest Service had wide discretion to decide the proper mix of uses under MUSY. *Id.*at 123. The court held, *inter alia*, that laches barred plaintiffs' claims. *Id.* at 123-24.
[87] *Ibid*. § 529 (1982).
[88] *Ibid*. § 529 (1982).
[89] 592 F. Supp. 931 (D. Or. 1984).
[90] 592 F. Supp. at 938-39. The court held, however, that the federal defendants' decision not to prepare an environmental impact statement was unreasonable and issued an injunction enjoining the sale of timber until the defendants prepared such a statement. *Id.* at 944-45.

Federal Land Policy and Management Act (FLPMA)

On October 21, 1976, four months after the Court issued the opinion in *Kleppe,*[91] Congress passed the FLPMA.[92] The FLPMA provided the BLM a stronger legislative charter for the largest public land system in the United States. The Act required the BLM, for the first time, not only to coordinate with and "assure that consideration is given to" relevant state-authorized plans, but also to "provide for meaningful public involvement of State and local government officials."[93] Courts have noted, in cases brought under the WFRHBA, that any challenge to how range use is allocated must be made pursuant to the FLPMA. Congress devoted little debate to the FLPMA provisions governing public rangeland management.[94] The FLPMA's main management requirement—to manage for multiple use[95] and sustained yield[96]—was modeled after the USFS's MUSY Act.[97]

The FLPMA governs the BLM's management of the federal public lands and requires the BLM to develop land use plans for the public lands under its control.[98] The statute directs that in developing and revising land use plans, the BLM must "use and observe the principles of multiples use and sustained yield set forth in this and other applicable law."[99] Further, all resource management decisions made by the BLM "shall conform to the approved plan," either by being "specifically provided for in the plan, or if not specifically mentioned, clearly consistent with the terms, conditions, and decisions of the approved plan or plan amendment."[100] The Secretary must decide which combination of uses of public lands will "best meet the present and future needs of the American people,"[101] therefore balancing revenue-producing uses against non-revenue-producing uses.[102]

Although the FLPMA retained much of the Taylor Grazing Act and thus stopped short of a thorough overhaul of the law of livestock grazing, it dramatically shifted the center of

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[91] *Kleppe v. Sierra Club*, 427 U.S. 390, 410, n. 21 (1976).
[92] 90 Stat. 2744; 43 U.S.C. § 1701, et seq.
[93] 43 U.S.C. § 1712(c)(9) (2006).
[94] The pertinent materials are compiled in SENATE COMM. ON ENERGY AND NATURAL RESOURCES, 95TH CONG., 2D SESS., LEGISLATIVE HISTORY OF THE FEDERAL LAND POLICY AND MANAGEMENT ACT OF 1976 (1978).
[95] The FLPMA defines "multiple use" in relevant part as:
[T]he management of the public lands and their various resource values so that they are utilized in ... a combination of balanced and diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or the greatest unit output.43 U.S.C. § 1702(c).
[96] 43 U.S.C. §§ 1702(c), 1702(h), 1732(a) (1976).
[97] 16 U.S.C. §§ 528-531 (1976).
[98] 43 U.S.C. § 1712(a).
[99] *Ibid.* at § 1712(c)(1).
[100] *Ibid.* at §§ 1601.0–5(b), 1610.5–3(a).
[101] *Ibid.* at § 1702(c) (1982).
[102] *Ibid*. at § 1702(c) (1982).

gravity in land management on public lands. The FLPMA was intended to bring comprehensive planning to the BLM.[103] It imposed on the public rangelands the multiple-use, sustained-yield rubric,[104] which had been the guiding legislative mandate of the national forests since 1960.[105] This shift in legislative policy meant that, theoretically, grazing no longer claimed dominant status on the rangelands.[106] The FLPMA also placed new environmental restrictions on BLM authority, including limits on grazing that caused unnecessary and undue degradation.[107] Now ranchers would supposedly have to contend not only with wild horses and burros, but also with anyone else who wanted to use the public lands, including recreationists and environmentalists. The Act encourages federal agencies to account for state concerns, but often requires little more than that the BLM "pay attention."[108]

In addition to providing the BLM with expansive rangeland management authority, including the ability to designate and regulate areas of critical environmental concern,[109] the FLPMA explicitly affirmed that "the public lands [will] be retained in Federal ownership."[110] Among other things, the Act substantially alters mining law[111] and better defines the law governing access and rights-of-way.[112] The FLPMA addresses two fundamental issues: retaining public lands in public ownership[113] and managing lands in ways that avoid the "unnecessary or undue degradation"[114] previously inflicted.

Under the FLPMA, the typical permit or lease is intended to be for a duration of 10 years except under specified conditions not relevant herein. Each permit may include such

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[103] See 43 U.S.C. § 1712 (2006). Oliver Houck argues that *Nat. Res. Def. Council v. Morton,* 388 F. Supp. 829 (D.D.C. 1974), aff'd, 527 F.2d 1386 (D.C. Cir. 1976), paved the way for long-range planning on BLM lands by imposing NEPA environmental impact analysis on the grazing districts.

[104] 43 U.S.C. §§ 1701(a)(7), 1702(c) (2006). In a certain sense, the WFRHBA had already brought multiple-use management to the public rangelands by raising the priority of horses, an aesthetic land use, to at least the same level as ranching, the former dominant use. See Protection of Wild Horses on Public Lands: Hearing on H.R. 795 and H.R. 5375 Before the H. Subcomm. on Pub. Lands of the H. Comm. on Interior and Insular Affairs, 92d Cong. 147-50 (1971) at 103 (testimony of Michael J. Pontrelli, Assistant Professor of Biology, University of Nevada, Reno) (arguing against livestock dominant use and in favor of multiple use management to protect horses).

[105] Multiple-Use Sustained-Yield Act of 1960, 16 U.S.C. §§ 528-531 (2006).

[106] Nat'l Wildlife Fed'n v. BLM, 140 I.B.L.A. 85, 99-101 (1997). In practice, ranchers remained successful in dominating grazing use decisions on BLM lands. Joseph M. Feller, Back to the Present: The Supreme Court Refuses to Move Public Range Law Backward, but Will the BLM Move Public Range Management Forward?, 31 Envtl. L. Rep. 10021, 10021, 10025 (2001); see also Joseph M. Feller, What Is Wrong With the BLM's Management of Livestock Grazing on the Public Lands?, 30 Idaho L. Rev. 555, 570 (1994).

[107] 43 U.S.C. § 1732(b) (2006).

[108] N.M. ex rel. Richardson v. Bureau of Land Mgmt., 459 F. Supp. 2d 1102, 1120-21, (D.N.M. 2006), aff'd in part, vacated in part, rev'd in part, 565 F.3d 683 (10th Cir. 2009)(upholding BLM's oil and gas development plan for New Mexico's Otero Mesa notwithstanding the objections of the governor and inconsistencies with certain state plans);

[109] 43 U.S.C. § 1701(a)(11).

[110] *Ibid.* at § 1701(a)(1).

[111] 43 U.S.C. §§ 1732(b), 1744 (1976).

[112] *Ibid*. at.§§ 1761-1763 (1976).

[113] *Ibid*. at § 1701(a)(1).

[114] *Ibid*. at § 1732(a).

"terms and conditions" deemed appropriate by the Secretary so long as those terms and conditions are "consistent with the governing law."[115] The terms and conditions in permits shall, however, include, but not be limited to, "the authority" of the Secretary "to cancel, suspend or modify" the permit "in whole or in part" pursuant to the terms and conditions in the permit, or to "cancel or suspend" the permit for violations by the permittee of grazing regulations or permit requirements. Assuming that during the term of the permit the land has been used for livestock grazing, and that the permittee has complied with all permit requirements, and has accepted any new conditions of the Secretary, the holder of an expiring permit "shall be given first priority" for permit renewal at the end of 10 years.[116]

Under the FLPMA, however, the Secretary is not given carte blanche authority to issue 10-year permits containing whatever terms and conditions are deemed appropriate. The statute is remarkably clear and specific in its requirement that *all* permits conform to one of two prescribed methods of issuance.[117] Furthermore, as noted, Congress directed that among the terms and conditions to be included in each permit shall be an express retention of authority by the Secretary to cancel, suspend, or modify the permit under specified circumstances.[118]

The first of the FLPMA's only two permissible methods of permit issuance is outlined in §1752(d) and entails the incorporation into some permits of so-called Allotment Management Plans (AMP).[119] AMPs have been described as "the penultimate step in the multiple use planning process" and as "basically land use plans tailored to specific grazing permits." Congress has defined an AMP as being a document which "*prescribes* the manner in, and extent to, which livestock operations will be conducted...."[120] On the other hand, AMPs need only *describe* "the type, location, ownership, and general specifications for ... range improvements" on grazing allotments,[121] and may include other appropriate terms and conditions the Secretary wishes to insert.[122] If the Secretary chooses to incorporate an AMP into a permit, §1752(d) requires that the AMP be "tailored to the specific range condition of the area" and mandates that the Secretary

[115] *Ibid*. at 43 U.S.C. § 1752(a).
[116] *Ibid*. at 43 U.S.C. § 1752(c)
[117] *Ibid*. at 43 U.S.C. § 1752(d), (e).
[118] *Ibid*. at 43 U.S.C. § 1752(a).
[119] In language of particular importance to this lawsuit, allotment management plans are defined in the FLPMA as follows: *An "allotment management plan"* means a document prepared in consultation with the lessees or permittees involved, which applies to livestock operations on the public lands or on lands within National Forests in the eleven contiguous Western States and which: (1) *prescribes the manner in, and extent to, which livestock operations will be conducted* in order to meet the multiple-use, sustained-yield, economic and other needs and objectives as determined for the lands by the Secretary concerned; and (2) describes the type, location, ownership, and general specifications for the range improvements to be installed and maintained on the lands to meet the livestock grazing and other objectives of land management; and (3) contains such other provisions relating to livestock grazing and other objectives found by the Secretary concerned to be consistent with the provisions of this Act and other applicable law. 43 U.S.C. § 1702(k) (emphasis added).
[120] 43 U.S.C. § 1702(k)(1)
[121] *Ibid*. at § 1702(k)(2),
[122] *Ibid*. at § 1702(k)(3).

review each AMP on a periodic basis to determine whether the AMP has been effective in improving range conditions in the area.

The statute, however, provides only a single alternative in the event the Secretary has *not* completed an AMP. In such cases, the Secretary need not proceed by way of consultation with permittees, but may simply issue permits which themselves prescribe appropriate livestock management practices.[123] This short-cut method of prescribing grazing practices requires the Secretary to "incorporate in grazing permits and leases such terms and conditions as [the Secretary] deems appropriate" but also requires that the Secretary "shall specify" in each permit: (1) "the number of animals to be grazed" by the permittee; (2) "the seasons of use" for livestock grazing; and (3) a provision that the Secretary "may reexamine the condition of the range *at any time* " and, if necessary, "readjust" the livestock grazing prescription for the allotment.[124]

The cases previously discussed construing the MUSY Act are relevant to an interpretation of the FLPMA, but no court has investigated the meaning of the 1960 legislation in any depth.

Horse advocates have unsuccessfully attempted to use the FLPMA to argue that the BLM has failed to consider wild horses as one of the multiple uses under the Act.[125] However, the FLPMA has been held to simply require the BLM to "develop, maintain, and *when appropriate*, revise land use plans which provide by tracts or areas for the use of public lands."[126] Because the statute does not require the BLM to issue land use plans at any specific interval, courts have deferred to the agency's interpretation if it is "a permissible construction of the statute."[127] The court in *Habitat for Horses* (2010) quoted testimony that the BLM's "planning horizon" for a resource management plan is "15 to 20 years," which the BLM follows "unless there [are] extenuating circumstances, major changes in resource uses, changes in other uses or new information."[128] Because the statutory language clearly confers discretion on BLM and does not require a specific time frame for updating the land use plan, Courts often cannot use the FLPMA to find the BLM's interpretation to be an impermissible one.

Thus, as a practical matter, the only significant difference between the two permissible methods for issuing livestock grazing permits under the FLPMA are: (1) permits containing AMPs must involve careful and considered consultation, cooperation, and coordination with permittees; and (2) the prescription of livestock practices in a permit containing an AMP must be tailored to the specific conditions of the range on the allotment, whereas the permit without an AMP may apparently reflect general or

[123] *Ibid*. at § 1752(e).
[124] *Ibid.* (emphasis added).
[125] *Habitat for Horses v. Salazar*, 745 F.Supp.2d 438, 456 (S.D.N.Y., 2010).
[126] 43 U.S.C. § 1712.
[127] *Chevron,* 467 U.S. at 843, 104 S.Ct. 2778.
[128] *Habitat for Horses v. Salazar*, 745 F.Supp.2d 438, 456 (S.D.N.Y., 2010). Although the court held that individuals who frequently visit land to observe horses would suffer irreparable harm absent an injunction, it also held that BLM determined excess horses sufficiently as a matter if first impression and failure to evaluate all effects on observers of removing horses did not render its EA defective under NEPA.

universal livestock management standards. In sum, Congress by enactment of the FLPMA, did not weaken but rather strengthened the mandate it handed the Secretary in 1934 to rule the range. By the FLPMA's provisions requiring the Secretary to issue permits prescribing grazing practices and expressly retaining authority to cancel, suspend or modify, Congress gave specific meaning to its general instructions to the Secretary, to wit: "The Secretary *shall* manage the public lands …."[129]

Public Rangeland Improvement Act (PRIA)

The Public Rangelands Improvement Act of 1978[130] clarified and refined the essential Congressional message to the Secretary, namely, that the public lands be managed with more attention paid to range *improvement.* Congress made several findings which shed light on the purposes of the various statutes pertaining to public management of grazing lands. "[V]ast segments of the public rangelands" were found to be "producing less than their potential" for the multiple uses for which those lands were being managed.[131] For this reason, Congress found that these vast areas were in "an unsatisfactory condition." *Id.* Congress recognized the need for additional funding to resurrect the damaged lands,[132] and noted specific unsatisfactory conditions.[133] Congress found that such devastating potential impact might be avoided through "intensive" maintenance, management, and improvement programs,[134] and established and reaffirmed the national policy and commitment to inventorying public lands, and to managing the public lands "so that they become as productive as feasible for all rangeland values."[135] PRIA expressly reenacted the Taylor Act and the FLPMA.[136]

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[129] 43 U.S.C. § 1732(a) (emphasis added).
[130] *Ibid*. at § 1901, *et seq.*
[131] *Ibid.* at § 1901(a)(1).
[132] *Ibid*. at § 1901(a)(2),
[133] Unsatisfactory conditions present a high risk of soil loss, desertification, and a resultant underproductivity for large acreages of the public lands; contribute significantly to unacceptable levels of siltation and salinity in major western watersheds including the Colorado River; negatively impact the quality and availability of scarce western water supplies; threaten important and frequently critical fish and wildlife habitat; prevent expansion of the forage resource and resulting benefits to livestock and wildlife production; increase surface runoff and flood danger; reduce the value of such lands for recreational and esthetic purposes; and may ultimately lead to unpredictable and undesirable long-term local and regional climatic and economic changes. *Ibid*. at § 1901(a)(3).
[134] *Ibid*. at § 1901(a)(4),
[135] *Ibid*. at § 1901(b)(1).
[136] "The Secretary shall manage the public rangelands in accordance with the Taylor Grazing Act (43 U.S.C. 315–315(o)), [and] the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701–1782) ..." 43 U.S.C. § 1903(b). A principal issue in this lawsuit concerns the PRIA provisions contained in §1908, authorizing the Secretary to implement an "Experimental Stewardship Program" in order to provide "incentives to, or rewards for" grazing permittees whose practices have resulted in "improvement of the range condition." 43 U.S.C. §1908. As will be discussed in a later section of this opinion, the Secretary has argued in this case that the experimental program provides all necessary authorization for the programs challenged by plaintiffs herein. Detailed description of §1908 and its degree of applicability to this case is reserved for later treatment.

In response to problems with the Adoption Program, Congress added special provisions to PRIA[137] in 1978. They were intended to rein in administrative costs and to provide more authority for the BLM to combat overpopulation, but many of the original problems remain. These provisions made substantive changes to the Program itself, and created additional responsibilities for the BLM. Changes to the Adoption Program limited the number of adoptions to four horses per year per owner, and delayed the passage of title to the adopter for one year. These sections of the PRIA also spelled out, in some detail, BLM's responsibilities for (1) inventorying the wild herds, (2) determining appropriate population levels, and (3) determining whether excess animals should be removed from a given area.[138]

[137] 43 U.S.C. §§ 1901-1908 (2006). In its 1978 statement of national policy, Congress reaffirmed the policy of protection, but also addressed the need to "facilitat[e] the removal and disposal of excess wild free-roaming horses and burros which pose a threat to themselves and their habitat and to other rangeland values." Id. § 1901(b)(4).
[138] 16 U.S.C. §§ 1332-1333.

AWI Concerns about BLM's Management of Wild Horses and Burros:

For decades, AWI has identified and publicized a variety of its concerns relevant to the management of America's wild horses and burros. These concerns have ranged from broad, programmatic deficiencies with the entire management program to specific inadequacies pertaining to individual wild horse or burro roundups. AWI's concerns include:

Management incompetency, agency structural inadequacies, and procedural failings:

- BLM has demonstrated a lack of competency to be the primary agency responsible for wild horse and burro management.

Recognizing the conflicting opinions in regard to the BLM's primary role in managing wild horses and burros, AWI questions the BLM's objectivity, given the clear conflict of interest between its livestock and wild horse and burro management responsibilities. This is magnified by the decades of controversy that has plagued the wild horse and burro management program. Elements of the program that have spawned controversy include the elimination of over 22 million acres of wild horse and burro range without sufficient explanation or justification, an apparent lack of scientific rigor in establishing AMLs, no mechanism to routinely review AMLs, unknown methods of forage allocation, no objective measure of what constitutes a "thriving natural ecological balance," inadequate rangeland condition monitoring mechanisms, woefully deficient wild horse and burro planning documents, misuse of "emergency" declarations to justify roundups, a lack of documentation of measureable criteria to assess the impacts of range management decisions, a preference for action informed by speculation instead of credible science, and political and economic incentives to favor livestock.

Furthermore, as the sole agency determining livestock stocking rates, grazing permit conditions, wild horse and burro AMLs, and management actions to address "excess" wild horses/burros, as well as having the authority to enforce standards relevant to both livestock and wild horses and burros, the existence of a conflict of interest is indisputable. Such an intra-agency conflict would not be without precedent; concerns over just such a conflict led to the reorganization of the former Minerals Management Service to create separate, independent divisions to permit oil/gas development activities and to enforce the relevant laws pertaining to such activities.

- BLM has deficiencies in agency structure and a lack of internal mandates and procedures.

The BLM's internal structure is not conducive to responsible management. Field office managers appear to have considerable discretion to make land, livestock, and other decisions without adequate oversight or accountability to the state or national BLM offices. This contributes to suspect decision-making processes, as those at the field office and district level are often making decisions that will affect the communities in which they reside, including friends, colleagues, associates, and relatives. With rare exception, there appears to be no check and balance mechanism at the state or national level to ensure the integrity of the decisions or to confirm that all required processes were followed. Furthermore, though the BLM recently published its first Handbook for the Management of Wild Horses and Burros (hereafter "Handbook"), which contains various procedures for managing the animals and setting or adjusting AMLs, it is unclear if all field or district office personnel responsible for wild horse and burro management are operating in compliance with the Handbook standards. In any case, there is no known timetable established by the BLM to achieve agency-wide compliance with the standards, particularly to reevaluate existing AMLs for each HMA or HMA complex.

This deficiency extends beyond wild horses and burros to encompass many other agency practices, including livestock management, rangeland condition monitoring, and vegetation sampling. Though the BLM is required to comply with a multitude of statutes and regulations and despite promulgating a variety of policies and handbooks, it is not clear, for example, how the BLM monitors rangeland conditions, how frequently such assessments are made, whether they are based on subjective ocular estimates or credible and objective field surveys relying on robust monitoring procedures, whether the procedures used are standardized across the agency, how the data are analyzed, and how the results are used to make or reform management decisions.

- BLM's Standard Operating Procedures relevant to wild horse and burro roundups, handling, transportation, and care are deficient.

Though the BLM has improved its routine reporting of injuries and mortalities sustained by wild horses and/or burros during roundup, transport, and handling procedures at the capture site and at the short-term holding facilities, often such incidents are the result of preventable accidents, outright negligence, or unacceptable disregard for the welfare of the wild horses and burros. Substantive changes to the SOPs to ensure that animal welfare is the predominant consideration when conducting roundup operations could ameliorate many of the inherent risks associated with the capture, handling, transportation and care of these animals. The BLM is presently reviewing the relevant SOPs, but is doing so behind closed doors – with input provided by BLM-selected "experts" but without any opportunity for interest groups, concerned citizens, or outside experts to provide input to the assessment and decision-making process.

- The procedure used by the BLM to allocate forage between wild horses and burros and livestock is, at best, unclear, and, at worst, illegal.

Regulations implementing the WFRHBA require the BLM to consider wild horses comparably with other resource values. This mandate has direct implications to the allocation of forage to wild horses and burros, livestock and wildlife. The mechanism used by the BLM to comply with this mandate is unknown and does not appear to be explained in writing. Without disclosing how the BLM meets the "consider comparably" mandate and/or describes the forage allocation procedure used, it is impossible to determine if wild horses and burros are being provided forage allocations to which they are legally entitled.

What is known, based on AWI's analysis, is that there are approximately 669 grazing allotments wholly or partially contained within the 179 HMAs managed for wild horses or burros.[139] Within those allotments, based on data obtained from the BLM's Rangeland Administration database (accessed in September 2012), the BLM authorized a total of 4,565,308 livestock (i.e., cattle, sheep, goats, domestic horses) to be grazed annually or seasonally with combined permitted use AUMs set at 4,286,252. When corrected to account for the actual percentage of each allotment found within each HMA, the total number of livestock grazed is 1,302,259 at a permitted AUM level of 1,626,450. In FY 2012, the total wild horse and burro high AML for all HMAs is 26,545 which corresponds to 25,083 AUMs (using a 1:1 conversion factor between wild horse and AUMs and a 0.5:1 conversion rate for wild burros to AUMs as used by the BLM in its Handbook) or an annual AUM level of 299,562. Considering this significant discrepancy between livestock and wild horse and burro numbers, understanding the forage allocation process is crucial for determining if the BLM is complying with existing regulations and whether wild horses/burros are truly being considered comparably with livestock in particular when forage allocation decisions are made.

- The wild horse and burro advisory board is in need of reform.

The value of the wild horse and burro advisory board, as currently structured, in providing guidance to the BLM on the management of wild horses and burros is questionable. With substantive reform to its structure, membership, and role, the advisory board could be a useful tool to (1) provide a level of check and balance to the activities of the BLM, (2) open constructive dialogue with multiple interest/user groups, and (3) improve the transparency of the agency. Necessary changes include the use of an independent third party to select committee members, the imposition of term limits to prevent any person from serving more than two consecutive terms or three terms total, expansion of the board's authority to expand its role to provide input to the BLM into all aspects of its wild horse and management program, provision to board members of access to all relevant BLM data as needed, and reformation of board meeting structure to accommodate greater participation by interest/user groups into the debate and dialogue among board members. At present, of particular concern, is the BLM process for selecting board members, which appears to prefer those less likely to challenge or question the BLM's management practices and decisions.

[139] This does not include Montana since no livestock are permitted to graze within the Pryor Mountain Wild Horse Range.

Scientific deficiencies:

- There is a lack of credible science to inform BLM's wild horse and burro management decisions.

Despite being responsible for over 245 million acres of public lands, including 157 million acres on which livestock grazing is authorized, there is a glaring lack of science underlying BLM's land and habitat, livestock, and wild horse and burro management programs. For the vast majority of BLM decisions relevant to livestock and/or wild horse and burro management (e.g., stocking rates, stocking densities, AMLs, roundups) there appears to be little credible range condition, vegetation monitoring, impact assessment, or other data underlying these decisions or – if data is available – it is often old, the methodologies used to collect it are unclear or inadequate, its role in informing management decisions is not clear, its interpretation may be biased, it is not routinely disclosed in decision-making documents, and/or it is not readily accessible to permit outside analysis and critique.

- The BLM fails to properly assess the impacts of its management decisions on the genetic diversity and health of wild horse and burro populations.

Based on 2012 BLM data, of the 179 HMAs, wild horses are managed on 144 HMAs, wild burros are managed on 21 HMAs, there are 10 HMAs that are managed for both wild horses and burros, and there are four HMAs where the AML for both wild horses and burros is set a zero. Of the 144 HMAs managed only for wild horses, 63.2 percent (91 of 144) have high AML set for less than 150 wild horses.[140] For the 21 HMAs managed only for wild burros, nearly 81 (17 of 21) have high AML set for less than 150 burros. For the mixed HMAs, 70 percent (7 of 10) have high AML (for wild horses or burros) set at less than 150 animals.

While even the sufficiency of the 150–200 number is debatable, the BLM does not adequately address the genetic implications of such low AML numbers on herd genetic health, including heterozygosity, allelic diversity, and/or kinship. Though the BLM acknowledges that it collects materials for genetic analysis from horses in many HMAs, it often does not fully disclose the results of the analyses, fully explain the implications of the results, or identify actions available to address short- or long-term genetic concerns if they exist. Furthermore, even when genetic data indicates that a herd should be maintained at a particular size or allowed to increase in order to address genetic concerns, the BLM has done the opposite by authorizing further capture and removal of animals from the herd. Such actions along with so many HMA AML being set well below the 150–200 recommended levels provides ample evidence that the BLM is managing wild horses and burros to extinction.

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[140] This does not take into consideration HMA complexes where the combined AML for wild horses in specific HMAs may exceed the 150 minimum number, assuming herds within those complexes do intermingle.

- The BLM's historical decisions to permanently remove wild horses and/or burros from rangelands have not been suitably documented or justified.

Since 1971, the BLM has "zeroed-out" wild horses and/or burros from over 22 million acres of land that Congress designated for their use. These decisions have affected tens of thousands of wild horses and contributed to the high numbers of animals currently in long-term holding facilities. A report documenting these decisions was to be released by the BLM in December 2008 (see GAO 2008). To date, however, the BLM has provided only a broad-scale summary of the number of acres closed to wild horses and burros and the alleged justification for such decisions;[141] a two-page table containing the state-by-state information;[142] and a set of maps identifying, for each HA, the reason for the decision to zero-out the herds[143] (e.g., checkerboard private-public land ownership patterns, lack of critical resources, legal opinions, and conflict with other resource values). AWI welcomes this information but remains skeptical of the justifications for many of the decisions. The information provided does not permit a site-by-site analysis of the veracity of the decisions, nor does it cite to any scientific or survey evidence to justify these decisions. A more detailed HA-specific analysis substantiated with relevant data, evidence, or citation to information (e.g., legal opinions) that justified the closures would be helpful to address these concerns. In addition, the BLM has made no effort to reassess the suitability of these sites for wild horses and/or burros in order to potentially develop alternatives for the placement of animals removed from other HAs or HMAs or to reestablish herds using animals from long-term holding facilities, despite the increasing costs of wild horse care in such contract facilities.

- The BLM does not understand, fails to investigate, and rarely considers the impact of its management actions on wild horse and burro herd social structure, band dynamics, reproductive potential, or other important individual, band, herd, or population behaviors when making or implementing management decisions.

The routine roundup and removal of large numbers of wild horses and burros from the range disrupts social dynamics of those animals captured, those who avoid capture, and those animals released post-capture. More specifically, based on evidence in the scientific literature, such impacts include increased rates of male-male, female-female, and male-female aggression; infanticide or feticide; loss of intra-harem band stability; termination of affiliative relationships; and a decline in mare productivity. Many of these potential deleterious impacts may be consistent with the BLM's intent to reduce herd growth rates. Yet, in its management decision-making documents it often claims that, with the exception of increased wariness, animals who are not captured and removed are not impacted by roundup operations.

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[141] See http://www.blm.gov/wo/st/en/prog/whbprogram/history_and_facts/quick_facts.html
[142] See http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/public_land_stats.Par.45796.File.dat/Non_managed_HA_justifications.pdf
[143] See http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/HMA_and_HA_Maps.html#unmanaged (The relevant maps are also appended to this report – See Appendix A).

Similarly, BLM use of sex-ratio manipulation or proposals to establish gelding-only populations, beyond questions of effectiveness or legality, also raise concerns about behavioral impacts that have not been considered by the agency.

- The BLM has not fully embraced or implemented immunocontraceptive technologies to humanely address wild horse and burro management concerns.

It has been well established that immunocontraception is a safe and efficacious tool to humanely address wild horse and burro management concerns. Multiple immunocontraceptive agents, most notably PZP-22, provide a duration of contraceptive effectiveness that warrant wide-scale use on wild horse and burro populations in need of human-induced population control. As has been documented in the field, not only can immunocontraception rapidly stabilize herd growth rates but, in time, herd sizes can be reduced without the need for removals. Though any effort to prevent pregnancy will result in an impact to individual animals, herd structure, and mare/stallion behavior, the vast majority of scientists have determined that those impacts are miniscule or inconsequential, and pale in comparison to the disruptive impacts of roundups and removals. Where behavioral impacts have been reported, it remains unclear if those impacts were a product of the vaccine or due to other management actions, past or present, affecting those animals. Though the BLM has engaged in immunocontraceptive research in the field and routinely proposes its use in its roundup plans, outside of research studies, relatively few animals have been treated as part of standard management strategies. Recognizing the need to protect a herd's genetic variability and health, AWI strongly endorses the use of immunocontraception to reduce or ideally eliminate the number of wild horses and burros being removed from the range, while also attaining management objectives.

- BLM wild horse and burro herd size and population growth estimates are often inaccurate.

The adequacy of the methods used to determine wild horse and burro herd sizes is questionable and has led to significant distrust of the agency's estimates. While direct aerial counts can be done in open areas, they likely are not feasible in heavily forested areas. The potential of double-counting or missing animals entirely is also of concern. Similarly, the BLM's assessment of population growth rates by determining the changes in herd sizes through aerial surveys and extrapolating that rate over time is replete with potential error. Since these estimates are crucial for establishing the need for wild horse and burro removals, it is imperative that the survey methods used are as accurate as possible – recognizing the inherent difficulties in surveying any large mammal that occupies a diverse suite of landscapes. Given BLM's bias in favor of livestock over wild horses, it is critical that these estimates stand up to scrutiny.

- The WinEquus model is a simplistic model that is often run without the appropriate data, is deficient in its scope, and fails to incorporate sufficient

> detail to understand the implications of BLM wild horse management decisions on a full range of ecosystem variables and processes.[144]

The WinEquus model is used by the BLM to predict how its management actions (i.e., wild horse removals, contraception, and sex-ratio manipulation) will impact wild horse population over a ten year period. All models are, at best, tools designed to predict outcomes based on management actions taken. Consequently, model output is only as reliable as the quality of the data used to populate the model.

Admittedly, the WinEquus model is not intended to provide a holistic or ecosystem-wide analysis of the impacts of proposed management actions. Nevertheless, even for its intended purpose, the WinEquus model is deficient. For example, even assuming that all of the model parameters are valid, the reliability of the model's output depends on the veracity of the data input into the model, including survival and productivity rates, contraceptive and roundup efficacy, and population estimates; such data is frequently (though inexplicably) not available or inaccurate for many populations.

Fundamental deficiencies in the current use of the model include the routine reliance on population data from one particular HMA, the Garfield Flat HMA, when utilizing the model to predict the impact of management actions for HMAs throughout the western United States, without any consideration as to the comparability of the HMAs (i.e., topographically, geographically, and climatically) or the wild horse populations (i.e., productivity and survival rates). While this process may be tolerable for comparable HMAs, as implemented by the BLM, the population data from the Garfield Flat HMA is used even when the agency concedes that it has relevant population data for the HMA or HMA complex under consideration.

The WinEquus model, though it permits user manipulation to examine the potential impact of a stochastic event, does not incorporate stochasticity automatically in the model. Consequently, prolonged drought conditions, precipitation quantity or timing, severe storms, disease or other factors that can adversely impact wild horses or their habitat are not considered in the model. Nor does it necessarily accurately capture the full duration of effectiveness of immunocontraception vaccines (though this can be corrected via parameter manipulation).

Finally, the model is not sufficiently complex to predict the impact of wild horse management action on a full range of ecosystem variables, processes, and patterns, nor does it permit any consideration of cost-benefit impacts. There are more detailed or sophisticated models including, but not limited to, a model developed by the Humane Society of the United States that could be used to include economic considerations in the modeling process and/or predict population responses to management actions while also examining how those responses will affect other

[144] The WinEquus model is not designed to model the impacts of management action on burro populations and, therefore, is not used by the BLM to predict such impacts.

ecosystem variables (e.g., plant production, abundance, composition, and soil characteristics such as erosion potential). Such models inherently include a more complex set of parameters, but their predictions may more accurately mimic natural ecosystem variability. Far more data is required to employ such models, thereby mandating greater effort to compile such data.

- The BLM's determination of AMLs is often based on outdated data, fails to consider changes in range condition over time, is not subject to routine reevaluation, and has not been consistently applied across all BLM offices.

The setting of AMLs is critical to the management of wild horses and burros. Direction and guidance for setting or adjusting AMLs is provided in the BLM Handbook. This guidance includes a description of the data and analytical methods required to make the calculation. It also identifies the specific planning processes whereby AMLs can be set or reset. Despite this guidance, many of the existing wild horse and burro AMLs are decades old, have not been subject to reevaluation or, if reevaluated, the original AML has been retained regardless of the credibility of the science allegedly underlying the decision. Furthermore, there is no evidence that BLM field or district offices have the data required to reevaluate AMLs – or, if such evidence has been collected, it is not readily accessible for analysis. Indeed, the original data or documents containing the evidence used to set or reset AMLs are difficult to identify and obtain. Furthermore, if the requisite data is available, it is unclear how, if, or when such data is used to reassess AMLs, nor is there any known or standardized timetable for reevaluating AMLs to determine their accuracy.

Public outreach deficiencies, lack of objectivity, and failure to be transparent:

- BLM has deficiencies in public outreach, education, transparency, and objectivity inherent to its management of wild horses and burros.

Despite recent proclamations about improving select elements of its wild horse and burro management program, including transparency and outreach efforts, the BLM remains mired in a culture that has historically promoted secrecy and animosity toward interest groups that question its decisions and decision-making processes. Though some minor improvements have slowly been implemented, significant improvement is required to alter the relationship between the BLM and interest groups/concerned citizens from one of divisiveness to one of constructive dialogue, objectivity, openness, and transparent decision-making. Recent reports of efforts made by a BLM field office director in Utah to facilitate issuance of oil and gas drilling authorizations[145] provide additional fodder to those who question the impartiality and credibility of BLM management at the national, state, and field office levels.

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[145] See New York Times, "*Drillers in Utah Have a Friend in U.S. Land Agency*," July 27, 2012. Available at: http://www.nytimes.com/2012/07/28/us/politics/bureau-of-land-managements-divided-mission.html?pagewanted=all

Legal deficiencies:

- At all levels, BLM compliance with National Environmental Policy Act (NEPA) is deficient and inadequate, particularly in regard to its management of wild horses and burros.

Though NEPA analyses associated with Resource Management Plans (RMPs) are lengthy documents intended to represent a blueprint for long-term BLM management of its lands, these reviews rarely provide sufficient disclosure and discussion of the relevant data (e.g., rangeland and other monitoring data required to set or reset AML). NEPA documents prepared to evaluate the impacts of proposed wild horse and/or burro roundups, with few exceptions, do not disclose the data or provide the analysis necessary to properly inform the public about BLM's actions or to justify said actions as is required by law. Such analyses are often based entirely on speculative impacts (e.g., wild horses and/or burros are adversely impacting rangeland conditions, vegetation composition/production/abundance, riparian areas, water quality, and soil stability) without any data to substantiate such claims. Even when the BLM concedes in the analysis that data is routinely collected, the data is frequently entirely absent from the document.

- The BLM fails to manage wild horses and burros consistent with federal law or to utilize existing authorities to improve and emphasize wild horse and burro management on the range.

The protection of wild horses and burros on select public lands is mandated by federal law. Congress also authorized the BLM to permit grazing, at a substantially reduced fee compared to market prices, on public lands under conditions dictated by the BLM, ostensibly to protect and improve rangeland conditions. Protecting wild horses and burros consistent with federal law is, therefore, a statutory requirement while grazing livestock on public lands is a privilege which, theoretically, can be lost due to non-compliance with permit conditions or due to factors out of the permittees control.

The WFRHBA provides the BLM with the authority to establish wild horse and/or burro ranges to provide increased protections to wild horses and burros. Multiple use activities, including livestock grazing, are permitted within designated ranges, but wild horses and burros and their needs are to be given, by law, preference in these areas. Since 1971, the BLM has created only three wild horse or burro ranges (one for wild horses and two for burros).

In addition, the authorized BLM officer has regulatory authority under 43 CFR §4710.5 "if necessary to provide habitat for wild horses or burros, to implement herd management actions, or to protect wild horses or burros," and also "to protect wild horses or burros from disease, harassment or injury … to close appropriate areas of the public lands to grazing use by all or a particular kind of livestock." Though the BLM often discounts this authority, claiming that it is intended to be used only in emergencies, this interpretation is not consistent with the regulatory language. The

BLM should employ these and any other legal options it has to benefit wild horses and burros when necessary to improve and emphasize wild horse and burro management on the range, in a manner consistent with other legal requirements.

- The BLM's wild horse and burro adoption process, sale authority, and transfer of title is poorly managed.

The slaughter of wild horses led to adoption of the WFRHBA. However, evidence that wild horses continued to be sold to slaughter even after passage of the Act, and the high number of horses being removed from public land, has brought a high level of attention and controversy to the management of wild horses and burros. AWI acknowledges the BLM's efforts to promote wild horse and burro adoptions, yet the number of horses in holding facilities is staggering – well exceeding the number of horses on the range. Further, the adoption efforts are not without fault, particularly in regard to the ongoing potential for adopted horses to be sold for slaughter. Though adoptees are required to sign attestations indicating that they will not knowingly sell, donate, or cause the adopted horse to be slaughtered, once title is transferred a year post-adoption, there is no mechanism established to track the location, "ownership," or well-being of these former wild horses. In addition, it is unclear if violations of the attestations are routinely investigated or prosecuted.

Similarly, the authority provided to the BLM to sell unadoptable wild horses has escalated fears of these animals being sold for slaughter. Under the sale authority, title is transferred immediately upon sale. Those purchasing horses are required to sign the attestation regarding slaughter though, as with adopted horses, it is unclear what, if any, effort is made by the BLM to identify, investigate, and prosecute those who violate said agreement. For example, only weeks ago ProPublica published an article raising concerns about the disposition of at least 1,700 wild horses the BLM sold to Mr. Tom Davis, a Colorado livestock hauler who is also a longtime advocate of horse slaughter.[146] In the article, unnamed BLM employees opine that the BLM may not be interested in examining what Mr. Davis does with the horses he purchases as he is a "relief valve" for an agency and program with "more wild horses than it knows what to do with."

Nor has the BLM made any apparent effort to enter into agreements with customs/border patrol agencies or foreign (i.e., Mexican or Canadian) slaughterhouses to identify (by brand) those wild horses who may have been illegally sold or donated for slaughter. Finally, though the BLM had promised to blacklist any adopters/buyers who have, at any time, had wild horses under their care identified at slaughter facilities, so as to prevent subsequent adoption/sale to these individuals, it is unclear if such a list was ever developed or if it is maintained.

[146] See, "All the Missing Horses: What Happened to the Wild Horses Tom Davis Bough from the Gov't," ProPublica, September 28, 2012. Available at: http://www.propublica.org/article/missing-what-happened-to-wild-horses-tom-davis-bought-from-the-govt

Finally, Congress explicitly directed the BLM that "the management of wild free-roaming horses and burros be kept to a minimum" which is not a standard that would likely apply to current management practices. It also never explicitly authorized removing wild horses from the range and maintaining them in long-term care facilities off public lands, as is currently done.

Planning for the future:

- The BLM has not engaged in any planning process to consider changing climatic and other environmental variables that may influence its management of public lands and the multiple uses of those lands.

While natural variability is part of any ecosystem, artificial perturbations caused by anthropogenic factors introduce an added complexity for any agency responsible for the management of land or animals (domestic or wild). There is little remaining debate that climate change is here, that it is human-caused, and that its impacts are already being felt across a large geographic range from the Arctic to the Antarctic. Though drought is a reoccurring reality in the western United States, the current extensive drought may foreshadow changes in climatic patterns that may become more common in future decades. This is not to suggest that all western states will experience a long-term drying trend, as some may see increased precipitation. Nevertheless, climate change will reshape many western rangelands leading to, in many cases, a decline in precipitation events, alteration in precipitation timing, increased intensity of storms, changes in hydrology, alterations to the frequency and intensity of stochastic events (e.g., fire, drought) – all potentially contributing to changes (and probable reduction) in forage abundance/composition/production/vigor, with concomitant impacts on wildlife, wild horses and burros, and livestock.

With the exception of its use of "emergency" declarations to expedite the urgent removal of wild horses and burros due to stochastic events, it does not appear that the BLM has engaged in short- or long-term planning (1) to ensure it understands how rangeland condition is changing over time and the implications of those changes to the myriad resources and animals under its management, and (2) to develop mitigation measures to ensure consistency in its management efforts while protecting the animals and their habitat. Other federal agencies, including the National Park Service and U.S. Fish and Wildlife Service, have been engaged in such preemptive climate change planning efforts for years.

Solutions to some of these concerns may be found in science, including credible published or ongoing studies or future research endeavors designed to address some of the most pressing management concerns. Science alone cannot address the range of deficiencies inherent to the BLM's management of wild horses and burros, however, as much of the controversy stems not only from the failure to use best scientific practices, but also from the conflicting values and attitudes of the various interest/user groups as to wild horses and burros protection and management, livestock management, public land use and management, and wildlife protection and management.

National Analysis of BLM Wild Horse and Burro and Grazing Statistics:

According to Fiscal Year 2012 data, the BLM estimates that there are (as of February 29, 2012) 31,453 wild horses and 5,841 wild burros for a total of 37,294 animals on lands under its jurisdiction. These estimates do not include wild horse and/or burro numbers on lands managed by other federal or state agencies. Since 2005, the number of wild horses and burros has been variable but has generally increased. It is unknown if this increase is due to expanding population, improvement in census methodologies, or a combination of both factors. See Figures National-1 and National-2.

Figure National-1:

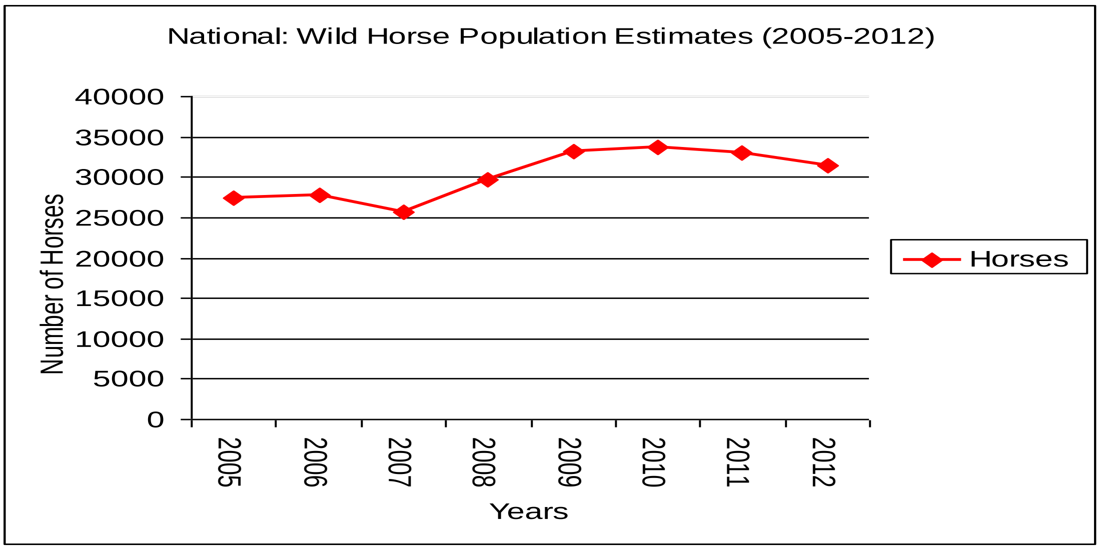
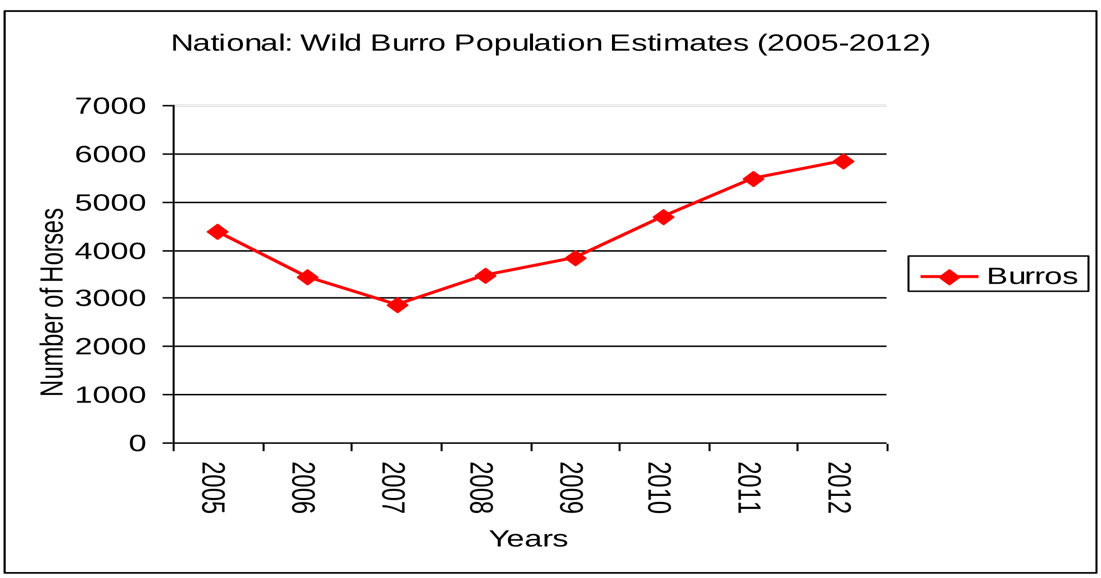


Figure National-2:



For 2012, the BLM's high AML for all wild horse and burro populations combined is 26,545, with 23,622 and 2,923 AML established for wild horses and burros, respectively. See Figure National-3. These AML limits are not static. While original AML numbers could not be located, only seven years ago, in FY 2005, the high AML for wild horses and burros was 28,186. See Figure National-4. AMLs are modified by the BLM based on alterations in environmental conditions, modifications in land usage, stochastic events, or other factors that affect range conditions.

Figure National-3:

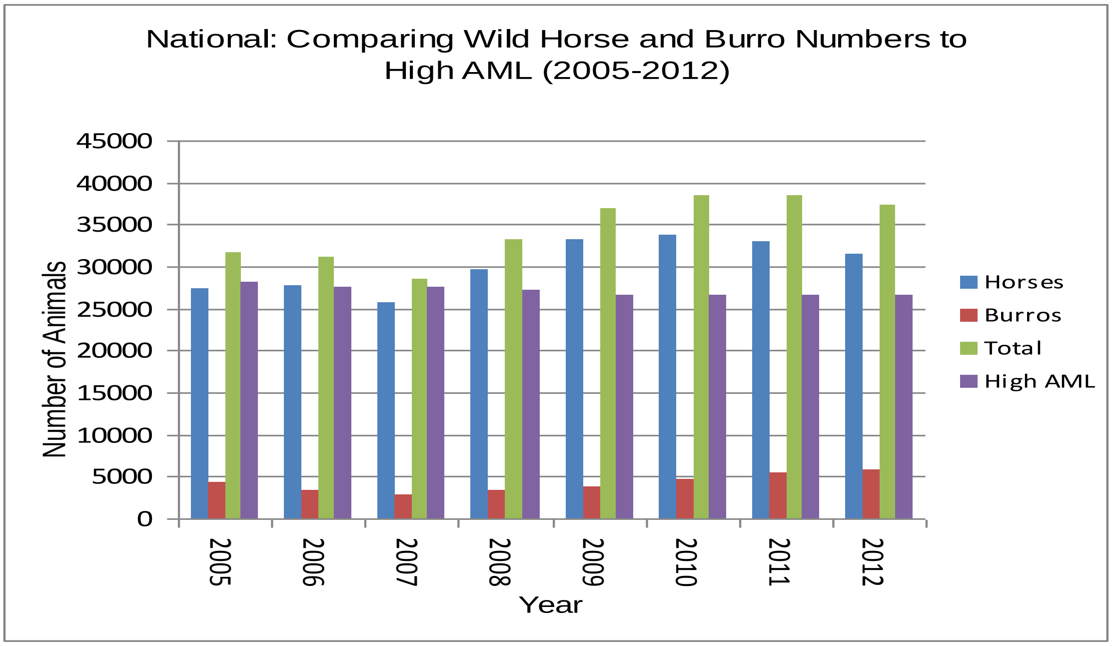
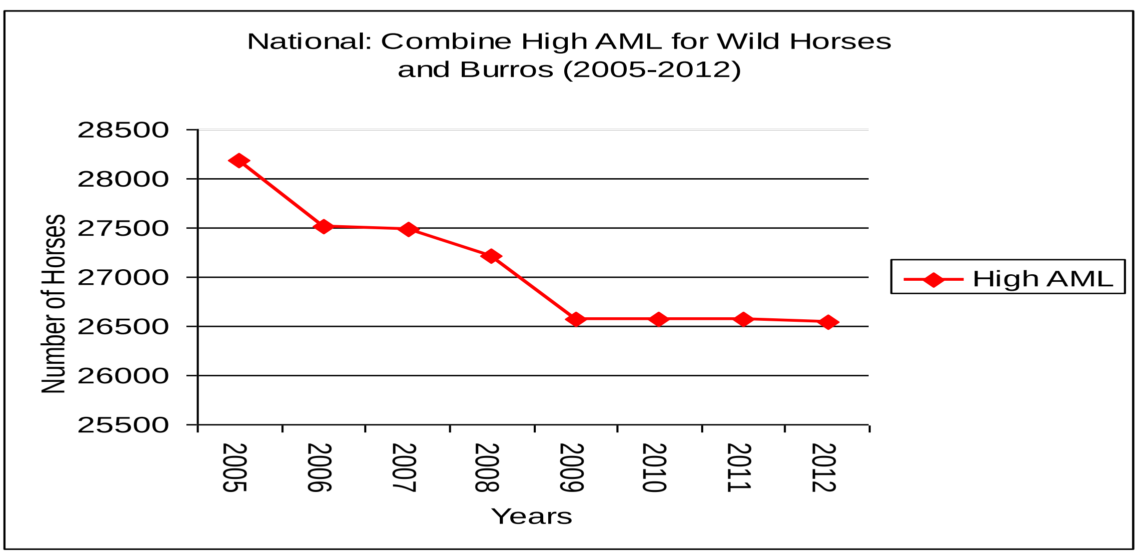
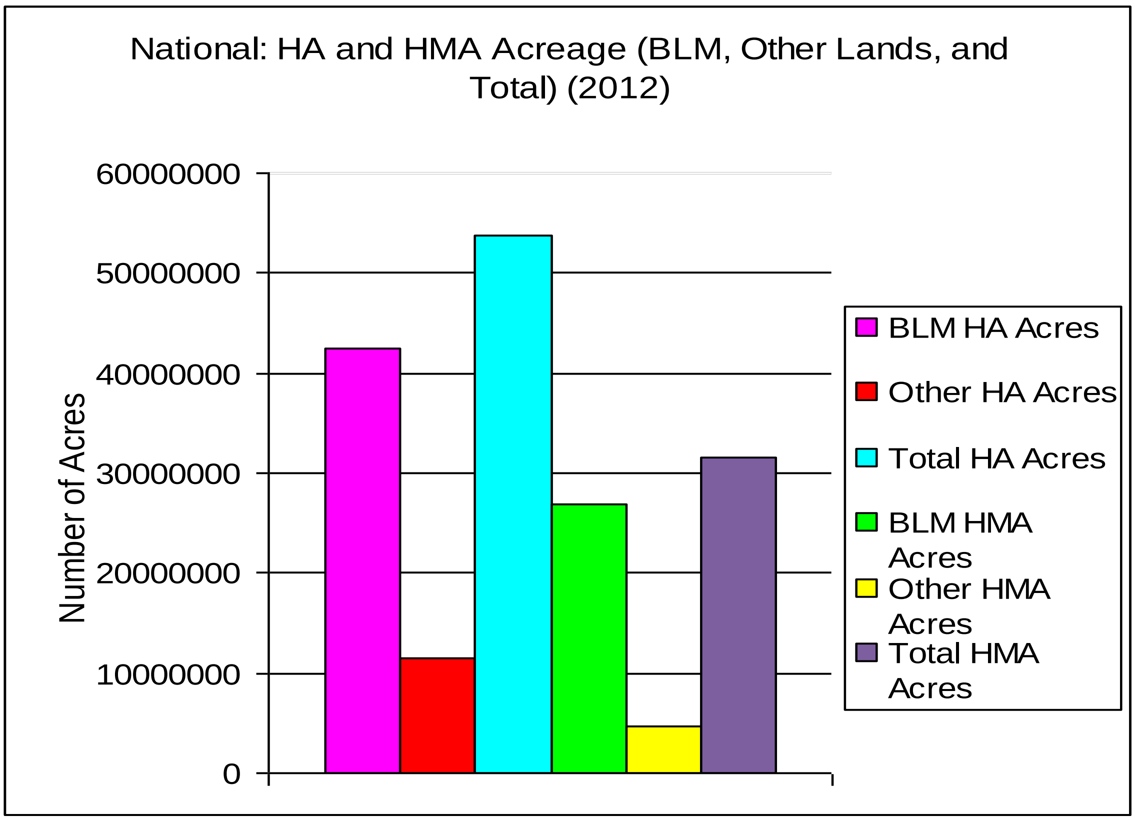


Figure National-4:



In 2012, horses and burros on BLM lands are located within 179 HMAs. These HMAs comprise 26,905,179 and 4,729,183 acres of BLM and other lands, respectively, for a total of 31,634,362 acres available to wild horses and/or burros. The 179 HMAs are subsets of an equal number of generally larger HAs which encompass 53,813,117 total acres, including 42,403,054 acres of BLM lands. See Figure National-5. HAs were identified after the 1971 promulgation of the WFRHBA to be areas in which wild horses and burros were found and where the species were to be managed. HMAs are those actual areas within which the BLM manages wild horses and burros. As these terms are often misinterpreted, it must be emphasized that HAs generally encompass one or more HMAs but that wild horses and burros are only managed within HMAs.

Figure National-5:



While HAs are generally larger in size compared to HMAs, there are exceptions. In Nevada based on FY 2012 data, for example, total HMA acreage (15,718,630) is higher than total HA acreage (11,895,457). According to the BLM, this is due to the creation of new HMAs from other HAs (presumably those from which wild horses and burros have been zeroed out) and not adding the HMA acreage to the HA acreage in their own data sheets. The same circumstance (i.e., more HMA than HA acres) is found in Oregon and Wyoming. In total, for those three states, there are 6,228,709 more HMA acres than HA acres in 2012. For the remaining seven states, the total HMA acreage is 3,511,901 less than the total HA acreage meaning that, among all ten states based on 2012 data, there is a net increase of 2,716,808 HMA acres compared to HA acres. Nevertheless, since 1971 for all ten western states that provide habitat for wild horses and burros, HMA acreage represents only 58.8 percent of total HA acreage, reflecting a loss of 22,181,755 acres of potential wild horse and/or burro range.

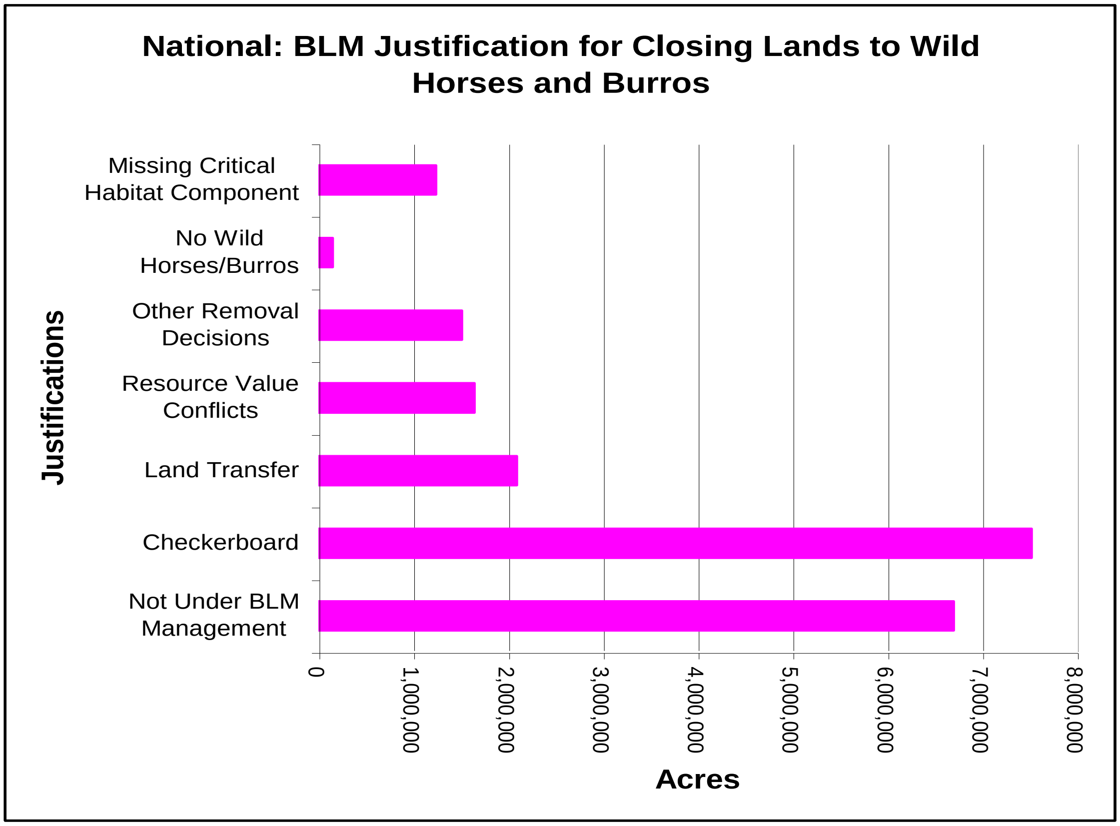
The nearly 22.2 million acres lost to wild horses and burros includes the land lost to wild horses and/or burros as a result of decisions to "zero-out" the herds or permanently close HAs to their use. The number of HAs affected, 172 according to 2012 data, encompass a total of 24,898,923 acres (including 19,514,123 BLM acres). Due to the net increase of 2,716,808 HMA acres compared to HA acres in the ten states, the net loss of lands is adjusted to approximately 22.2 million acres. This means that of the 245 million acres managed by the BLM and of the 157 million acres managed for grazing, only 13 and 20 percent, respectively, is available for use by wild horses and burros combined (with a much smaller percentage managed for wild burros). Even within HMAs, however, the total land area utilized by wild horses and burros is much less, as topographic, geologic, and other factors reduce the amount of land suitable for wild horses and/or burros.

The BLM justifies the loss of the over 22 million acres of wild horse and burro habitat claiming that of the 15.5 million acres under BLM management:

- 48.6 percent (7,522,100 acres) were closed due to a checkerboard land pattern that made management infeasible;
- 13.5 percent (2,091,709 acres) were transferred from the BLM through legislation or exchange;
- 10.6 percent (1,645,758 acres) had substantial conflicts with other resource values;
- 9.7 percent (1,512,179 acres) were lands removed from wild horse and burro use as a result of court decision, urban expansion, habitat fragmentation, and land withdrawals;
- 9.6 percent (1,485,068 acres) were lands where no wild horses or burros were present when the WFRHBA was passed in 1971 or where all animals were claimed as private property;
- 8.0 percent (1,240,894 acres) were lands where a critical habitat component was missing, making the land unsuitable for wild horse or burro use or where too few animals existed to permit effective management.

The remaining 6.7 million acres were never under BLM management. See Figure National-6. Though AWI has repeatedly questioned the decisions to permanently remove all wild horses and burros from the range – decisions that continue to be made – without an area-by-area analysis it is impossible to verify the scientific, land use, legal, or other evidence relied on by the BLM to support its decisions.

Figure National-6:

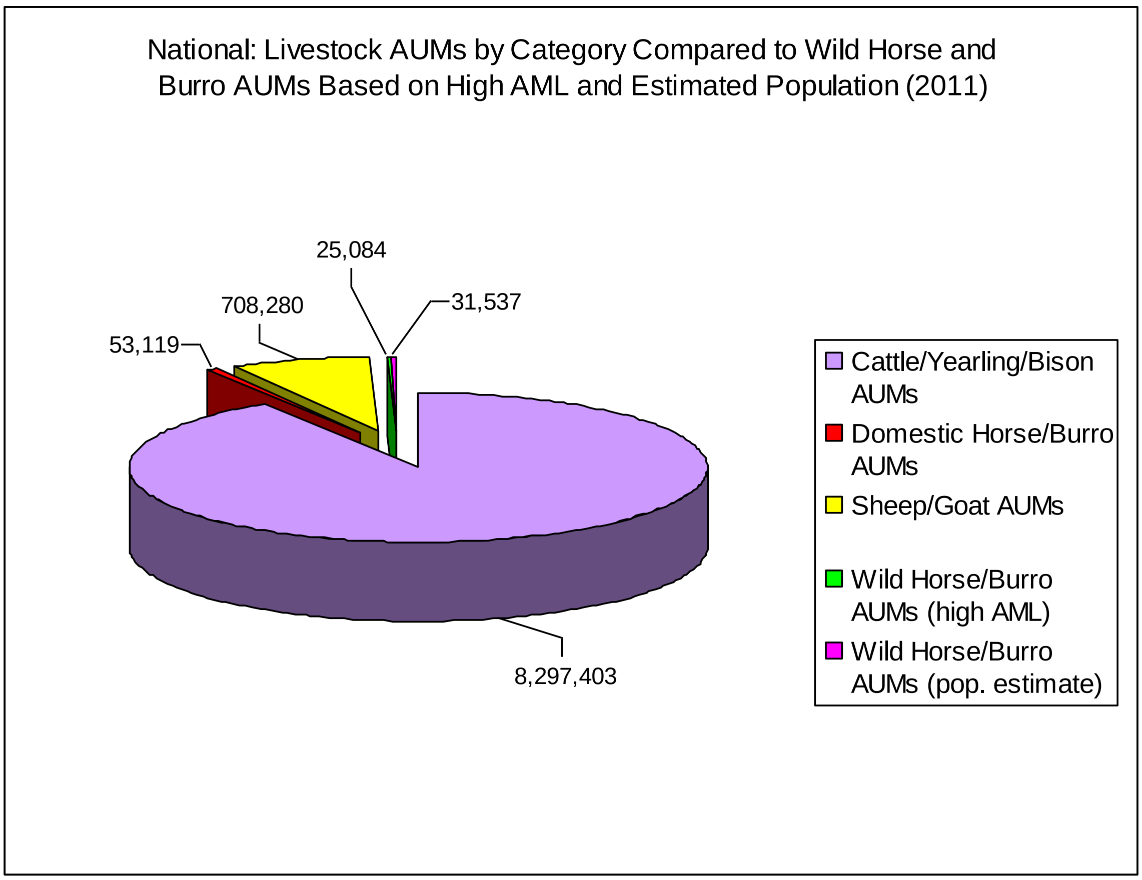


The number of HAs has been variable over time. While the number of original HAs is not known, since 2005 the number of HAs has been reported by the BLM to range from a low of 134 in 2005 to 347 in 2012. However, the BLM's own data is confusing. For example, in 2005 while reporting a total of 134 HAs the BLM separately reports a total of 317 HAs along with another 106 "HAs with no acres in HMAs." Similarly, from 2006 through 2008, the BLM reports either 105 or 106 HAs "remaining undesignated," though it is unclear what this means.

The number of HMAs has varied over time. While an annual record of the number of HMAs was not available, as recently as 2008 there were a total of 199 HMAs (GAO 2008). Over the past seven years, the number of HMAs has ranged from 201 in 2005 to 179 today. In some cases, HAs or HMAs were combined, contributing to a smaller number of HMAs while, in other cases, when HAs were permanently closed to wild horses and burros, a number of HMAs were lost.

For the ten western states occupied by wild horses and/or burros, BLM data reveals that the total number of authorized AUMs for 2011 was 9,058,802, 1,995,700, and 10,392,049, respectively. This included actual AUM use of 8,297,403 for cattle, yearlings and domestic bison, 53,119 for domestic horses and burros, and 708,280 for domestic sheep and goats.[147] The 2011 estimated combined population size for wild horses and burros within HMAs was 33,805, while the combined high AML for wild horses and burros was 26,576.[148] These figures correspond to AUMs of 31,537 (for the estimated population) and 25,225 (based on combined high AML). Consequently, the number of AUMs for livestock within the ten western states in which wild horses and/or burros are found are 287 times the AUMs based on estimated wild horse and burro population size and 359 times the AUMs for wild horses and burros based on high AML. See Figures National-7 and National-8. It is worth noting that, in a number of instances, the permitted use AUMs designated by the BLM were well in excess of the active AUM level (amount of use that could be allowed); a discrepancy that could not be explained by a BLM official.

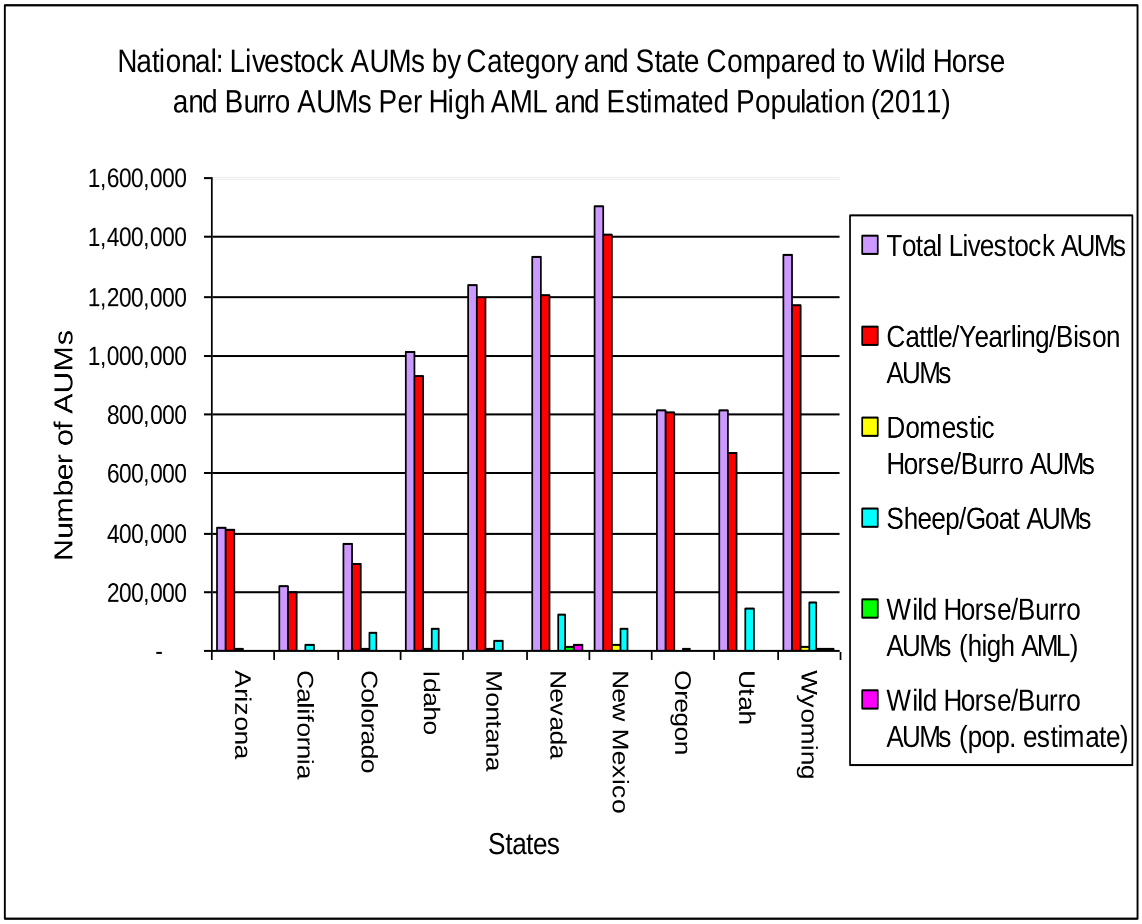
Figure National-7:



[147] The amount of livestock allowed to graze does not reflect the actual number authorized to be grazed on public lands. The BLM determines the number of active AUMs (which reflects the number of stock that could be grazed) but then may suspend some AUMs, thereby reducing stocking rates. The difference between active AUMs and suspended AUMs reflect permitted AUM use levels. The permittee can also voluntarily reduce his or her stocking rate further, lowering the AUMs stocked.

[148] To calculate wild horse and burro AUM, one wild horse was equal to one AUM and one burro was equal to .5 AUM as specified in the BLM Handbook.

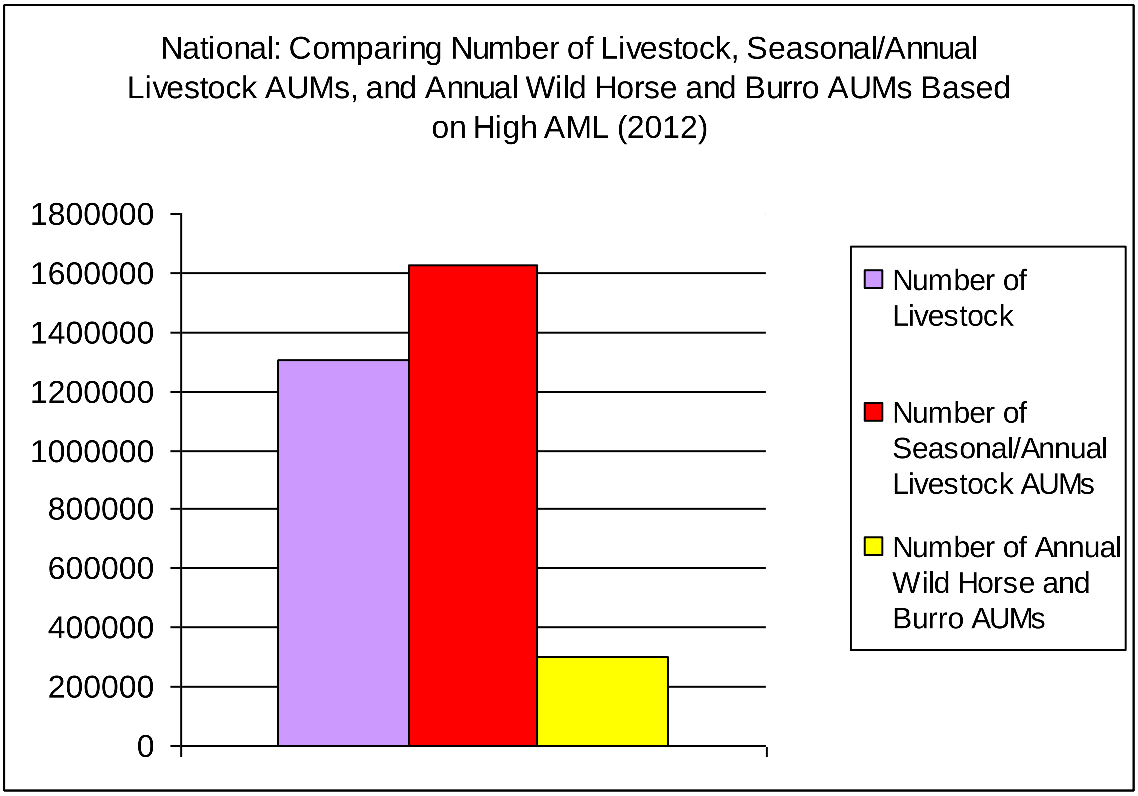
Figure National-8:



According to the BLMs Rangeland Administration database (accessed in September 2012), a total of 4,565,208 livestock (i.e., cattle and yearlings, domestic bison, domestic sheep, domestic horses and burros, and goats) have been grazed on the estimated 669 allotments found entirely or partially within HMA boundaries within the past BLM billing cycle. This equates to 4,286,252 permitted use AUMs. When adjusted to compensate for the percentage of each allotment found within or outside of HMA boundaries, the total number of stock grazed is 1,302,259, which correlates to 1,626,450 seasonal/annual permitted use AUMs.[149] When compared to the combined high AML for wild horses and burros for 2012, which corresponds to 299,562 annual AUMs, total livestock AUMs on HMAs is 5.4 times higher than the AUMs for wild horses and burros. See Figure National-9.

[149] This is only an estimate since livestock use is not consistent across an allotment. This is because the animals tend to utilize those portions of an allotment that are most suitable in regard to water, forage, shelter, and other requirements. For the purpose of this analysis, the number of AUMs and individual livestock obtained from various BLM data sets was multiplied by the percentage of the allotment found within each HMA. Due to the lack of equal distribution of livestock across an allotment, these figures may under- or over-estimate actual use.

Figure National-9:



Livestock authorization and stocking rates are not static, but frequently change over time as a consequence of rangeland condition, economics, environmental factors (such as prolonged drought), changes to allotment permit conditions, changes in the type of livestock grazed, and other factors. For the ten states that harbor wild horses and burros, livestock AUMs are highly variable. For example, based on BLM data, total livestock AUMs were 9,708,638 in 1996, declining to 9,058,802 in 2011.

In sum, based on the BLM data referenced above, 1,302,259 livestock are authorized to graze within HMAs occupied by an estimated 24,264 wild horses and 5,017 wild burros as of February 2012. Therefore, of the total number of livestock and wild horses and/or burros known or authorized to graze within HMAs and their associated grazing allotments, 1.8 percent are wild horses, 0.4 percent are wild burros and the remaining 97.8 percent are livestock. At the state, individual HMA, or HMA complex level, these statistics differ. Regardless of the geographic scale of the analysis, however, the number of livestock grazing on HMAs is far in excess of the number of wild horses and/or burros.

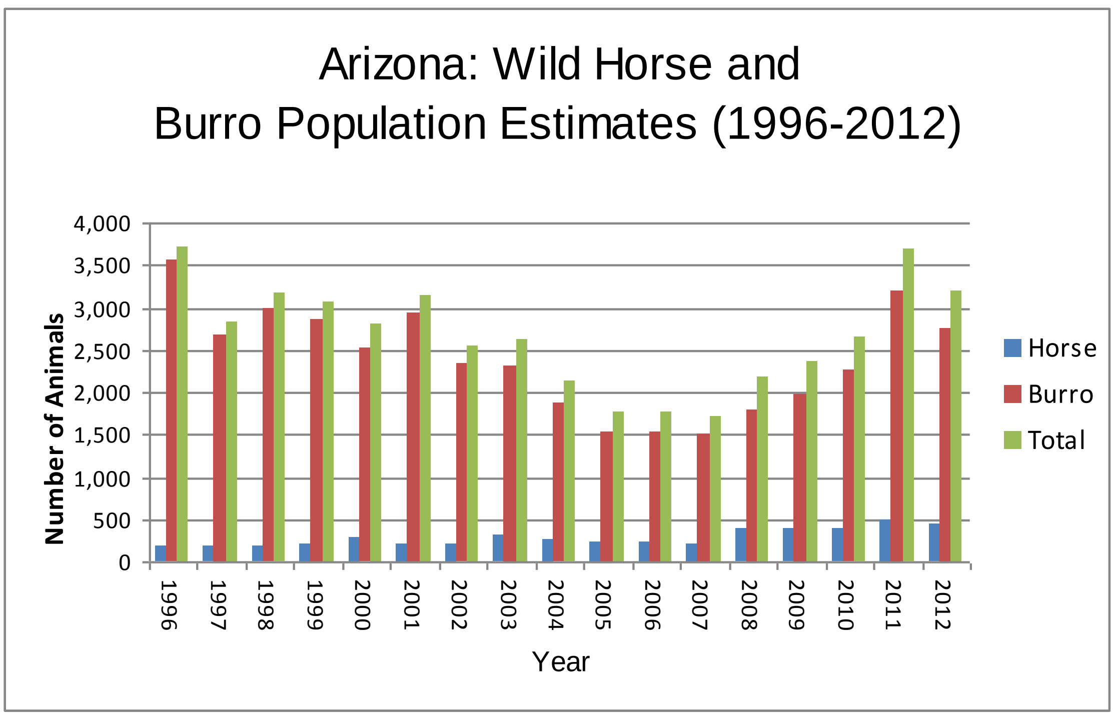
State by State Analysis of Wild Horse and Burro Management:

Wild horses and burros are managed by the BLM in ten western states (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, and Wyoming). Nevada is home to, by far, the largest number of wild horses, while the largest number of burros are found in Arizona. The largest number of HMAs are found in Nevada (85), while in Montana there is but a single HMA.

Arizona:

Based on fiscal year 2012 data there are, as of February 29, an estimated 434 wild horses and 2,761 wild burros in Arizona occupying a total of seven HMAs.[150] See Figure AZ-1.[151] In addition, there are an estimated 75 wild horses and 435 wild burros on HAs that are not managed for the species.[152] As a result, there are an estimated 502 wild horses and 3,194 wild burros, for a total of 3,696 animals, in Arizona.

Figure AZ-1:



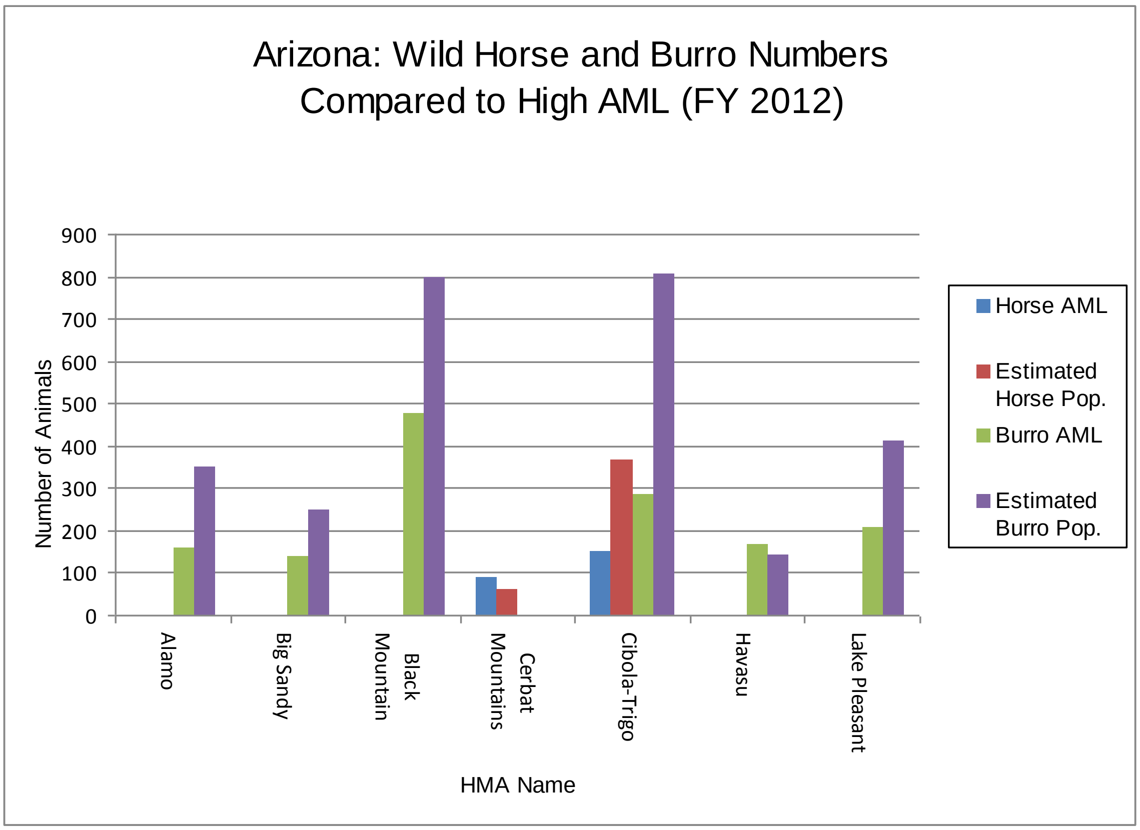
[150] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.

[151] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

[152] *Ibid*.

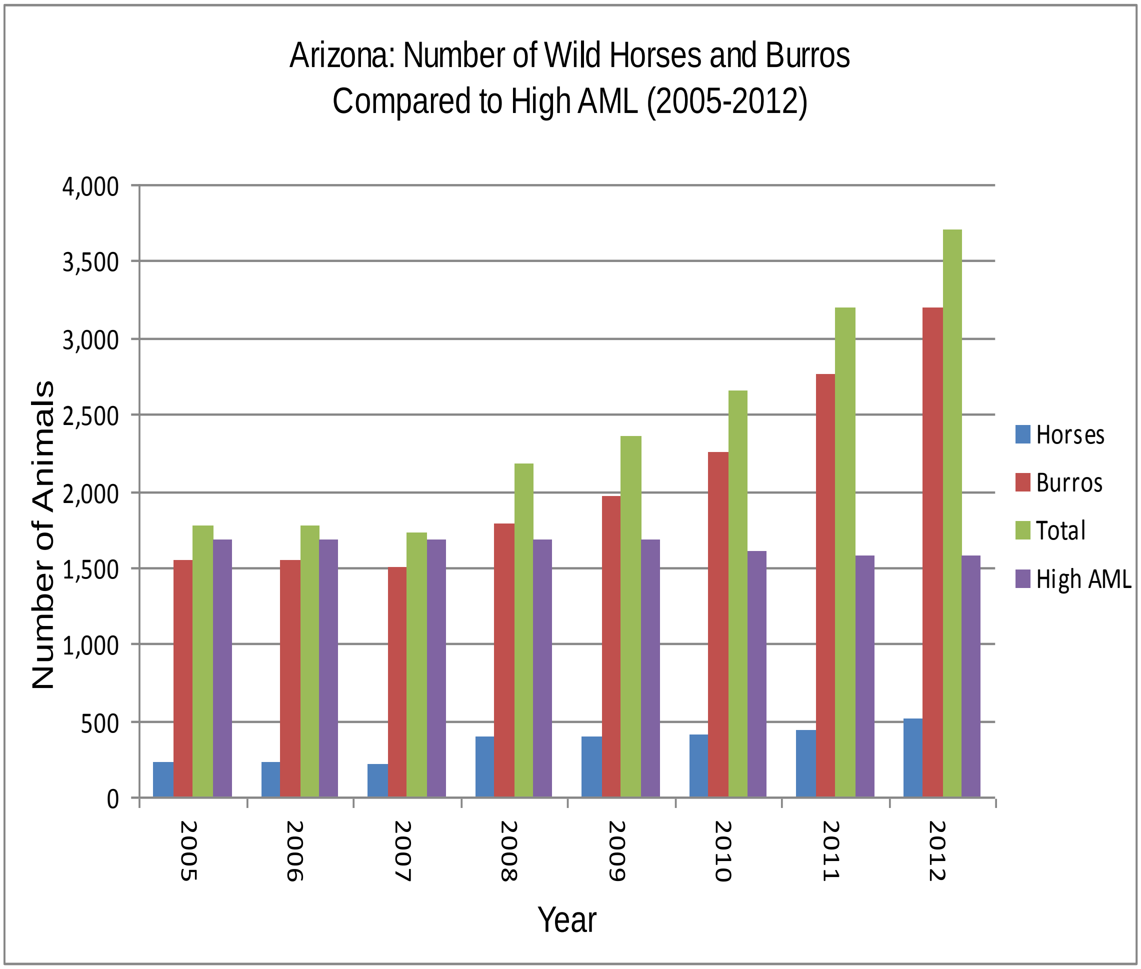
Wild horses are found in only two of the seven HMAs while wild burros are found in six of the HMAs. The total current high AML[153] for wild horses and burros in the state is 240 and 1,436, respectively, or 1,676 combined. Therefore, as of February 2012, the number of wild horses and burros in Arizona is approximately 2,000 over the current combined high AML for wild horses and burros. If the AMLs for wild horses and burros are justified – which remains highly questionable – wild horses and wild burros are 262 and 1,758 in excess of their respective AMLs. See Figure AZ-2.[154] This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses and burros in Arizona was closer to the combined high AML from 2005 through 2007. See Figure AZ-3.[155]

Figure AZ-2:



[153] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.
[154] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_ management/Data.html
[155] *Ibid.*

Figure AZ-3:



In 2011, the BLM removed 102 wild burros and 0 wild horses from in and/or outside of HMAs in Arizona. In total, from 1996 to 2011, 166 wild horses and 5,791 wild burros have been captured and removed from the range. See Figures AZ-4, AZ-5, and AZ-6.[156] During that same time period, 2,582 and 1,098 wild horses and burros, respectively, have been adopted in Arizona.[157] See Figure AZ-7.[158]

[156] *Ibid*.

[157] This includes wild horses and burros captured and removed from the range in other states.

[158] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

Figure AZ-4:

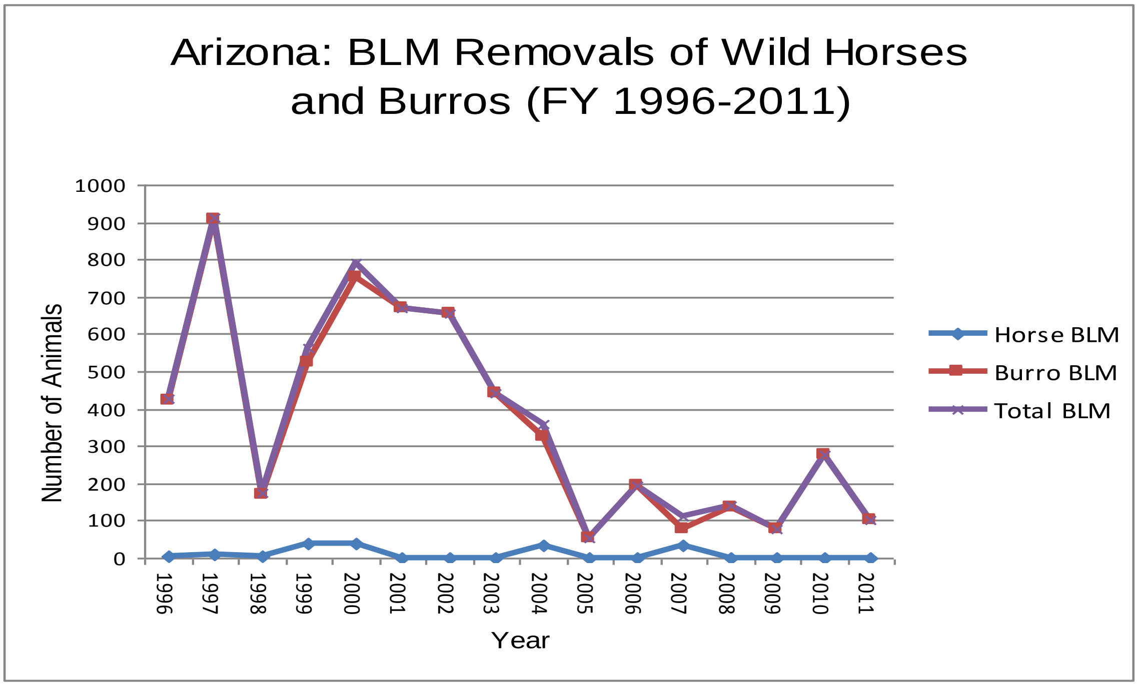


Figure AZ-5:

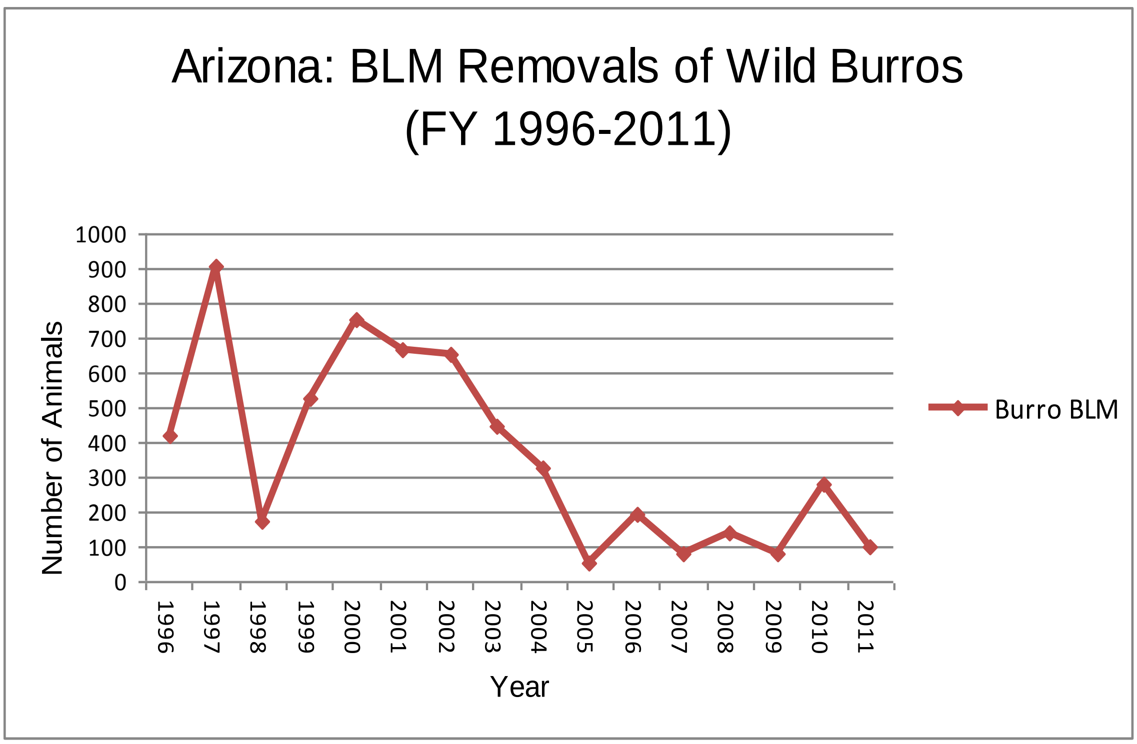


Figure AZ-6:

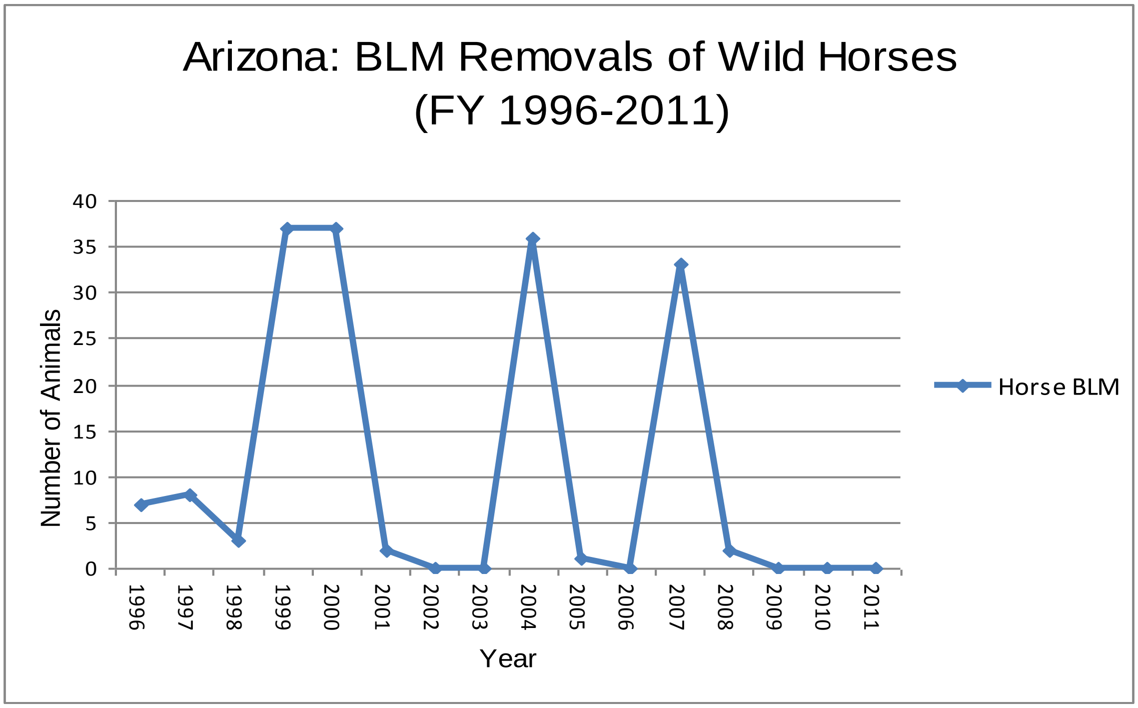
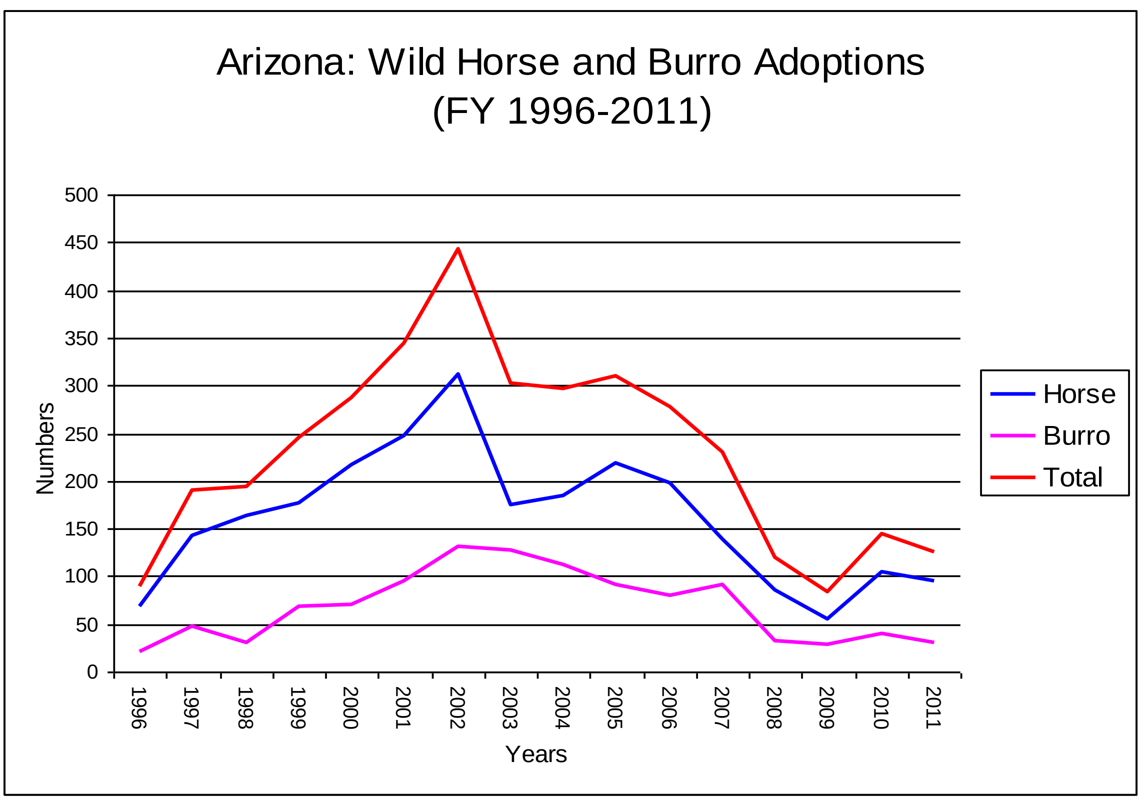
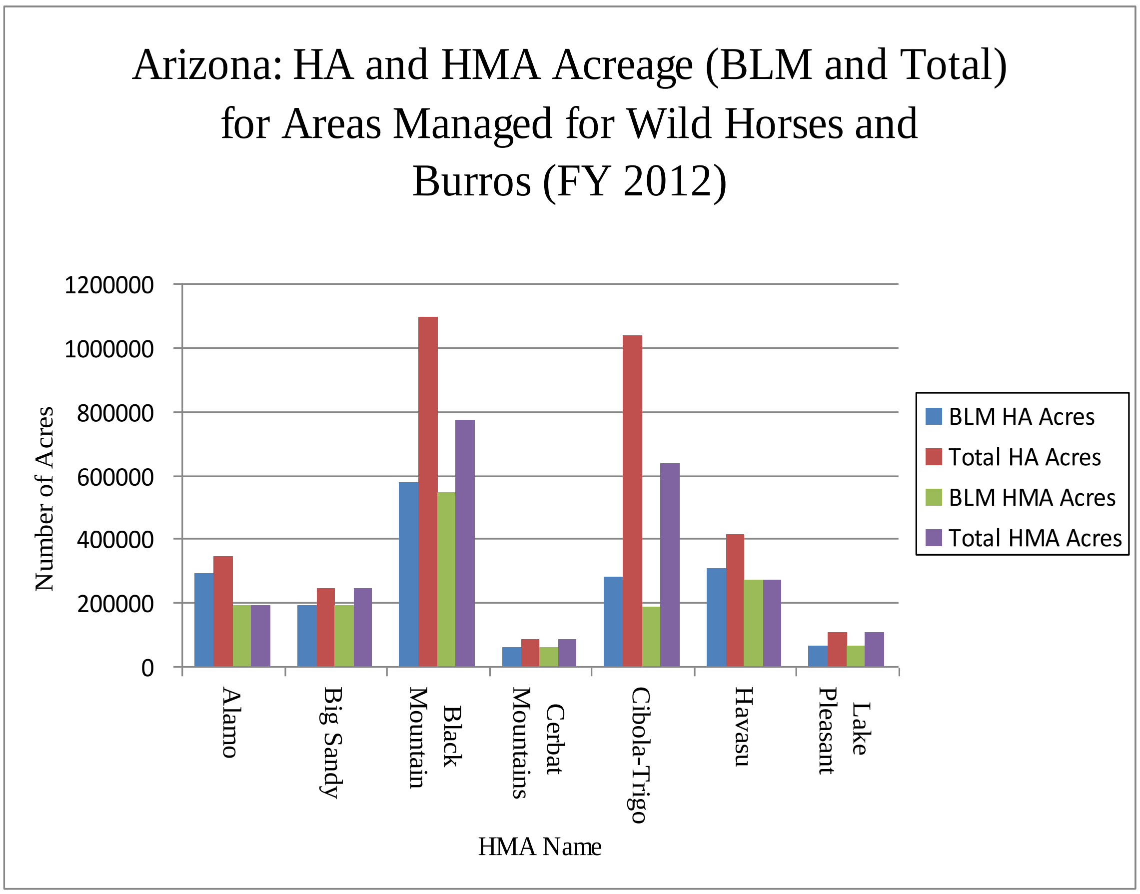


Figure AZ-7:



The seven HMAs in Arizona encompass 2,296,269 acres, including 1,498,207 acres of BLM lands. These HMAs are contained within 3,308,874 HA acres, including 1,765,281 acres of BLM lands. This indicates that 1,012,605 acres of HA habitat – in areas managed for wild horses and burros – is not available to the animals. See Figure AZ-8.[159] In addition, since 2005 (annual BLM data prior to 2005 was not available), the acres available to wild horses and/or burros in HMAs have declined by 787,594 acres. See Figure AZ-9.[160] Finally, according to BLM data, there are four HAs in the state from which wild horses and/or burros have been permanently removed. These four HAs encompass 334,323 acres, including 253,746 acres of BLM lands. See Figure AZ-10.[161] Consequently, 1,346,928 acres of habitat originally available for wild horses and burros in Arizona no longer exists. See Figure AZ-11.[162]

Figure AZ-8:



[159] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[160] *Ibid*.
[161] *Ibid*.
[162] *Ibid*.

Figure AZ-9:

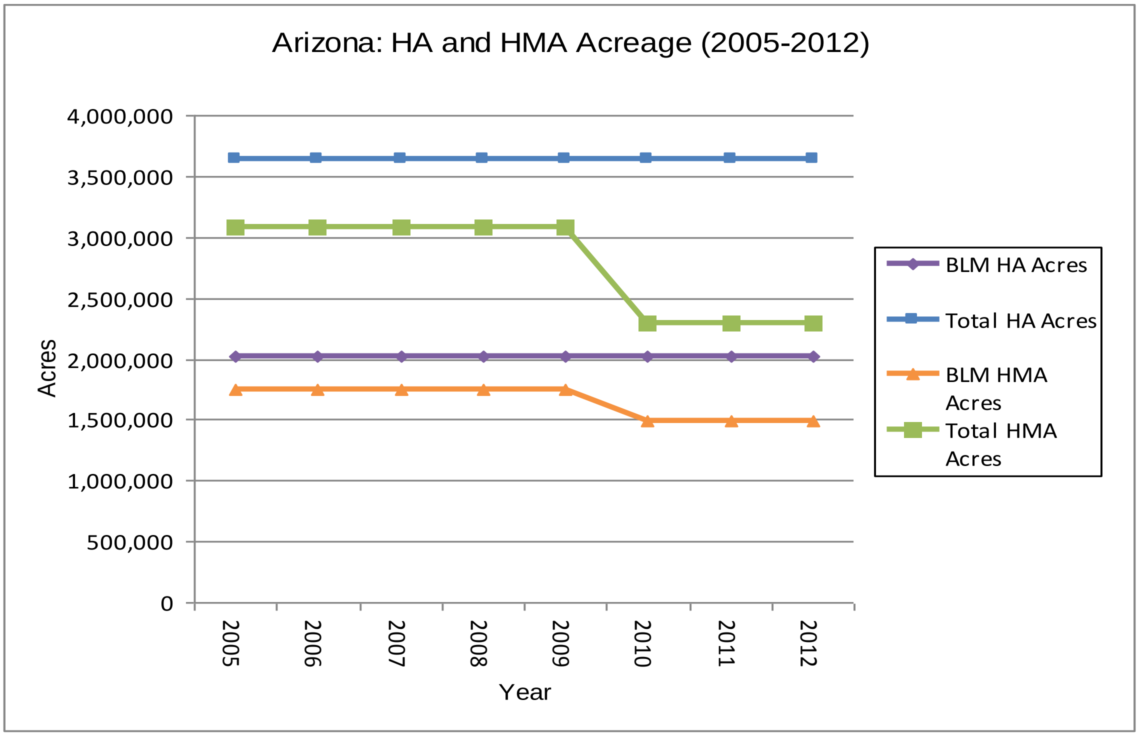


Figure AZ-10:

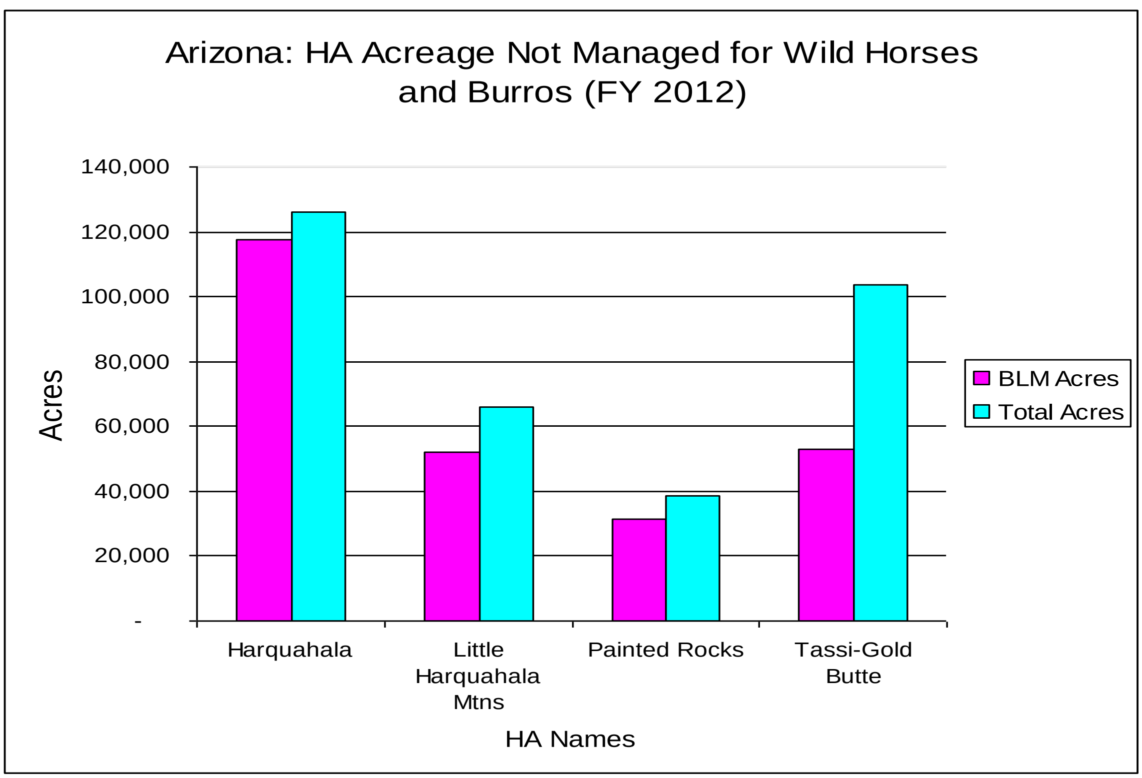
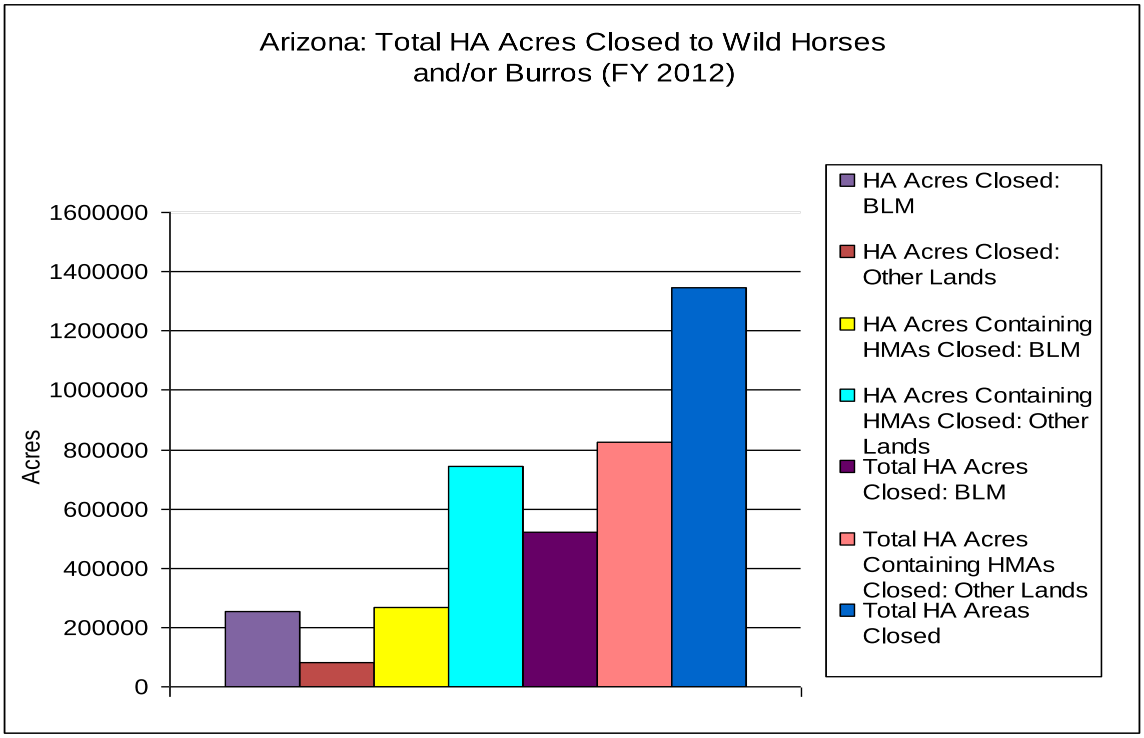


Figure AZ-11:



There are 820 total public land grazing allotments in Arizona, encompassing 11,425,818 acres. Of these acres, in 2011, rangeland monitoring has designated 2,080,165 acres in the "upward" trend, 3,608,645 acres in the "static" trend, 636,472 acres in the "downward" trend, and 5,100,536 acres in the "undetermined" trend.[163] The number of acres in these categories has varied over the years. See Figure AZ-12.[164] In 2011, of the 820 allotments, 202 have been designated as "I" (improve), 146 as "M" (maintenance), 471 as "C" (custodial), and 1 as "uncategorized."[165] The number acres of acres in these categories is subject to annual variation. See Figure AZ-13.[166]

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[163] Trends are designated as "upward" if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as "downward" if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[164] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

[165] The objective for "I" allotments is to "improve the current resource condition." The objective for "M" allotments is to "maintain the current resource condition." The objective for "C" allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-the-ground management efforts to those allotments where grazing management is most needed to improve

Figure AZ-12:

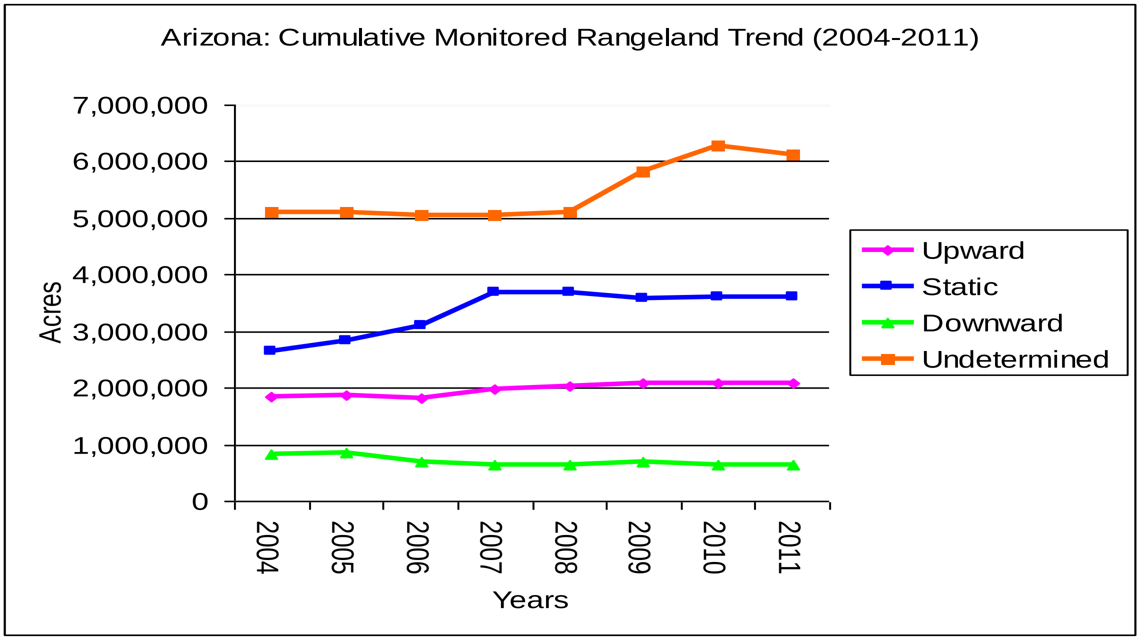
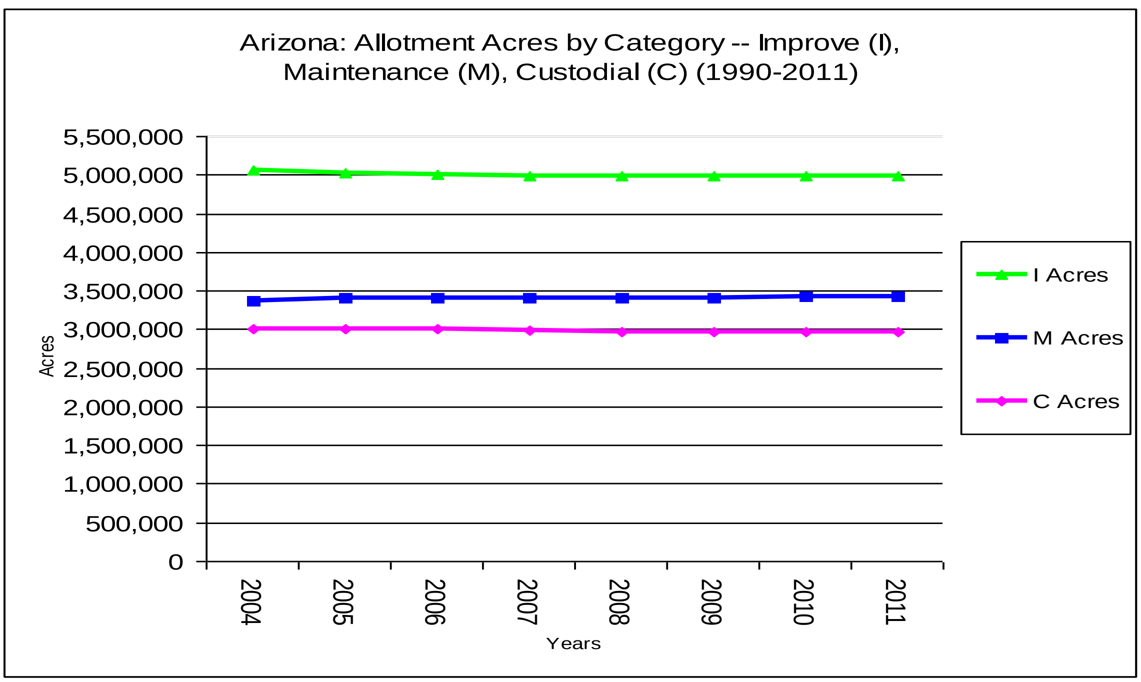


Figure AZ-13:

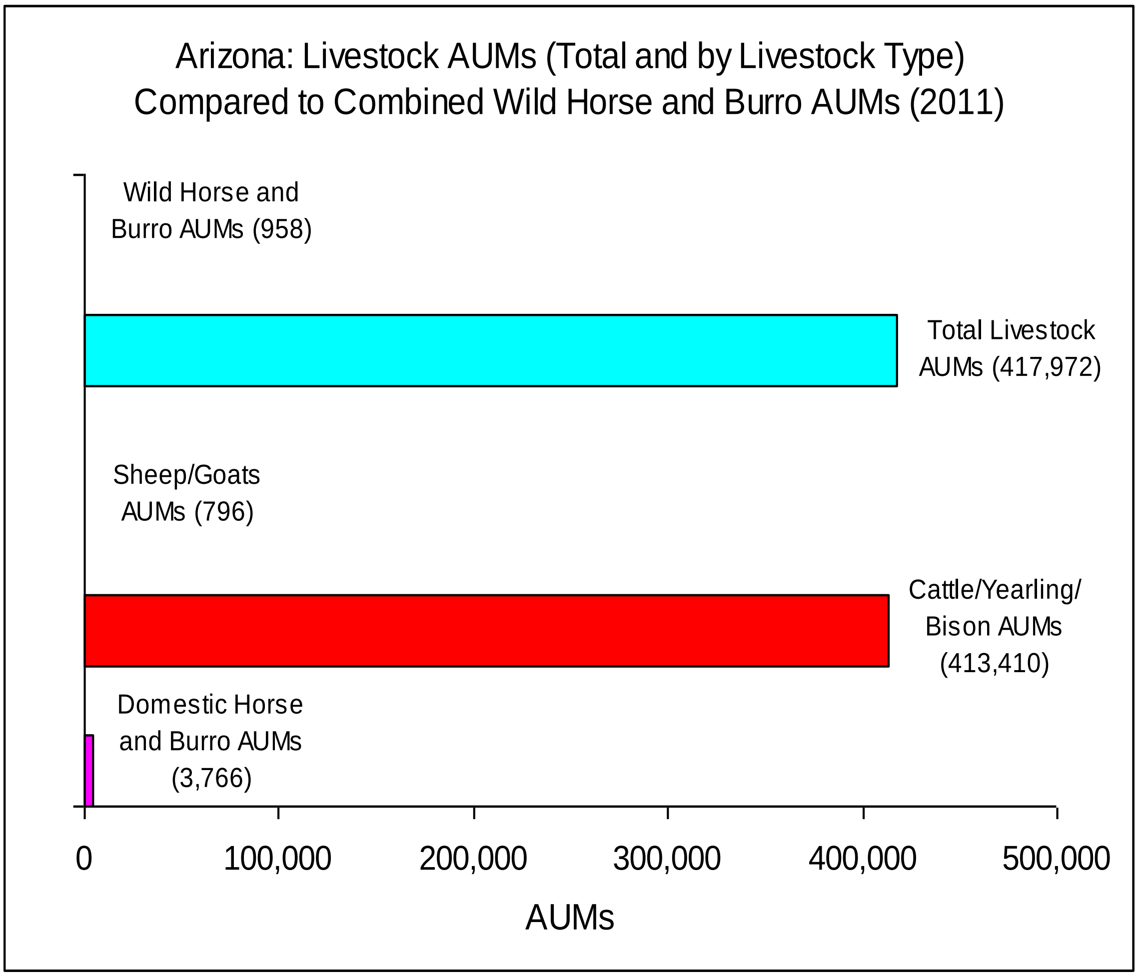


resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

[166] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

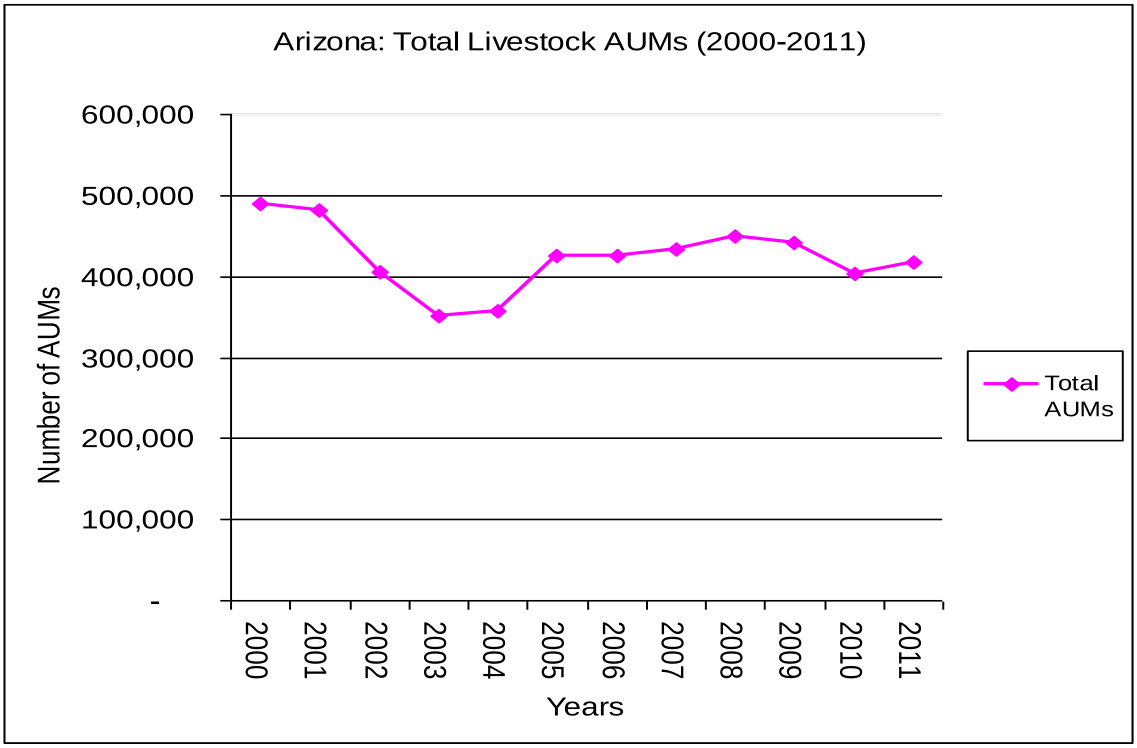
In 2011, the total number of AUMs used for grazing was 417,972. This included 413,410 for cattle/yearlings/bison, 3,766 for domestic horses and burros, and 796 for sheep and goats. The total AUMs for wild horses and burros in Arizona in 2011 was 958, [167] indicating that, statewide, livestock AUMs are 436 times higher than wild horse and burros AUMs. See Figure AZ-14.[168] Since 2000, the total for livestock AUMs has been variable, ranging from 489,199 in 2000, declining to 350,553 in 2003 and then increasing to 417,972 in 2011. See Figure AZ-15.[169]

Figure AZ-14:



[167] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[168] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm.
[169] *Ibid*.

Figure AZ-15:



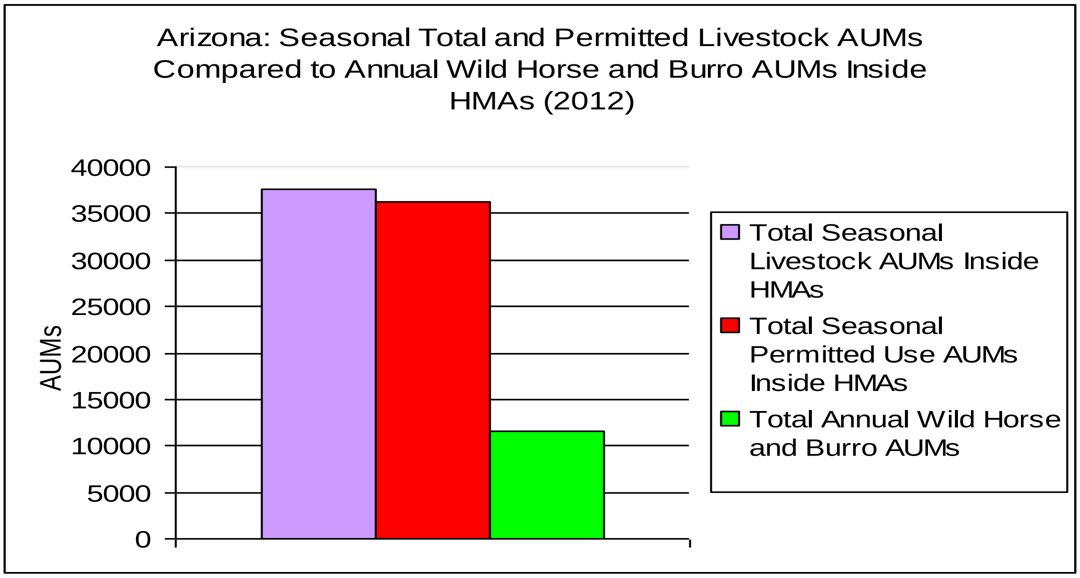
According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 1,811 livestock (7,744 cattle, 32 domestic horses/burros, and 35 goats) were grazed on allotments wholly or partially within an estimated 64 HMAs in Arizona.[170] This corresponds to approximately 7,781 AUMs or, if extrapolated to a full year, 93,372 AUMs. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing was 102,995, 72,408, 12,666, and 90,074, respectively.[171]

When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[172] the number of livestock grazed within the HMAs is 3,317, corresponding to 36,312 seasonal/annual AUMs compared to 11,496 annual AUMs for wild horses and burros. See Figures AZ-16 and AZ-17. Hence, even at the HMA level, livestock AUMs are over three times larger than wild horse and burro AUMs. In addition, of the total number of livestock, wild horses, and/or wild burros estimated to use all Arizona HMAs in 2012, 51 percent are livestock, 6.6 percent are wild

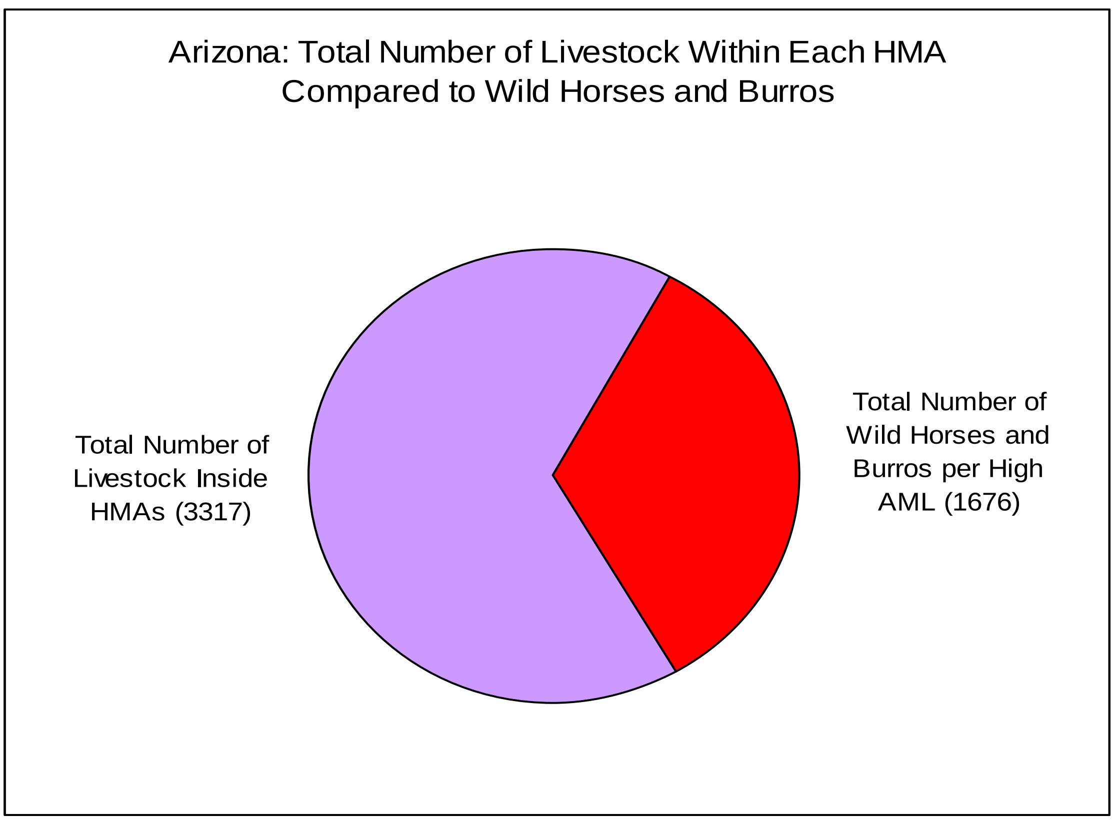
[170] Per BLM policy, the BLM is not permitted to allow domestic horses and/or burros to utilize HMAs. It is not known if the 32 domestic horses/burros identified in the RAS database are permitted to graze on lands within HMAs in Arizona.
[171] Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.
[172] This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

horses, and 42.4 percent are wild burros. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

AZ Figure-16:



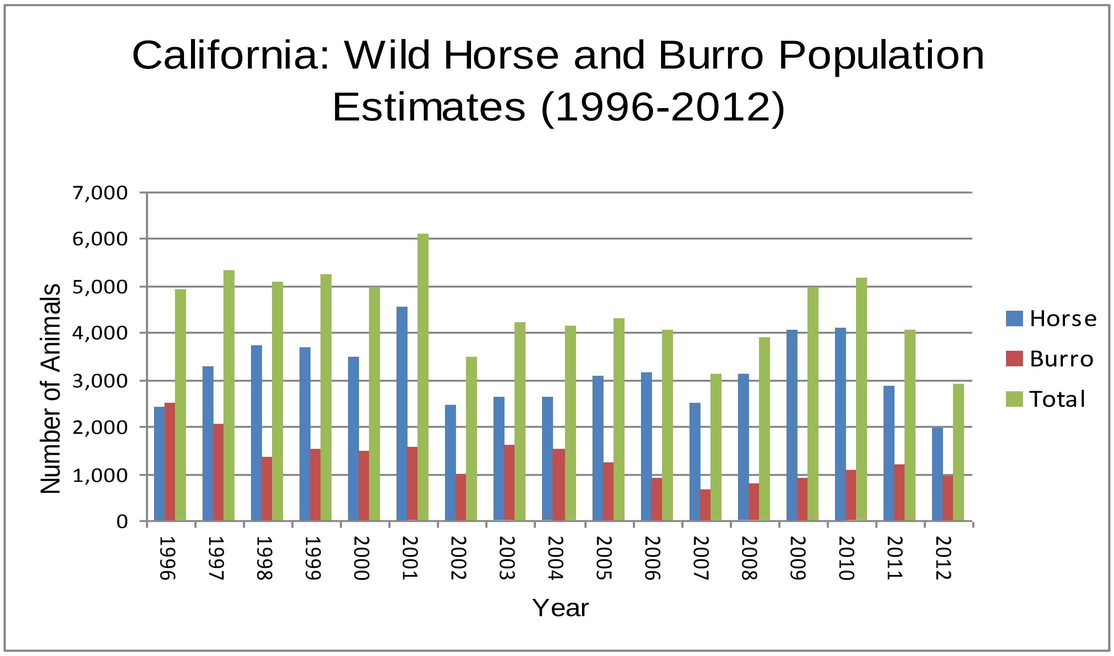
AZ Figure-17:



California:

Based on fiscal year 2012 data there are, as of February 29, an estimated 1,842 wild horses and 581 wild burros in California occupying a total of 21 HMAs.[173] See Figure CA-1.[174] In addition, there are an estimated 123 wild horses and 358 wild burros on HAs that are not managed for the species.[175] As a result, there are an estimated 1,965 wild horses and 939 wild burros, for a total of 2,904 animals, in California.

Figure CA-1:



Wild horses are found in 15 of the 21 HMAs while wild burros are found in 5 of the 21 HMAs in California. Burros are also found in a sixth HMA though there is not an AML for burros in that HMA. The total current high AML[176] for wild horses and burros in the state is 1,585 and 478, respectively, or 2,063 combined. Therefore, as of February 2012, the number of wild horses and burros in California are an estimated 841 over high AML. If the AMLs for wild horses and burros are scientifically justified – which remains highly

[173] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.

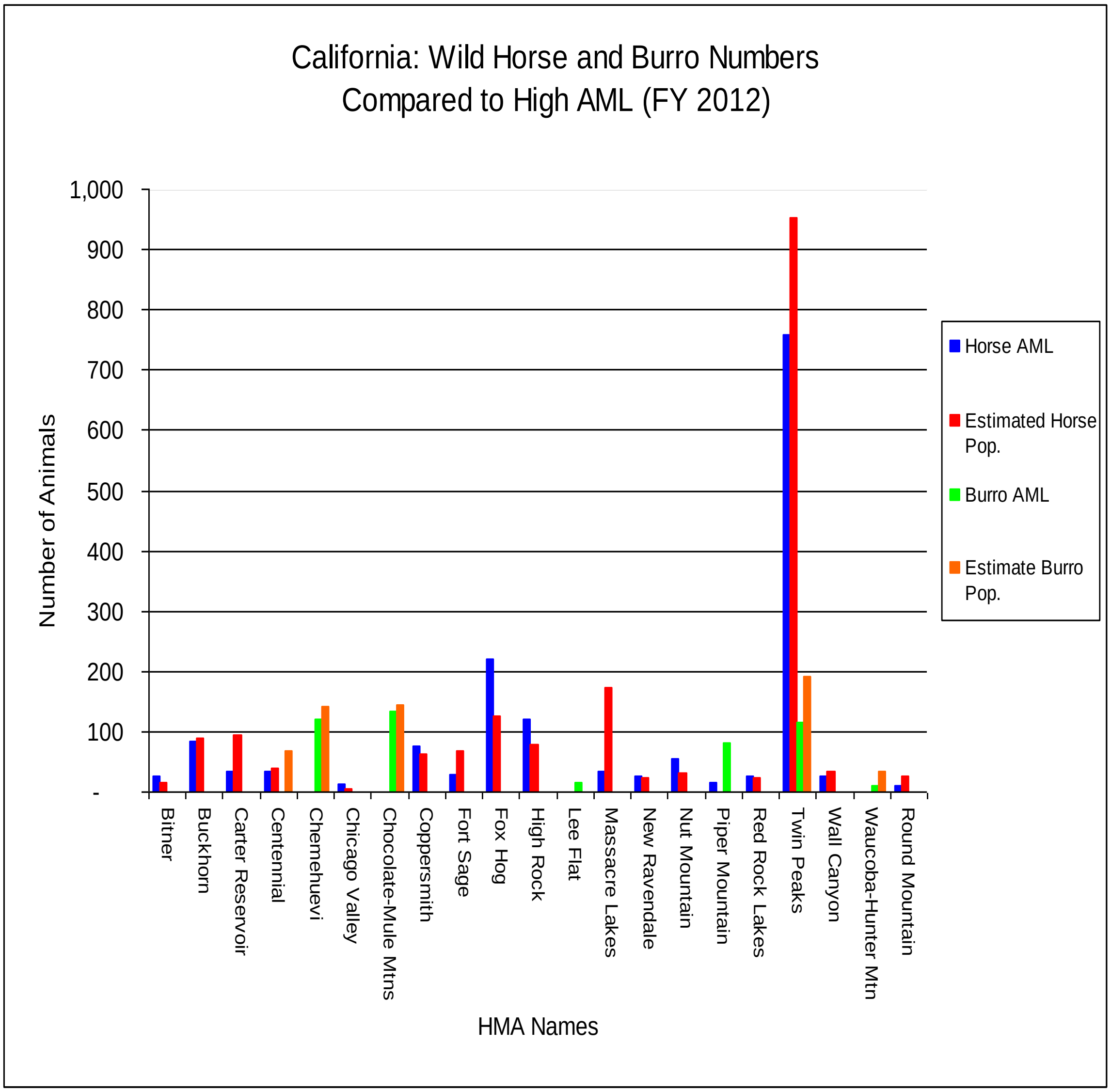
[174] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

[175] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

[176] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.

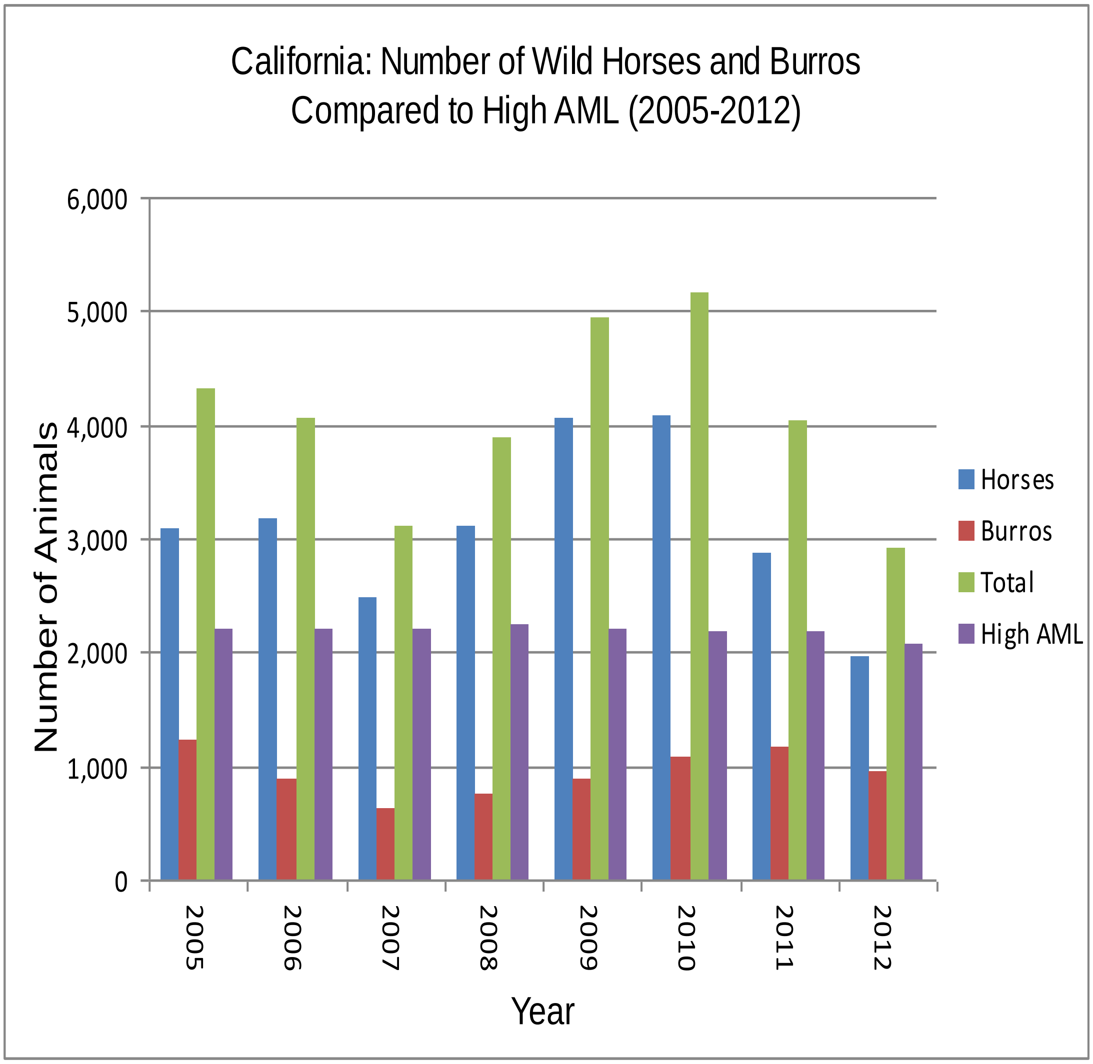
questionable – wild horses and burros are 380 and 461 in excess of their respective high AMLs. See Figure CA-2.[177] This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses and burros in California has never been below high AML during that period. See Figure CA-3.[178]

Figure CA-2:



[177] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[178] *Ibid*.

Figure CA-3:



In 2011, the BLM removed 88 wild horses and 311 wild burros from in and/or outside of HMAs in California. In total, from 1996 to 2011, 11,530 wild horses and 5,774 wild burros have been captured and removed from the range. See Figures CA-4, CA-5, and CA-6.[179] During that same time period, 8,814 and 2,750 wild horses and burros, respectively, have been adopted in California.[180] See Figure CA-7.[181]

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[179] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

[180] This includes wild horses and burros captured and removed from the range in other states.

[181] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

Figure CA-4:

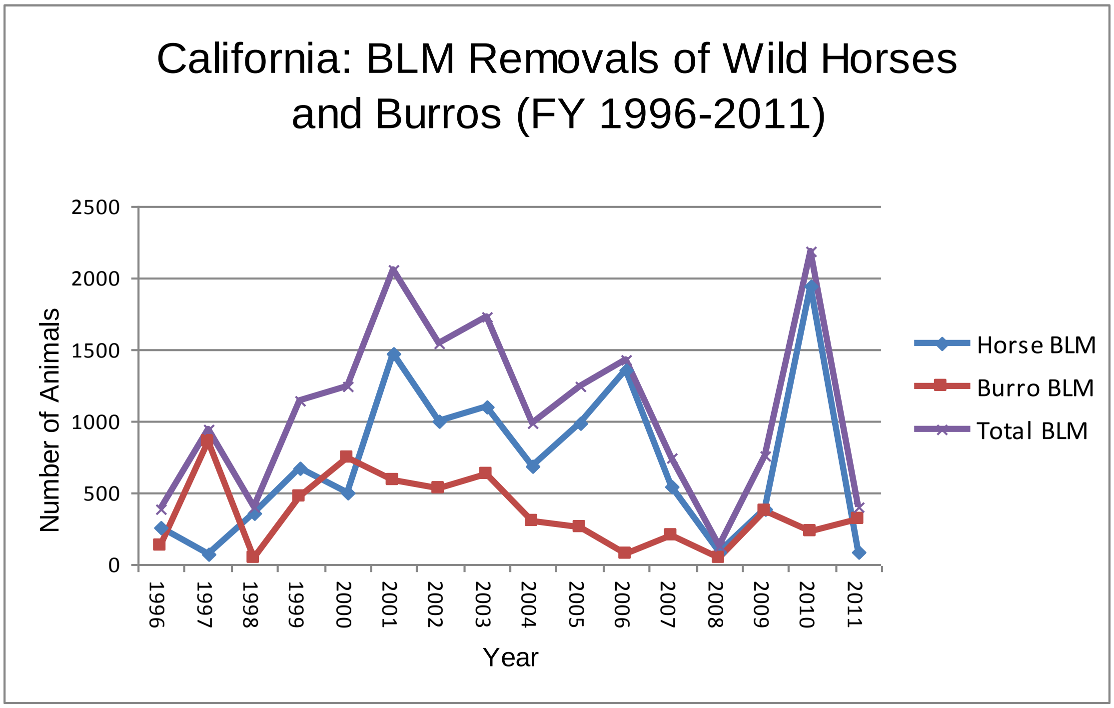


Figure CA-5:

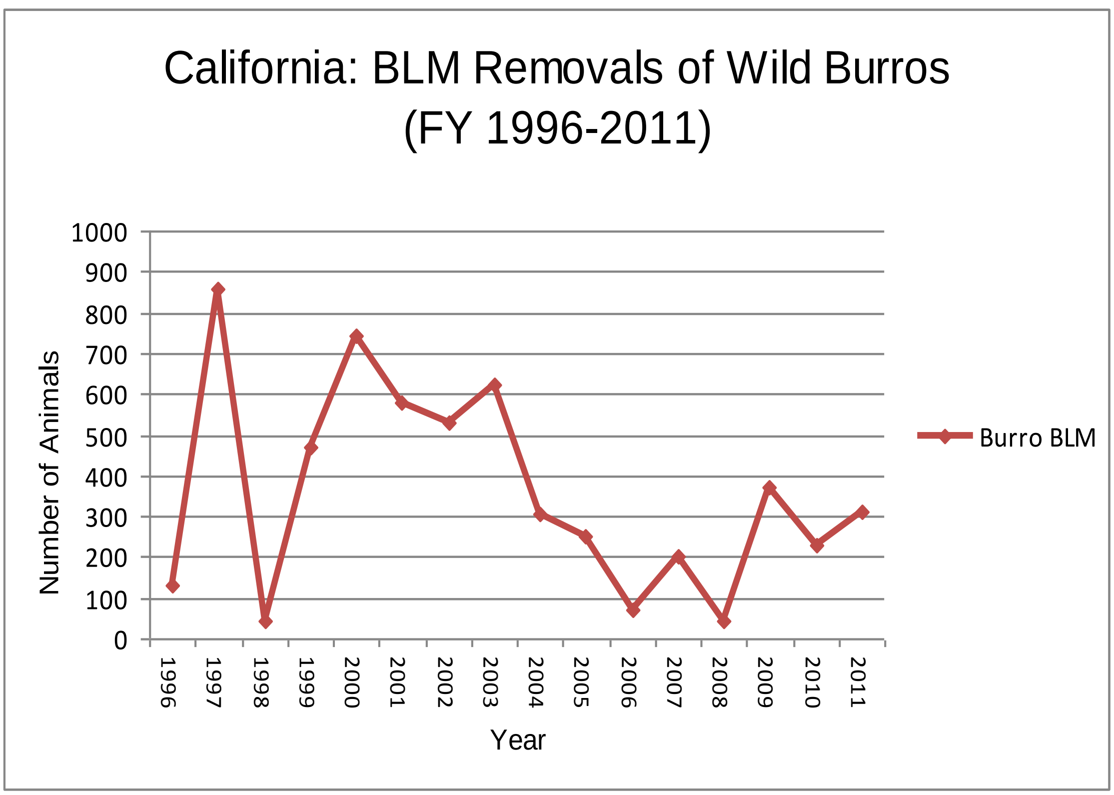


Figure CA-6:

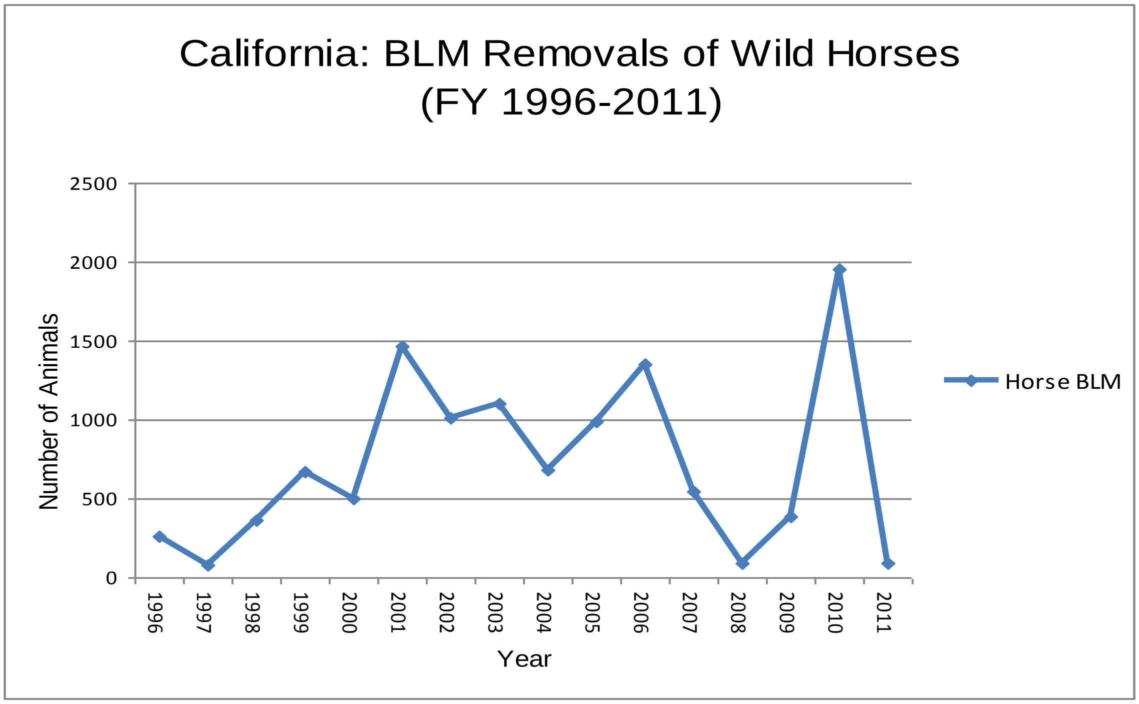
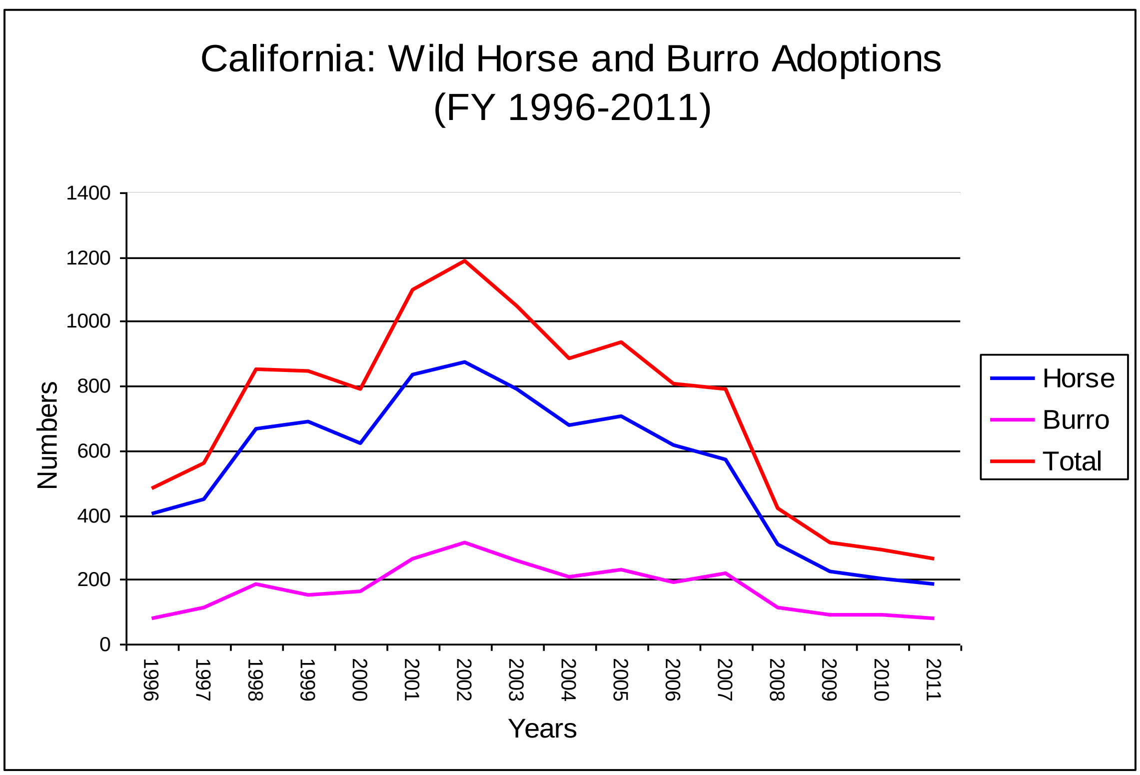
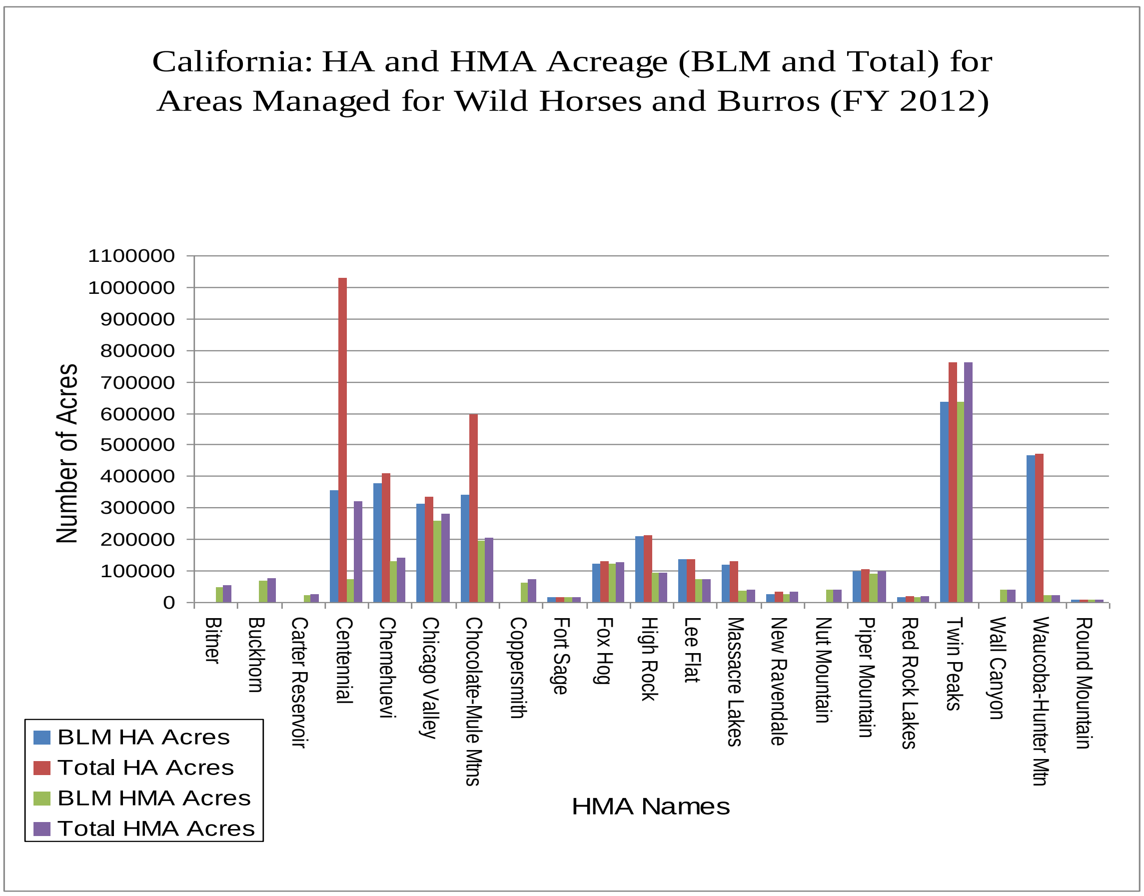


Figure CA-7:



The 21 HMAs in California encompass 2,533,722 acres, including 2,053,082 acres of BLM lands. These HMAs are contained within 4,380,134 HA acres, including 3,224,907 acres of BLM lands. This indicates that 1,846,412 acres of HA habitat – in areas managed for wild horses and burros – is not available to the animals. See Figure CA-8.[182] In addition, since 2005 (annual BLM data prior to 2005 was not available), the acres available to wild horses and/or burros in HMAs have declined by 115,277 acres. See Figure CA-9.[183] Finally, according to BLM data, there are 17 HAs in the state from which wild horses and/or burros have been permanently removed. These 17 HAs encompass 2,641,517 acres, including 1,946,024 acres of BLM lands. See Figure CA-10.[184] Consequently, 4,487,929 acres of habitat originally available for wild horses and burros in California no longer exists. See Figure CA-11.[185]

Figure CA-8:



182 Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
183 *Ibid.*
184 *Ibid.*
185 *Ibid.*

Figure CA-9:

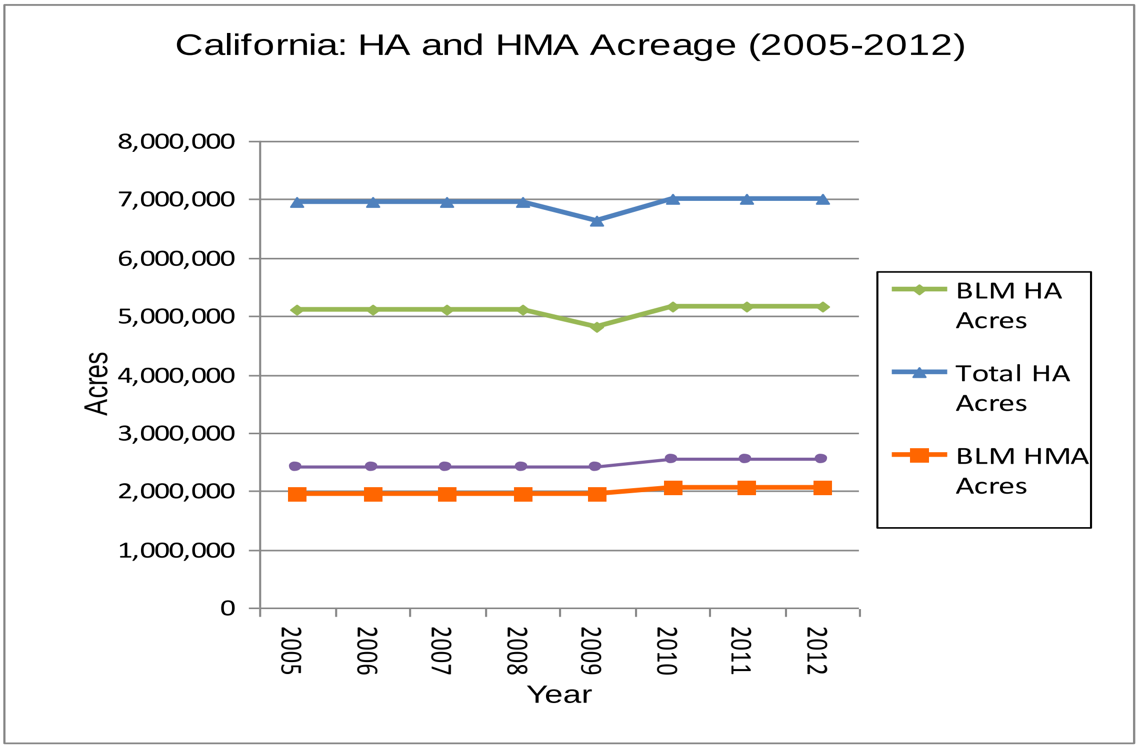


Figure CA-10:

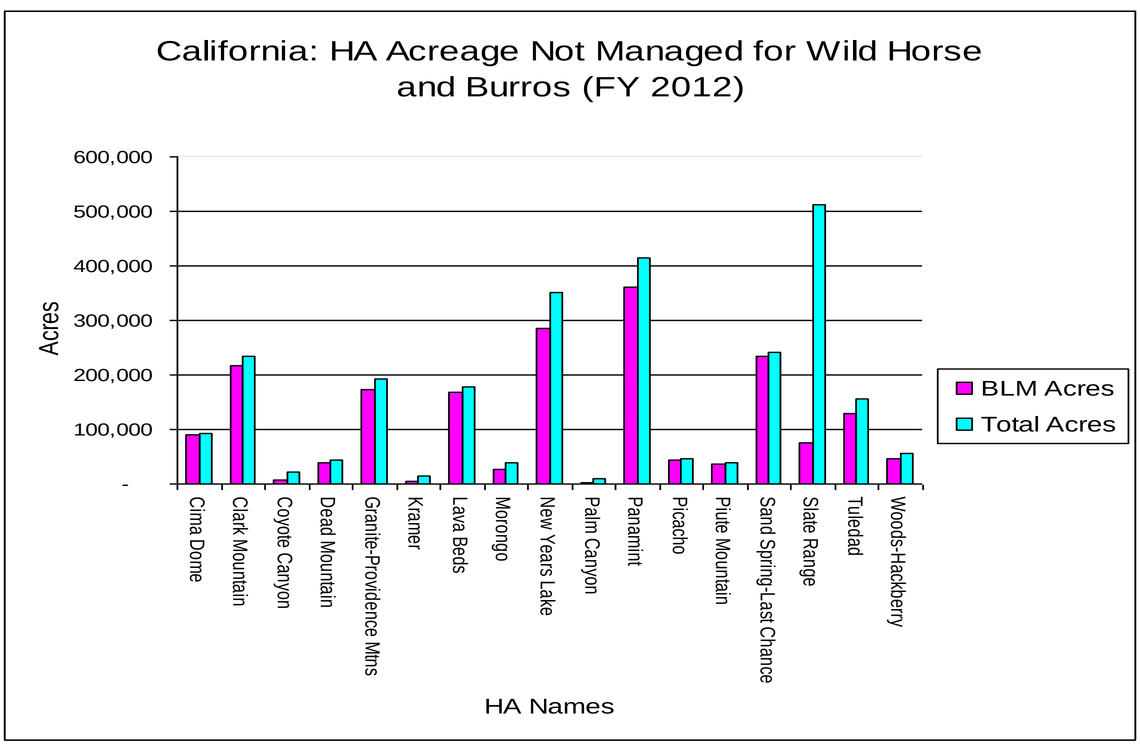
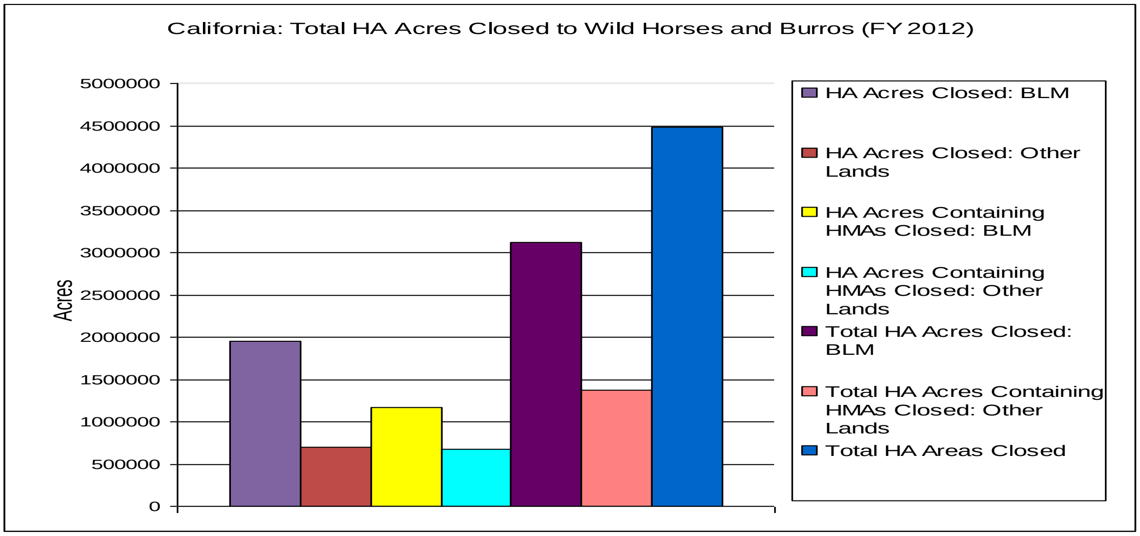


Figure CA-11:



There are 684 total public land grazing allotments in California, encompassing 7,912,236 acres. Of these acres, in 2011, rangeland monitoring has designated 378,927 acres in the “upward” trend, 122,108 acres in the “static” trend, 59,409 acres in the “downward” trend, and 7,351,792 acres in the “undetermined” trend.[186] The number of acres in these categories has varied over the years. See Figure CA-12.[187] In 2011, of the 684 allotments, 169 have been designated as “I” (improve), 177 as “M” (maintenance), 338 as “C” (custodial), and 0 as “uncategorized.”[188] The number of allotments and their corresponding acreage in these categories is subject to variation. See Figures CA-13 and CA-14.[189]

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[186]Trends are designated as “upward” if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as “downward” if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "Undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[187] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

[188] The objective for “I” allotments is to "improve the current resource condition." The objective for “M” allotments is to "maintain the current resource condition." The objective for “C” allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-the-ground management efforts to those allotments where grazing management is most needed to improve resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

[189] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

Figure CA-12:

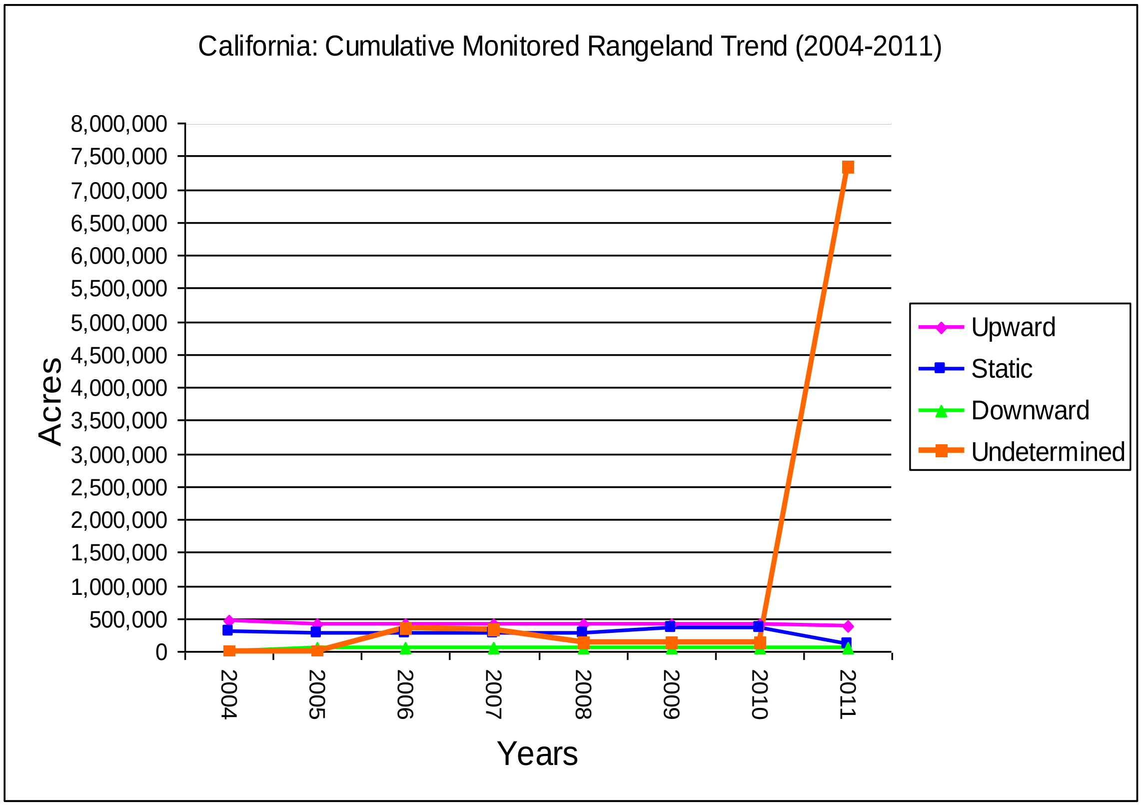


Figure CA-13:

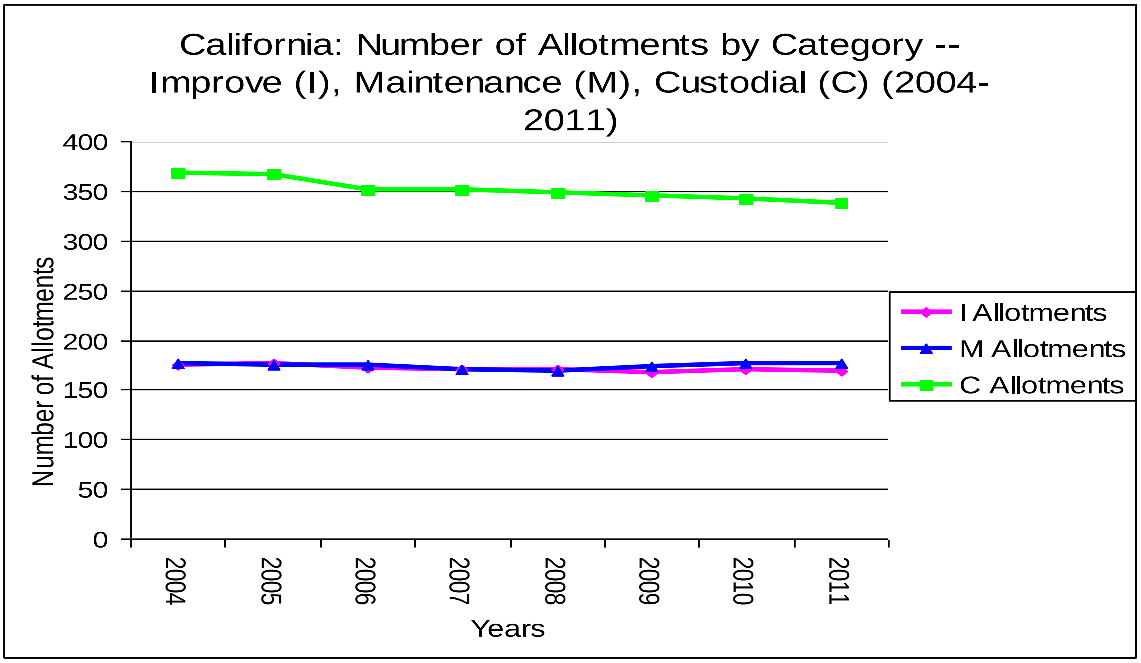
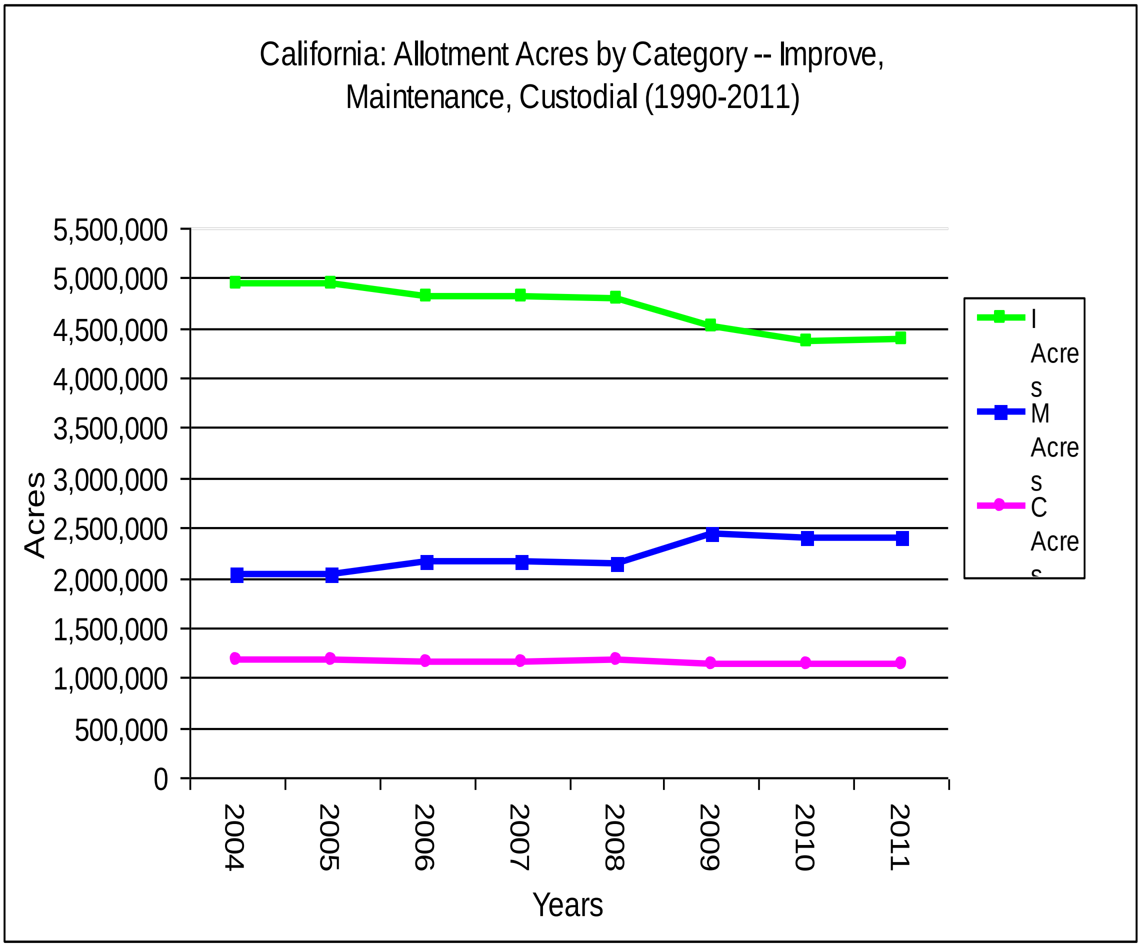


Figure CA-14:



In 2011, the total number of AUMs used for grazing was 217,576. This included 199,242 for cattle/yearlings/bison, 361 for domestic horses and burros, and 17,973 for sheep and goats. The total AUMs for wild horses and burros in California in 2011 was 1,824, [190] indicating that, statewide, livestock AUMs are 119-times higher than wild horse and burro AUMs. See Figure CA-15.[191] Since 2000, the total for livestock AUMs has been variable, ranging from a low of 183,991 in 2003 to a high of 242,686 in 2000. See Figure CA-16.[192]

[190] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[191] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm.
[192] *Ibid*.

Figure CA-15:

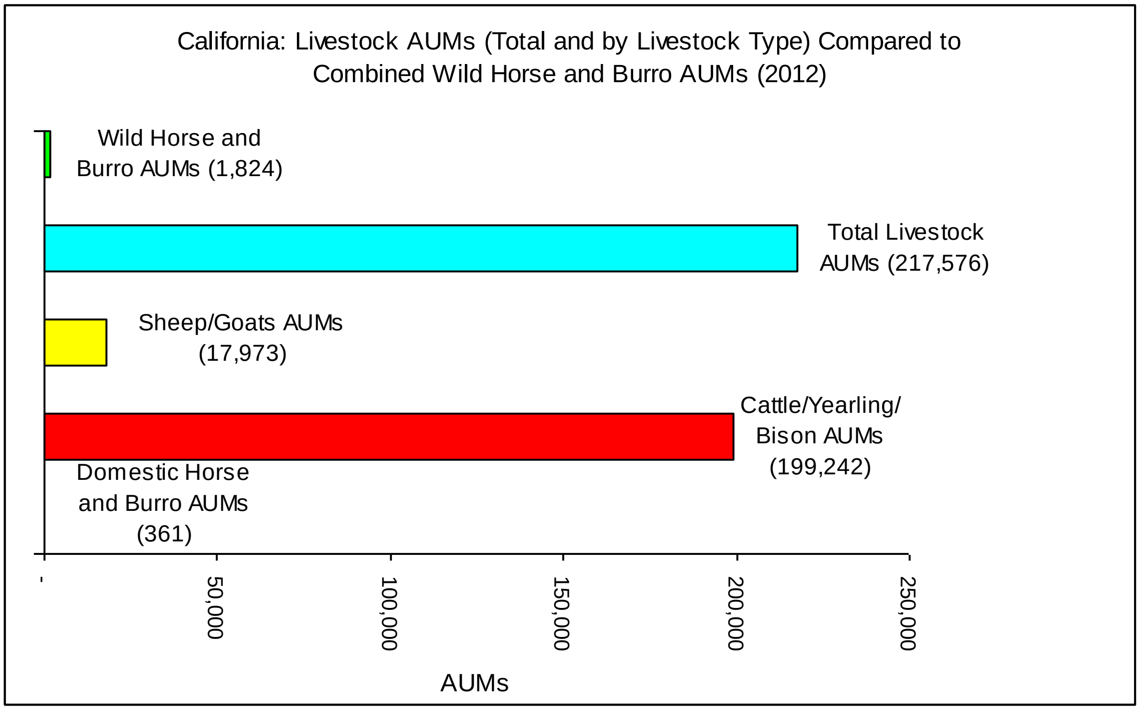
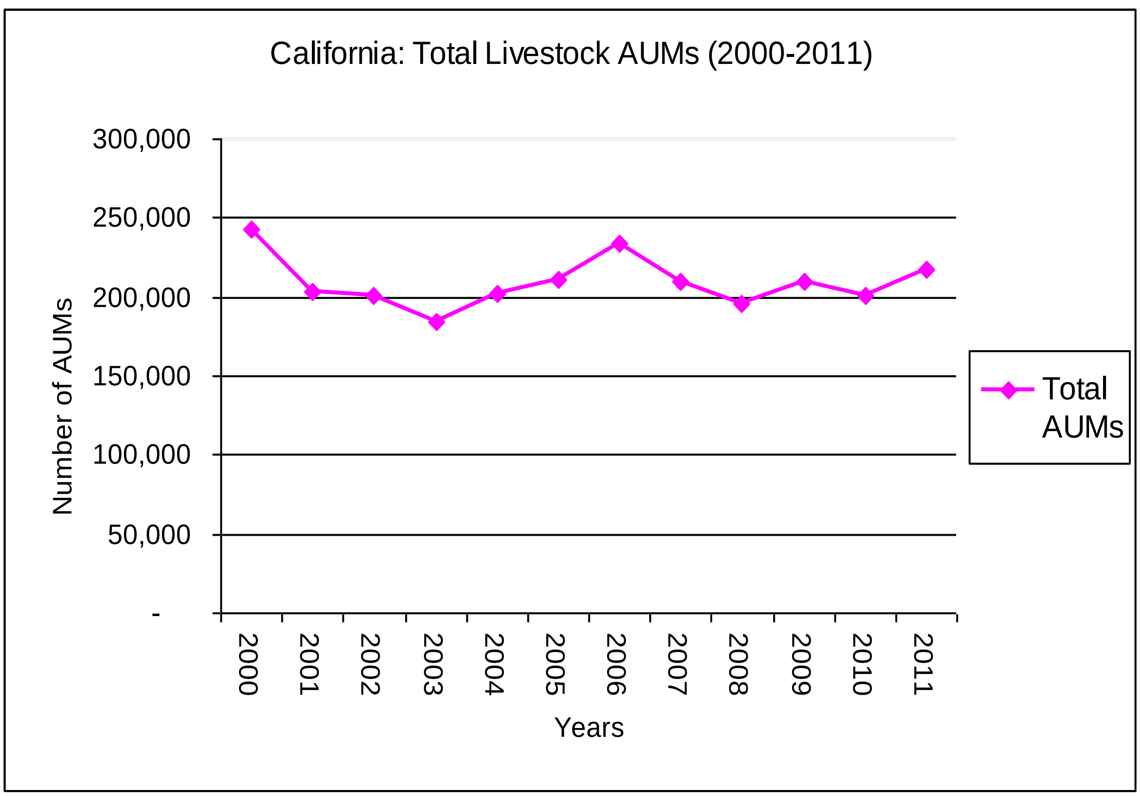


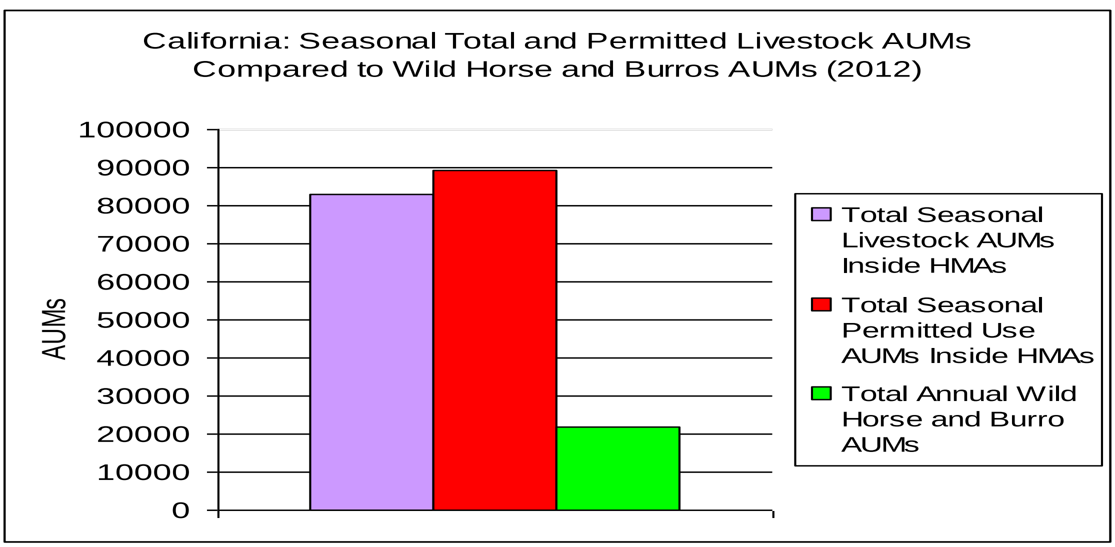
Figure CA-16:



According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 84,268 livestock (24,728 cattle and 59,540 sheep) were grazed on an estimated 41 allotments wholly or partially within HMAs in California. This corresponds to approximately 36,636 AUMs.[193] The total AUMs used annually depends on the type of livestock grazed and the duration for which they are grazed on public lands. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing for livestock using allotments wholly or partially within HMAs was 150,991, 97,540, 55,519 and 153,059, respectively.[194]

When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[195] the number of livestock grazed within the HMAs is 43,908 corresponding to 82,071 total AUMs and 89,215 AUMs permitted for use for seasonal/annual grazing. This compares to a high AML for wild horses and burros of 2,063 (1,585 horses and 478 burros) which equates to an annual AUM of 21,888. See Figures CA-17 and CA-18. Hence, even at the HMA level, permitted use livestock AUMs are nearly 7 times larger than annual wild horse and burros AUMs. In addition, of the total number of livestock, wild horses, and/or wild burros estimated to use all California HMAs in 2012, 97.4 percent are livestock, 2.4 percent are wild horses, and 0.2 percent are wild burros. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

Figure CA-17:

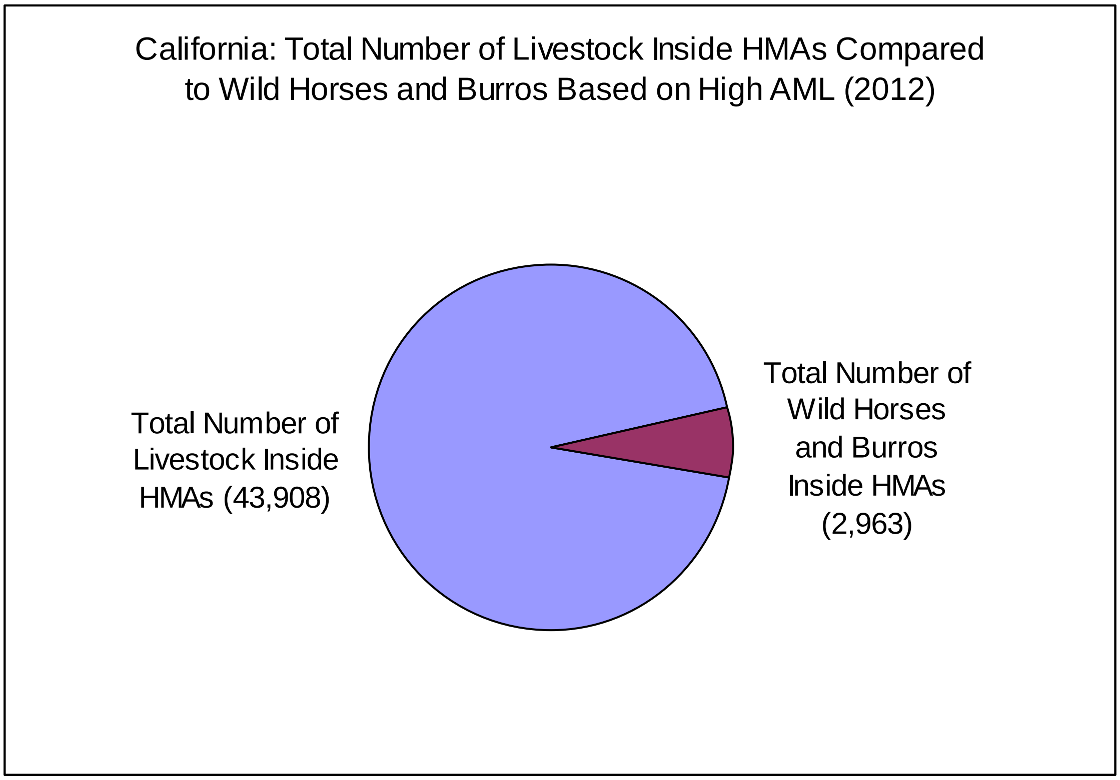


[193] The AUMs were calculated using conversion rates of 1 cow = 1 AUM and .2 sheep = 1 AUM. These conversion rates are consistent with BLM policies or were identified in various agricultural sources found on the Internet.

[194] Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.

[195] This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

Figure CA-18:

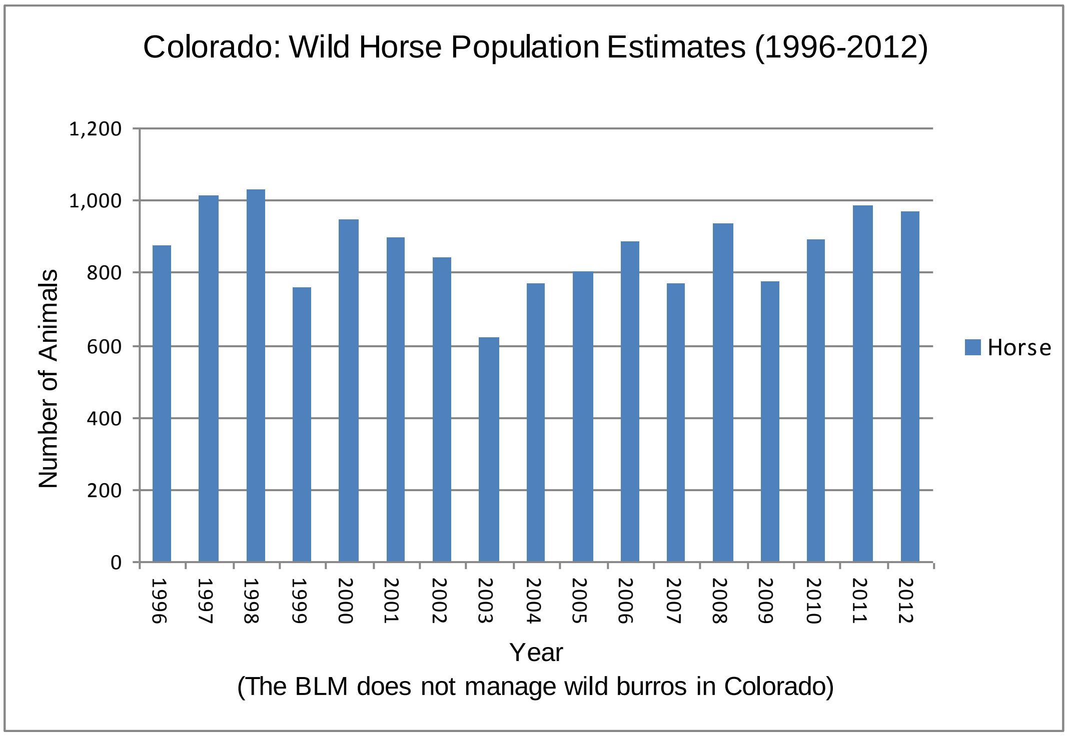


California: Total Number of Livestock Inside HMAs Compared to Wild Horses and Burros Based on High AML (2012)
Total Number of Livestock Inside HMAs (43,908)
Total Number of Wild Horses and Burros Inside HMAs (2,963)

Colorado:

Based on fiscal year 2012 data there are, as of February 29, an estimated 697 wild horses and 0 wild burros in Colorado occupying a total of four HMAs.[196] See Figure CO-1.[197] In addition, there are an estimated 270 wild horses and 0 wild burros on HAs that are not managed for the species.[198] As a result, there are an estimated 967 wild horses in Colorado.

Figure CO-1:

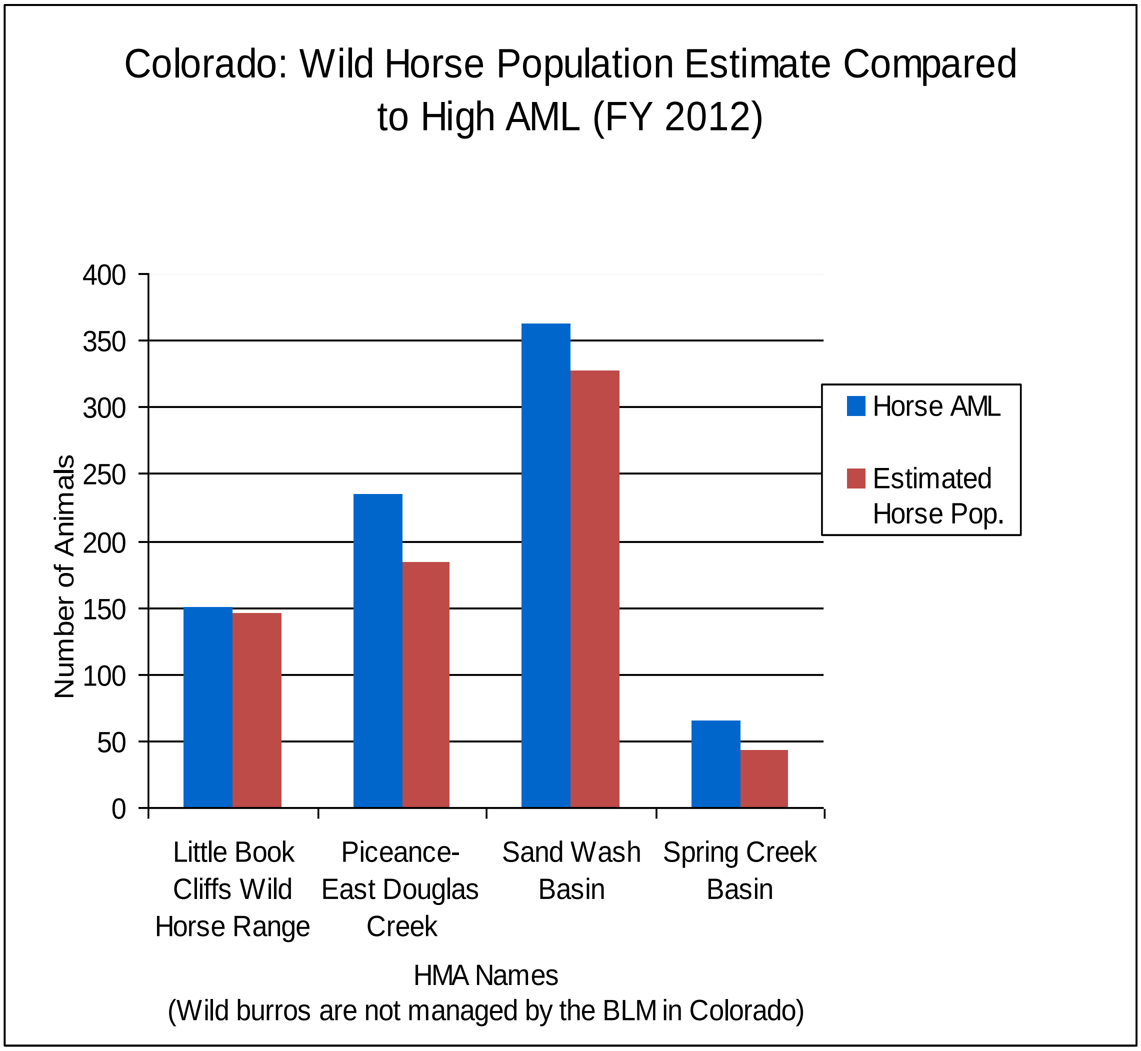


Wild horses are found in all four of the HMAs. The total current high AML[199] for wild horses in the state is 812. Therefore, as of February 2012, the number of wild horses in Colorado is 150 over the current high AML for wild horses. This assumes that the current AMLs for wild horses are justified – which remains highly questionable. See Figure CO-

[196] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.
[197] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[198] *Ibid*.
[199] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.

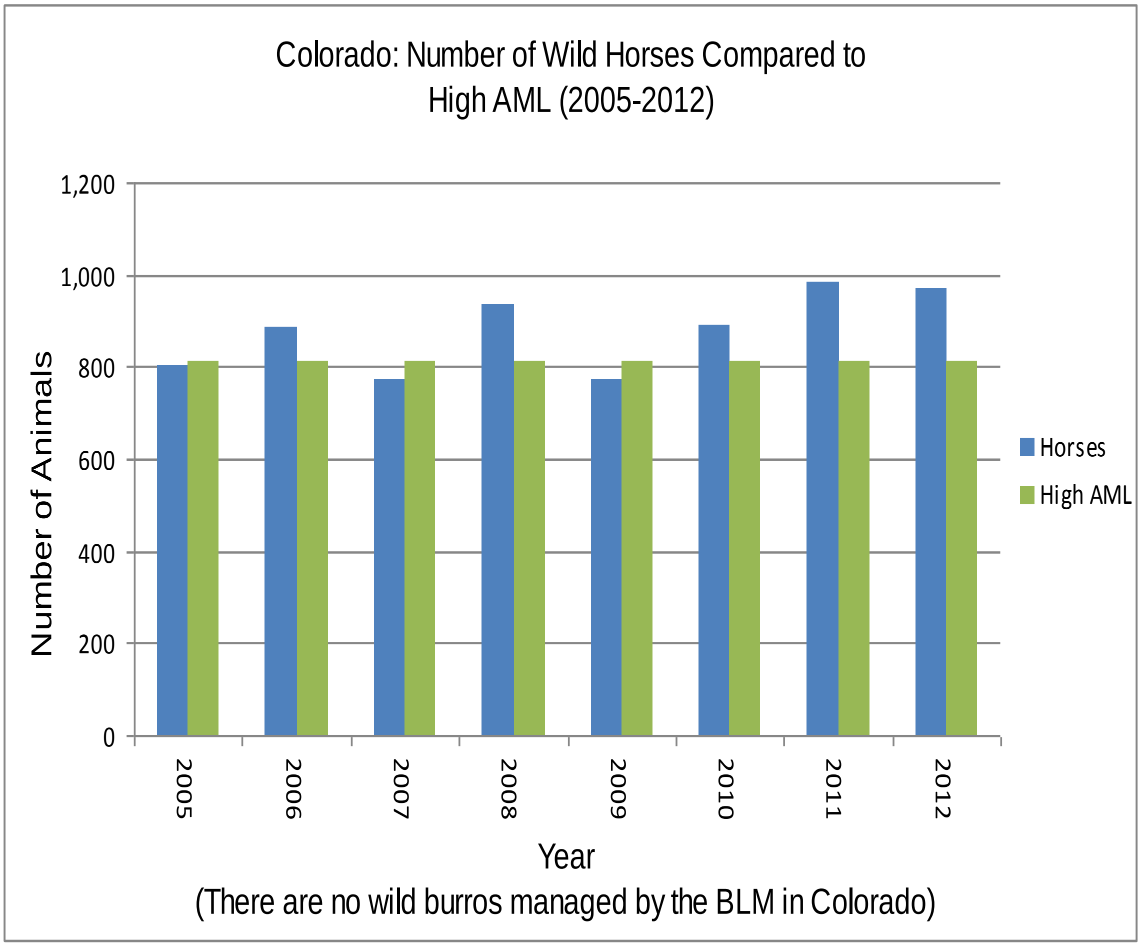
2.[200] This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses and burros in Colorado were below the current high AML in 2005, 2007, and 2009. See Figure CO-3.[201]

Figure CO-2:



[200] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[201] *Ibid*.

Figure CO-3:



In 2011, the BLM removed 370 wild horses from in and/or outside of HMAs in Colorado. In total, from 1996 to 2011, 3,334 wild horses have been captured and removed from the range. See Figure CO-4.[202] During that same time period, 4,015 and 563 wild horses and burros, respectively, have been adopted in Colorado.[203] See Figure CO-5.[204]

[202] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

[203] This includes wild horses and burros captured and removed from the range in other states.

[204] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

Figure CO-4:

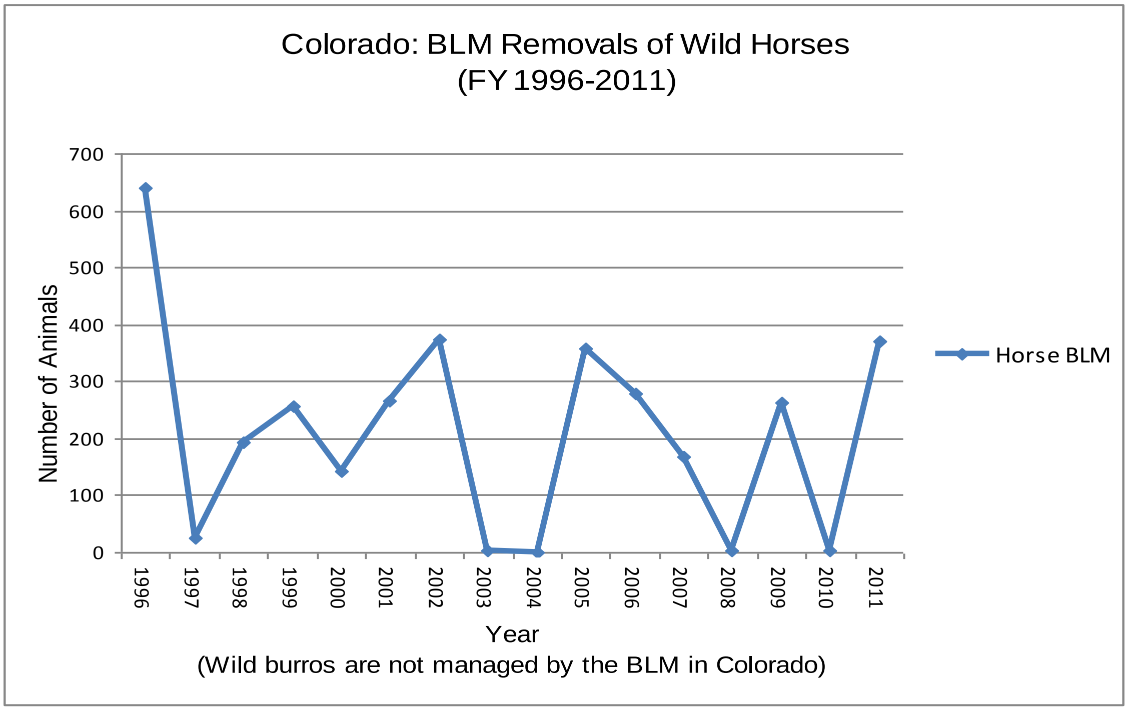
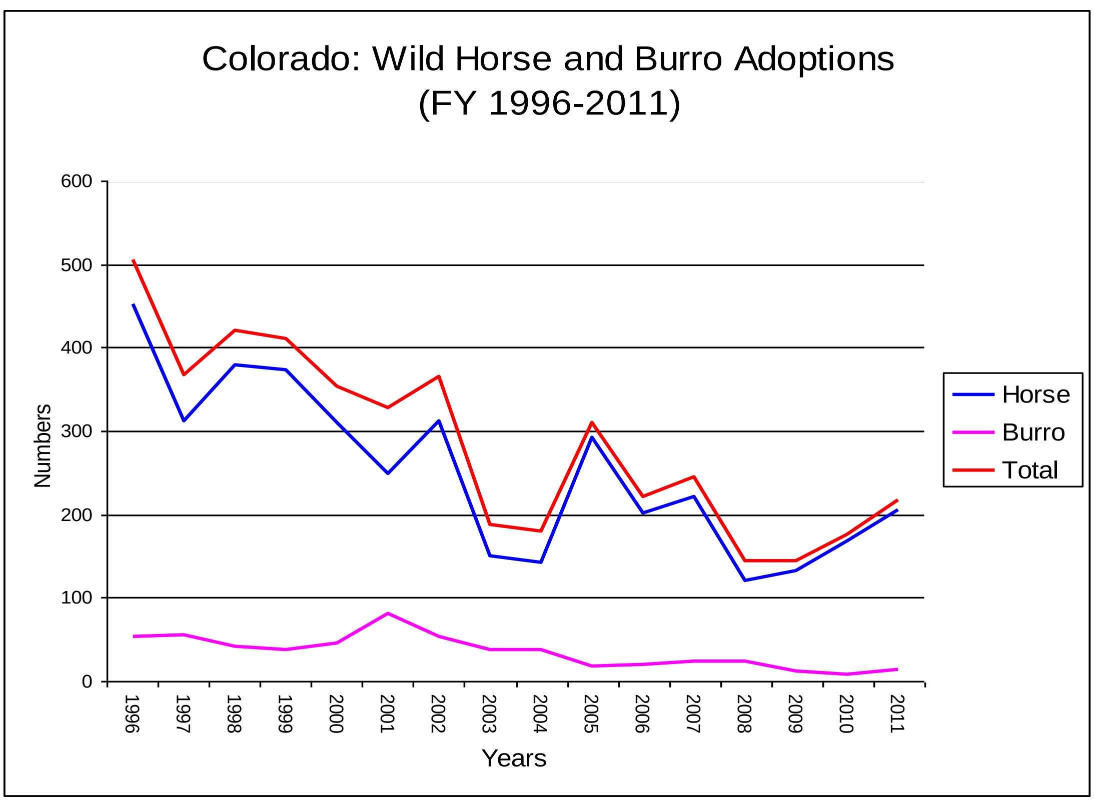
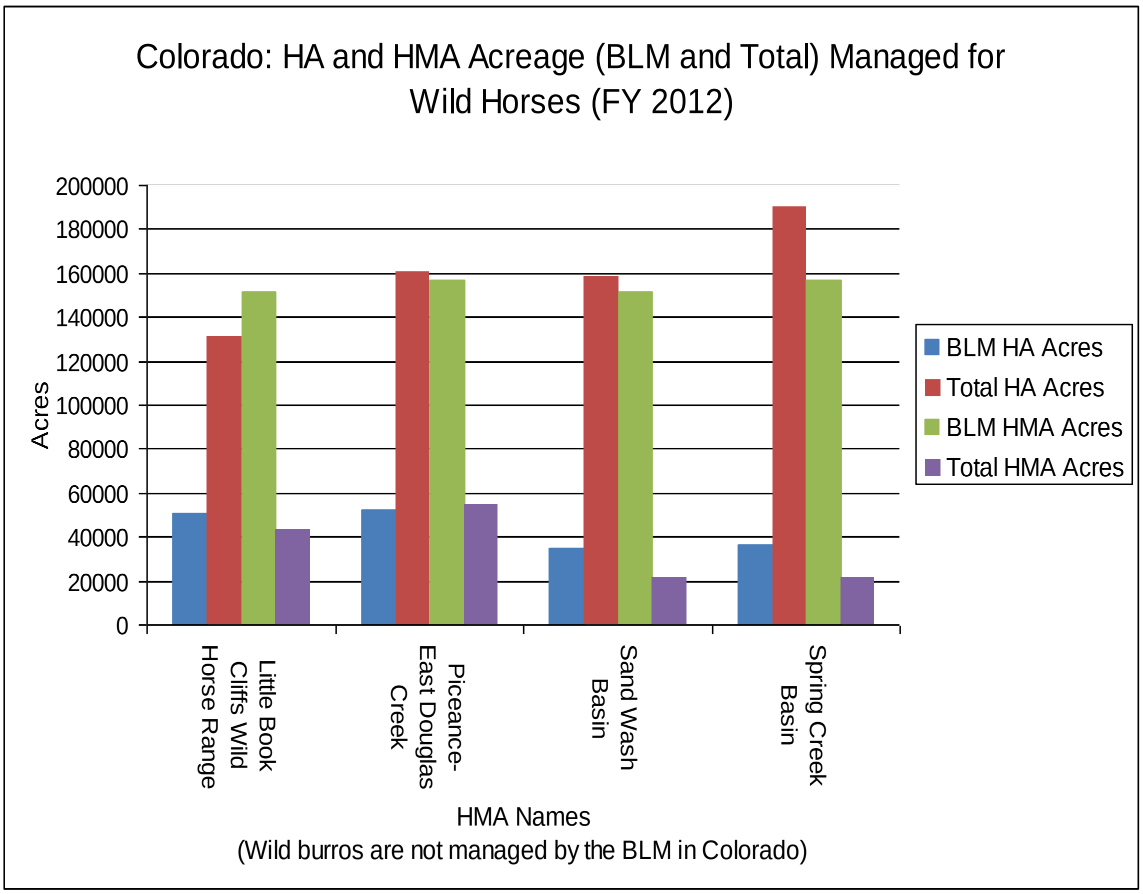


Figure CO-5:



The four HMAs in Colorado encompass 404,013 acres, including 365,988 acres of BLM lands. These HMAs are contained within 424,505 HA acres, including 376,538 acres of BLM lands. This indicates that 20,492 acres of HA habitat – in areas managed for wild horses and burros – is not available to the animals. See Figure CO-6.[205] Since 2005 (annual BLM data prior to 2005 was not available), however, the acres available to wild horses and/or burros in HMAs has increased by 741 acres. See Figure CO-7.[206] Finally, according to BLM data, there are four HAs in the state from which wild horses and/or burros have been permanently removed. These four HAs encompass 426,770 acres, including 346,557 acres of BLM lands. See Figure CO-8.[207] Consequently, 447,262 acres of habitat originally available for wild horses and burros in Colorado no longer exists. See Figure CO-9.[208]

Figure CO-6:



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[205] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[206] *Ibid*.
[207] *Ibid*.
[208] *Ibid*.

Figure CO-7:

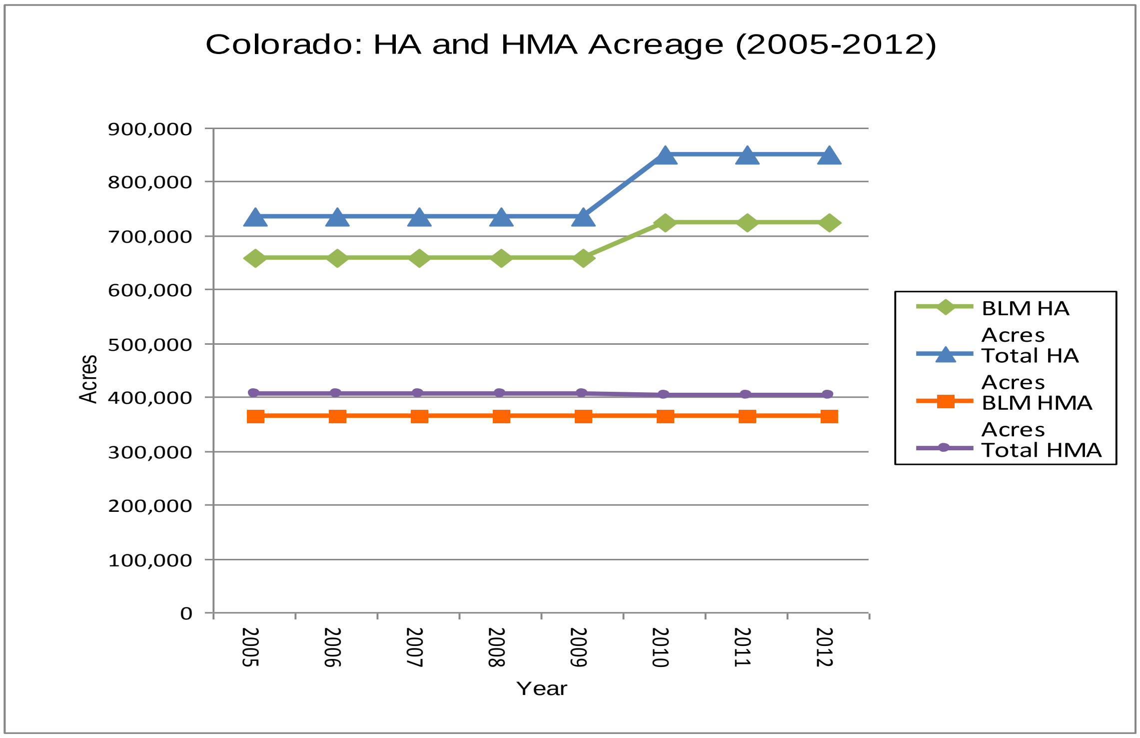


Figure CO-8:

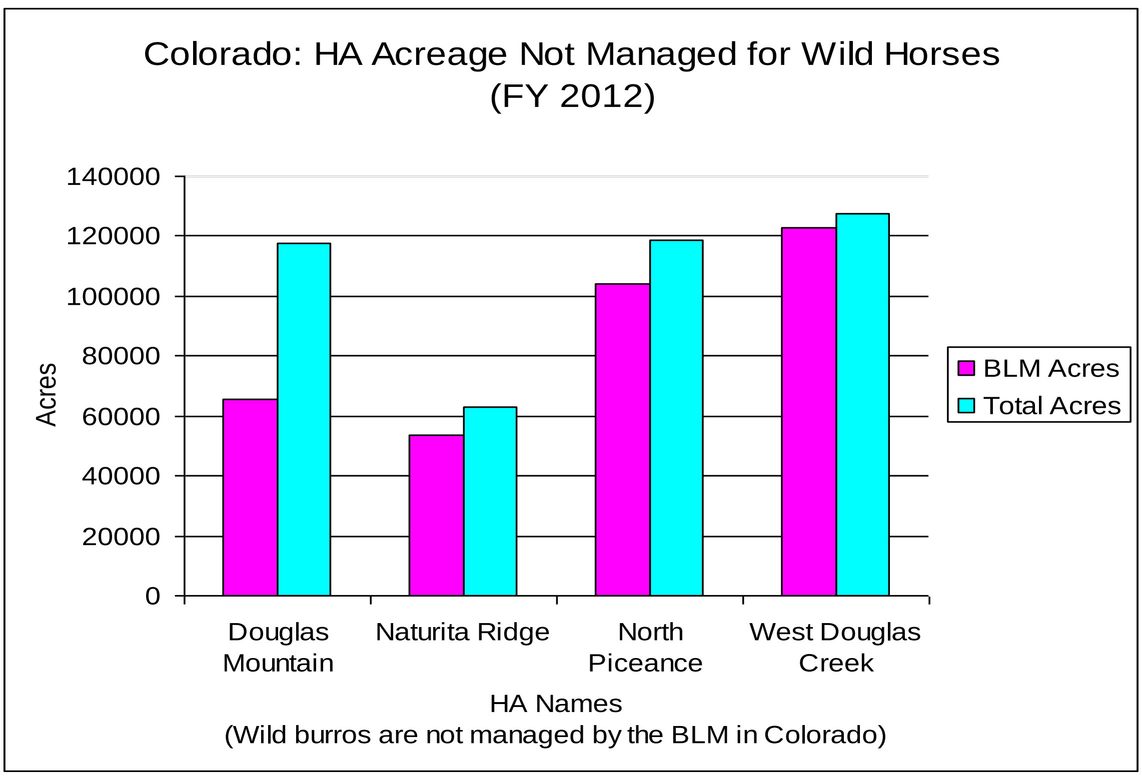
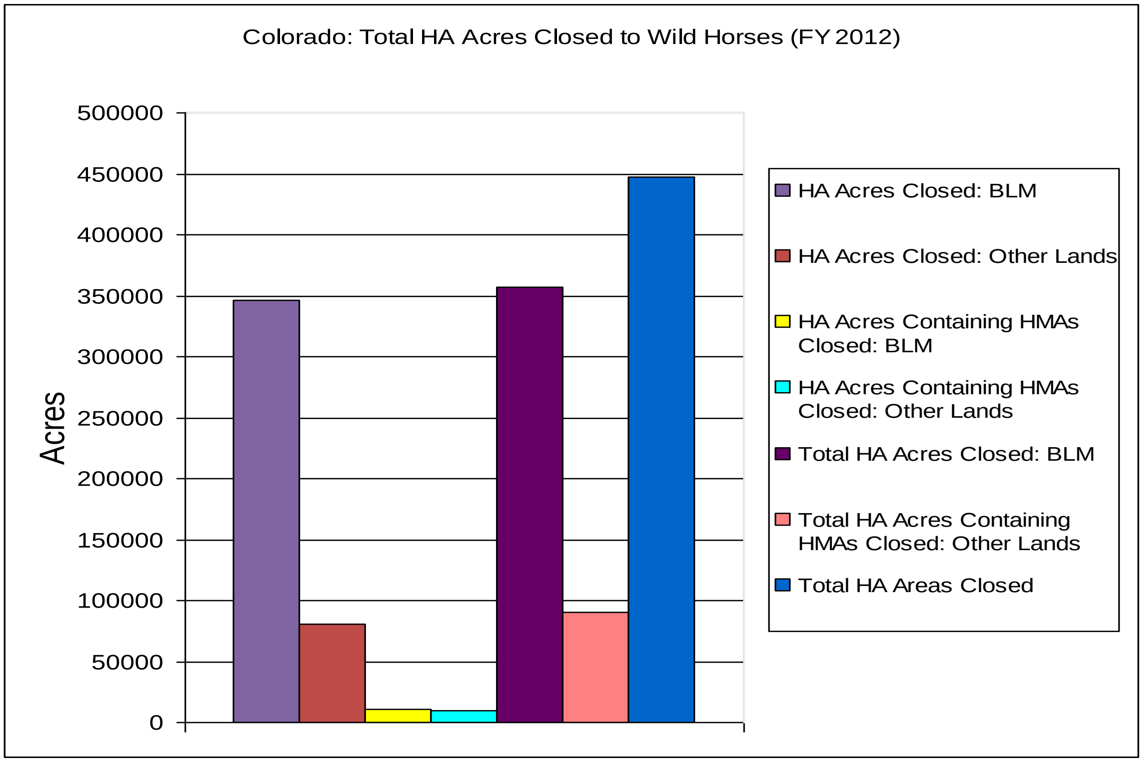


Figure CO-9:



There are 2,419 total public land grazing allotments in Colorado, encompassing 7,880,594 acres. Of these acres, in 2011, rangeland monitoring has designated 1,114,390 acres in the "upward" trend, 1,605,670 acres in the "static" trend, 532,840 acres in the "downward" trend, and 4,598,174 acres in the "undetermined" trend.[209] The number of acres in these categories has varied over the years. See Figure CO-10.[210] In 2011, of the 2,419 allotments, 620 have been designated as "I" (improve), 390 as "M" (maintenance), 1,047 as "C" (custodial), and 2 as "uncategorized."[211] The number of allotments in these

[209]Trends are designated as "upward" if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as "downward" if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[210] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

[211] The objective for "I" allotments is to "improve the current resource condition." The objective for "M" allotments is to "maintain the current resource condition." The objective for "C" allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-the-ground management efforts to those allotments where grazing management is most needed to improve

categories and the acreage so designated is subject to variation. See Figures CO-11 and CO-12.[212]

Figure CO-10:

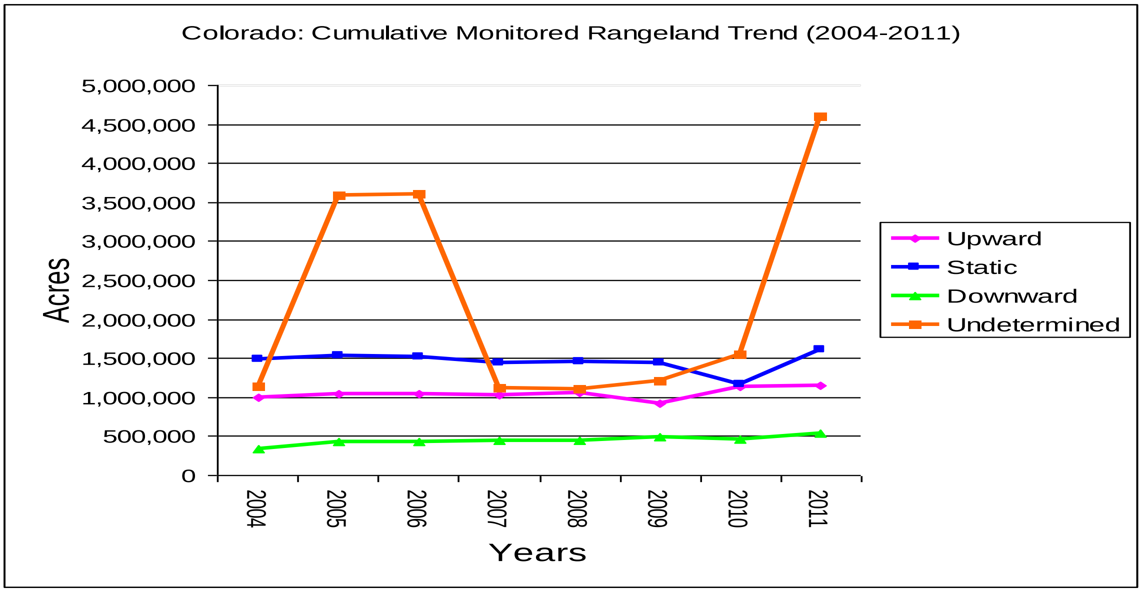
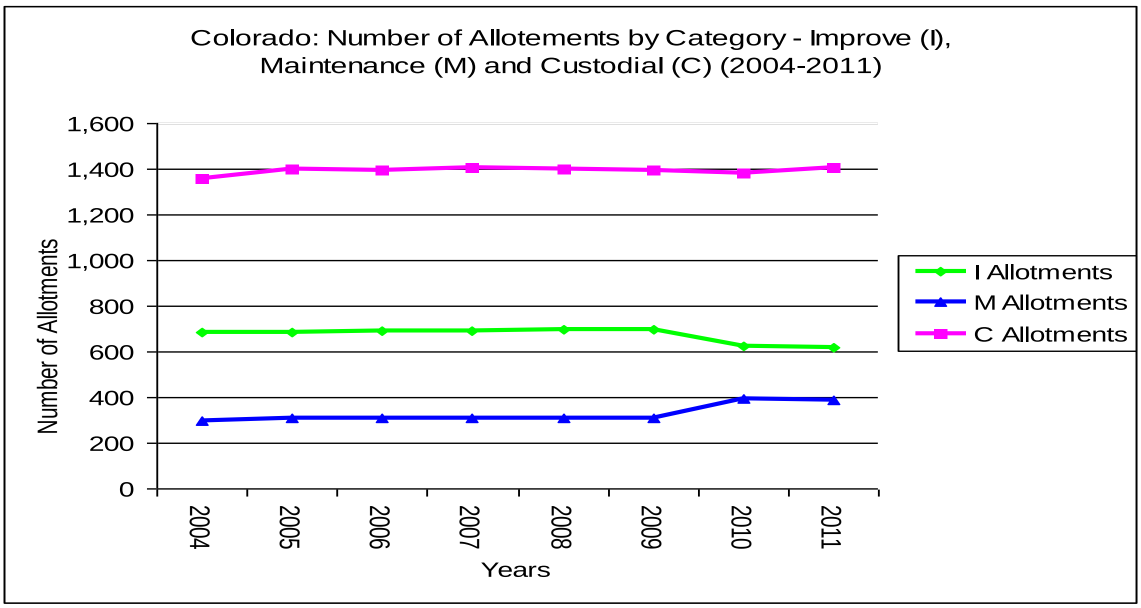


Figure CO-11:



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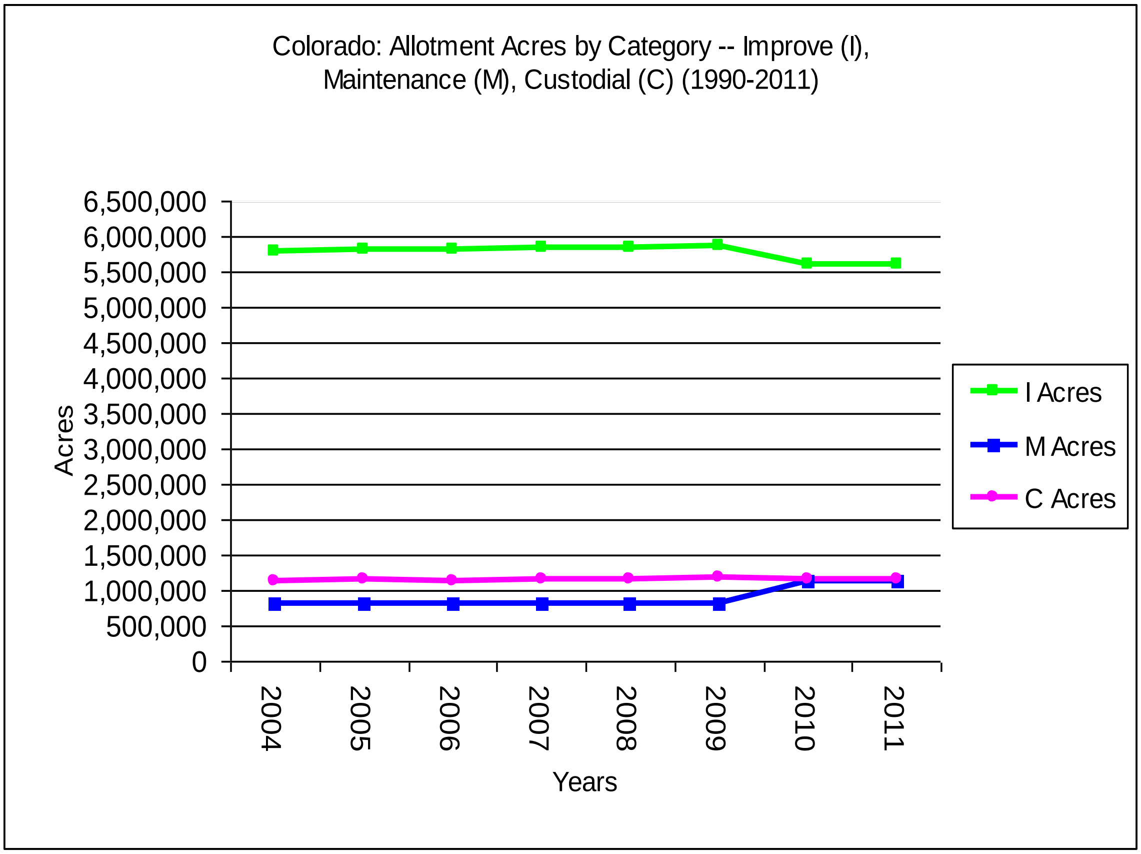
resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

[212] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

Figure CO-12:



In 2011, the total number of AUMs used for grazing was 363,789. This included 296,694 for cattle/yearlings/bison, 3,816 for domestic horses and burros, and 64,279 for sheep and goats. The total AUMs for wild horses and burros in Colorado in 2011 was 812, [213] indicating that, statewide, livestock AUMs are 448 times higher than wild horse and burro AUMs. See Figure CO-13.[214] Since 2000, the total for livestock AUMs has been variable, ranging from a high of 418,562 in 2000, declining to 269,617 in 2003 and the increasing to 363,789 in 2011. See Figure CO-14.[215]

[213] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[214] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm
[215] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm

Figure CO-13:

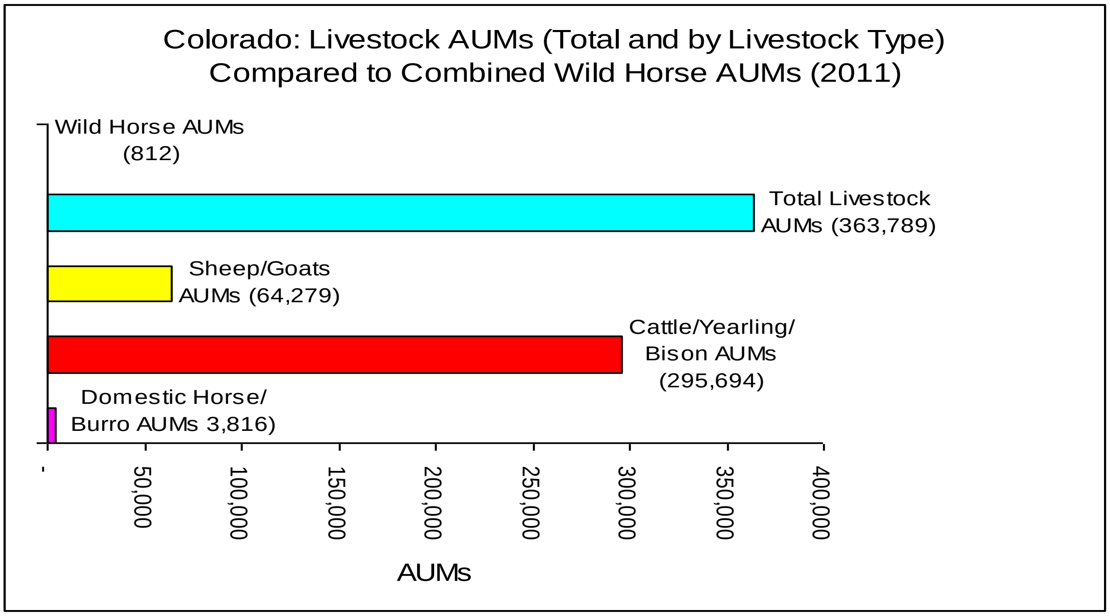
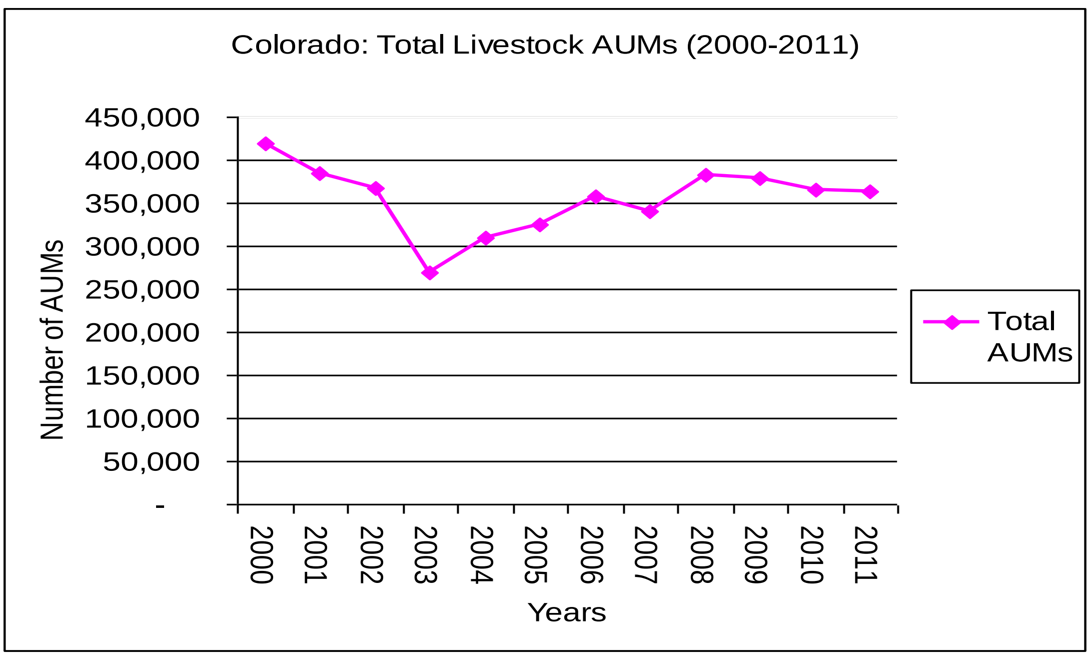


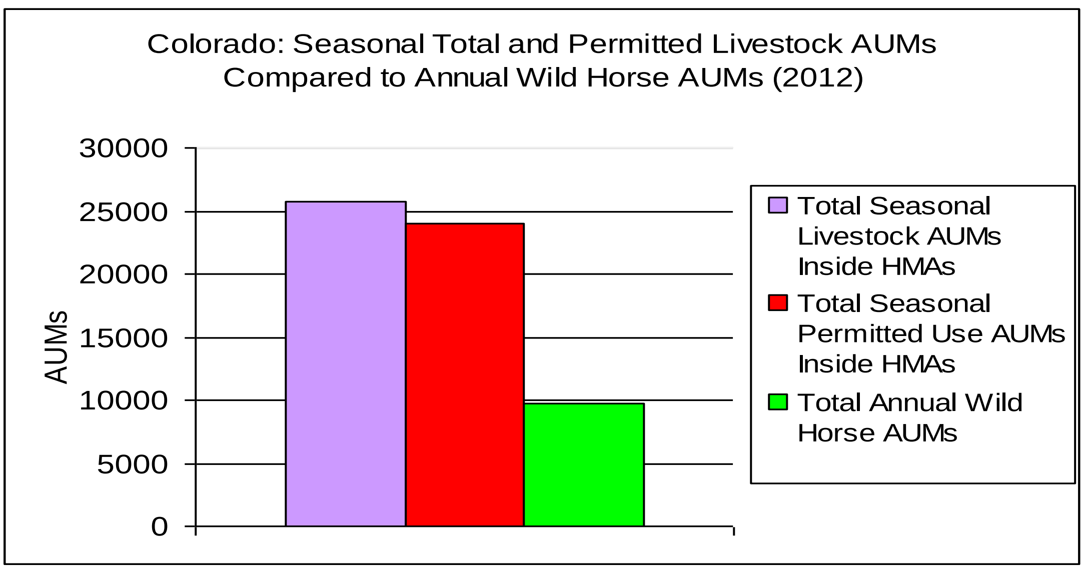
Figure CO-14:



According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 43,482 livestock (11,301 cattle, 971 domestic horses/burros, 30,010 sheep, and 1,200 yearlings) were grazed on an estimated 10 allotments wholly or partially within HMAs in Colorado.[216] This corresponds to approximately 19,114 AUMs.[217] The total AUMs used annually depends on the type of livestock grazed and the duration for which they are grazed on public lands. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing for livestock using allotments wholly or partially within HMAs was 39,361, 35,832, 1,591, and 37,423, respectively.[218]

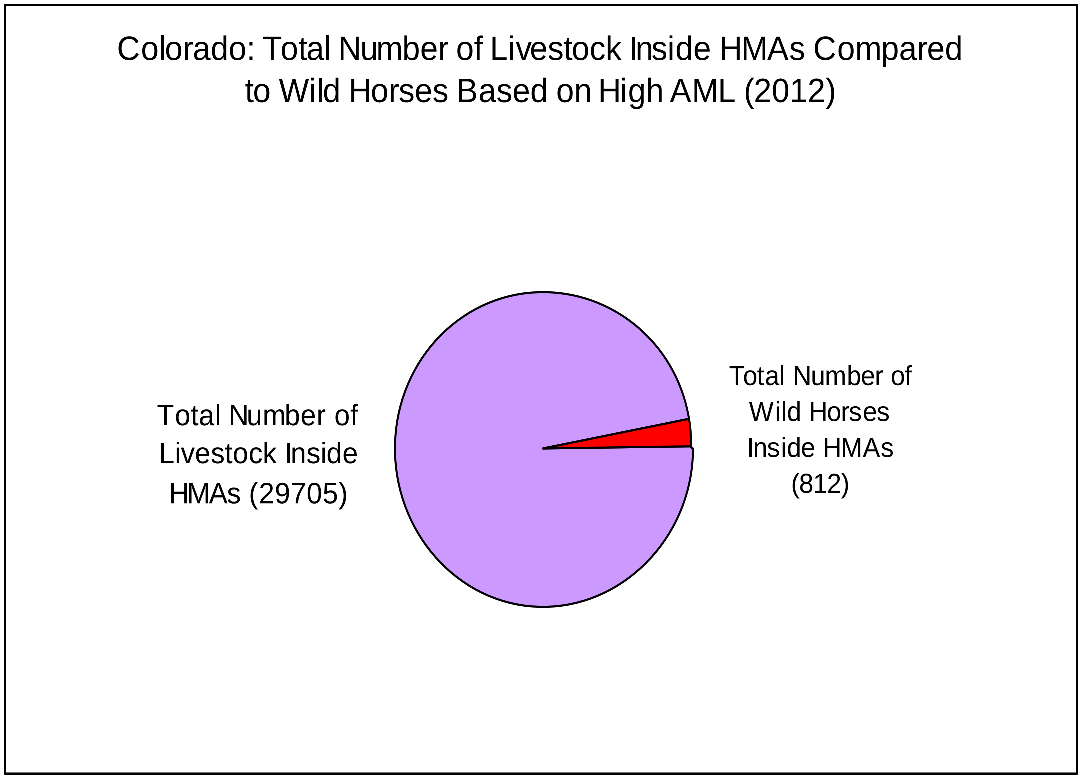
When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[219] the number of livestock grazed within the HMAs is 29,705, corresponding to 25,750 total AUMs and 23,981 AUMs permitted for use for seasonal/annual grazing. This compares to a high AML for wild horses of 812, which equates to an annual AUM of 9,744. See Figures CO-15 and CO-16. Hence, even at the HMA level, permitted use livestock AUMs are over 2.5 times larger than annual wild horse and burro AUMs. In addition, of the total number of livestock, wild horses, and/or wild burros estimated to use all Colorado HMAs in 2012, 97.3 percent are livestock and 2.7 percent are wild horses. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

Figure CO-15:



[216] Per BLM policy, the BLM is not permitted to allow domestic horses and/or burros to utilize HMAs. It is not known if the 971 domestic horses/burros identified in the RAS database are permitted to graze on lands within HMAs in Colorado.
[217] The AUMs were calculated using conversion rates of 1 cow = 1 AUM, 1 horse = 1 AUM (domestic horses and burros were combined in the BLM data set so the number of each species is unknown), .5 sheep = 1 AUM, and .7 yearlings = 1 AUM. These conversion rates are consistent with BLM policies or were identified in various agricultural sources found on the Internet.
[218] Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.
[219] This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

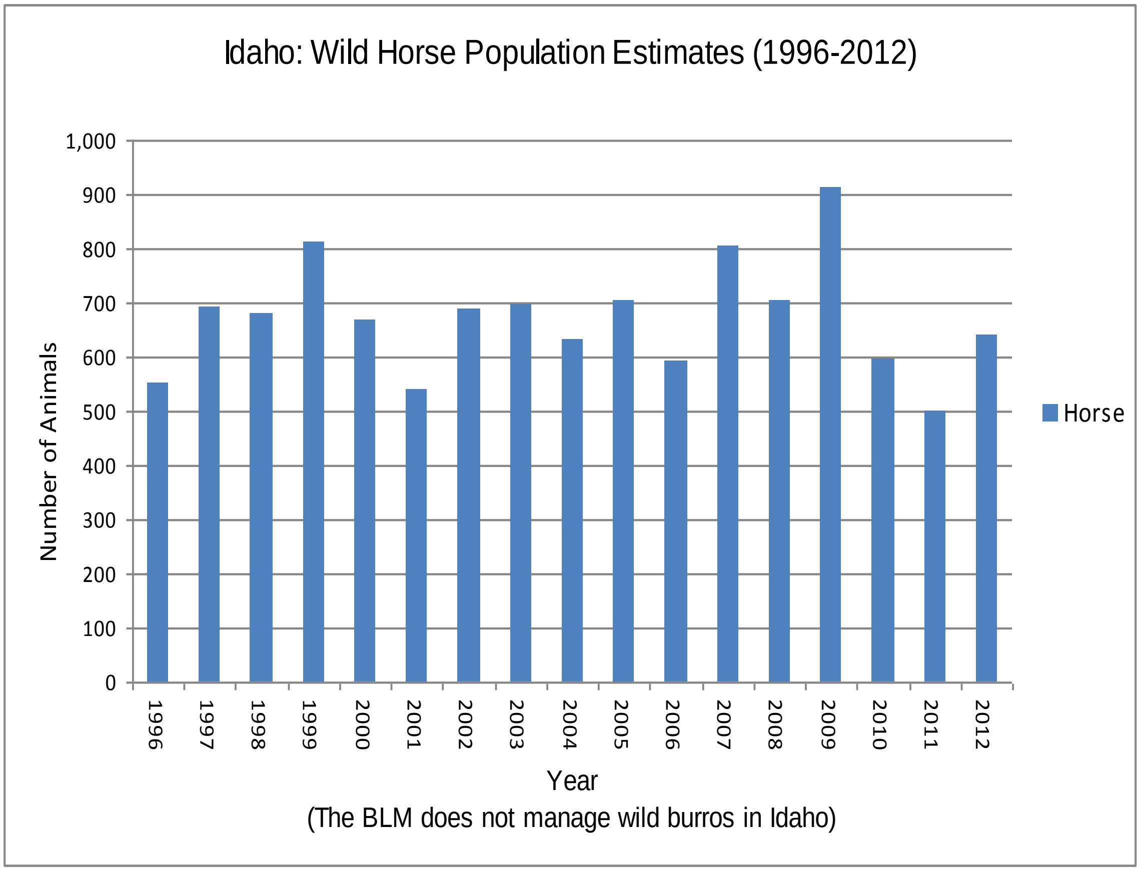
Figure CO-16:


Colorado: Total Number of Livestock Inside HMAs Compared to Wild Horses Based on High AML (2012)
Total Number of Livestock Inside HMAs (29705)
Total Number of Wild Horses Inside HMAs (812)

Idaho:

Based on fiscal year 2012 data there are, as of February 29, an estimated 640 wild horses and 0 wild burros in Idaho occupying a total of six HMAs.[220] See Figure ID-1.[221] No wild horses or wild burros are reported to exist on HAs that are not managed for the species.[222]

Figure ID-1:



Wild horses are found in all six of the HMAs. The total current high AML[223] for wild horses in the state is 617.[224] Therefore, as of February 2012, the number of wild horses in

[220] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.

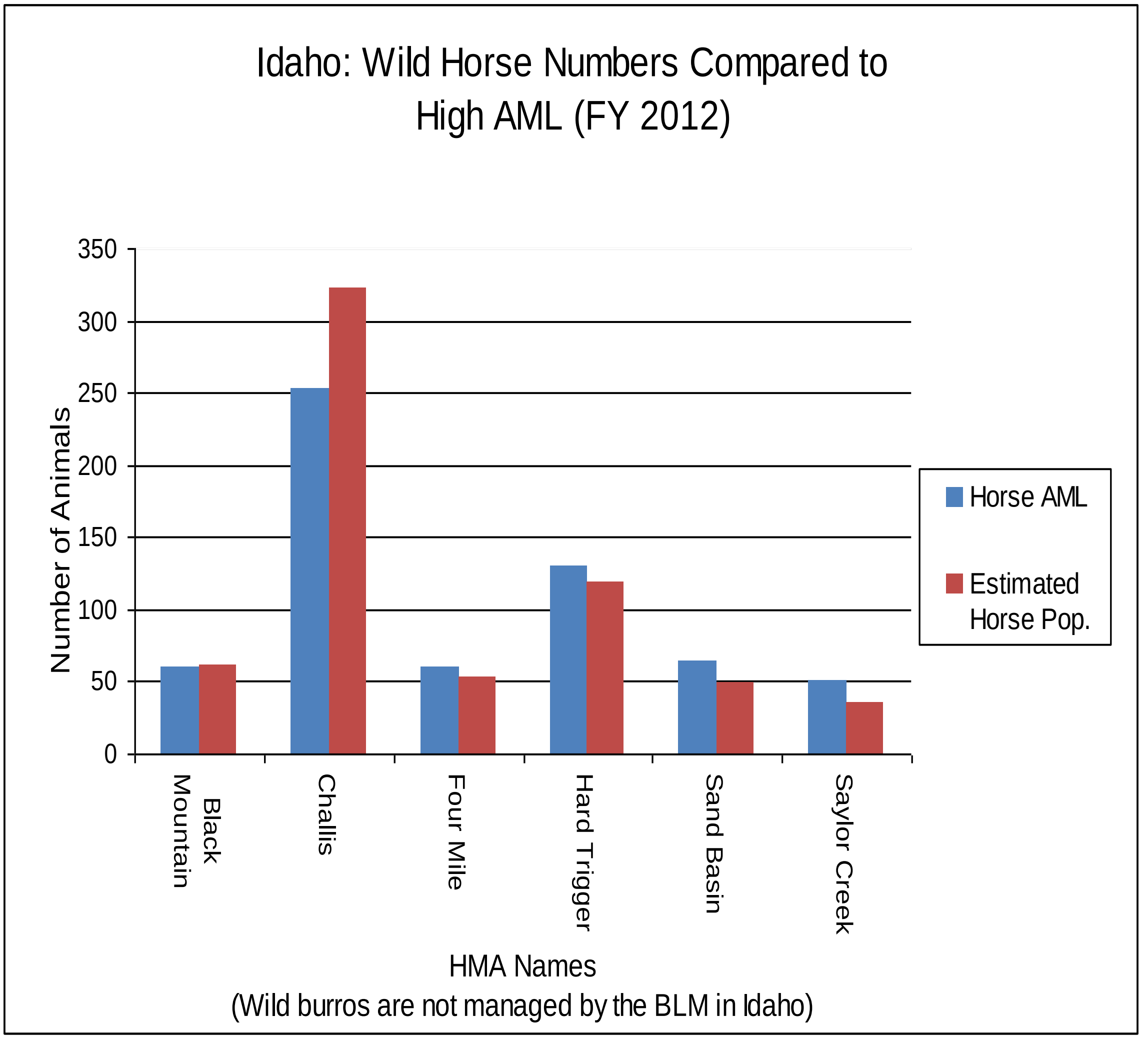
[221] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

[222] Ibid.

[223] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.

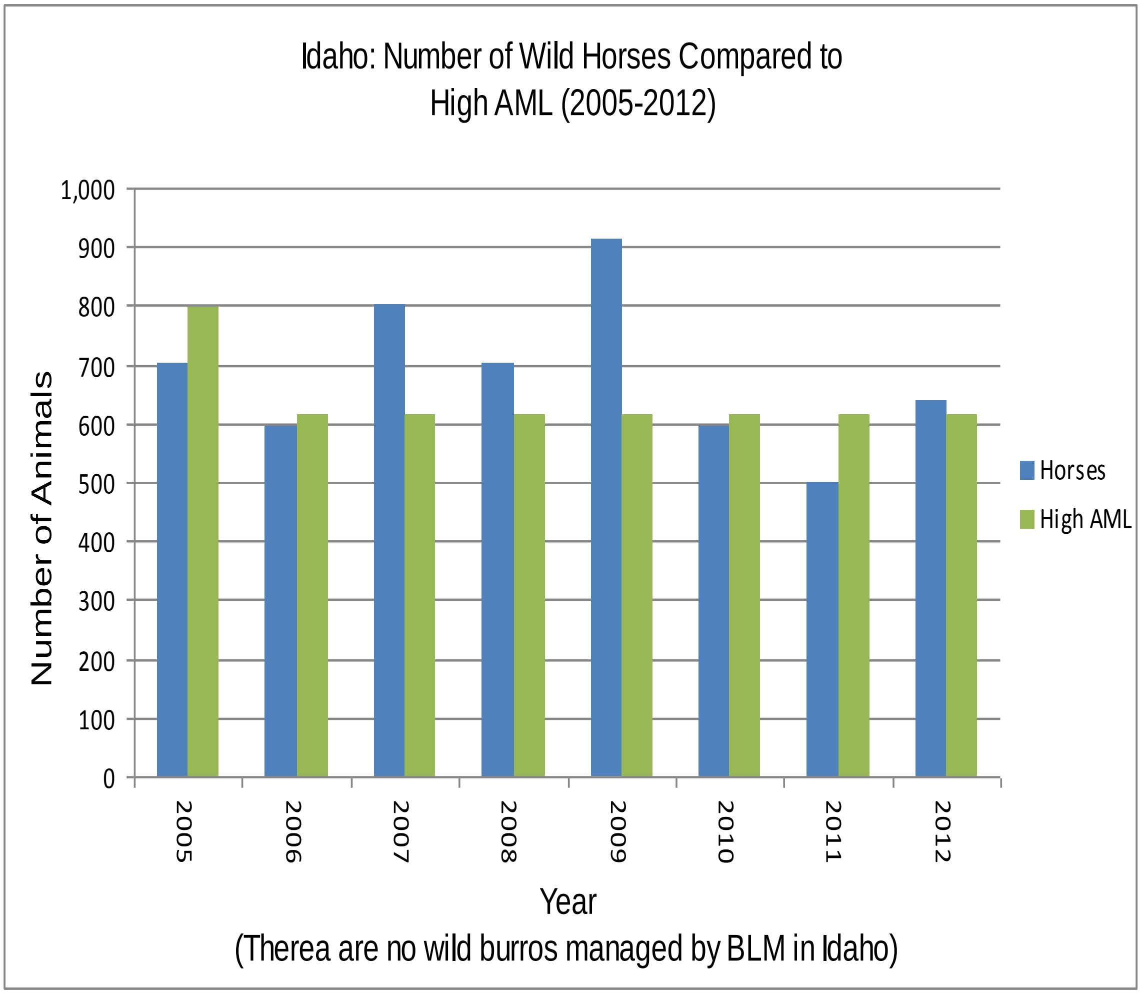
Idaho is only 23 animals over the current high AML. This assumes that the current AMLs for wild horses are justified – which remains highly questionable. See Figure Id-2.[225] This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses in Idaho was below the current high AML in 2005, 2006, 2010, and 2011. See Figure ID-3.[226]

Figure ID-2:



[224] It is not known if the BLM has ever managed wild burros in Idaho but, at present, no wild burros are managed by the BLM in the state.
[225] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[226] *Ibid*.

Figure ID-3:



In 2011, the BLM removed 42 wild horses from in and/or outside of HMAs in Idaho. In total, from 1996 to 2011, 2,309 wild horses have been captured and removed from the range. See Figure ID-4.[227] During that same time period, 2,447 and 259 wild horses and burros, respectively, have been adopted in Idaho.[228] See Figure ID-5.[229]

[227] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[228] This includes wild horses and burros captured and removed from the range in other states.
[229] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

Figure ID-4:

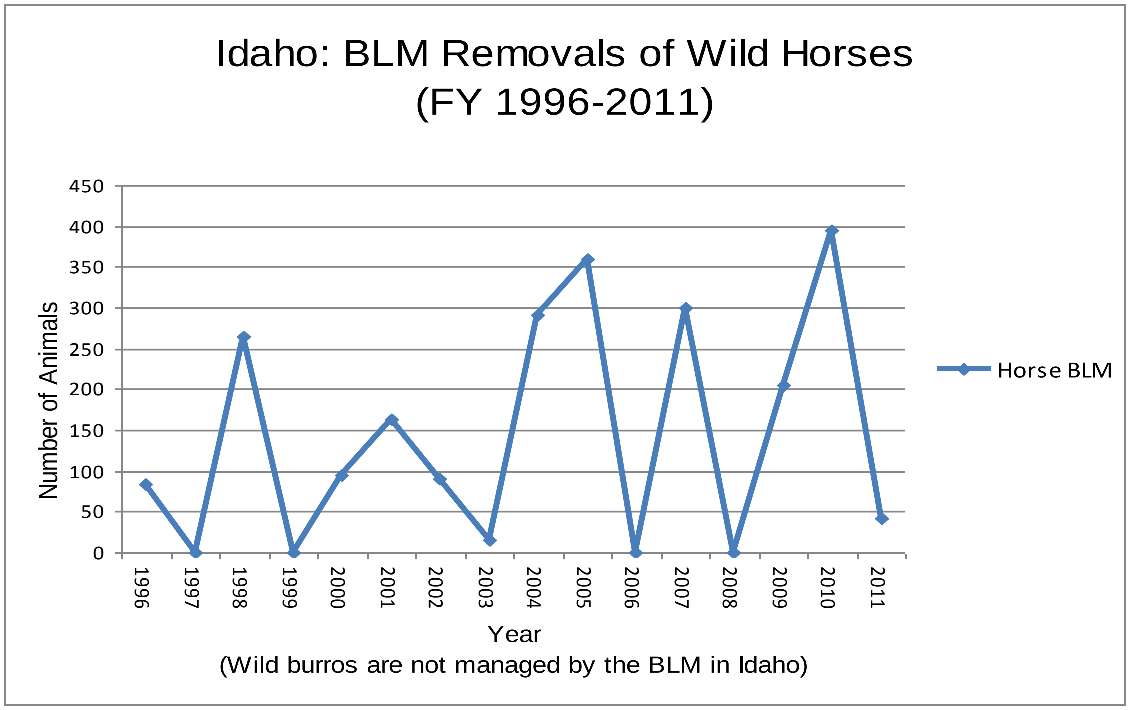
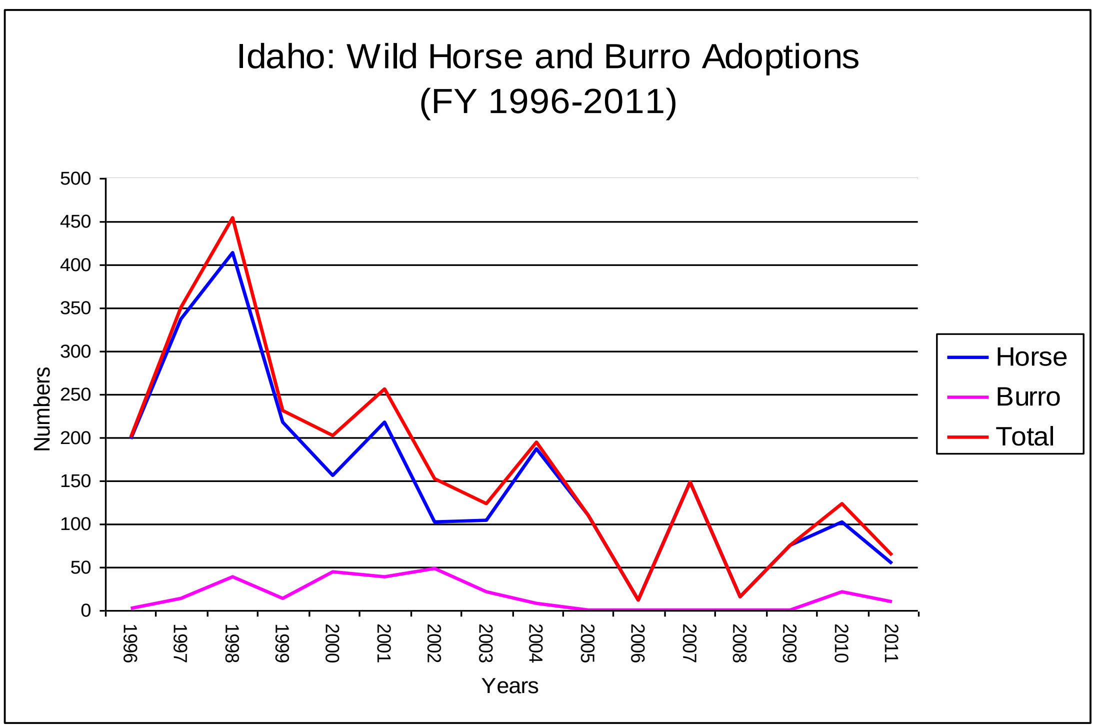
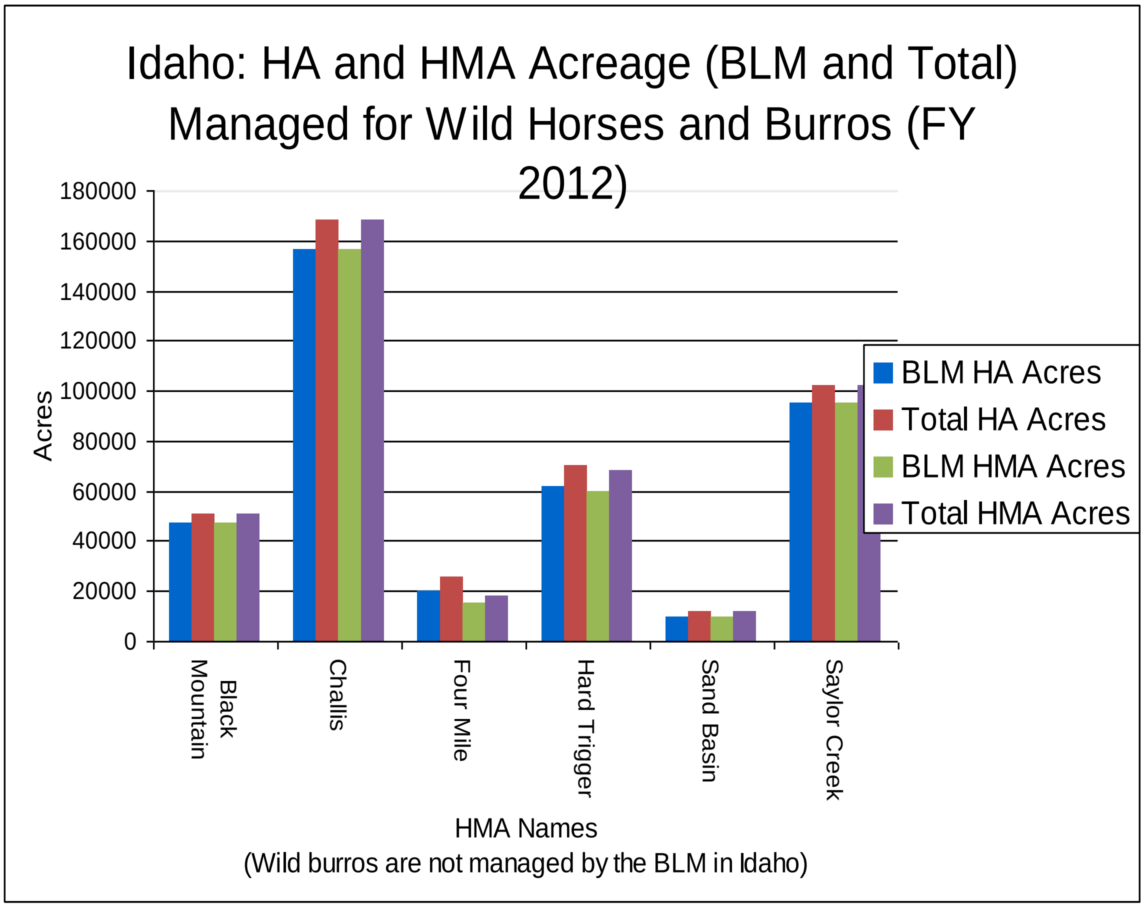


Figure ID-5:



The six HMAs in Idaho encompass 418,268 acres, including 383,894 acres of BLM lands. These HMAs are contained within 428,068 HA acres, including 390,969 acres of BLM lands. This indicates that 9,800 acres of HA habitat – in areas managed for wild horses and burros – is not available to the animals. See Figure ID-6.[230] Since 2005 (annual BLM data prior to 2005 was not available), the acres available to wild horses in HMAs has decreased by 74 acres. See Figure ID-7.[231] Finally, according to BLM data, there are four HAs in the state from which wild horses have been permanently removed. These four HAs encompass 49,232 acres, including 29,814 acres of BLM lands. See Figure ID-8.[232] Consequently, 59,032 acres of habitat originally available for wild horses in Idaho no longer exists. See Figure ID-9.[233]

Figure ID-6:



[230] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[231] *Ibid*.
[232] *Ibid*.
[233] *Ibid*.

Figure ID-7:

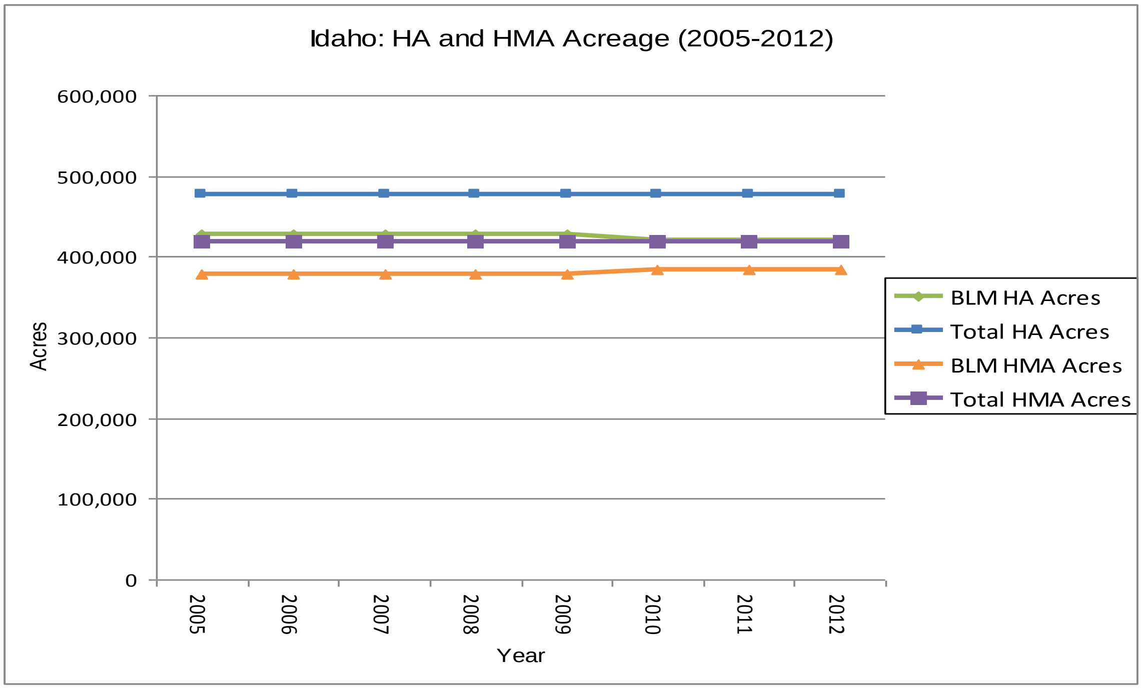


Figure ID-8:

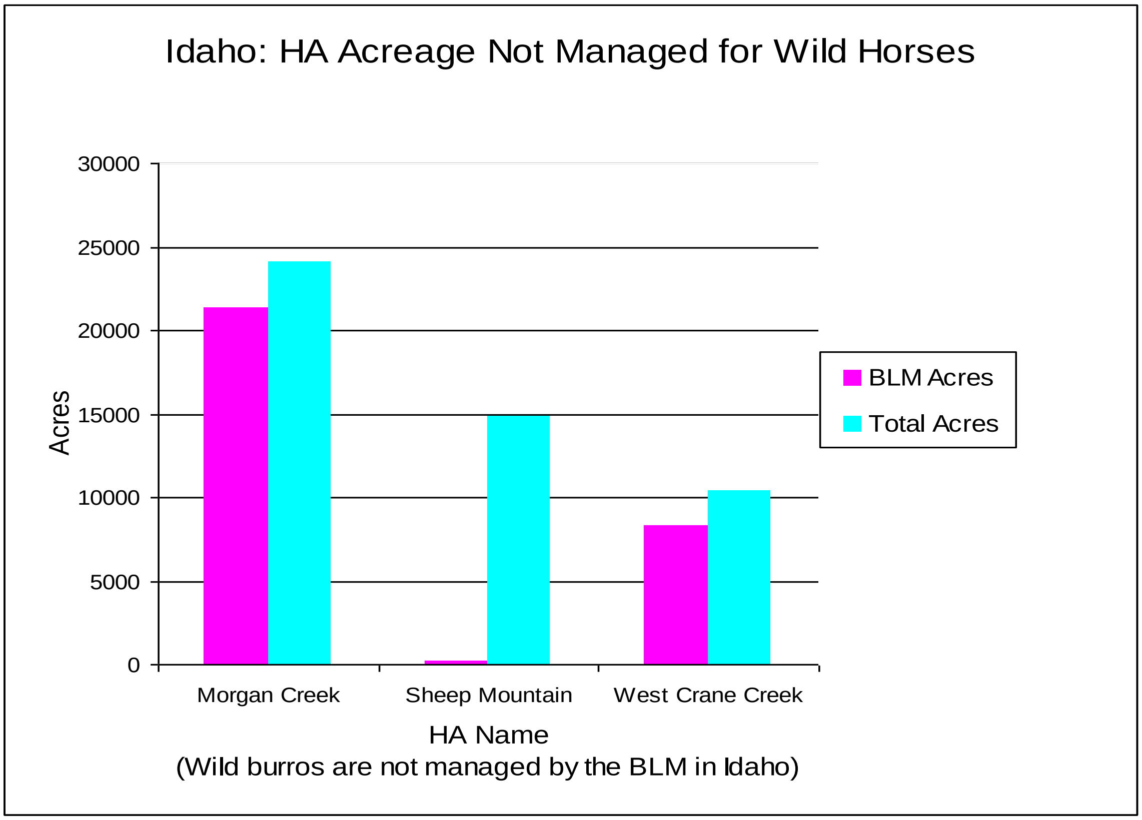
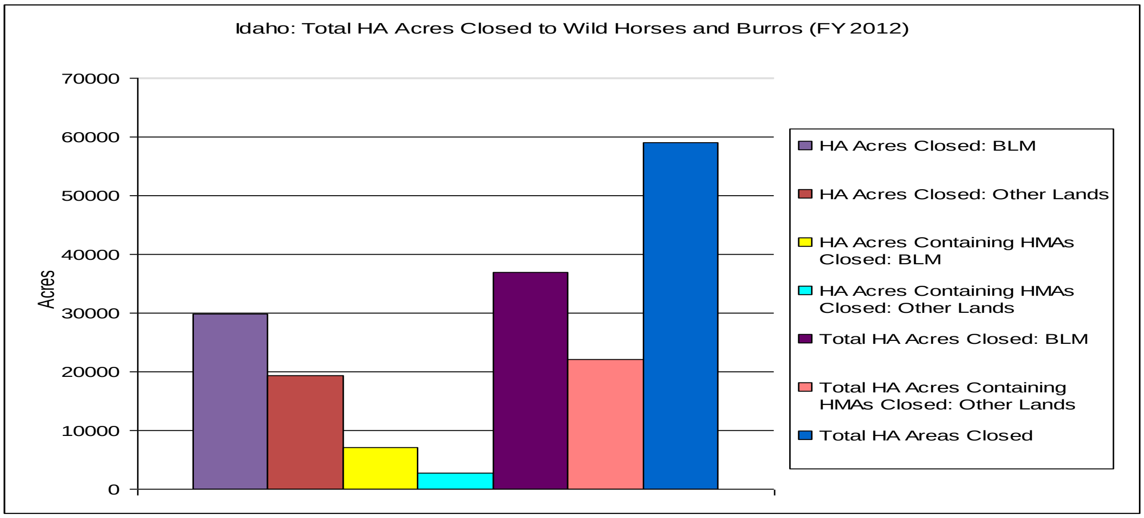


Figure ID-9:



There are 2,178 total public land grazing allotments in Idaho, encompassing 11,527,558 acres. Of these acres, in 2011, rangeland monitoring has designated 2,186,253 acres in the "upward" trend, 5,530,540 acres in the "static" trend, 1,125,781 acres in the "downward" trend, and 2,684,984 acres in the "undetermined" trend.[234] The number of acres in these categories has varied over the years. See Figure Id-10.[235] In 2011, of the 2,178 allotments, 793 have been designated as "I" (improve), 618 as "M" (maintenance), 763 as "C" (custodial), and 4 as "uncategorized."[236] The number of allotments in these categories and the acreage so designated is subject to variation. See Figures ID-11 and ID-12.[237]

[234]Trends are designated as "upward" if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as "downward" if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[235] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

[236] The objective for "I" allotments is to "improve the current resource condition." The objective for "M" allotments is to "maintain the current resource condition." The objective for "C" allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-the-ground management efforts to those allotments where grazing management is most needed to improve resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

[237] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

Figure ID-10:

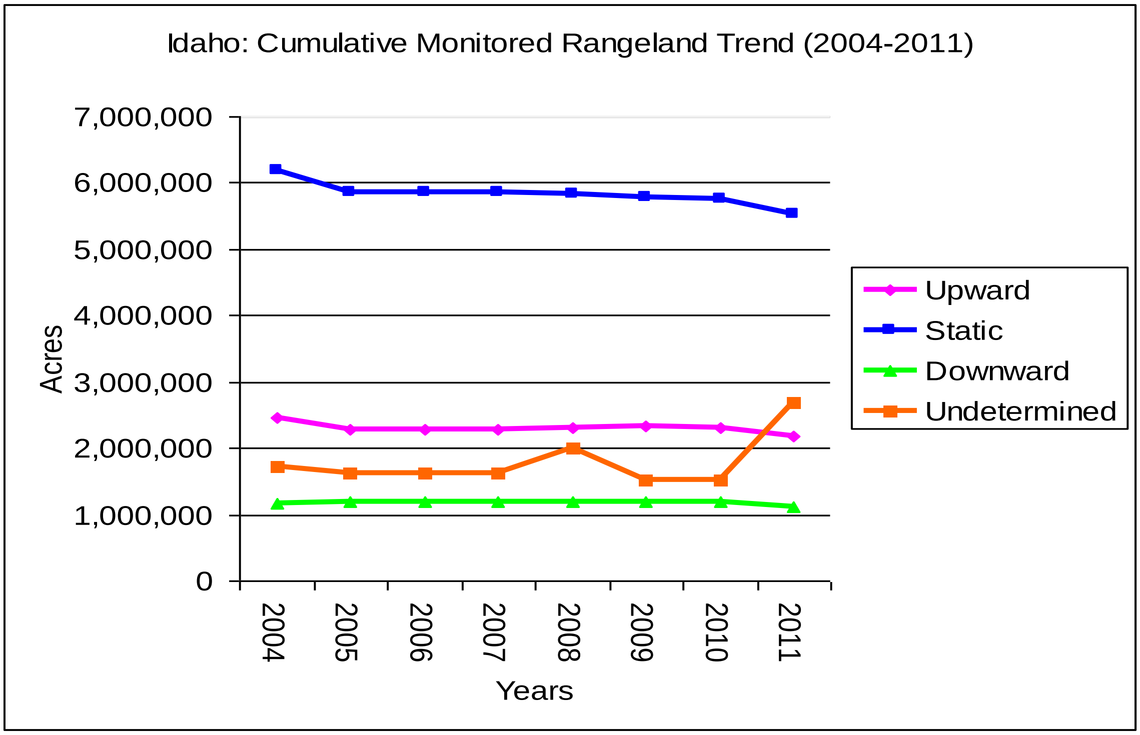


Figure ID-11:

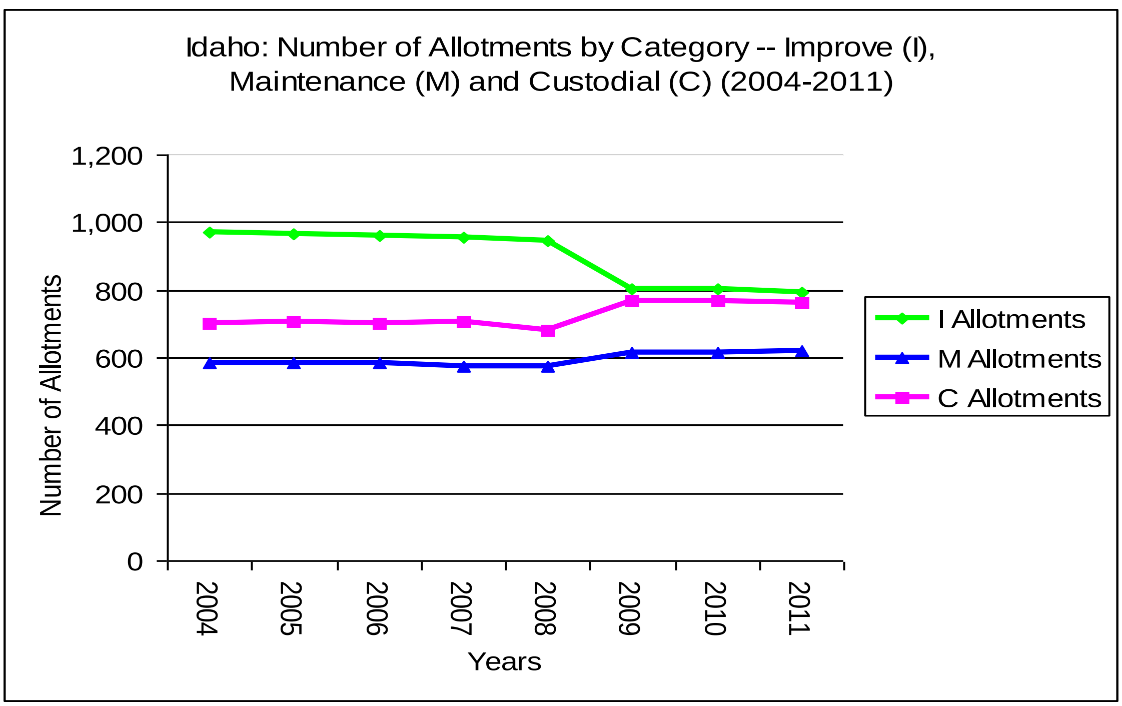
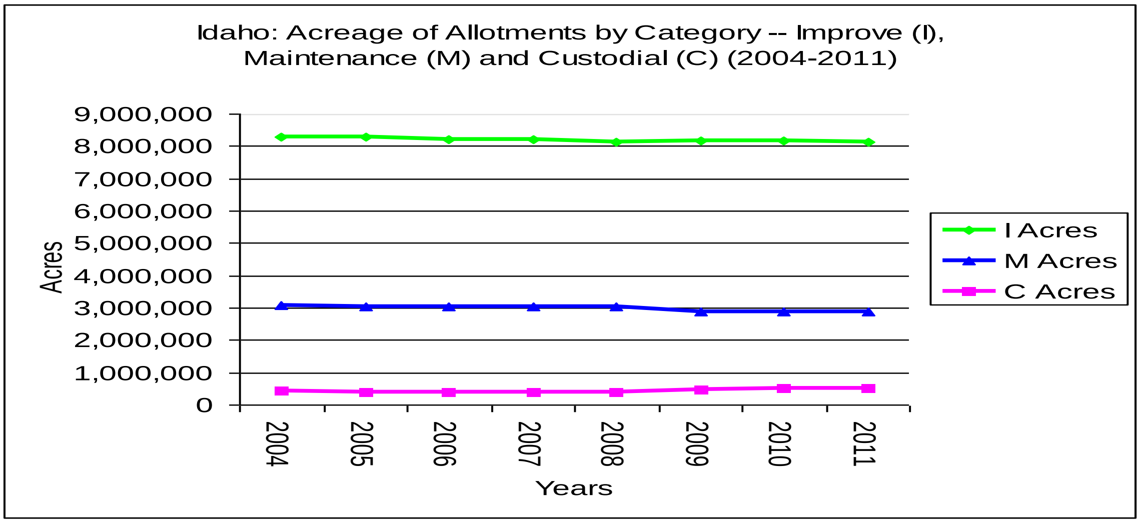
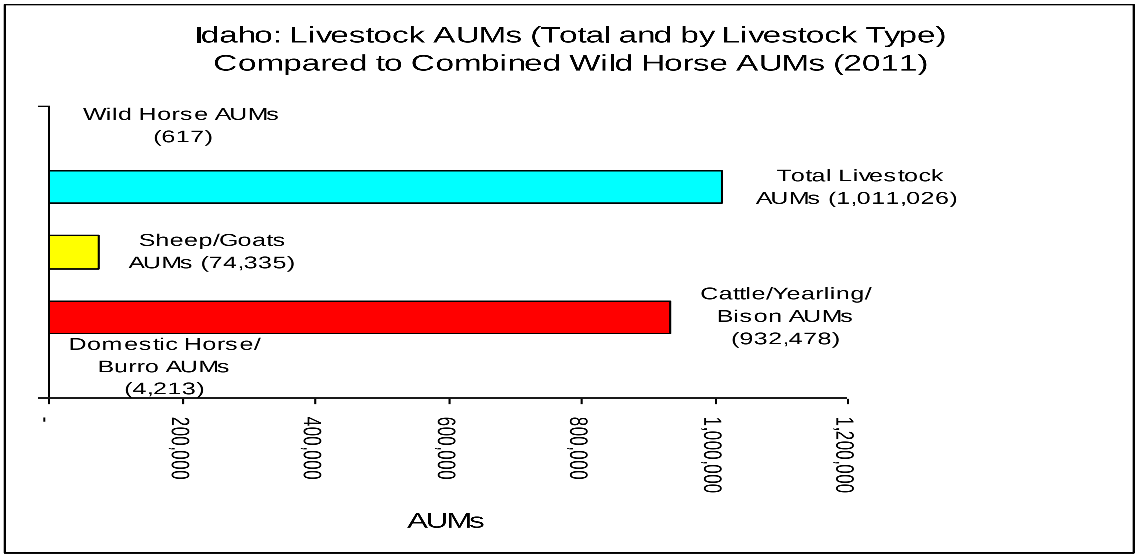


Figure ID-12:



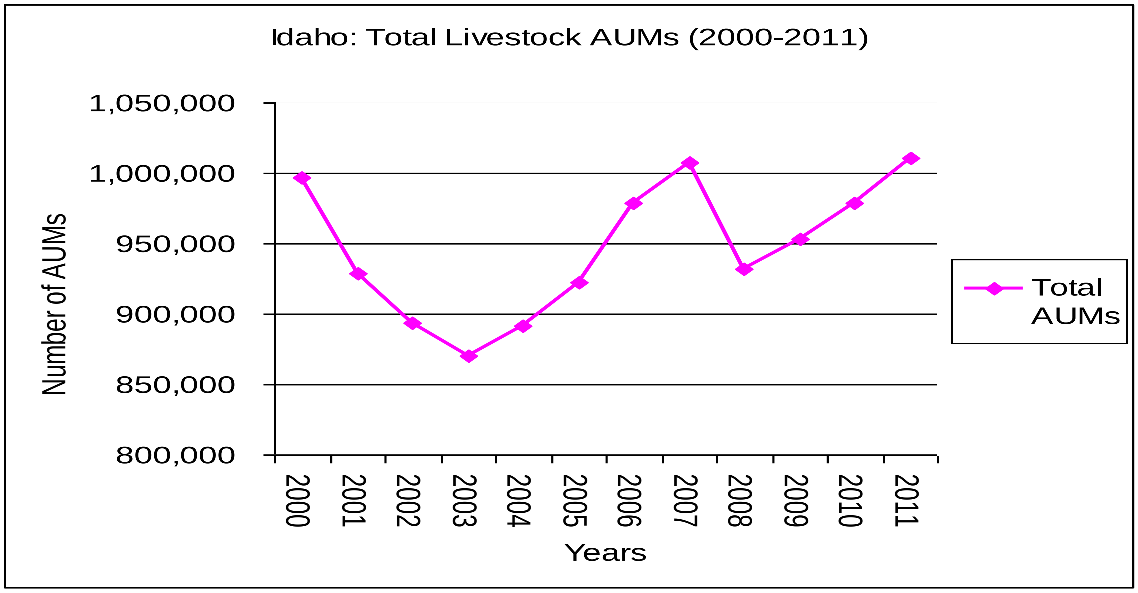
In 2011, the total number of AUMs used for grazing was 1,011,026. This included 932,478 for cattle/yearlings/bison, 4,213 for domestic horses and burros, and 74,355 for sheep and goats. The total AUMs for wild horses in Idaho in 2011 was 617, [238] indicating that, statewide, livestock AUMs are 1,639 times higher than wild horse AUMs. See Figure ID-13.[239] Since 2000, the total for livestock AUMs has been variable, ranging from a low of 870,376 in 2003 to a high, in 2011, of 1,011,026. See Figure ID-14.[240]

Figure ID-13:



[238] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[239] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm.
[240] *Ibid*.

Figure ID-14:



According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 20,346 livestock (18,346 cattle, 0 domestic horses/burros, and 2,000 sheep) were grazed on an estimated 59 allotments wholly or partially within HMAs in Idaho. This corresponds to approximately 18,746 AUMs.[241] The total AUMs used annually depends on the type of livestock grazed and the duration for which they are grazed on public lands. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing for livestock using allotments wholly or partially within HMAs was 75,883, 53,705, 14,430, and 70,225, respectively.[242]

When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[243] the number of livestock grazed within the HMAs is 10,510, corresponding to 46,460 total AUMs and 37,993 AUMs permitted for use for seasonal/annual grazing. This compares to a high AML for wild horses of 617, which equates to an annual AUM of 7,404. See Figures ID-15 and ID-16. Hence, even at the HMA level, permitted use livestock AUMs are over five times larger than annual wild horse and burro AUMs. In addition, of the total number of livestock and wild horses estimated to use all Idaho HMAs in 2012, 94.5 percent are livestock and 5.5 percent are

[241] The AUMs were calculated using conversion rates of 1 cow = 1 AUM, 1 horse = 1 AUM (domestic horses and burros were combined in the BLM data set so the number of each species is unknown), .5 sheep = 1 AUM, and .7 yearlings = 1 AUM. These conversion rates are consistent with BLM policies or were identified in various agricultural sources found on the Internet.

[242] Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.

[243] This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

wild horses. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

Figure ID-15:

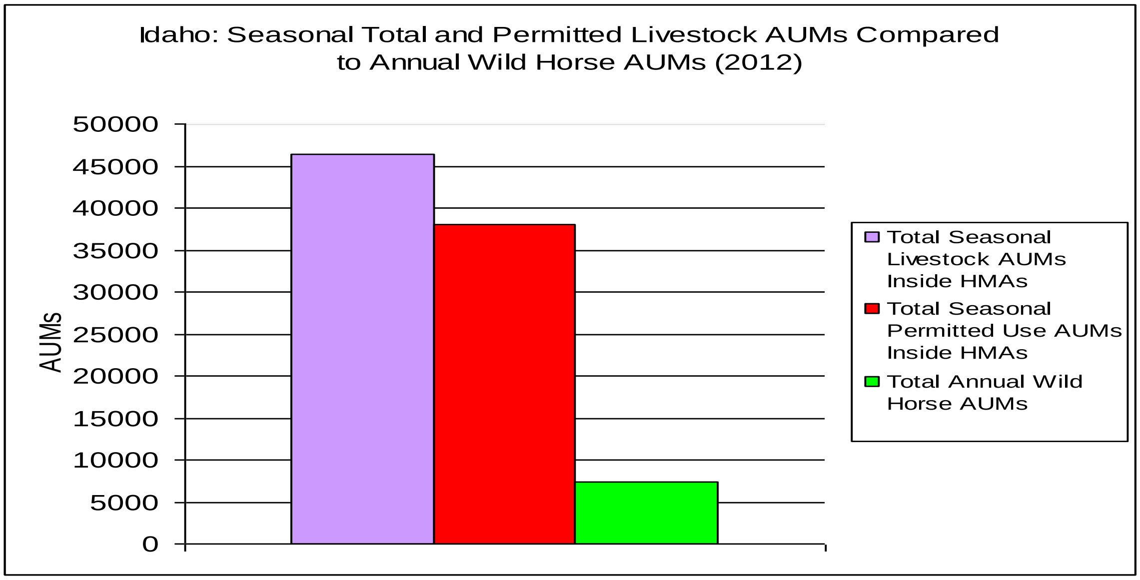
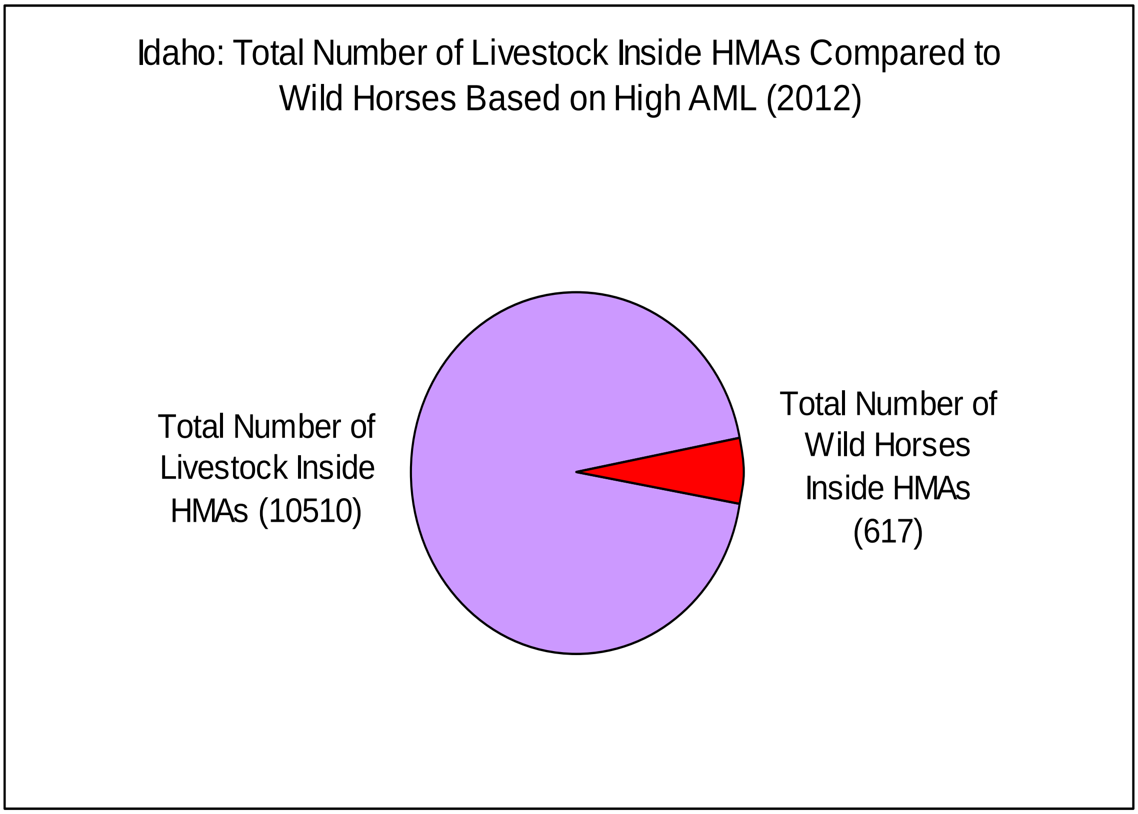


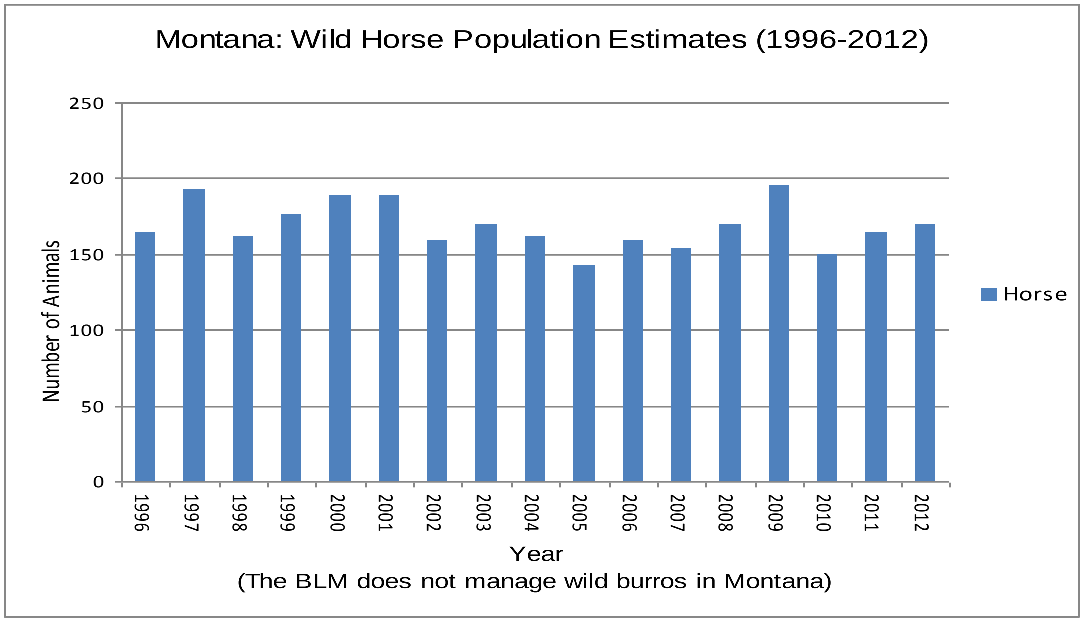
Figure ID-16:



Montana:

Based on fiscal year 2012 data there are, as of February 29, an estimated 170 wild horses and 0 wild burros in Montana occupying a total of one HMA.[244] See Figure MT-1.[245] There are no wild horses or wild burros reported to exist on HAs that are not managed for the species.[246]

Figure MT-1:



The total current high AML[247] for wild horses in the state is 120.[248] Therefore, as of February 2012, the number of wild horses in Montana is 50 animals over the current high AML. This assumes that the current AMLs for wild horses are justified – which remains highly questionable. See Figure MT-2.[249] This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological

[244] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.

[245] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

[246] *Ibid*.

[247] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.

[248] It is not known if the BLM has ever managed wild burros in Montana but, at present, no wild burros are managed by the BLM in the state.

[249] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses in Montana was closest to high AML in 2010 when the number of horses was estimated to be 150 animals. See Figure MT-3.[250]

Figure MT-2:

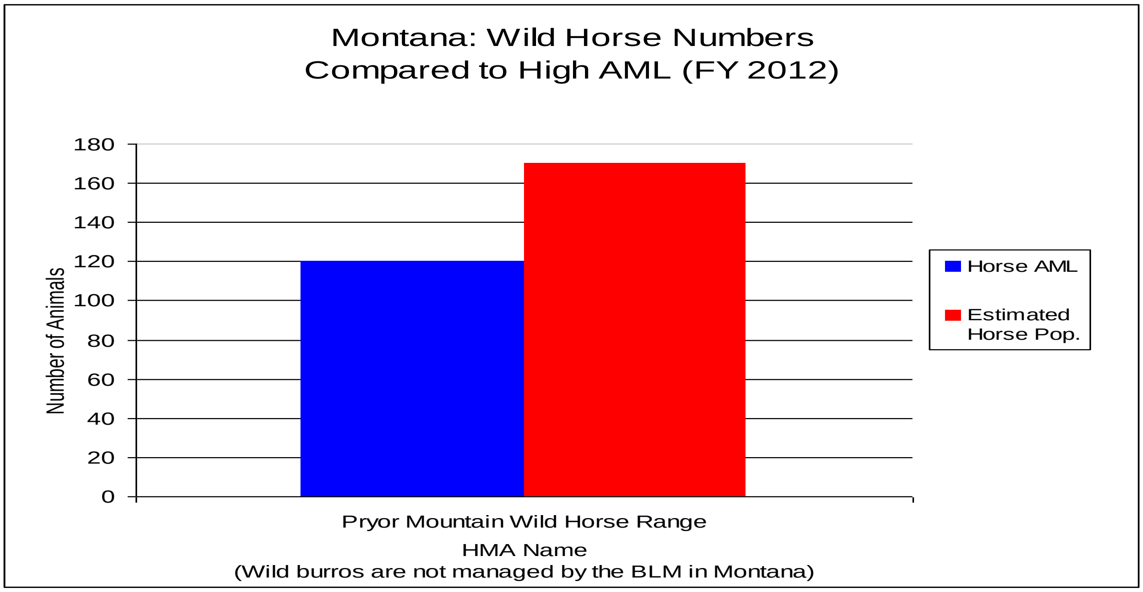
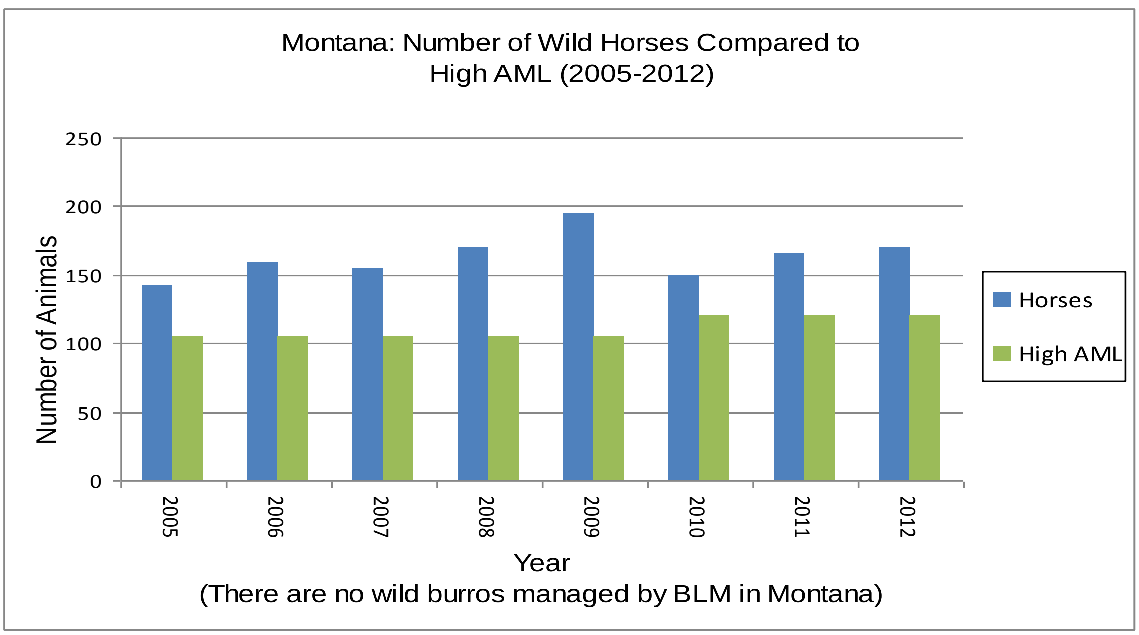


Figure MT-3:



[250] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_ management/Data.html

In 2011, the BLM removed one wild horse from in and/or outside of the HMA in Montana. In total, from 1996 to 2011, 187 wild horses have been captured and removed from the range. See Figure MT-4.[251] During that same time period, 2,423 and 357 wild horses and burros, respectively, have been adopted in Montana.[252] See Figure MT-5.[253]

Figure MT-4:

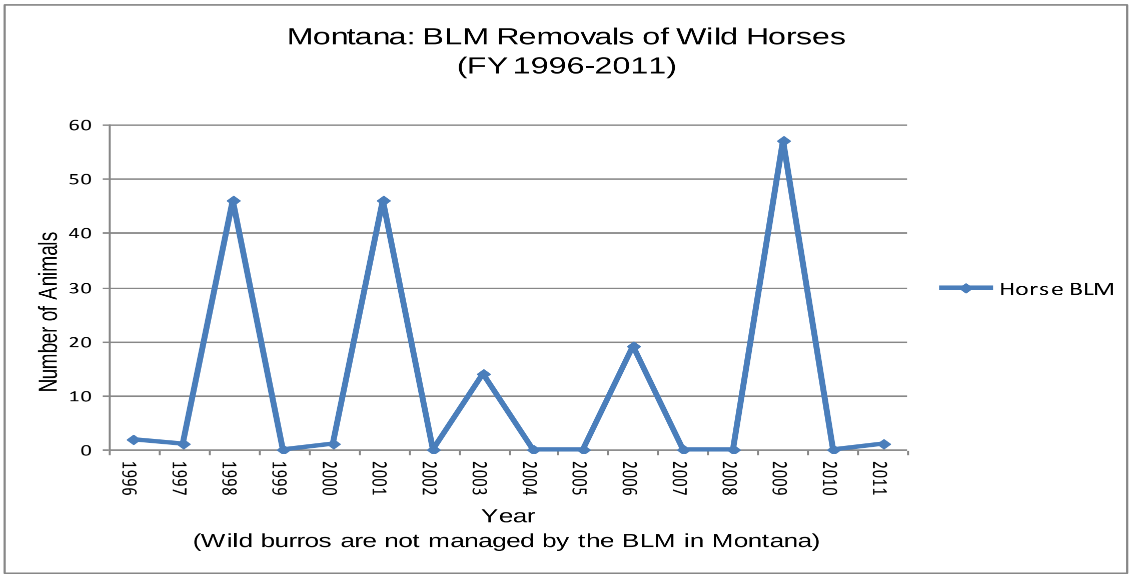
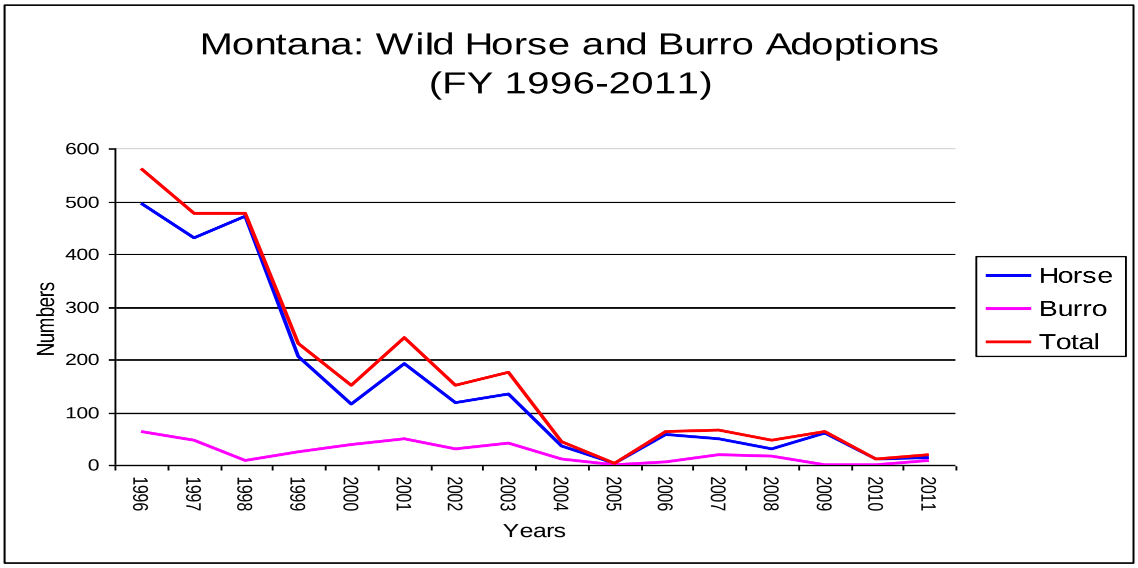


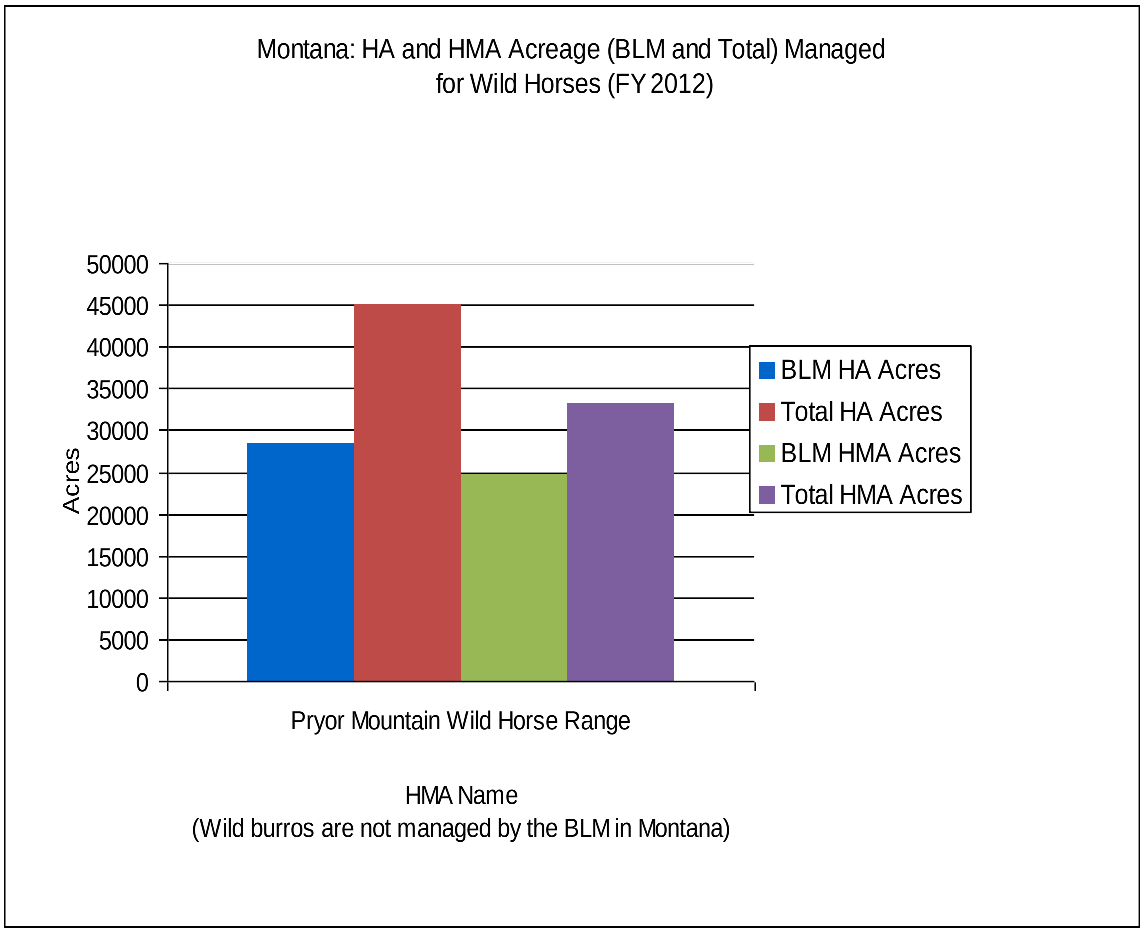
Figure MT-5:



[251] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[252] This includes wild horses and burros captured and removed from the range in other states.
[253] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

The single HMA in Montana encompasses 33,187 acres, including 24,641 acres of BLM lands. This HMA is contained within 44,920 HA acres, including 28,324 acres of BLM lands. This indicates that 11,733 acres of HA habitat – in areas managed for wild horses and burros – is not available to the animals. See Figure MT-6.[254] Since 2005 (annual BLM data prior to 2005 was not available), the acres available to wild horses in the HMA has increased by 3,960 acres. See Figure MT-7.[255] Finally, according to BLM data, there are six HAs in the state from which wild horses have been permanently removed. These six HAs encompass 185,153 acres, including 75,520 acres of BLM lands. See Figure MT-8.[256] Consequently, 196,886 acres of habitat originally available for wild horses in Montana no longer exists. See Figure MT-9.[257]

Figure MT-6:



[254] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[255] *Ibid*.
[256] *Ibid*.
[257] *Ibid*.

Figure MT-7:

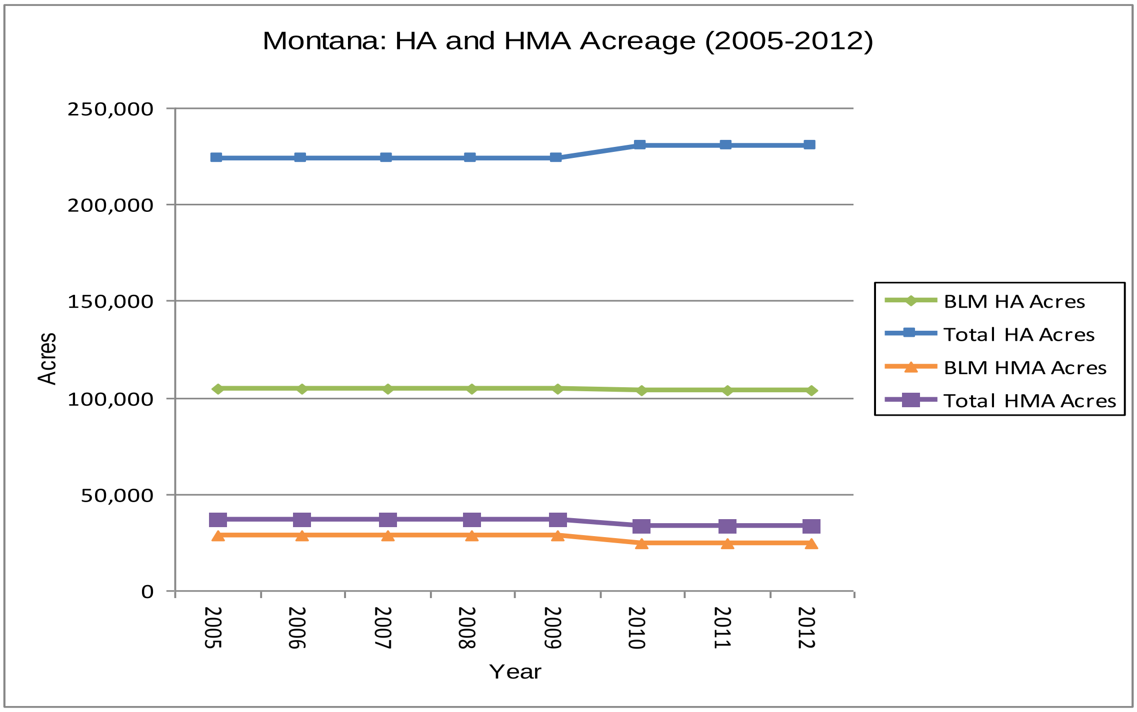


Figure MT-8:

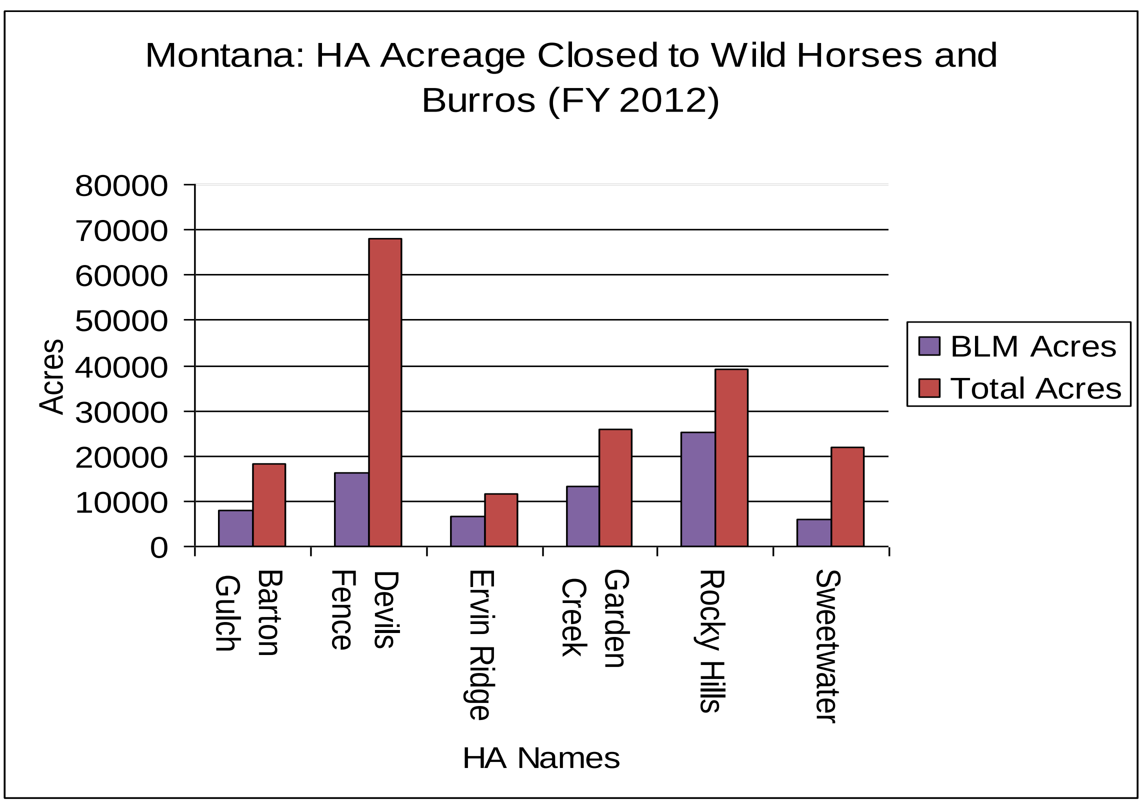
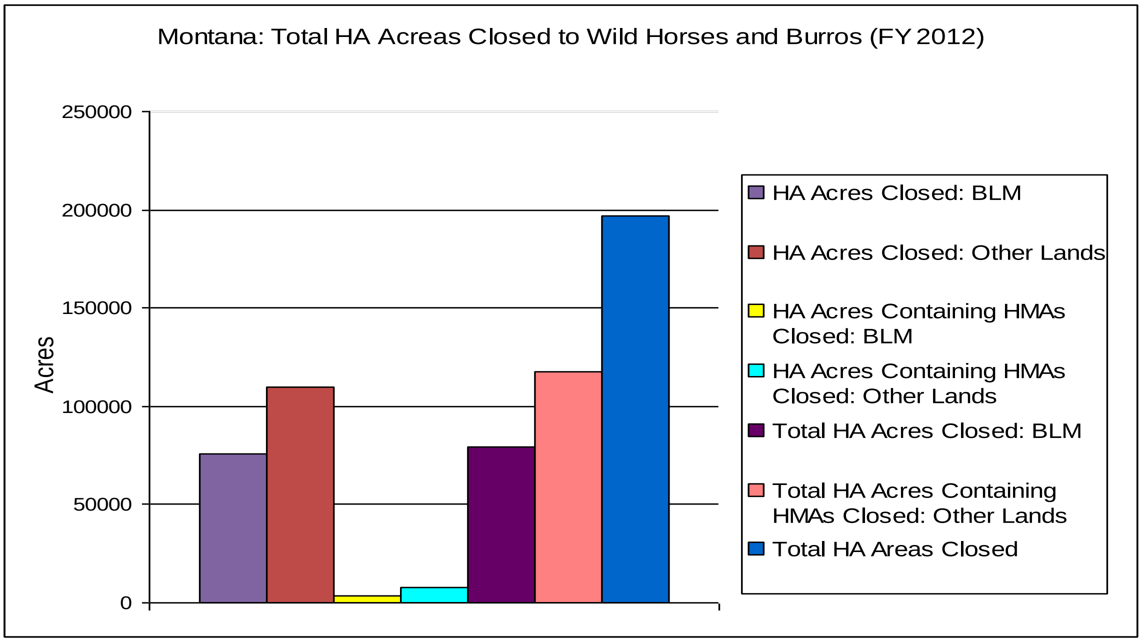


Figure MT-9:



There are 5,206 total public land grazing allotments in Montana, encompassing 8,164,302 acres. Of these acres, in 2011, rangeland monitoring has designated 1,584,600 acres in the "upward" trend, 1,575,903 acres in the "static" trend, 378,577 acres in the "downward" trend, and 4,625,222 acres in the "undetermined" trend.[258] The number of acres in these categories has varied over the years. See Figure MT-10.[259] In 2011, of the 5,206 allotments, 751 have been designated as "I" (improve), 1,743 as "M" (maintenance), 2,710 as "C" (custodial), and 2 as "uncategorized."[260] The number of

[258]Trends are designated as "upward" if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as "downward" if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[259] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html

[260] The objective for "I" allotments is to "improve the current resource condition." The objective for "M" allotments is to "maintain the current resource condition." The objective for "C" allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-the-ground management efforts to those allotments where grazing management is most needed to improve resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

allotments in these categories and the acreage so designated is subject to variation. See Figures MT-11 and MT-12.[261]

Figure MT-10:

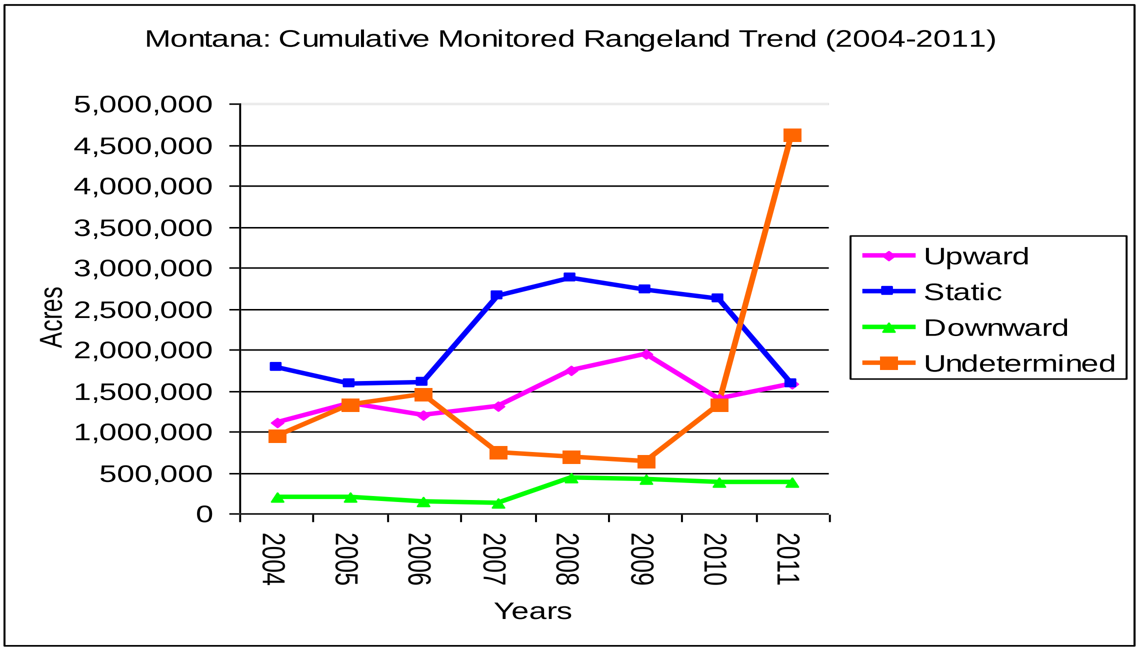
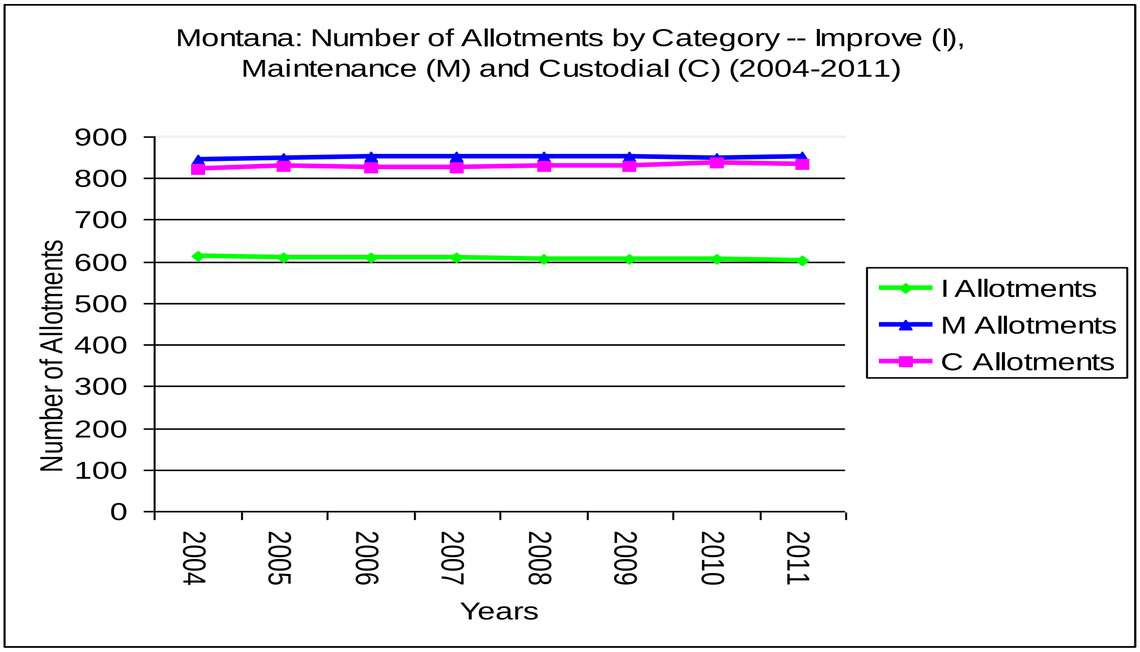
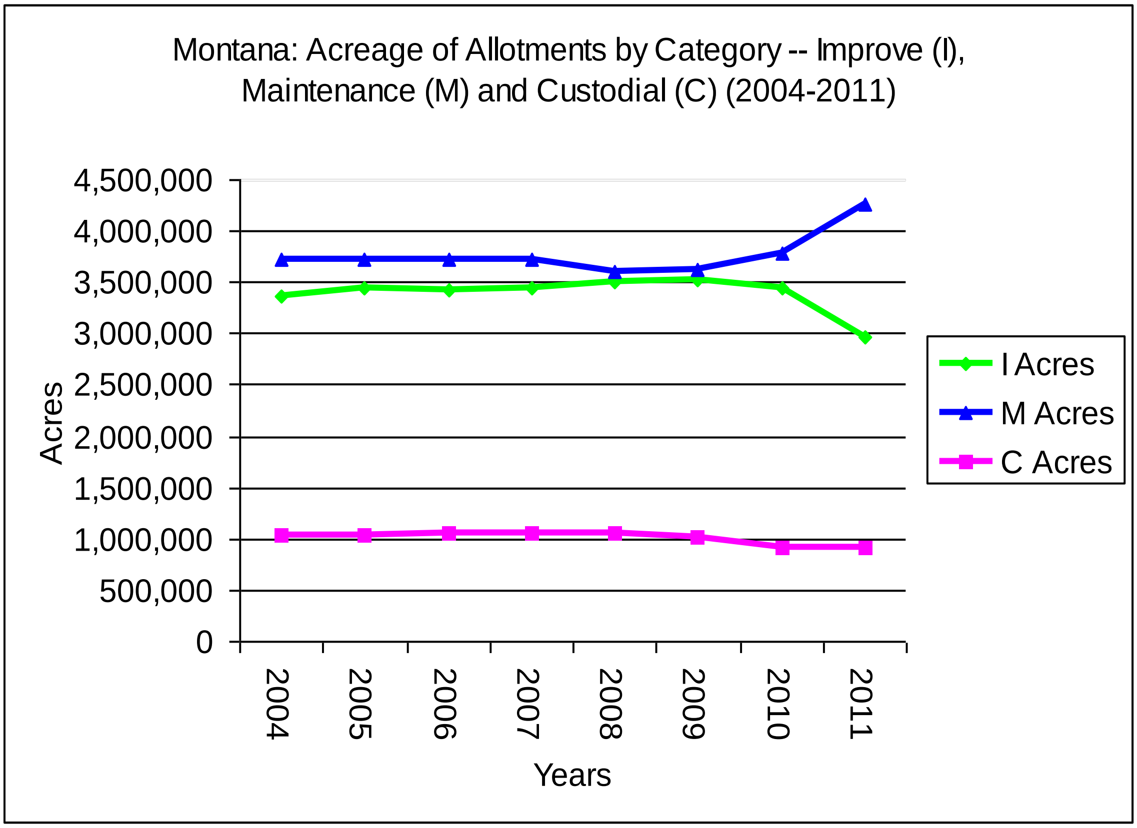


Figure MT-11:



[261] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

Figure MT-12:



In 2011, the total number of AUMs used for grazing was 1,238,491. This included 1,197,740 for cattle/yearlings/bison, 5,417 for domestic horses and burros, and 35,334 for sheep and goats. The total AUMs for wild horses in Montana in 2011 was 120, [262] indicating that, statewide, livestock AUMs are 10,321 times higher than wild horse AUMs. See Figure MT-13.[263] Since 2000, the total for livestock AUMs has been variable, ranging from a low of 1,162,822 in 2003 to a high of 1,250,891 in 2010. See Figure MT-14.[264]

[262] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[263] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm.
[264] Ibid.

Figure MT-13:

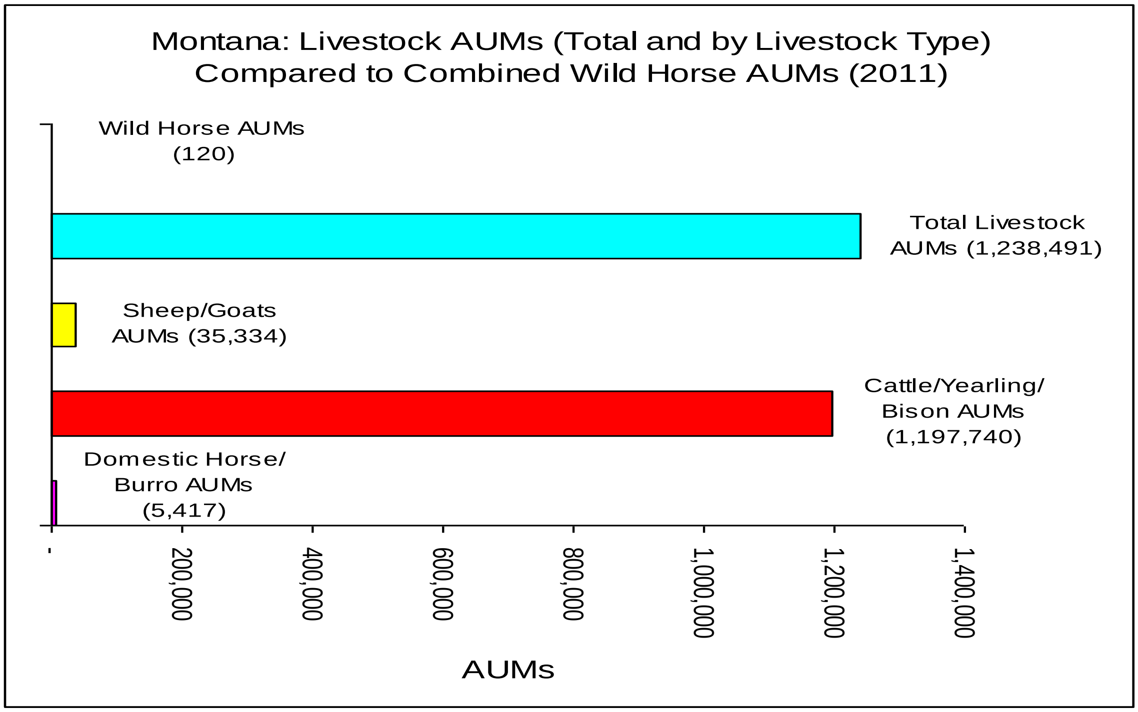
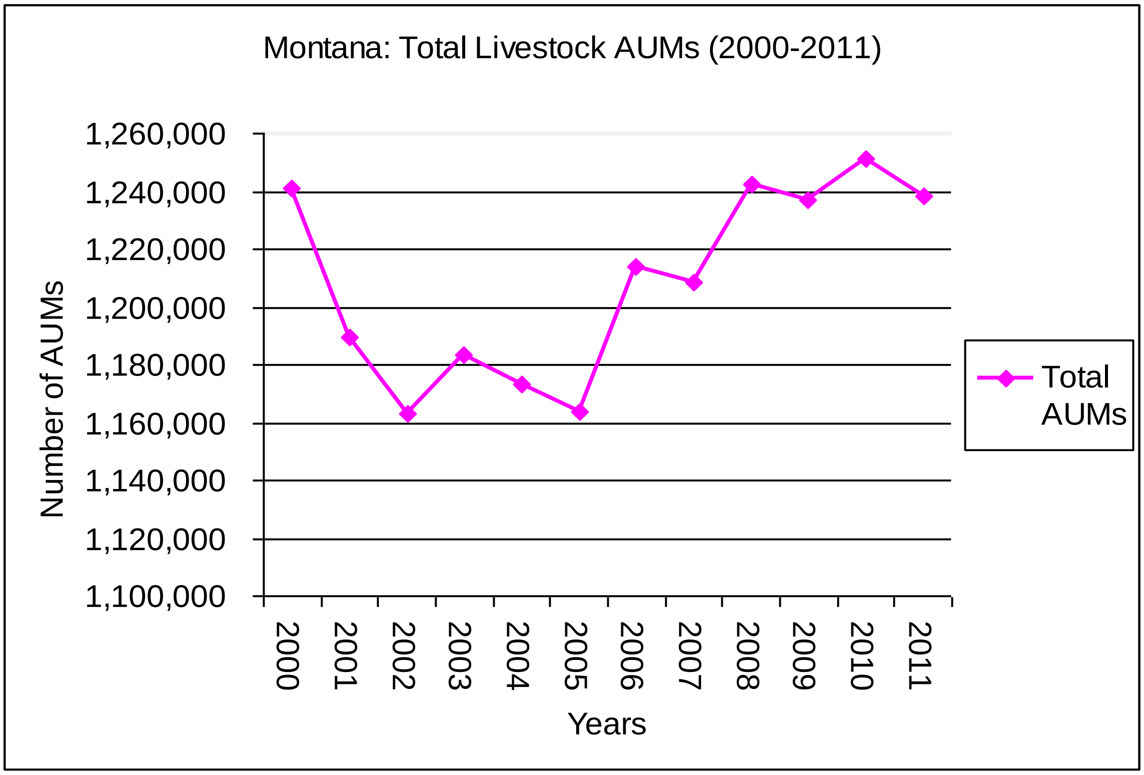


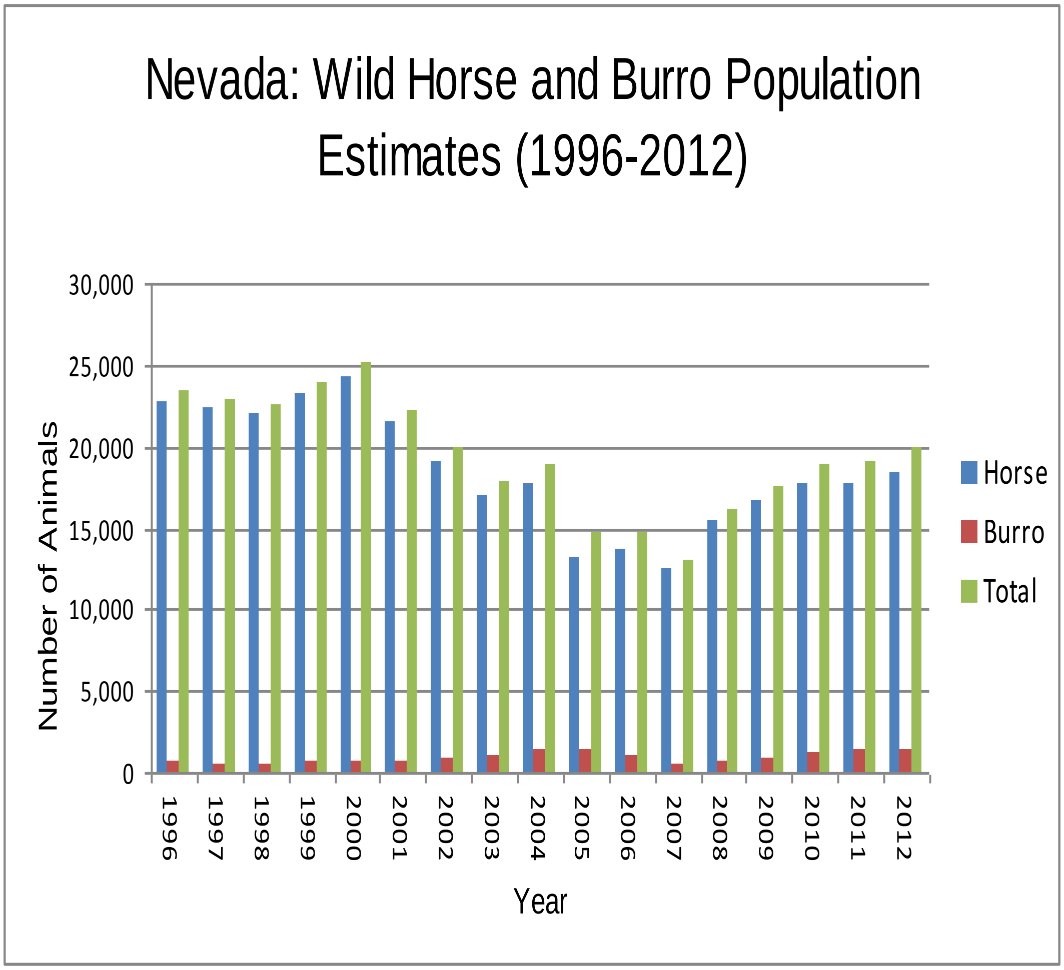
Figure MT-14:



Nevada:

Based on fiscal year 2012 data there are, as of February 29, an estimated 17,215 wild horses and 1,425 wild burros in Nevada occupying a total of 85 HMAs.[265] See Figure NV-1.[266] In addition, there are an estimated 1,210 wild horses and 31 wild burros on HAs that are not managed for the species.[267] As a result, there are an estimated 18,425 wild horses and 1,456 wild burros, for a total of 19,891 animals, in Nevada.

Figure NV-1:



Wild horses are managed in 65 of the 85 HMAs but are also found in five additional HMAs while wild burros are found in 10 of the 85 HMAs bur are also found in three

[265] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.
[266] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[267] Ibid.

additional HMAs in Nevada. In addition, there are 6 HMAs managed for both wild horses and burros and four HMAs for which high AML for wild horses and wild burros is set at zero. The total current high AML[268] for wild horses and burros in the state is 11,964 and 814, respectively, or 12,778 combined. Therefore, as of February 2012, the number of wild horses and burros in Nevada are an estimated 7,103 over high AML. If the AMLs for horses and burros are scientifically justified – which remains highly questionable – wild horses and wild burros are 6,461 and 642 in excess of their respective high AMLs. See Figure NV-2.[269] This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses and burros in Nevada were below high AML (when it was set at 13,485) in 2007. See Figure NV-3.[270]

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[268] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.

[269] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

[270] *Ibid*.

Figure NV-2 (1 of 3):

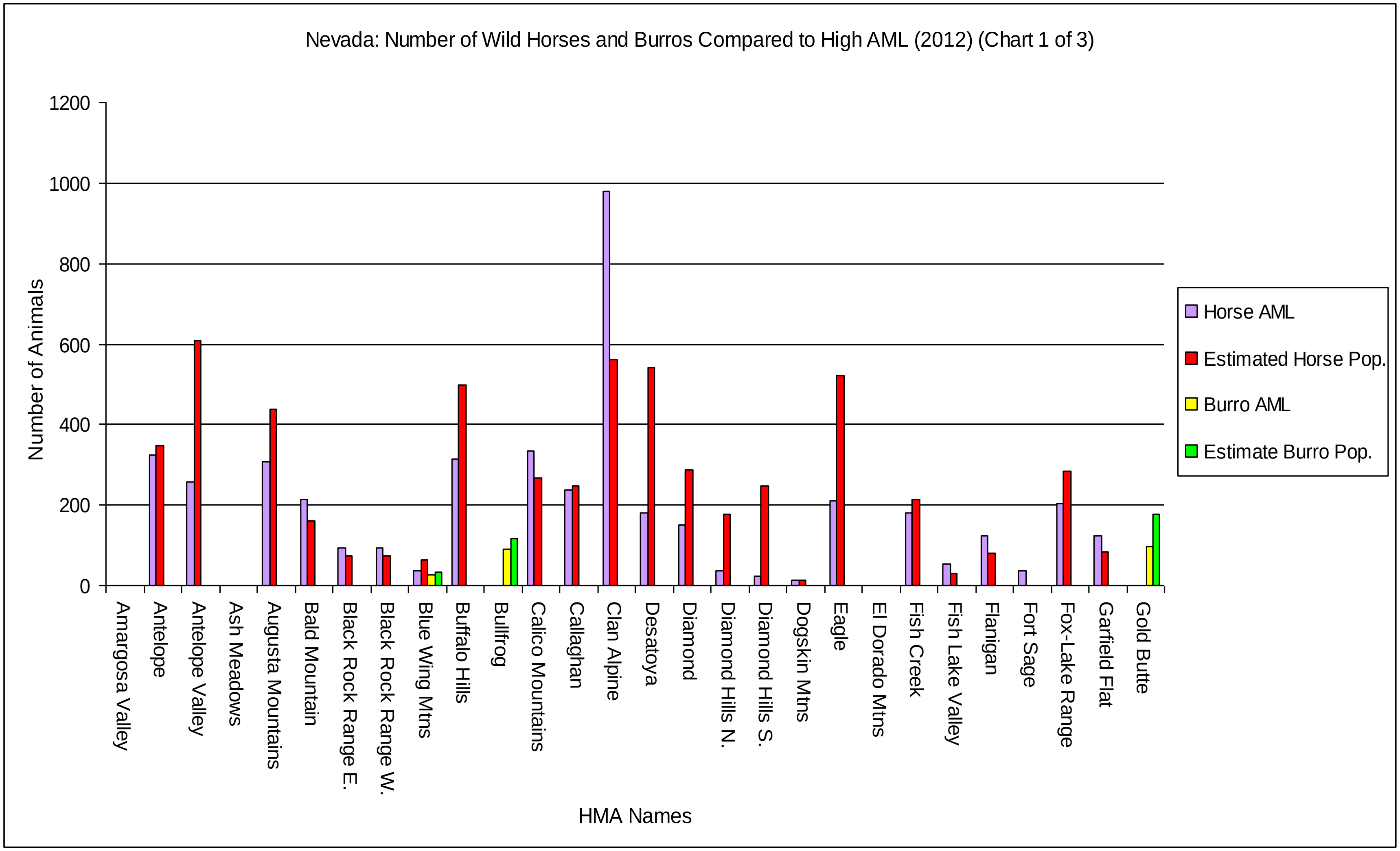


Figure NV-2 (2 or 3):

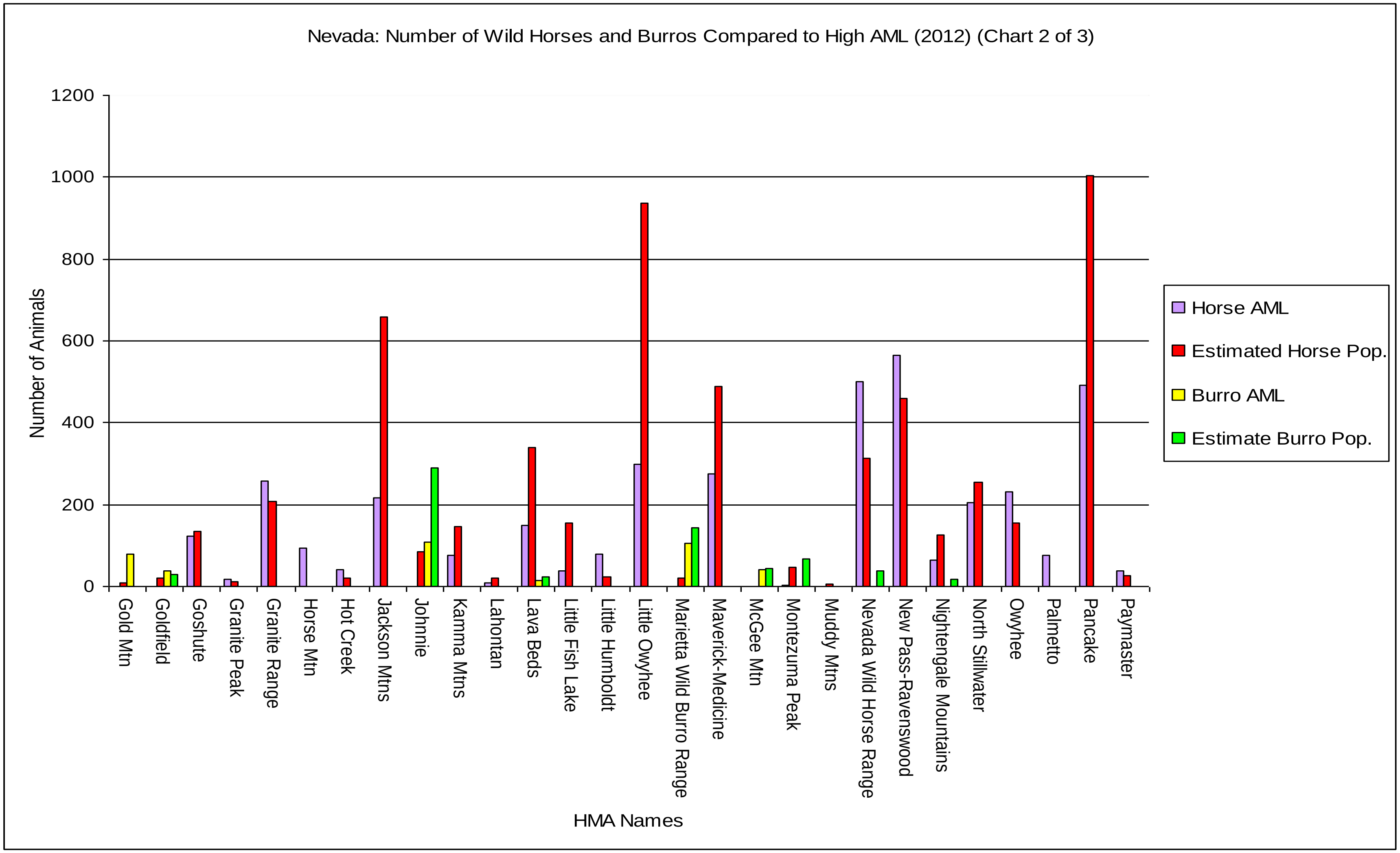


Figure NV-2 (3 of 3):

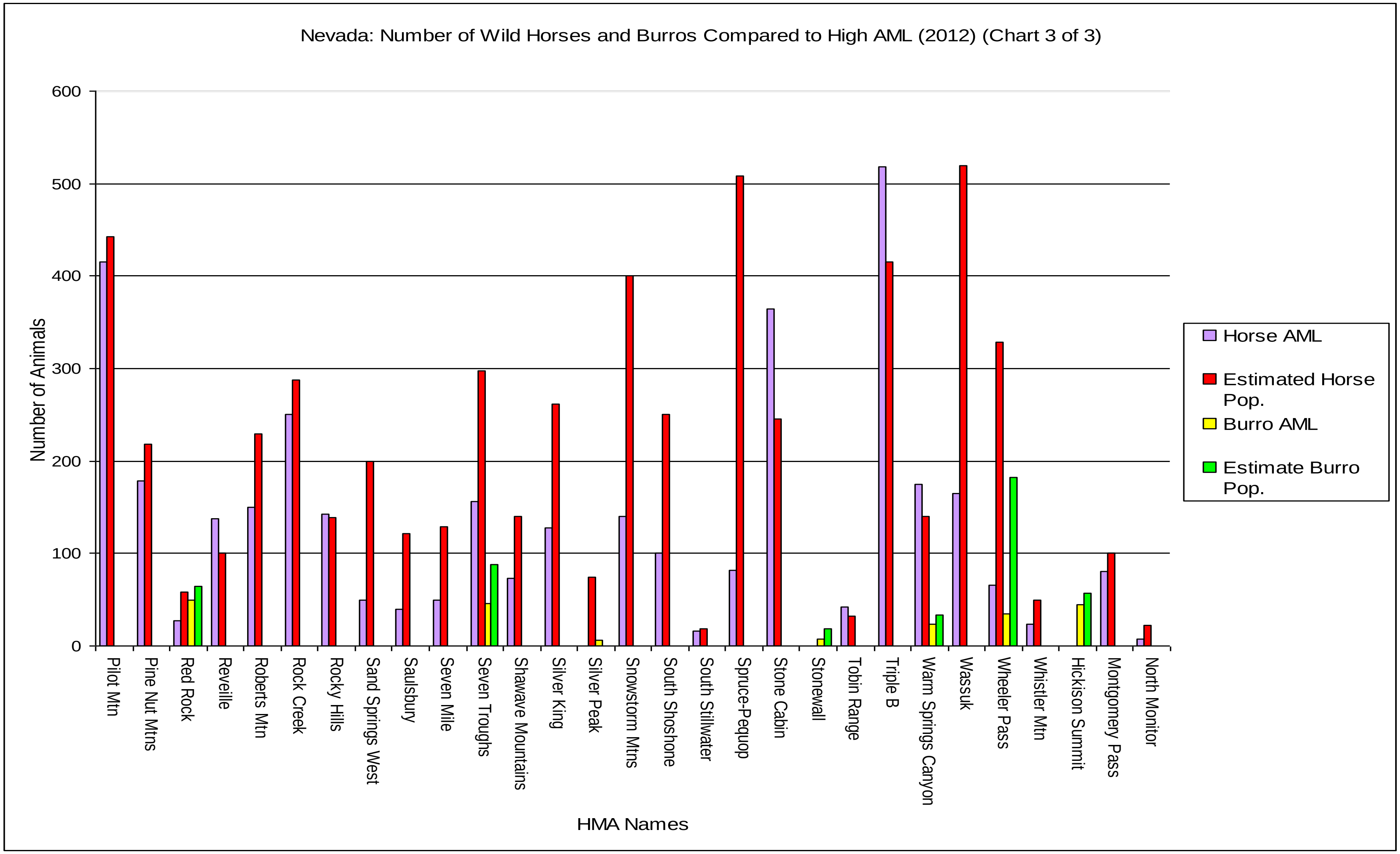
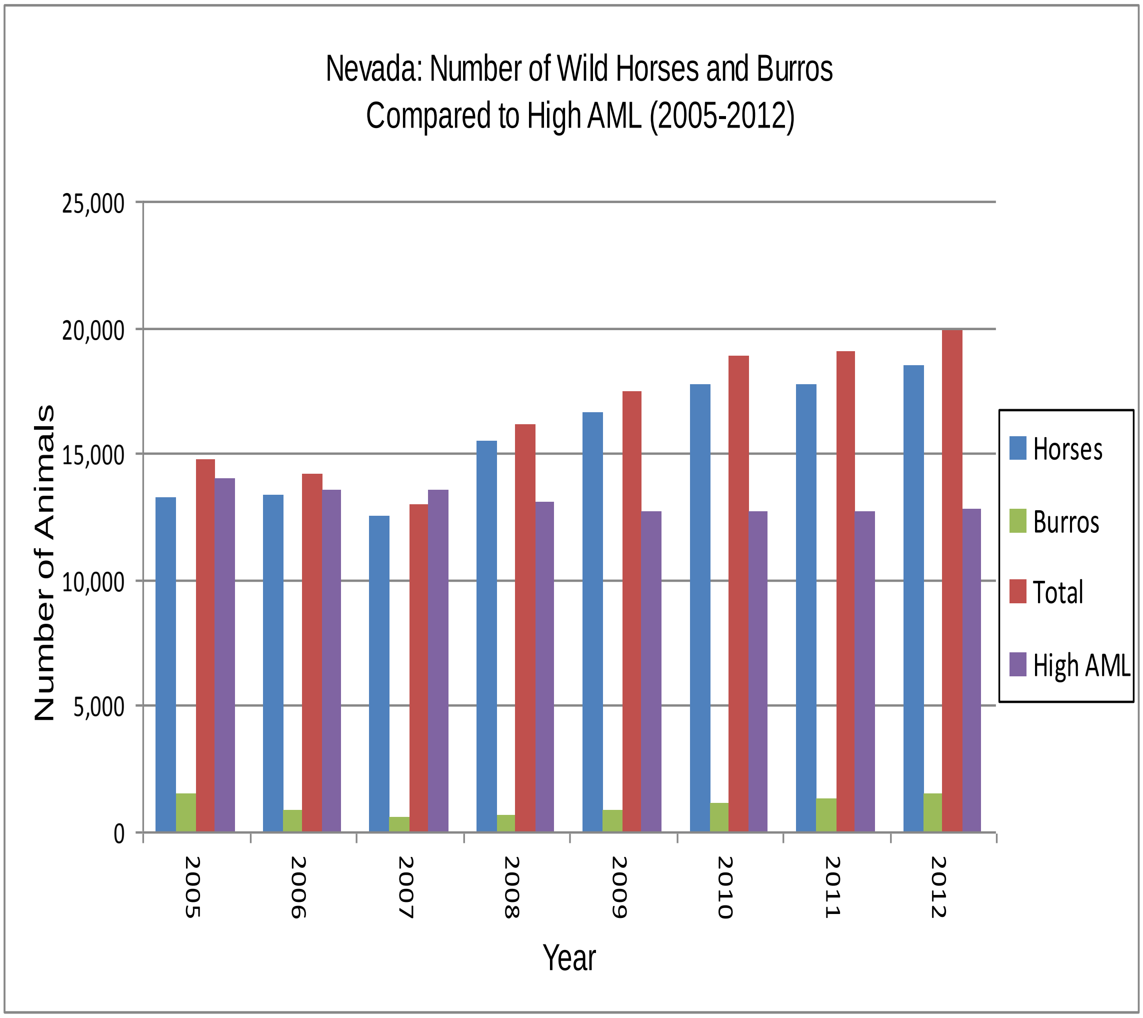


Figure NV-3:



In 2011, the BLM removed 3,991 wild horses and 0 wild burros from in and/or outside of HMAs in Nevada. In total, from 1996 to 2011, 69,936 wild horses and 4,304 wild burros have been captured and removed from the range. See Figures NV-4, NV-5, and NV-6.[271] During that same time period, 1,445 and 103 wild horses and burros, respectively, have been adopted in Nevada.[272] See Figure NV-7.[273]

[271] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[272] This includes wild horses and burros captured and removed from the range in other states.
[273] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

Figure NV-4:

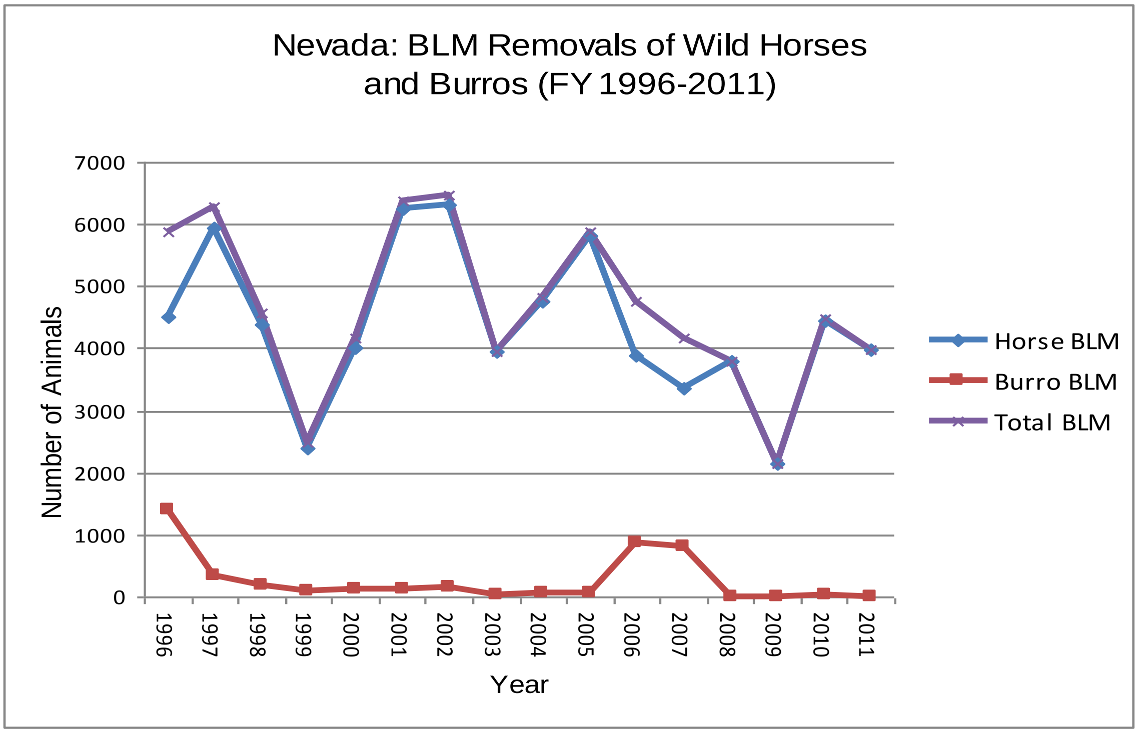


Figure NV-5:

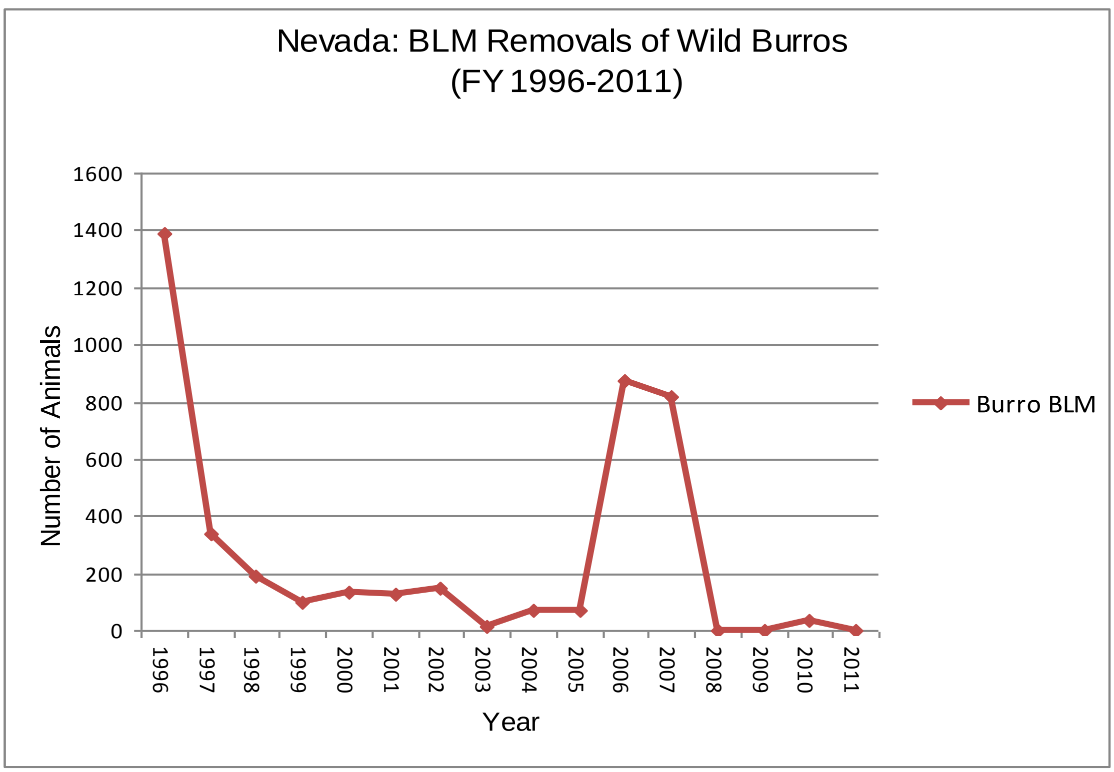


Figure NV-6:

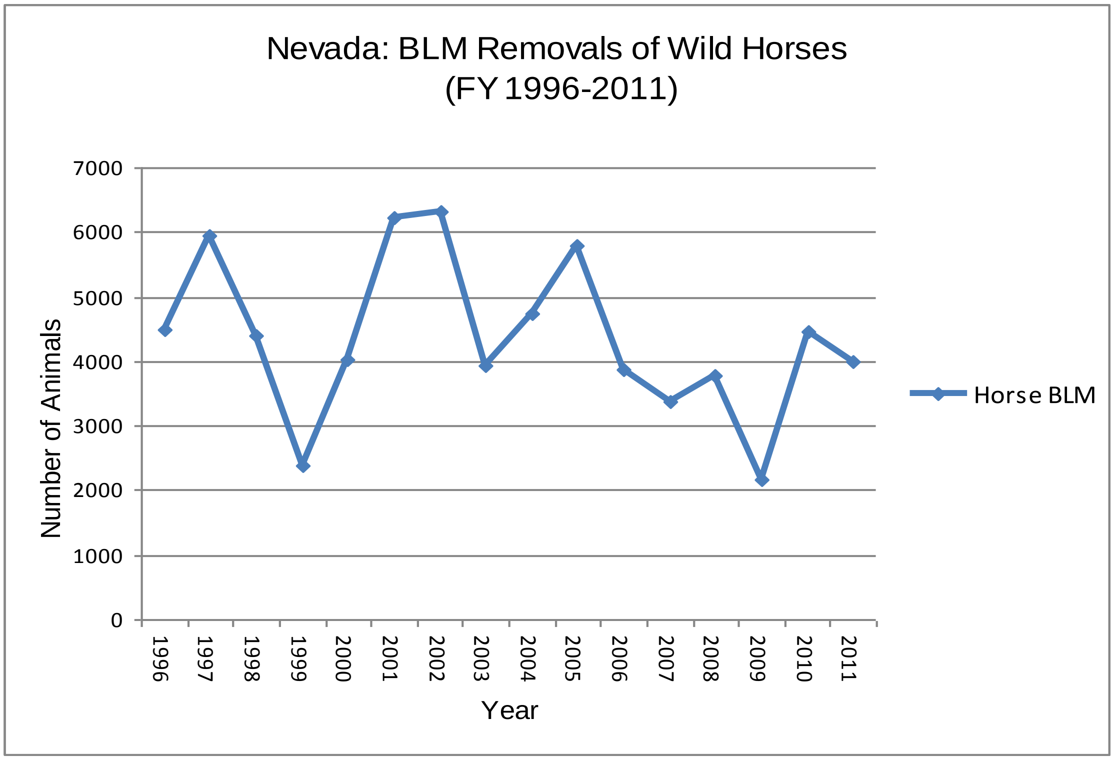
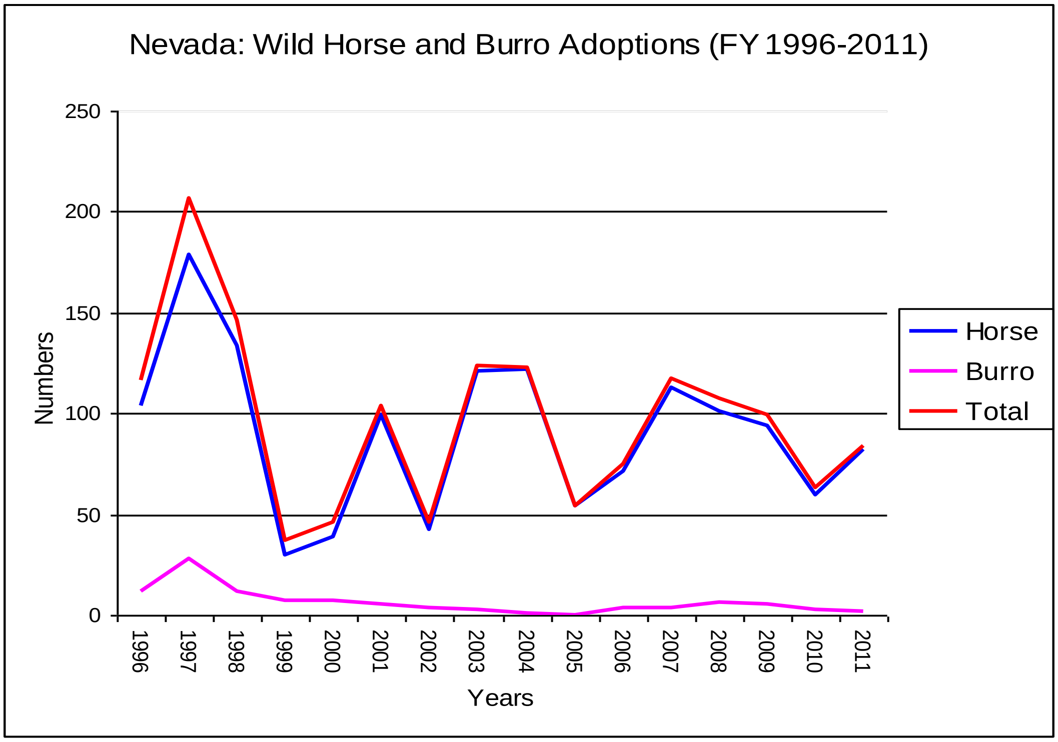


Figure NV-7:



The 85 HMAs in Nevada encompass 15,718,630 acres, including 14,032,947 acres of BLM lands. These HMAs are contained within 11,895,457 HA acres, including 9,885,852 acres of BLM lands. Unlike most states where the HA acres within which wild horse and burros are managed in HMAs exceed HMA acreage, this is not the case in Nevada. According to the BLM, the HMA acreage is larger than the HA acreage (for the areas management for wild horses and burros) in Nevada as a result of the acreage of HMAs created from other HAs not being included in the total HA acreage. As a result, the existing HMAs contain 3,823,173 acres more than their corresponding HAs. See Figure NV-6.[274] Nevertheless, since 2005 (annual BLM data prior to 2005 was not available), the total acres available to wild horses and/or burros in HMAs has declined by 1,755,318 acres. See Figure NV-7.[275] Finally, according to BLM data, there are 73 HAs in the state from which wild horses and/or burros have been permanently removed. These 73 HAs encompass 10,995,167 acres, including 9,855,341 acres of BLM lands. See Figure NV-8.[276] Consequently, 7,171,994 acres of habitat originally available for wild horses and burros in Nevada no longer exists. See Figure NV-9.[277]

[274] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[275] *Ibid*.
[276] *Ibid*.
[277] *Ibid*.

Figure NV-8 (1 of 3):

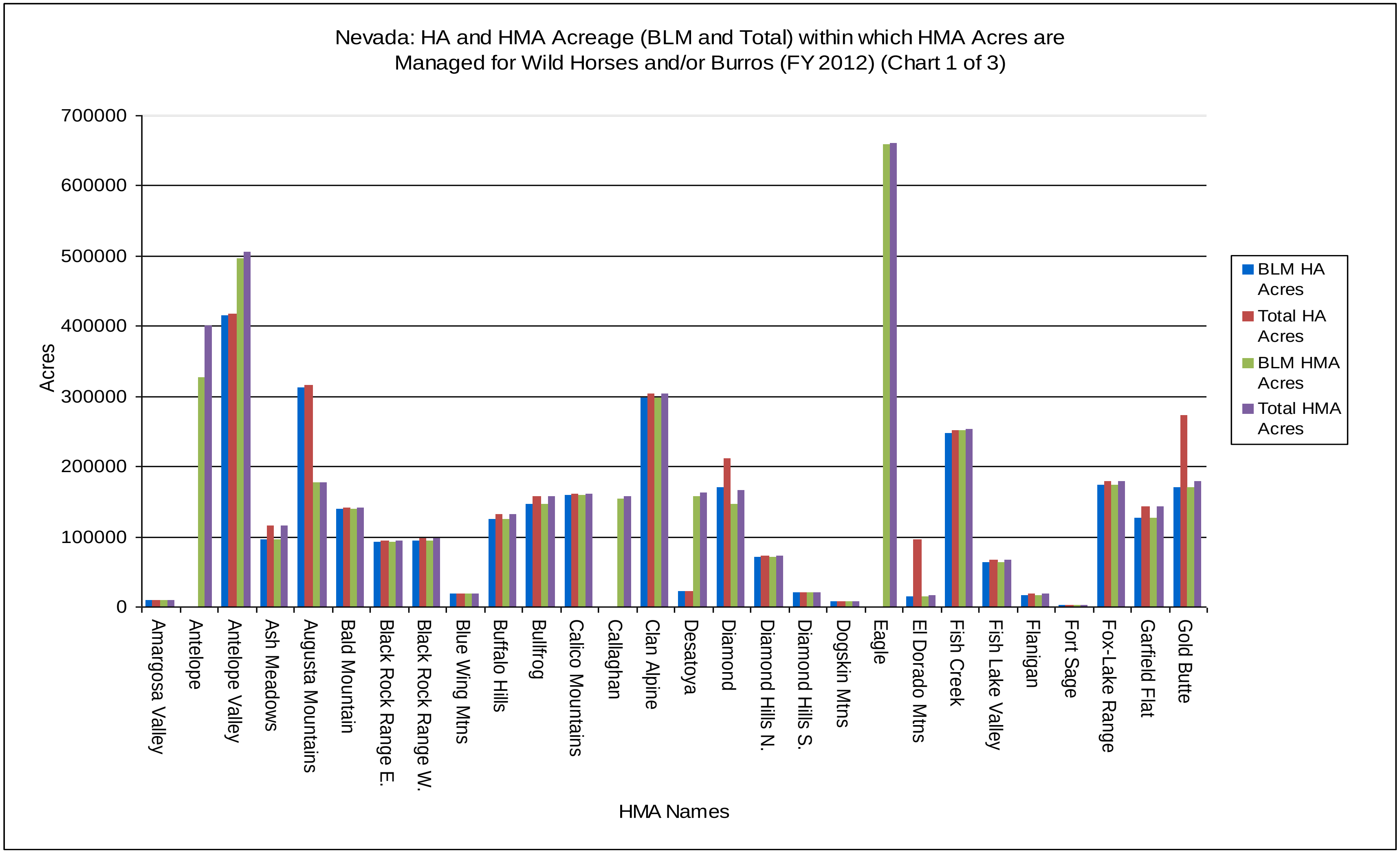


Figure NV-8 (2 of 3):

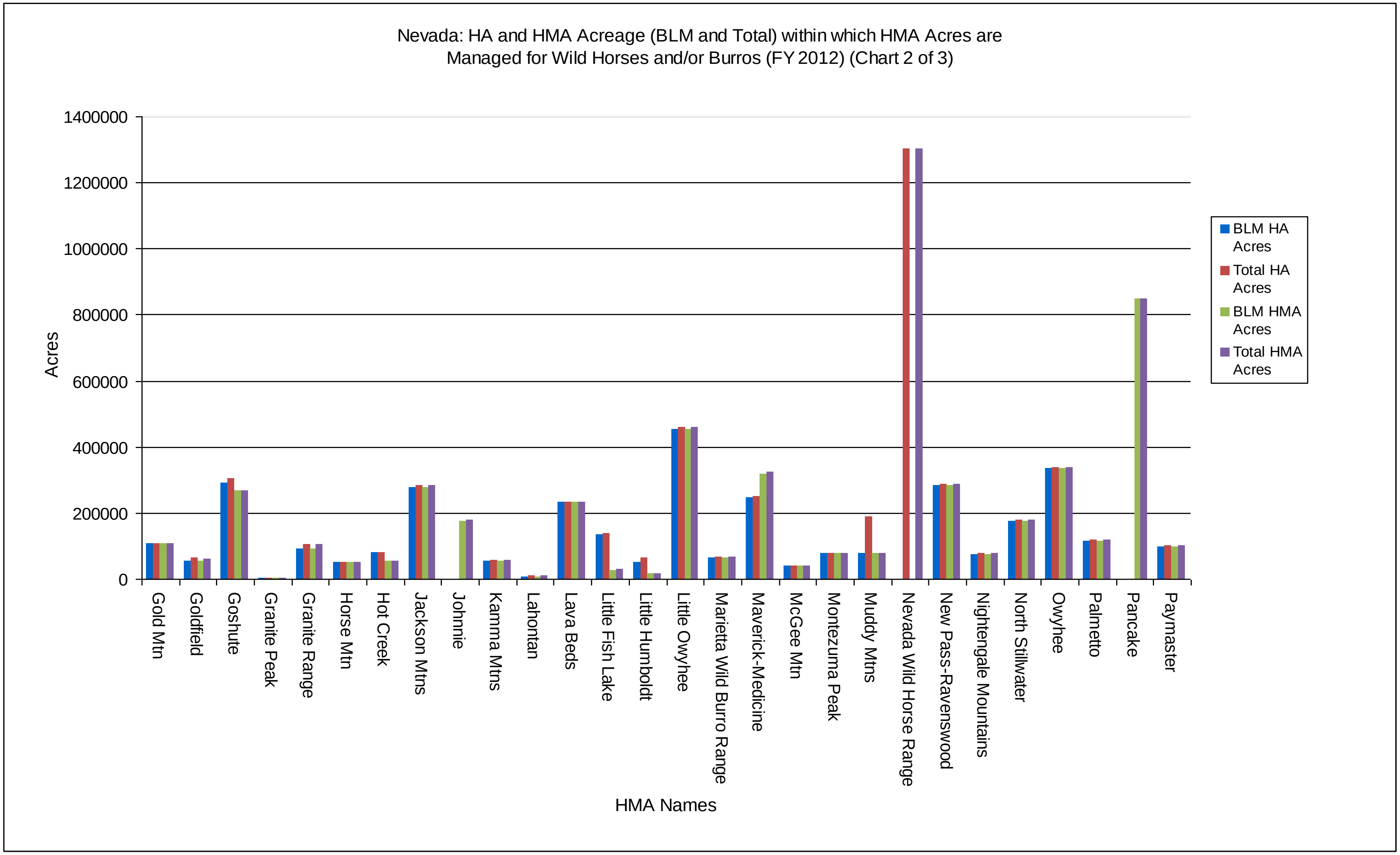


Figure NV-8 (3 of 3):

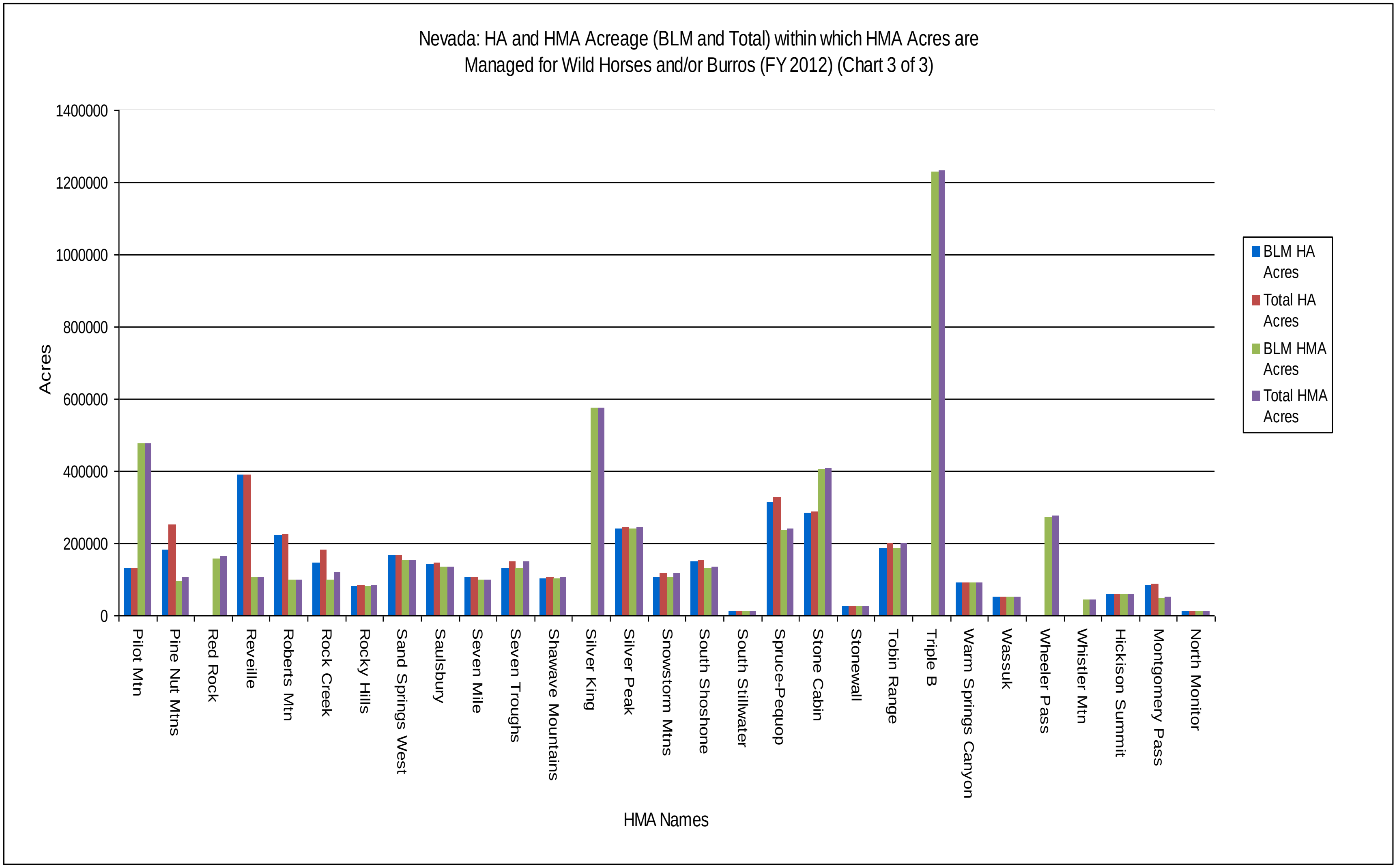
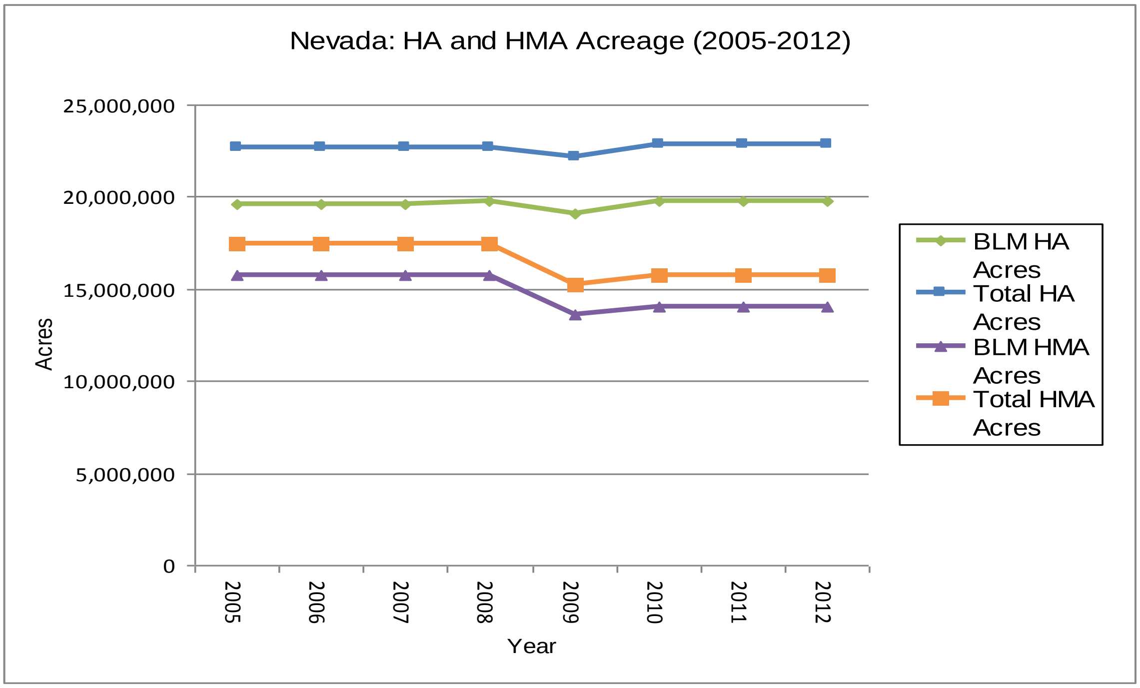


Figure NV-9:



Nevada: HA and HMA Acreage (2005-2012)
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
Acres
2005
2006
2007
2008
2009
2010
2011
2012
Year
BLM HA Acres
Total HA Acres
BLM HMA Acres
Total HMA Acres

Figure NV-10 (1 of 2):

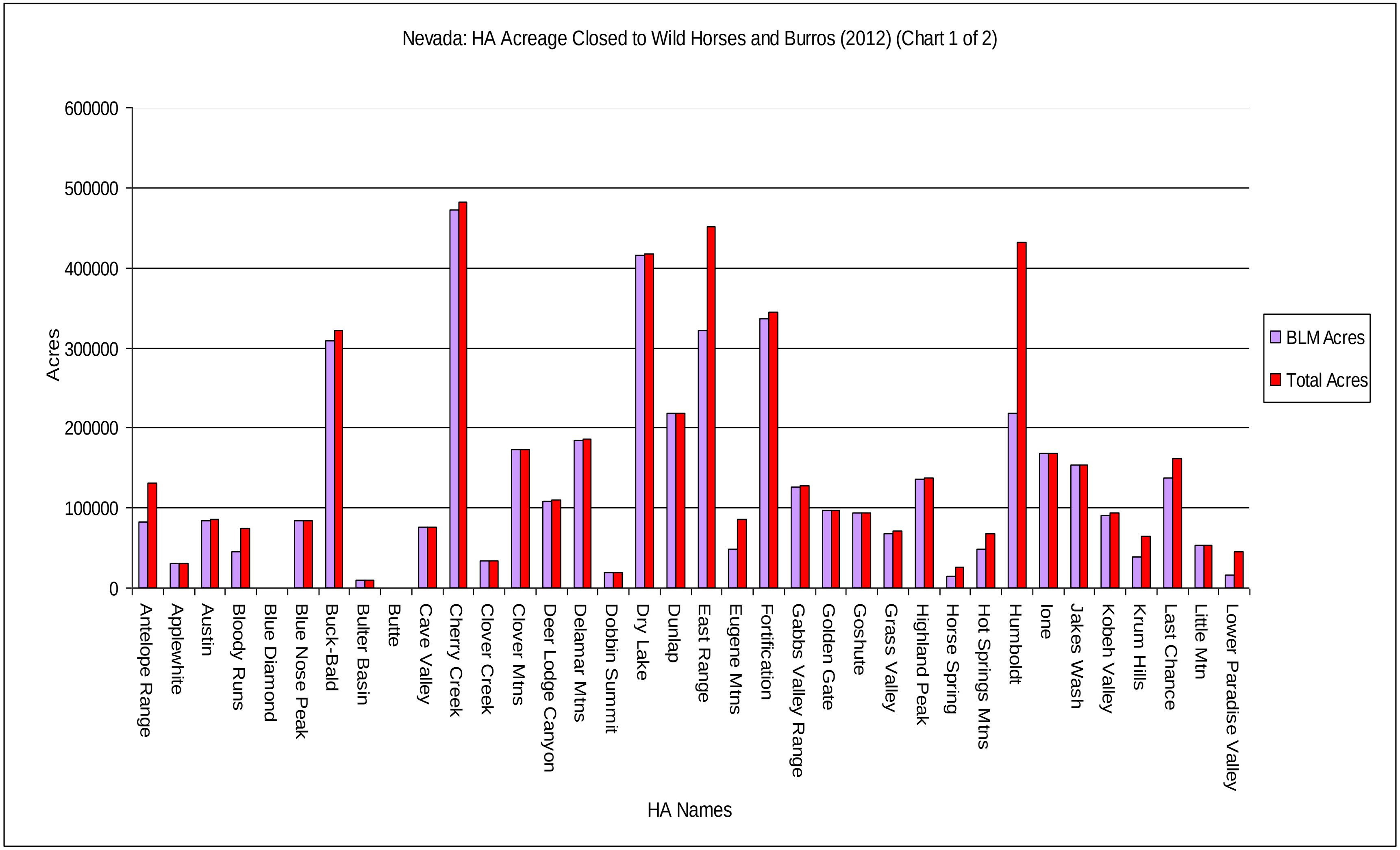


Figure NV-10 (2 of 2):

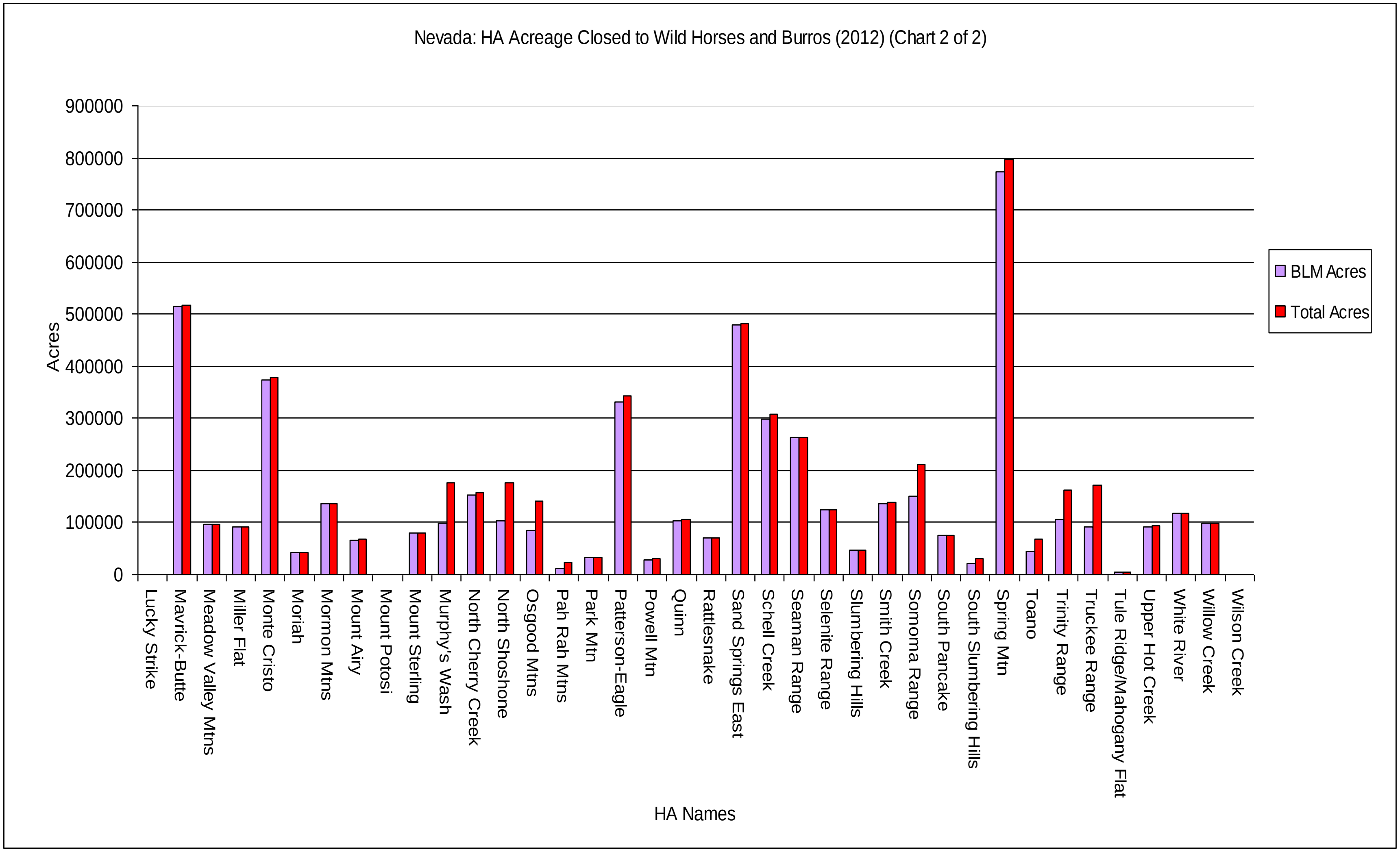
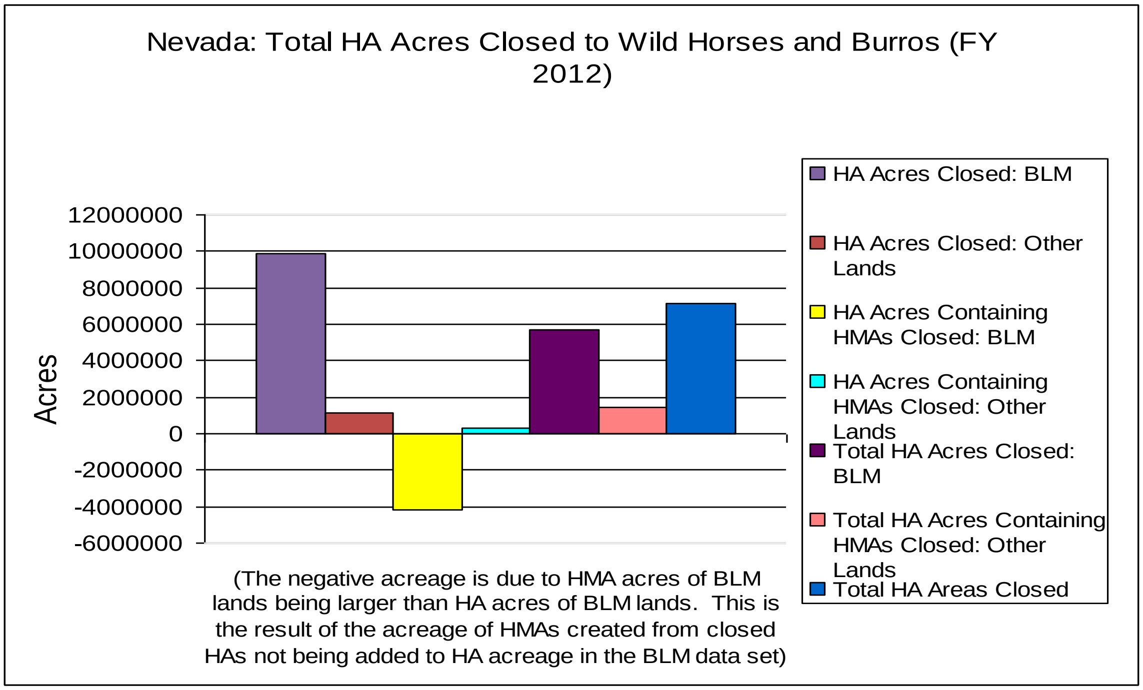


Figure NV-11:



There are 795 total public land grazing allotments in Nevada, encompassing 44,206,486 acres. Of these acres, in 2011, rangeland monitoring has designated 2,864,525 acres in the "upward" trend, 13,664,080 acres in the "static" trend, 7,049,181 acres in the "downward" trend, and 20,628,700 acres in the "undetermined" trend.[278] The number of acres in these categories has varied over the years. See Figure NV-12.[279] In 2011, of the 795 allotments, 274 have been designated as "I" (improve), 274 as "M" (maintenance), 233 as "C" (custodial), and 14 as "uncategorized."[280] The number of allotments and their

[278]Trends are designated as "upward" if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as "downward" if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[279] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

[280] The objective for "I" allotments is to "improve the current resource condition." The objective for "M" allotments is to "maintain the current resource condition." The objective for "C" allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-the-ground management efforts to those allotments where grazing management is most needed to improve resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

corresponding acreage in these categories is subject to variation. See Figures NV-13 and NV-14.[281]

Figure NV-12:

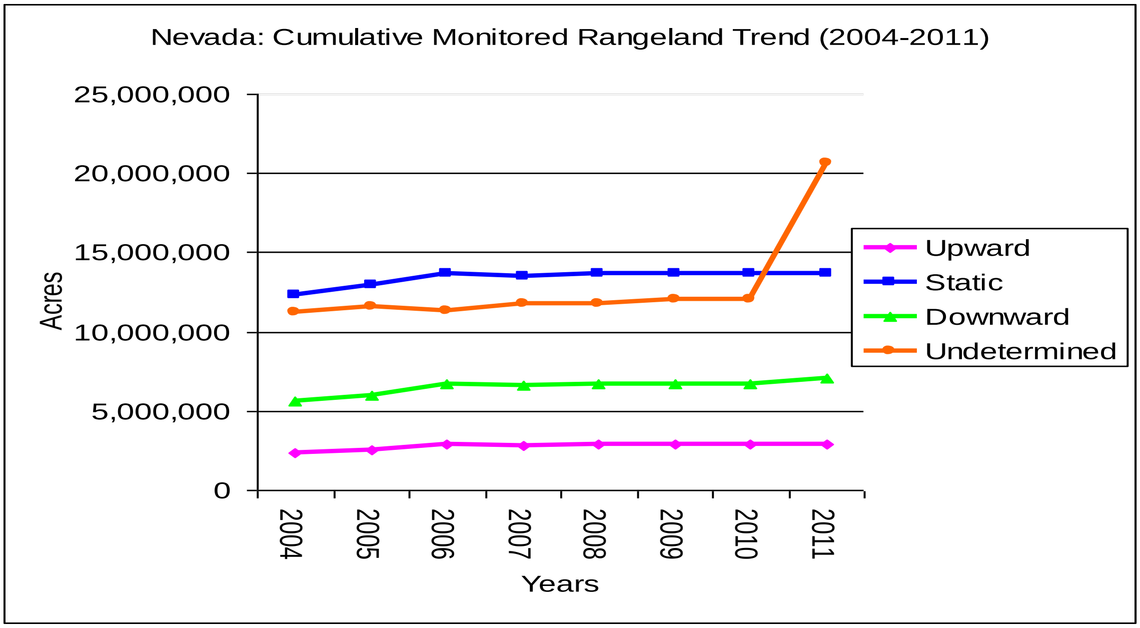
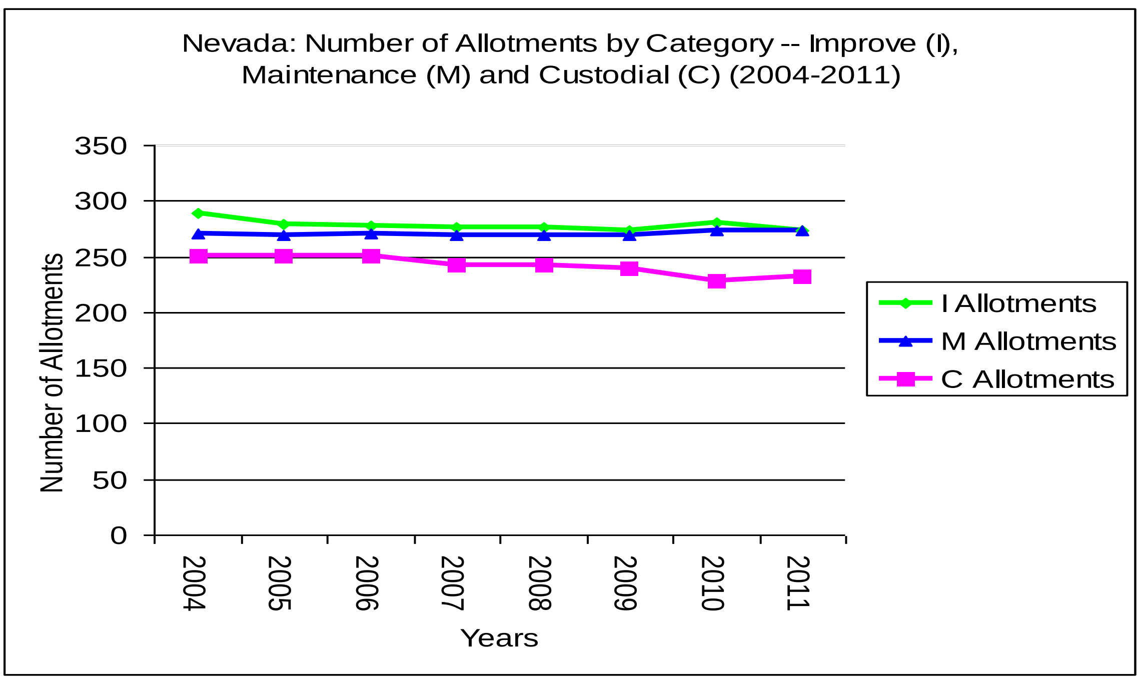
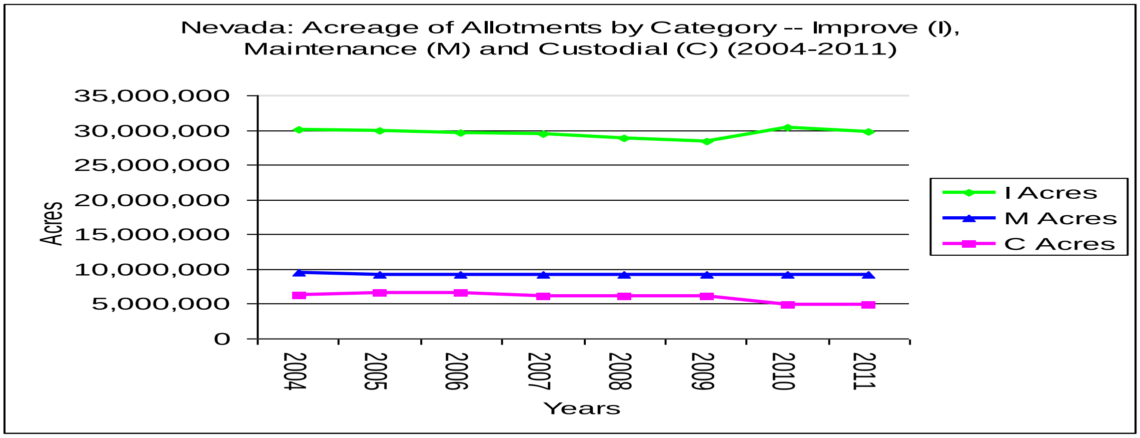


Figure NV-13:



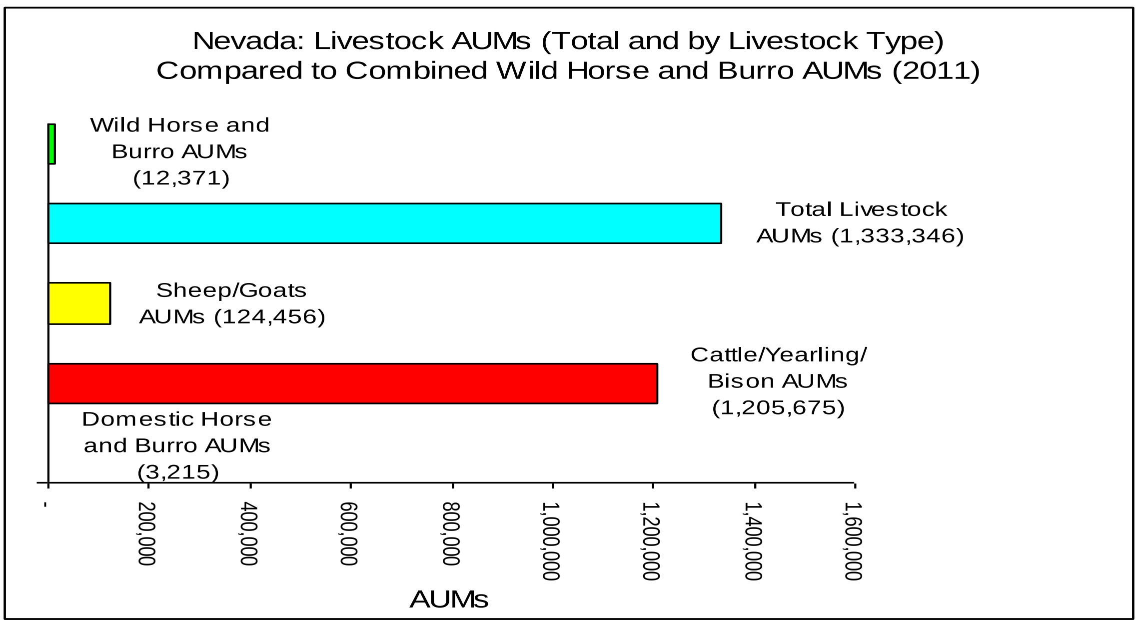
[281] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_ management/rangeland_inventory.html.

Figure NV-14:



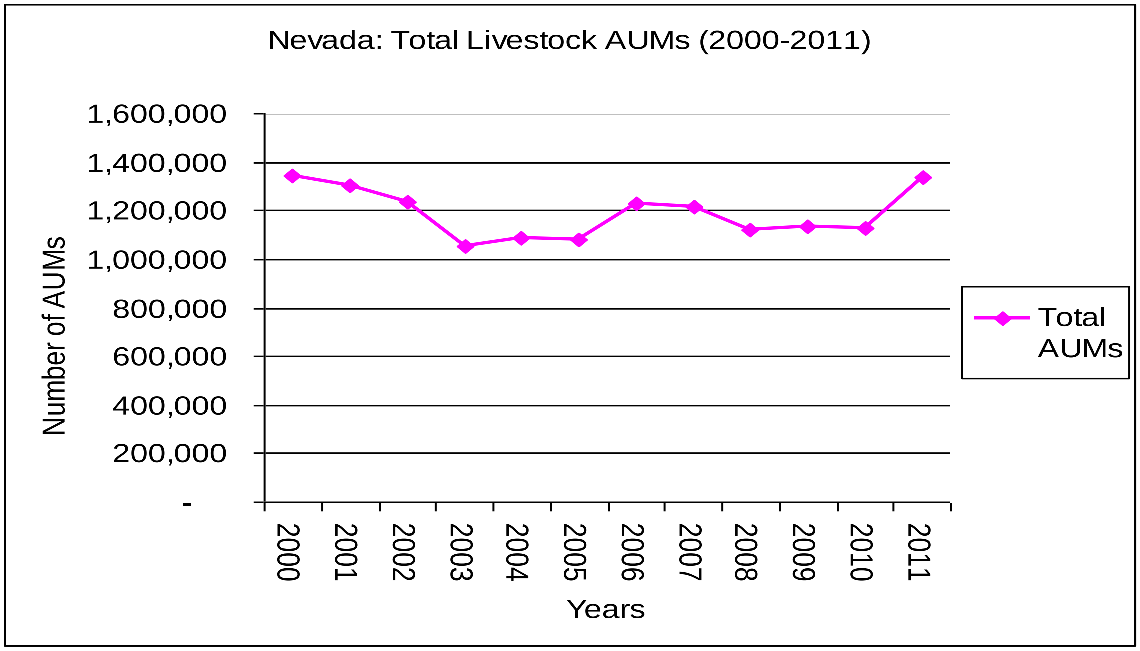
In 2011, the total number of AUMs used for grazing was 13,333,346. This included 1,205,675 for cattle/yearlings/bison, 3,215 for domestic horses and burros, and 124,456 for sheep and goats. The total AUMs for wild horses and burros in Nevada in 2011 was 12,371,[282] indicating that, statewide, livestock AUMs are 107 times higher than wild horse and burros AUMs. See Figure NV-15.[283] Since 2000, the total for livestock AUMs has been variable, ranging from a low of 1,054,267 in 2003 to a high of 1,341,565 in 2000. See Figure NV-16.[284]

Figure NV-15:



282 One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
283 Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm.
284 *Ibid*.

Figure NV-16:



According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 798,053 livestock (292,514 cattle, 313 domestic horses, 503,632 sheep, and 1,594 goats) were grazed on an estimated 227 allotments wholly or partially within HMAs in Nevada. This corresponds to approximately 393,872 AUMs.[285] The total AUMs used annually depends on the type of livestock grazed and the duration for which they are grazed on public lands. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing for livestock using allotments wholly or partially within HMAs was 2,102,337, 1,650,234, 594,716, and 2,261,386, respectively.[286]

When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[287] the number of livestock grazed within the HMAs is 235,188 corresponding to 583,917 total AUMs and 675,001 AUMs permitted for use for seasonal/annual grazing. This compares to a high AML for wild horses and burros of 12,778 (11,964 horses and 814 burros) which equates to an annual AUM of 148,452. See Figures NV-17 and NV-18. Hence, even at the HMA level, permitted use livestock AUMs are nearly 4.5 times larger than annual wild horse and burros AUMs. In addition, of the total number of livestock, wild horses, and/or wild burros estimated to use all

[285] The AUMs were calculated using conversion rates of 1 cow = 1 AUM and .2 sheep = 1 AUM. These conversion rates are consistent with BLM policies or were identified in various agricultural sources found on the Internet.

[286] Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.

[287] This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

Arizona HMAs in 2012, 94.8 percent are livestock, 4.8 percent are wild horses, and 0.3 percent are wild burros. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

Figure NV-17:

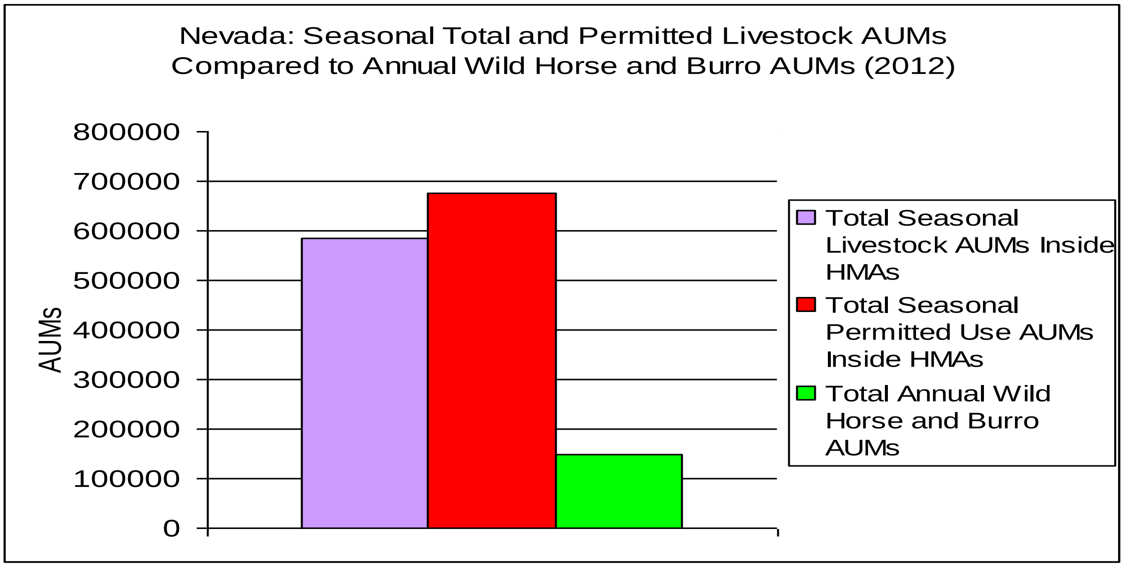
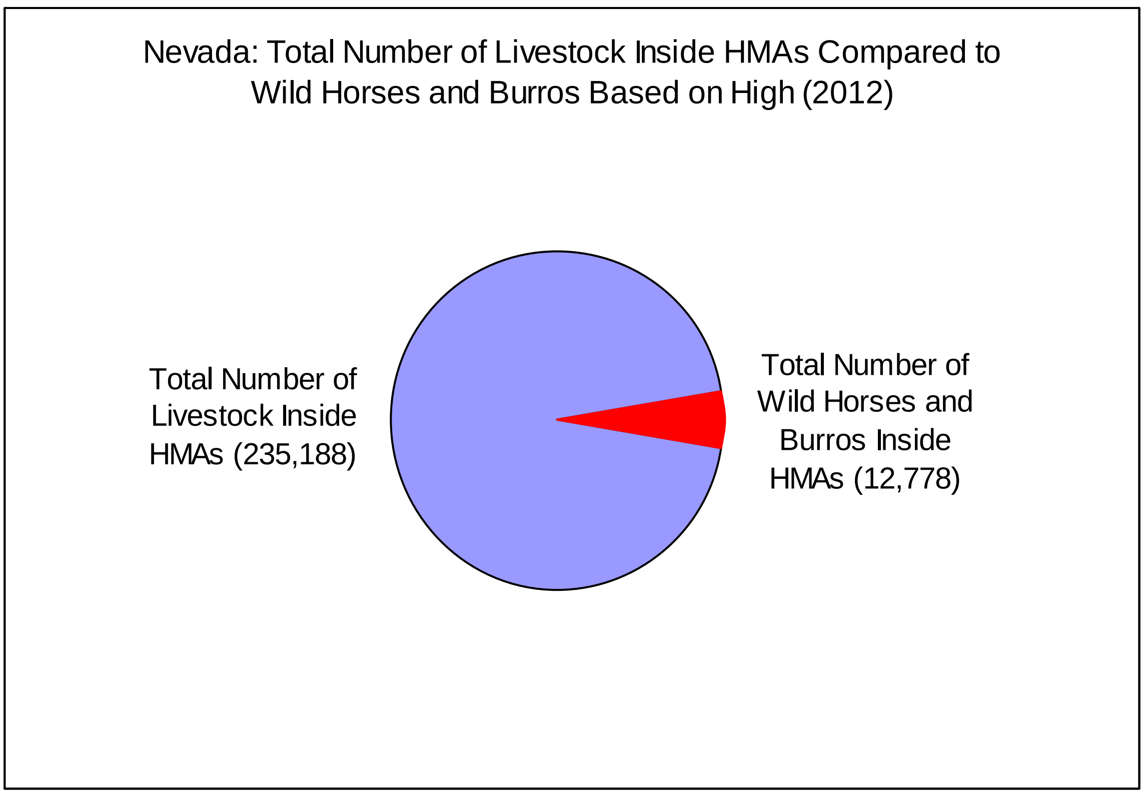


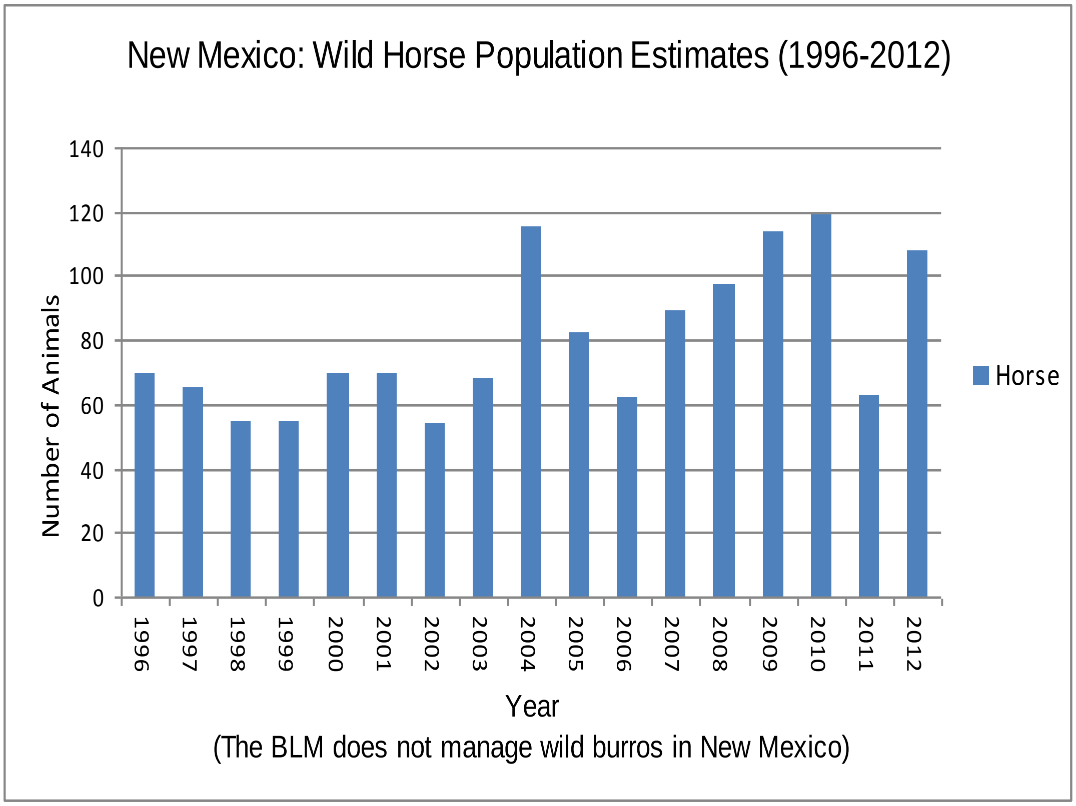
Figure NV-18:



New Mexico:

Based on fiscal year 2012 data there are, as of February 29, an estimated 108 wild horses and 0 wild burros in New Mexico occupying a total of two HMAs.[288] See Figure NM-1.[289] There are no wild horses or wild burros reported to exist on HAs that are not managed for the species.[290]

Figure NM-1:



Wild horses are found on both of the HMAs. The total current high AML[291] for wild horses in the state is 83.[292] Therefore, as of February 2012, the number of wild horses in

[288] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.

[289] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

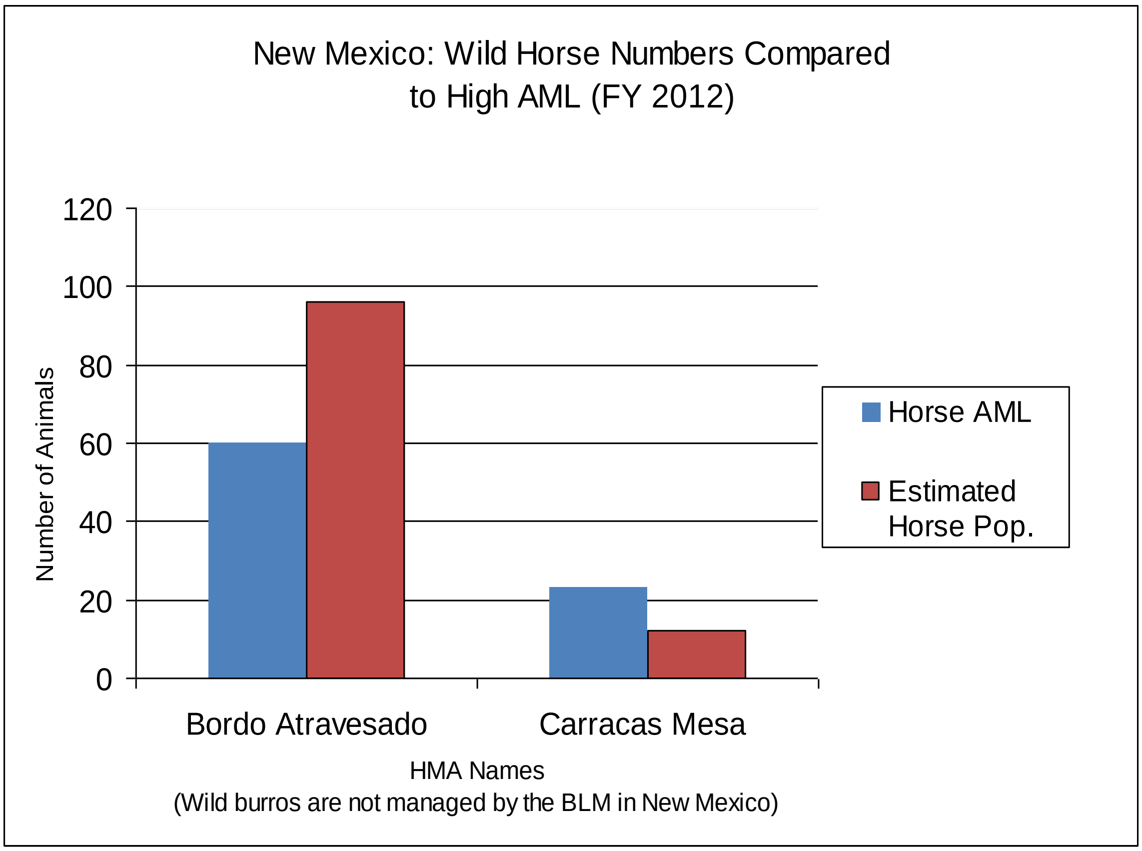
[290] *Ibid*.

[291] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.

[292] It is not known if the BLM has ever managed wild burros in New Mexico but, at present, no wild burros are managed by the BLM in the state.

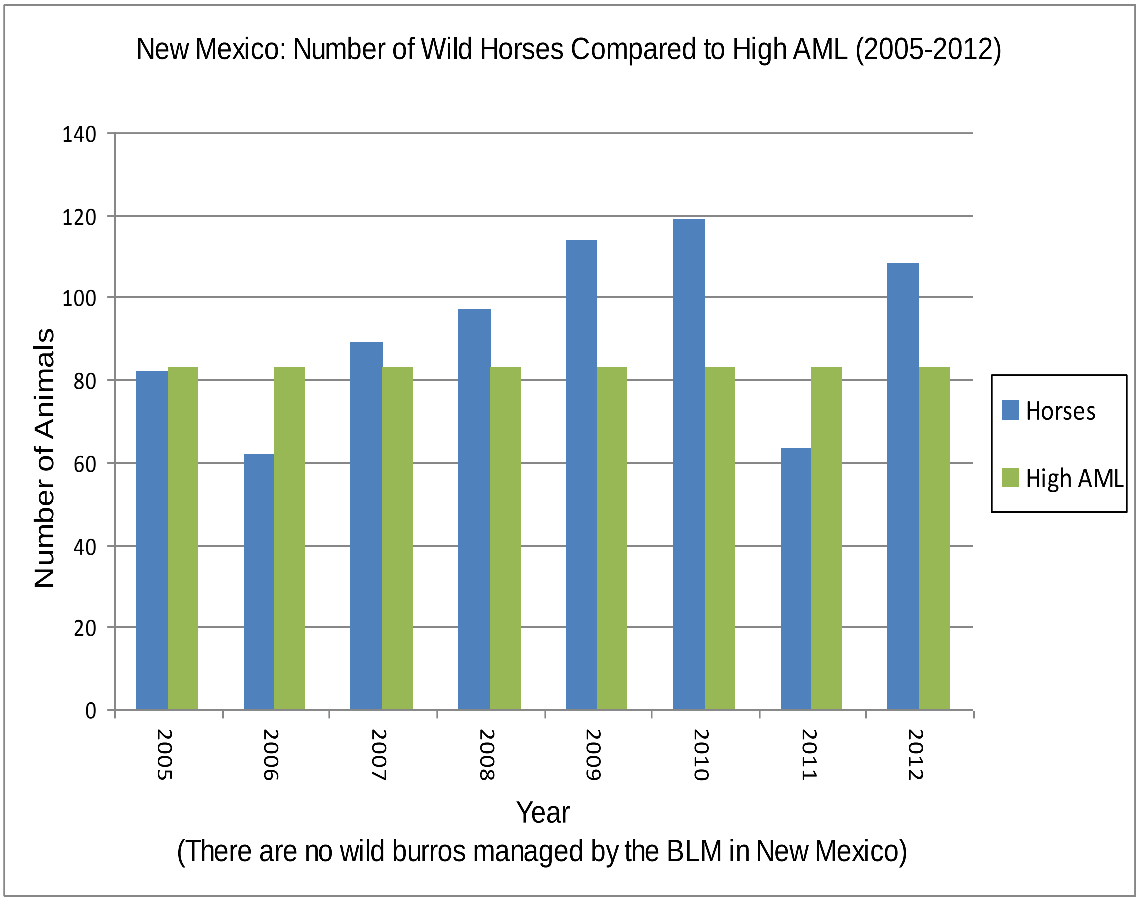
New Mexico is only 25 animals over the current high AML. This assumes that the current AMLs for while horses are justified – which remains highly questionable. See Figure NM-2.[293] This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses in New Mexico was below the current high AML in 2005, 2006, and 2011. See Figure NM-3.[294]

Figure NM-2:



[293] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[294] *Ibid*.

Figure NM-3:



In 2011, the BLM removed 86 wild horses from in and/or outside of HMAs in New Mexico. In total, from 1996 to 2011, 184 wild horses have been captured and removed from the range. See Figure NM-4.[295] During that same time period, 11,855 and 1,987 wild horses and burros, respectively, have been adopted in New Mexico.[296] See Figure NM-5.[297]

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[295] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

[296] This includes wild horses and burros captured and removed from the range in other states.

[297] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

Figure NM-4:

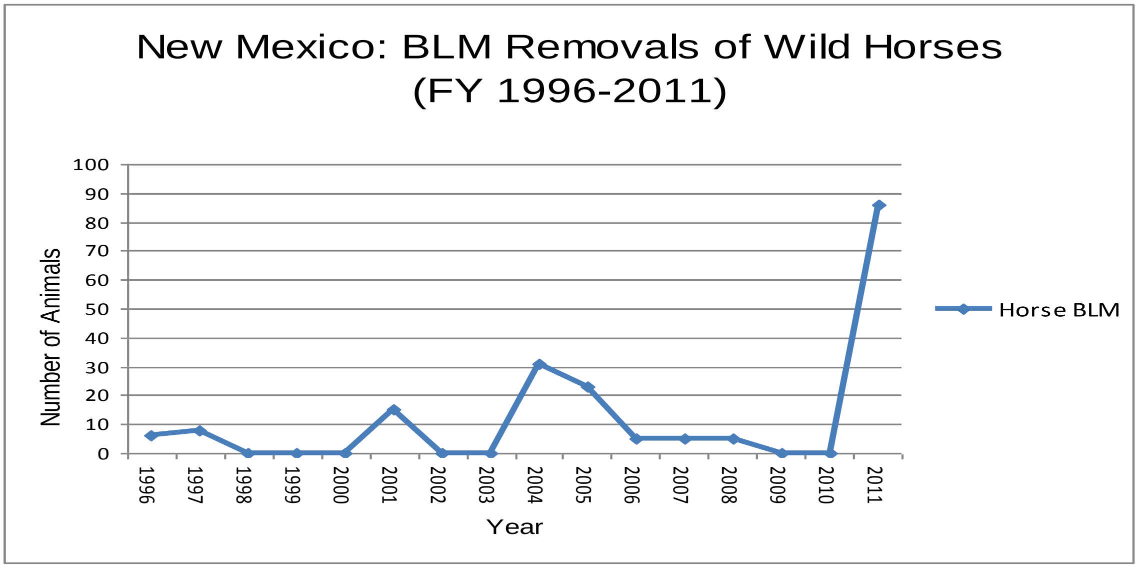
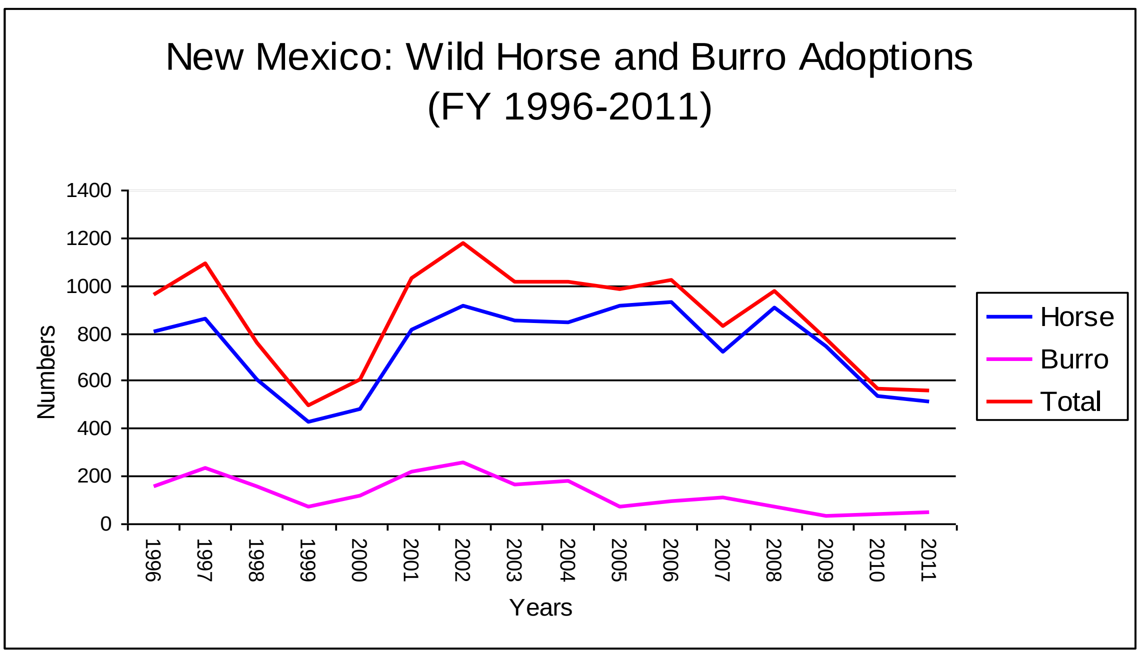


Figure NM-5:

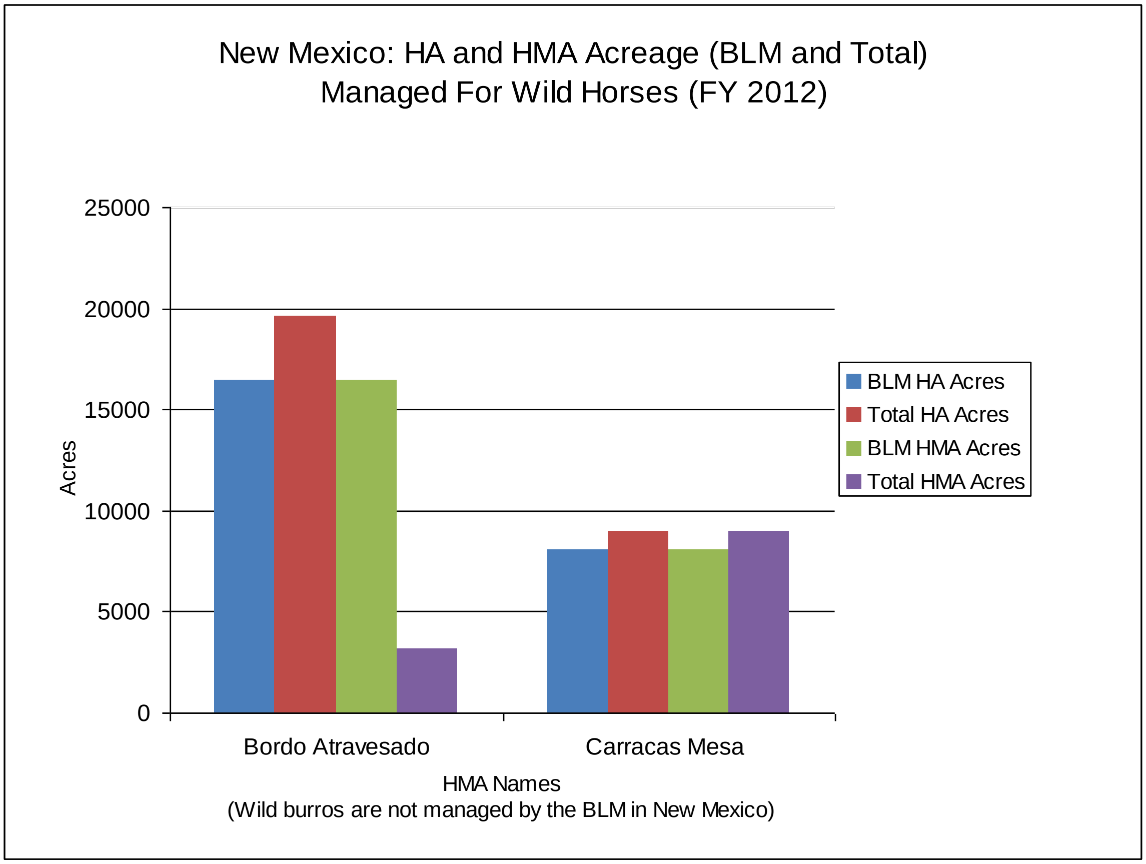


The two HMAs in New Mexico encompass 28,613 acres, including 24,506 acres of BLM lands. These HMAs are contained within HAs of the same acreage, including the same acreage of BLM lands. As a result, there has been no loss in HA acreage that provide habitat within which wild horses are managed in HMAs. See Figure NM-6.[298] Since

[298] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

2005 (annual BLM data prior to 2005 was not available), the acreage available to wild horses in HMAs has decreased by a single acre. See Figure NM-7.[299] Finally, according to BLM data, there are two HAs in the state from which wild horses have been permanently removed. These two HAs encompass 97,917 acres, including 64,149 acres of BLM lands. See Figure NM-8.[300] Consequently, 97,197 acres of habitat originally available for wild horses in New Mexico no longer exists. See Figure NM-9.[301]

Figure NM-6:



[299] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[300] *Ibid.*
[301] *Ibid.*

Figure NM-7:

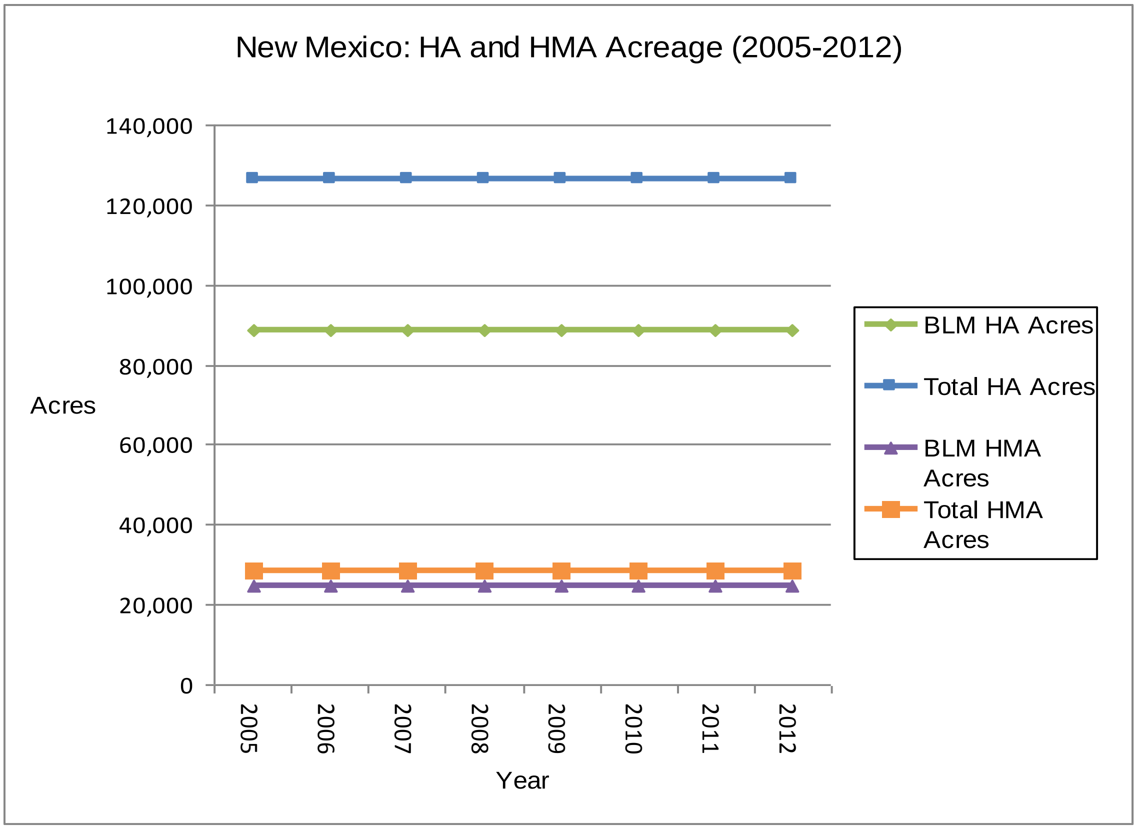


Figure NM-8:

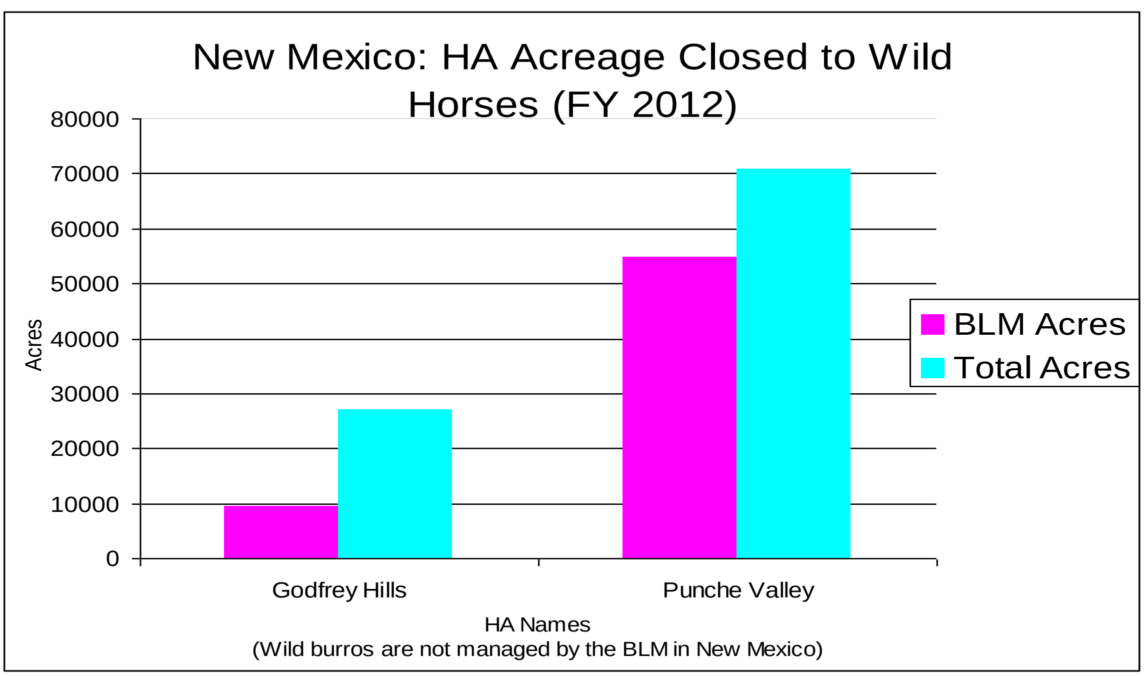
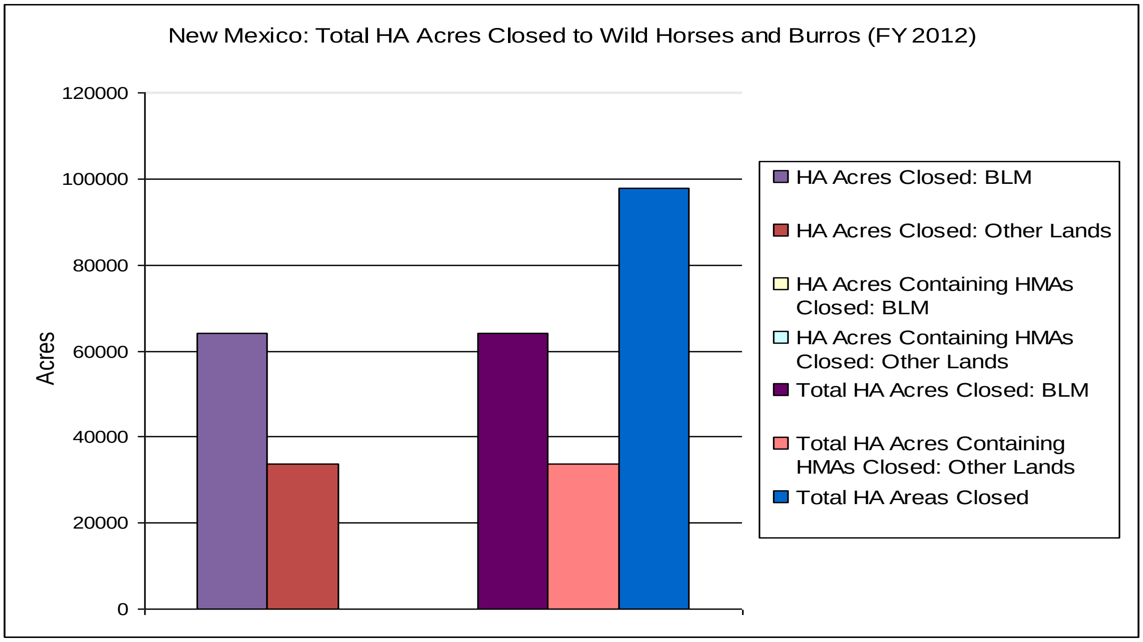


Figure NM-9:



There are 2,281 total public land grazing allotments in New Mexico, encompassing 12,764,434 acres. Of these acres, in 2011, rangeland monitoring has designated 1,814,534 acres in the “upward” trend, 3,971,225 acres in the “static” trend, 462,444 acres in the “downward” trend, and 6,516,231 acres in the “undetermined” trend.[302] The number of acres in these categories has varied over the years. See Figure NM-10.[303] In 2011, of the 2,281 allotments, 612 have been designated as “I” (improve), 846 as “M” (maintenance), 823 as “C” (custodial), and 0 as “uncategorized.”[304] The number of allotments in these

[302]Trends are designated as “upward” if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as “downward” if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[303] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

[304] The objective for “I” allotments is to "improve the current resource condition." The objective for “M” allotments is to "maintain the current resource condition." The objective for “C” allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-the-ground management efforts to those allotments where grazing management is most needed to improve resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

categories and the acreage so designated is subject to variation. See Figures NM-11 and NM-12.[305]

Figure NM-10:

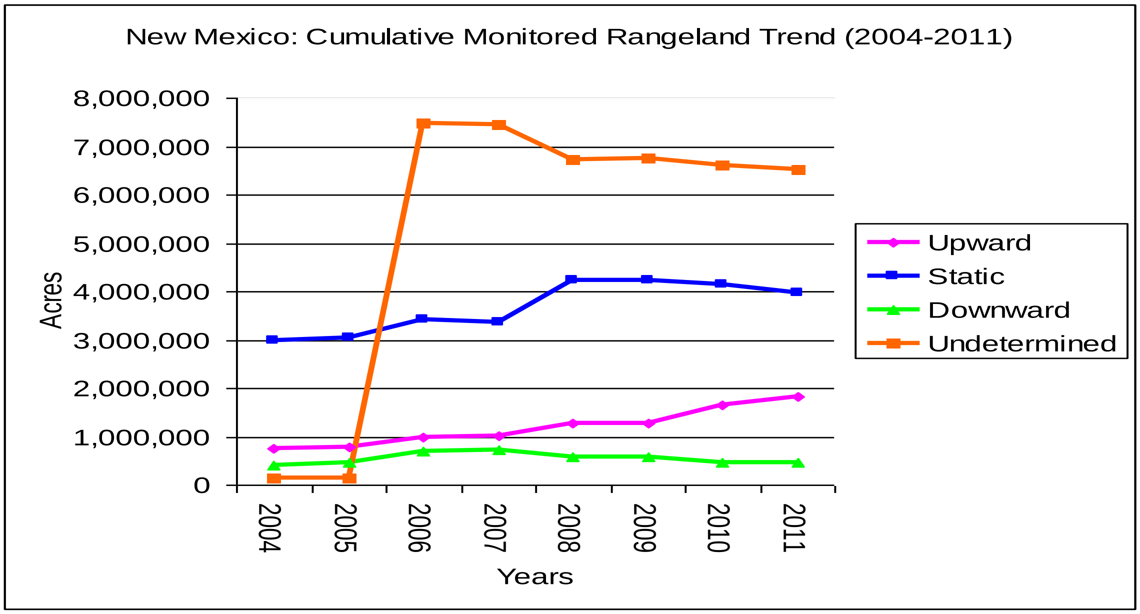
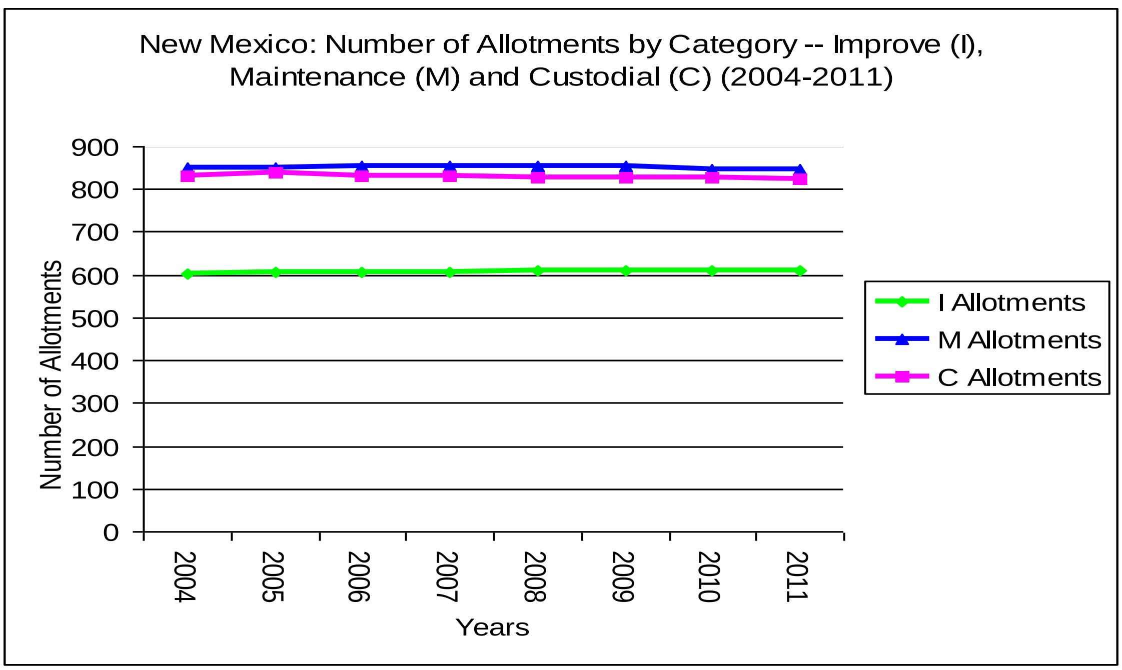
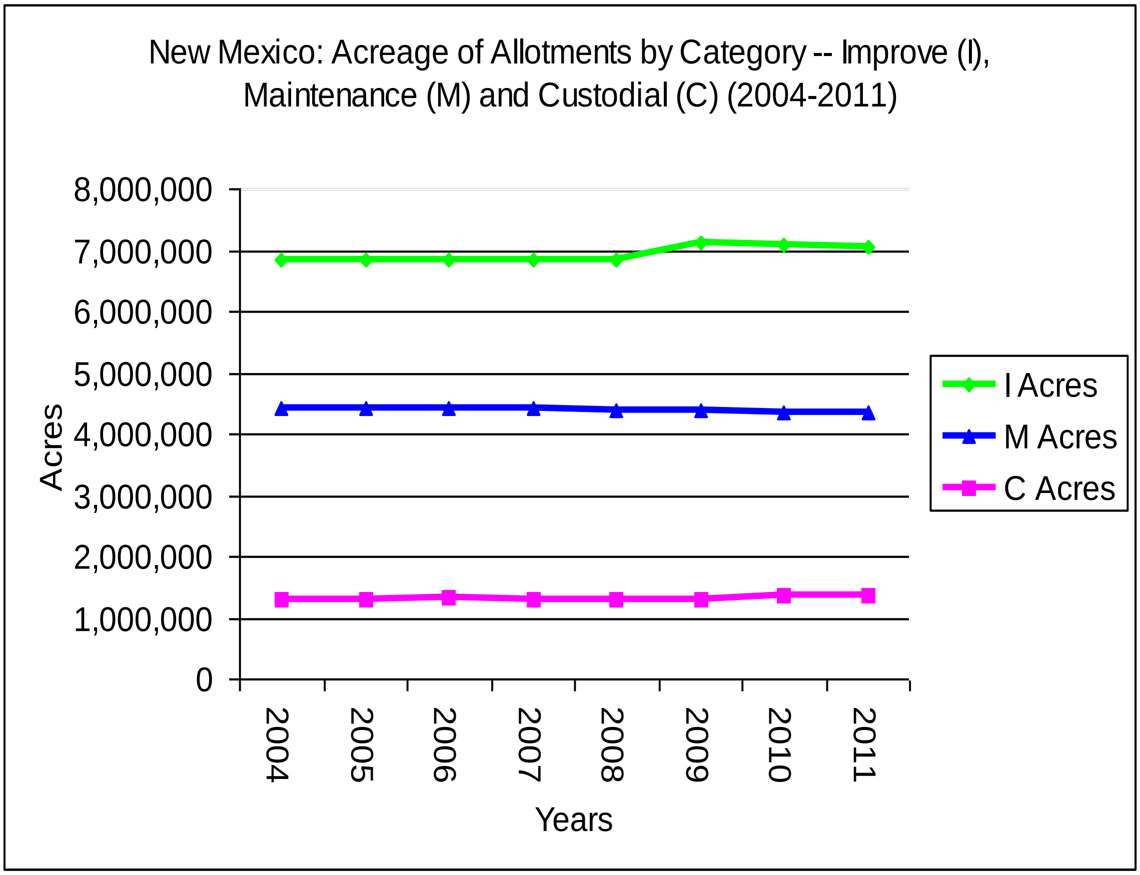


Figure NM-11:



[305] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

Figure NM-12:



In 2011, the total number of AUMs used for grazing was 1,506,494. This included 1,411,433 for cattle/yearlings/bison, 17,168 for domestic horses and burros, and 77,893 for sheep and goats. The total AUMs for wild horses in New Mexico in 2011 was 83,[306] indicating that, statewide, livestock AUMs are 18,151 times higher than wild horse AUMs. See Figure NM-13.[307] Since 2000, the total for livestock AUMs has been variable, ranging from a low of 702,833 in 2004 to a high in 2000 of 1,550,993. See Figure NM-14.[308]

[306] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[307] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm.
[308] *Ibid*.

Figure NM-13:

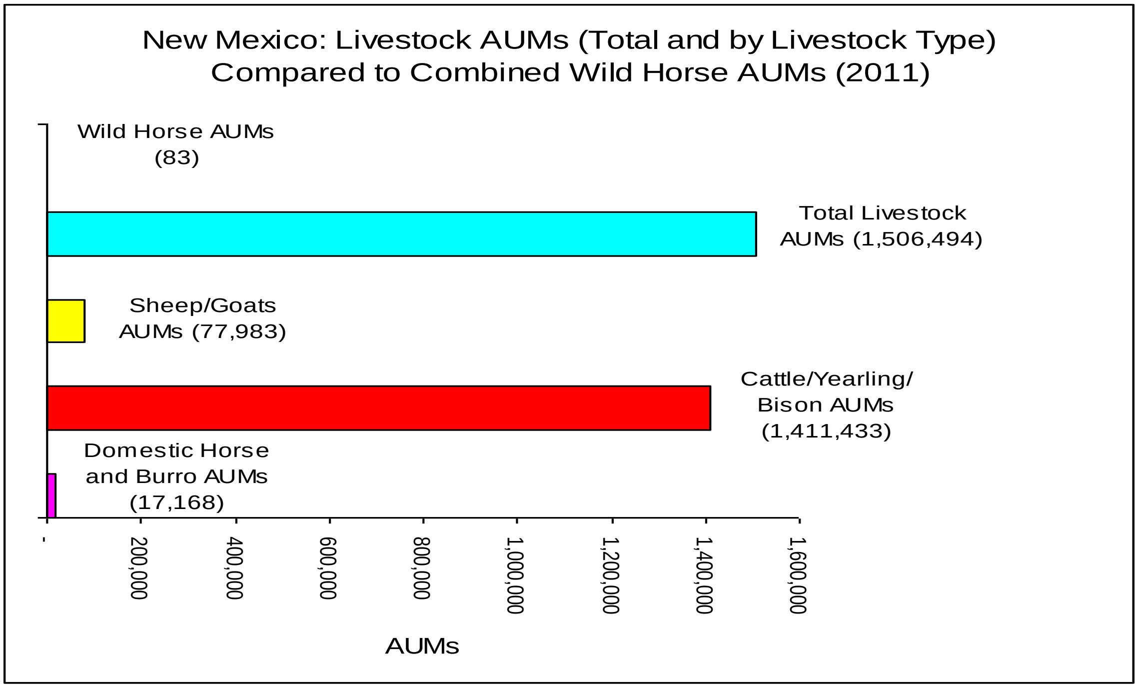
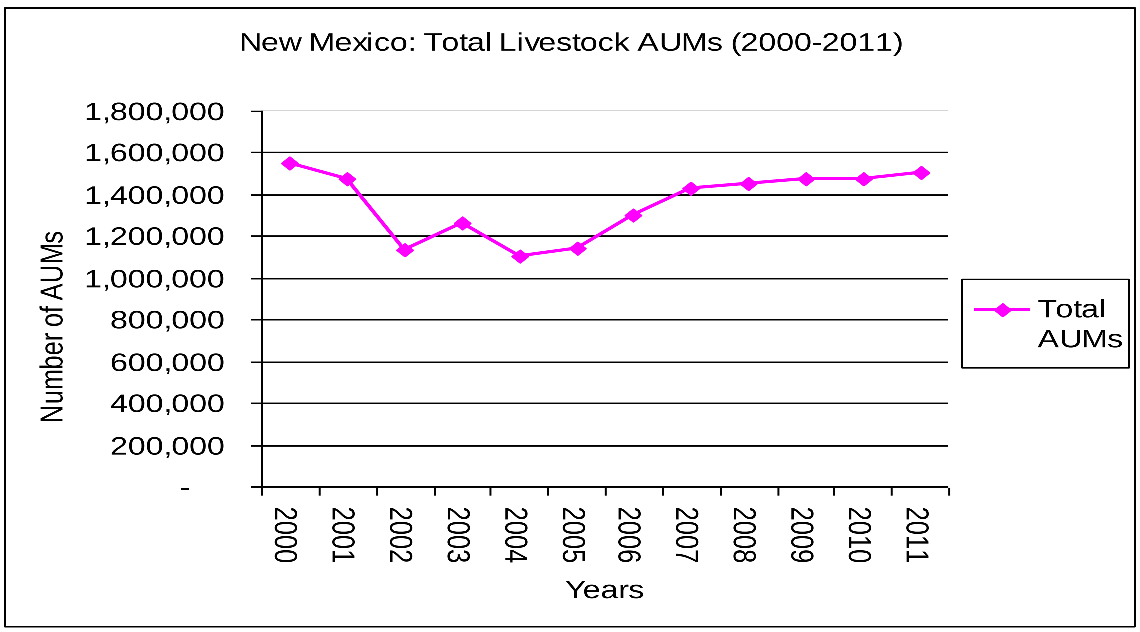


Figure NM-14:

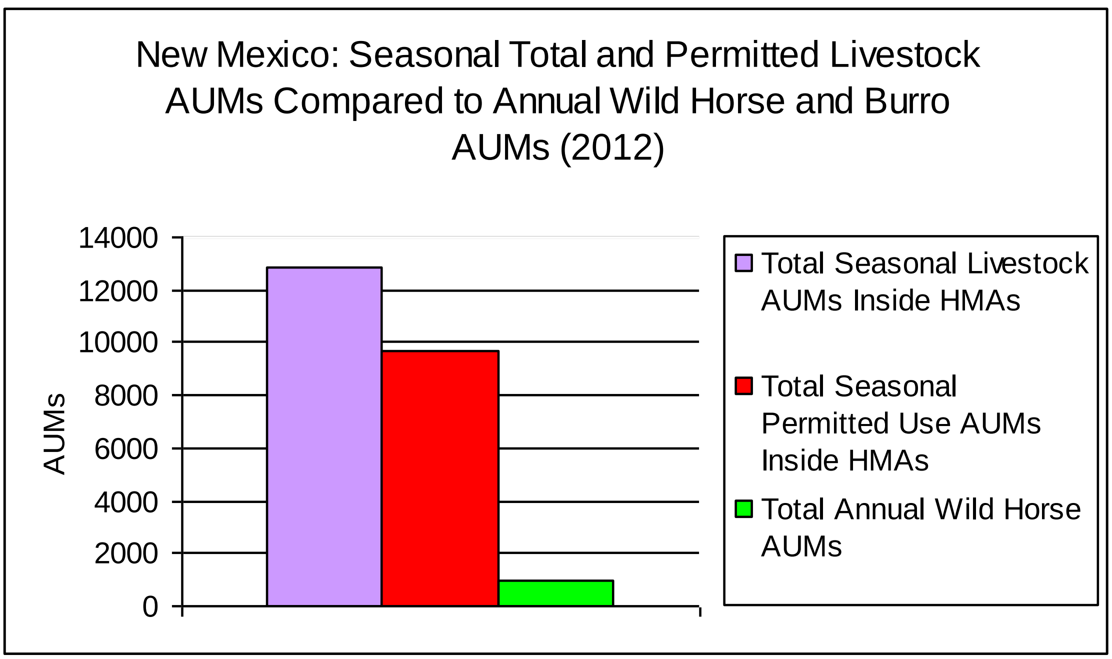


According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 9,452 livestock (7,946 cattle, 6 domestic horses/burros, and 1,500 sheep) were grazed on an estimated 24 allotments wholly or partially within HMAs in

New Mexico. This corresponds to approximately 8,246 AUMs.[309] The total AUMs used annually depends on the type of livestock grazed and the duration for which they are grazed on public lands. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing for livestock using allotments wholly or partially within HMAs was 24,977, 15,049, 2,593, and 17,642, respectively.[310]

When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[311] the number of livestock grazed within the HMAs is 6,436, corresponding to 12,879 total AUMs and 9,665 AUMs permitted for use for seasonal/annual grazing. This compares to a high AML for wild horses of 83, which equates to an annual AUM of 996. See Figures NM-15 and NM-16. Hence, even at the HMA level, permitted use livestock AUMs are nearly ten times larger than annual wild horse and burro AUMs. In addition, of the total number of livestock and wild horses estimated to use all New Mexico HMAs in 2012, 98.7 percent are livestock and 1.3 percent are wild horses. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

Figure NM-15:

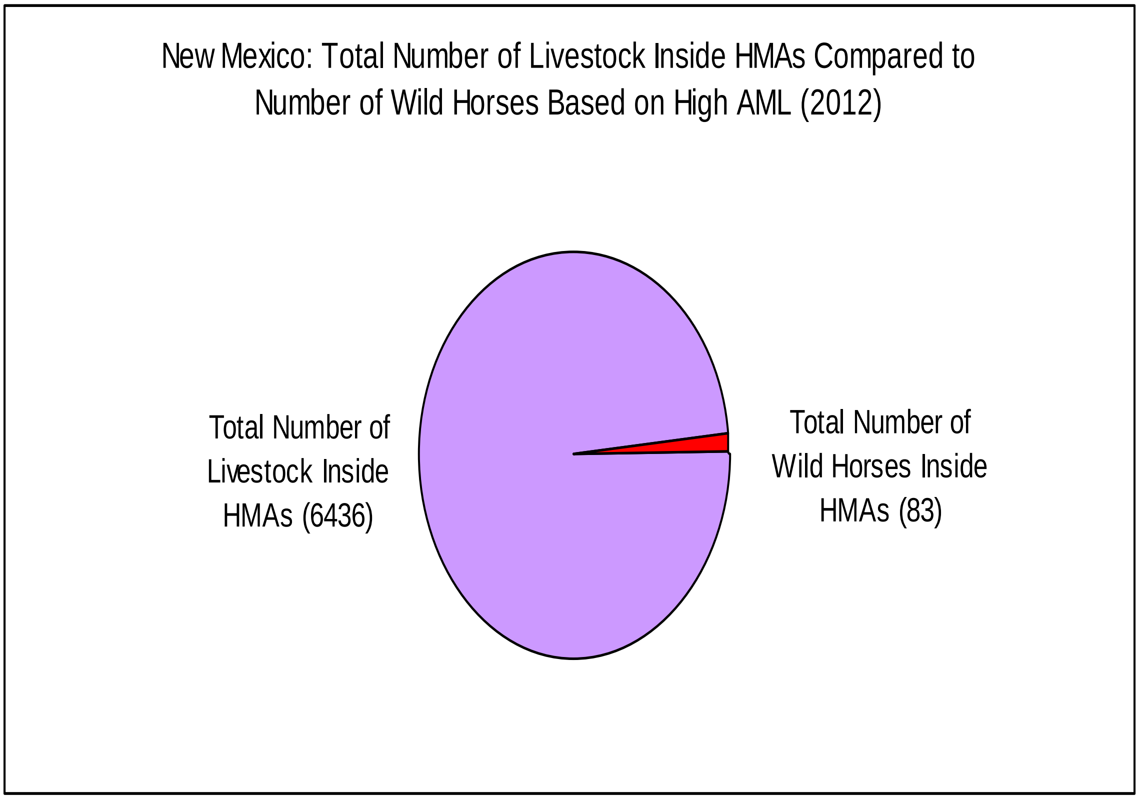


[309] The AUMs were calculated using conversion rates of 1 cow = 1 AUM, 1 horse = 1 AUM (domestic horses and burros were combined in the BLM data set so the number of each species is unknown), and .5 sheep = 1 AUM. These conversion rates are consistent with BLM policies or were identified in various agricultural sources found on the Internet.

[310] Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.

[311] This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

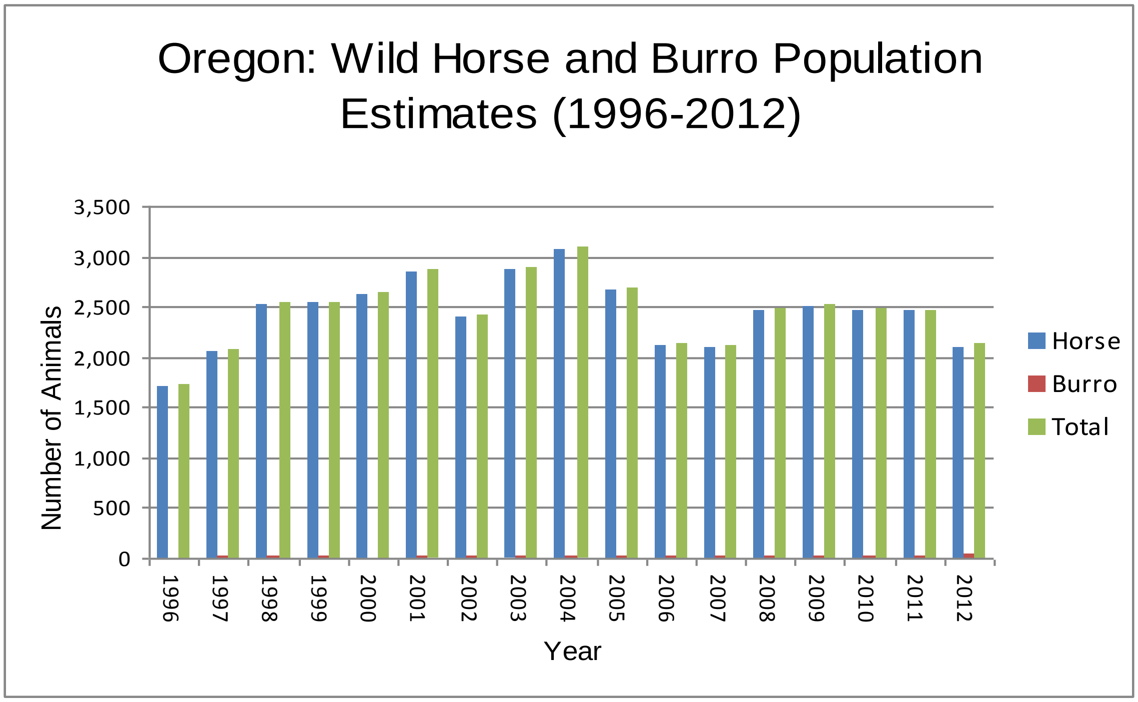
Figure NM-16:


New Mexico: Total Number of Livestock Inside HMAs Compared to Number of Wild Horses Based on High AML (2012)
Total Number of Livestock Inside HMAs (6436)
Total Number of Wild Horses Inside HMAs (83)

Oregon:

Based on fiscal year 2012 data there are, as of February 29, an estimated 2,053 wild horses and 35 wild burros in Oregon occupying a total of 18 HMAs.[312] See Figure OR-1.[313] In addition, there are an estimated 40 wild horses and zero wild burros on HAs that are not managed for the species.[314] As a result, there are an estimated 2,093 wild horses and 35 wild burros, for a total of 2,128 animals, in Oregon.

Figure OR-1:



Wild horses are found in 17 HMAs while wild burros and horses are both found in one HMA. The total current high AML[315] for wild horses and burros in the state is 2,690 for wild horses and 25 for wild burros, or 2,715 combined. Therefore, as of February 2012, the number of wild horses in Oregon is below high AML and wild burros only exceed

[312] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.

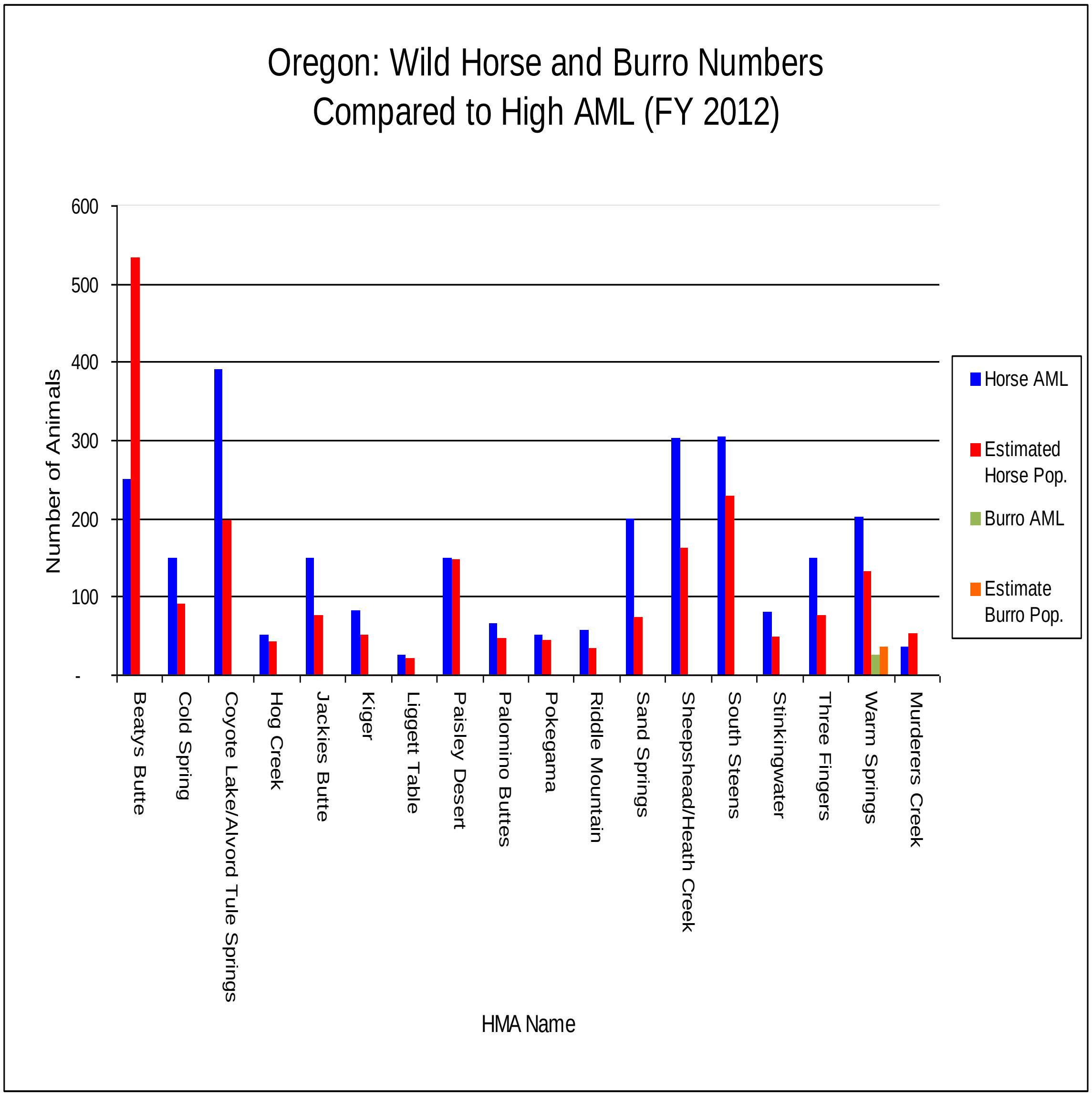
[313] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

[314] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

[315] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.

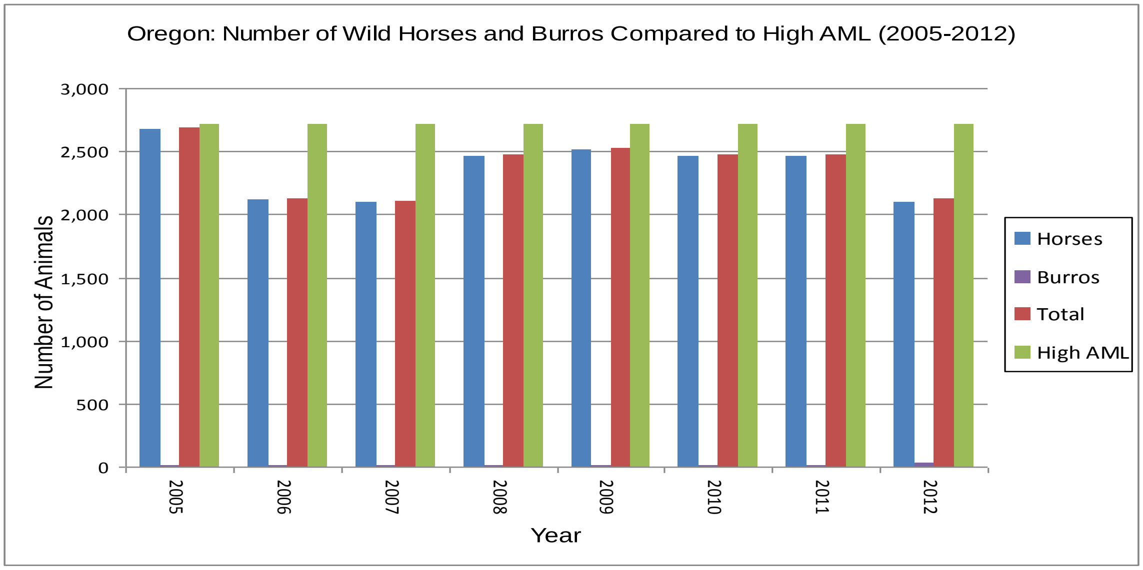
high AML by ten animals. See Figure OR-2.[316] This assumes that current AMLs are scientifically justified – which remains highly questionable. This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses and burros in Oregon have been under the combined high AML every year. See Figure OR-3.[317]

Figure OR-2:



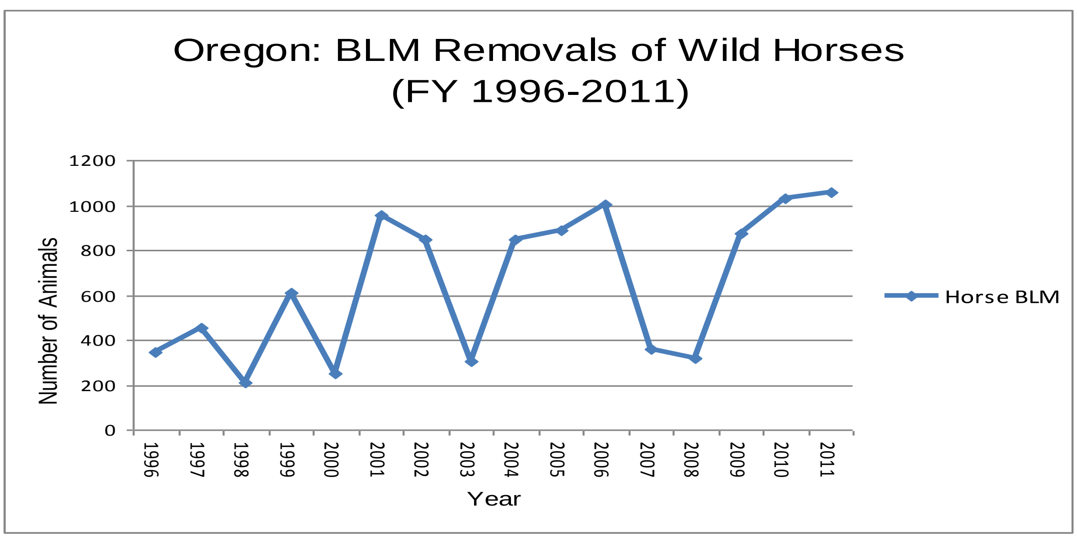
[316] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[317] *Ibid*.

Figure OR-3:



In 2011, the BLM removed 1060 wild horses and 0 wild burros from in and/or outside of HMAs in Oregon. In total, from 1996 to 2011, 10,369 wild horses and 2 wild burros have been captured and removed from the range. See Figure OR-4.[318] During that same time period, 4,691 and 408 wild horses and burros, respectively, have been adopted in Oregon.[319] See Figure OR-5.[320]

Figure OR-4:



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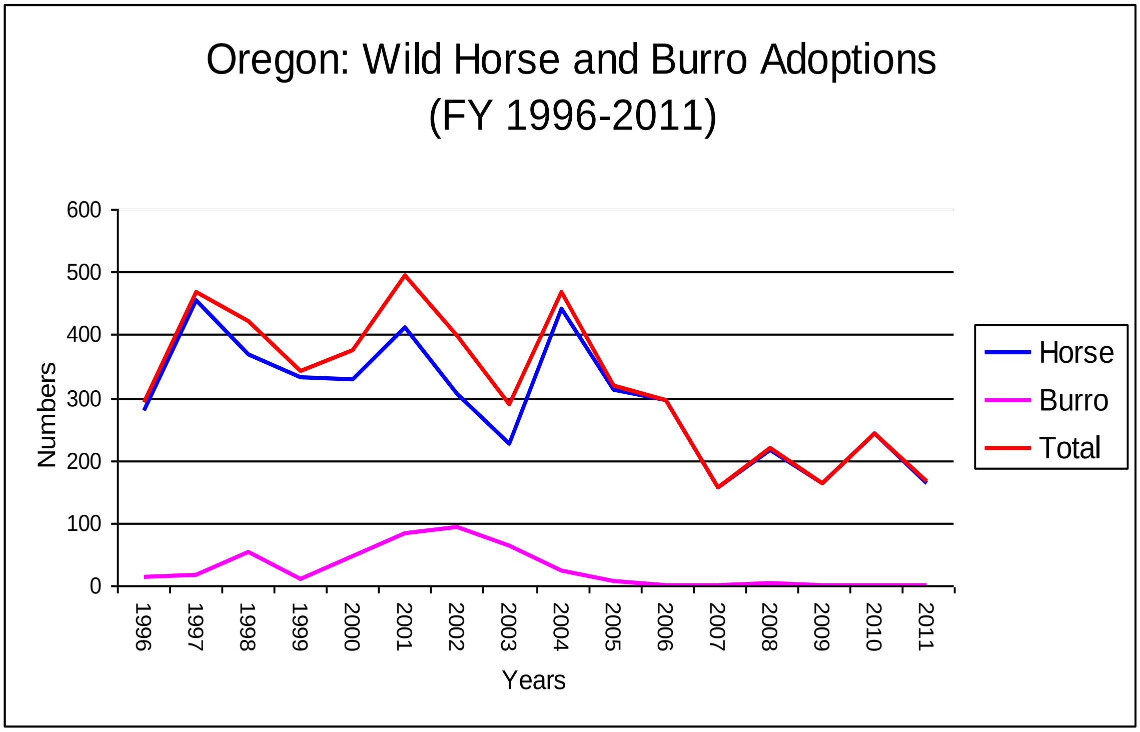
[318] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

[319] This includes wild horses and burros captured and removed from the range in other states.

[320] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

Figure OR-5:



The 18 HMAs in Oregon encompass 2,978,751 acres, including 2,733,577 acres of BLM lands. The corresponding amount of HA acreage is 2,879,711 including 2,532,733 BLM lands. Unlike most states where the HA acres within which wild horse and burros are managed in HMAs exceed HMA acreage, this is not the case in Oregon. According to the BLM, the HMA acreage is larger than the HA acreage (for the areas management for wild horses and burros) in Oregon as a result of the acreage of HMAs created from other HAs not being included in the total HA acreage. As a result, the existing HMAs contain 9,040 acres more than their corresponding HAs. See Figure OR-6.[321] Nevertheless, since 2005 (annual BLM data prior to 2005 was not available), the total acres available to wild horses and/or burros in HMAs has declined by 54,907 acres. See Figure OR-7.[322] Finally, according to BLM data, there are 20 HAs in the state from which wild horses and/or burros have been permanently removed. These 20 HAs encompass 1,432,645 acres, including 1,075,927 acres of BLM lands. See Figure OR-8.[323] Consequently, 1,333,605 acres of habitat originally available for wild horses and burros in Oregon no longer exists. See Figure OR-9.[324]

[321] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[322] *Ibid.*
[323] *Ibid.*
[324] *Ibid.*

Figure OR-6:

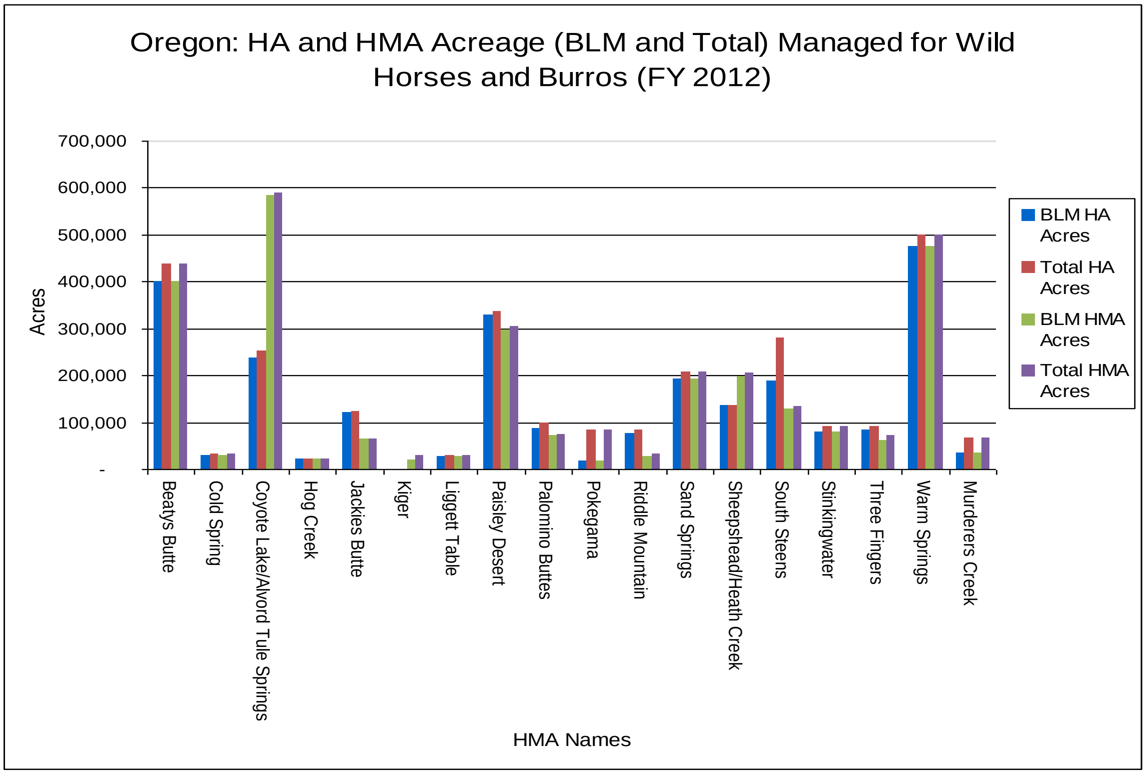


Figure OR-7:

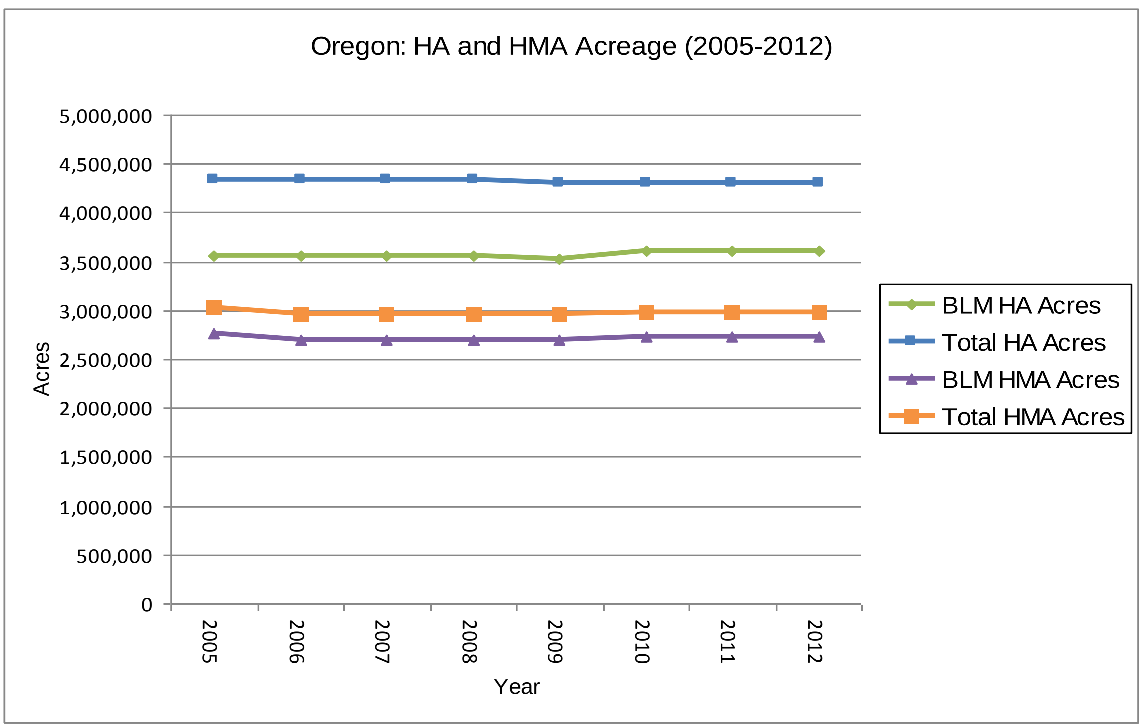


Figure OR-8:

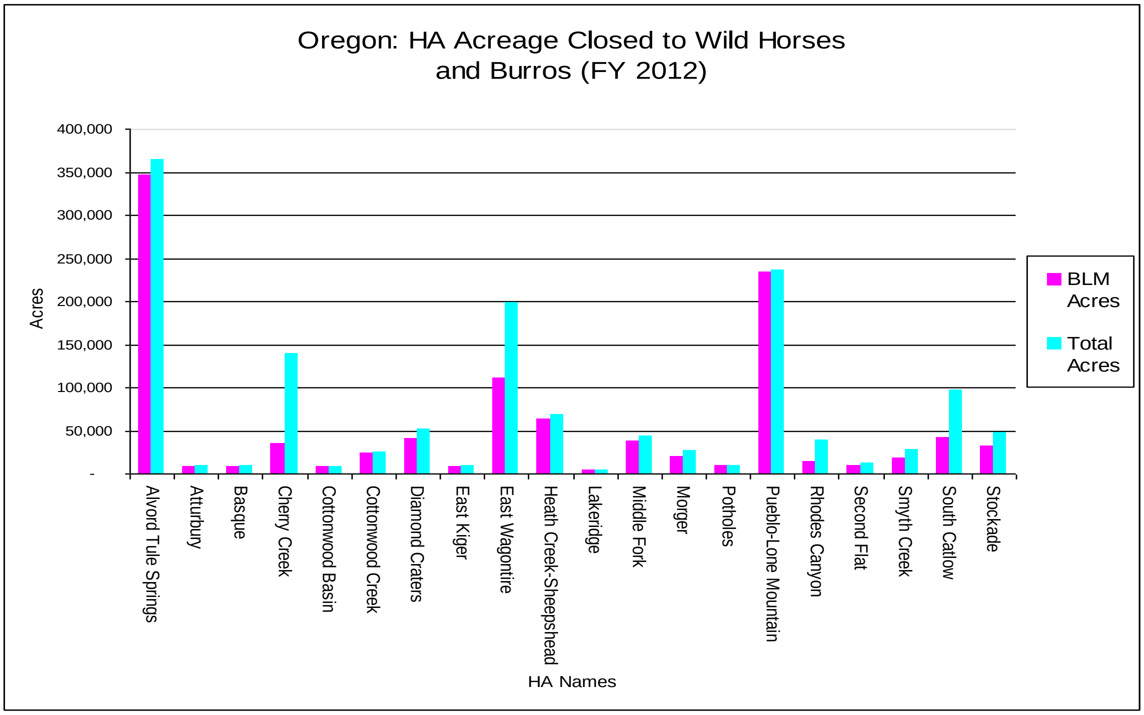
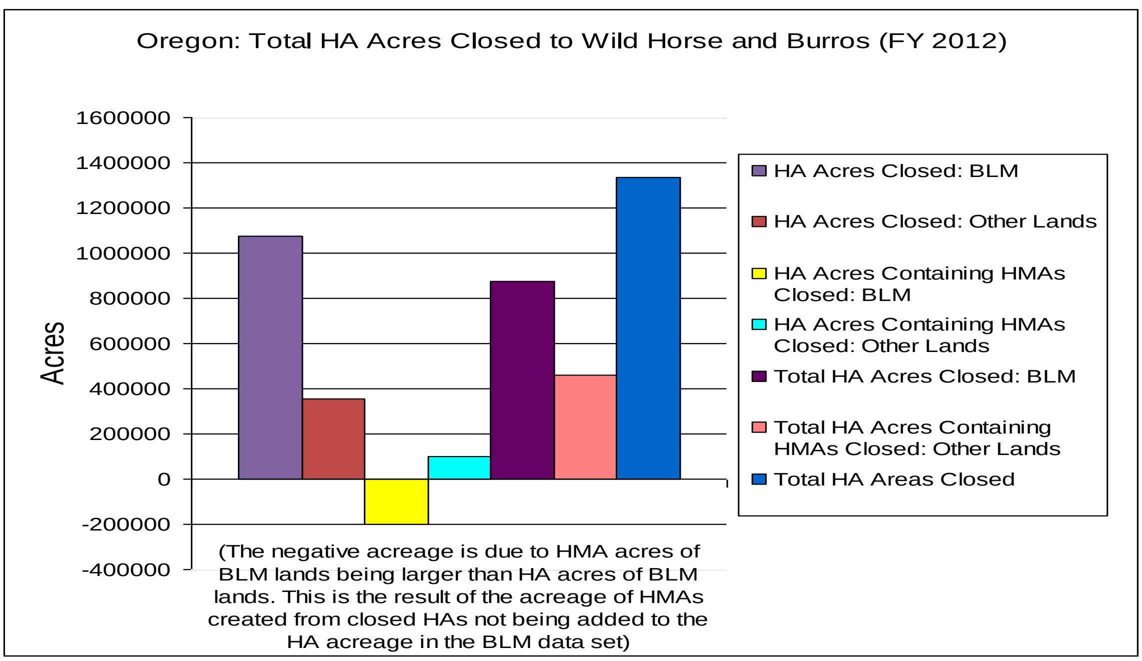
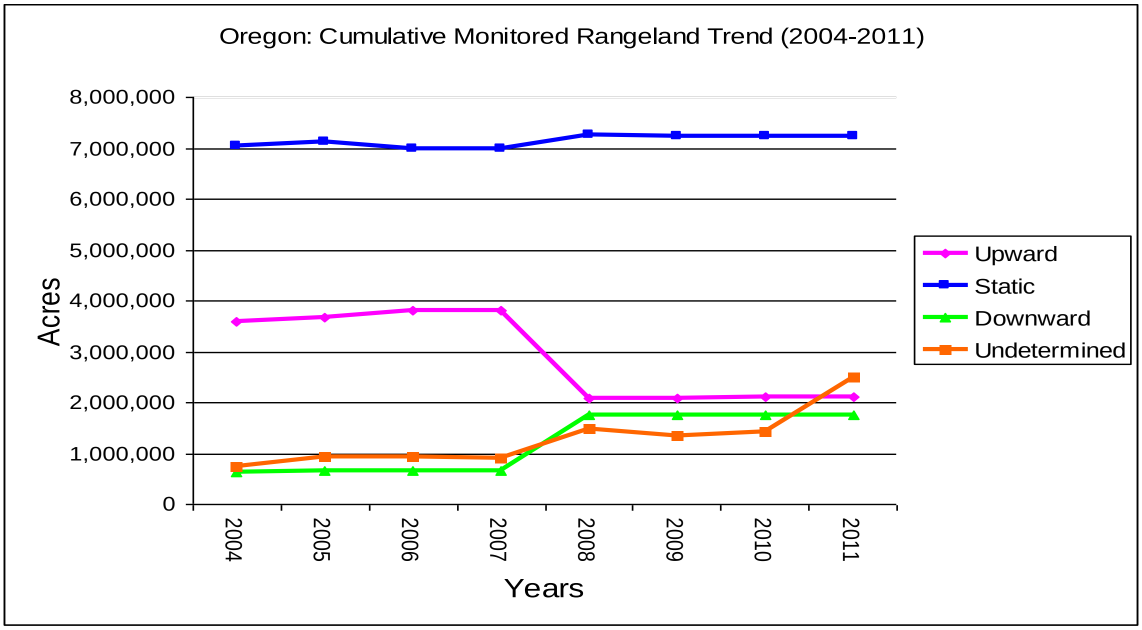


Figure OR-9:



There are 2,027 total public land grazing allotments in Oregon, encompassing 13,577,959 acres. Of these acres, in 2011, rangeland monitoring has designated 2,110,431 acres in the "upward" trend, 7,224,661 acres in the "static" trend, 1,754,734 acres in the “downward” trend, and 2,488,133 acres in the “undetermined” trend.[325] The number of allotments and corresponding acreage in these categories has varied over the years. See Figures OR-10.[326] In 2011, of the 2,027 allotments, 471 have been designated as “I” (improve), 441 as “M” (maintenance), 1,145 as “C” (custodial), and 2 as uncategorized.”[327] The number of allotments and corresponding acreages in these categories is subject to variation. See Figures OR-11 and OR-12.[328]

Figure OR-10:



[325]Trends are designated as “upward” if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as “downward” if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[326] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_ management/rangeland_inventory.html

[327] The objective for “I” allotments is to "improve the current resource condition." The objective for “M” allotments is to "maintain the current resource condition." The objective for “C” allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-the-ground management efforts to those allotments where grazing management is most needed to improve resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

[328] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_ management/rangeland_inventory.html

Figure OR-11:

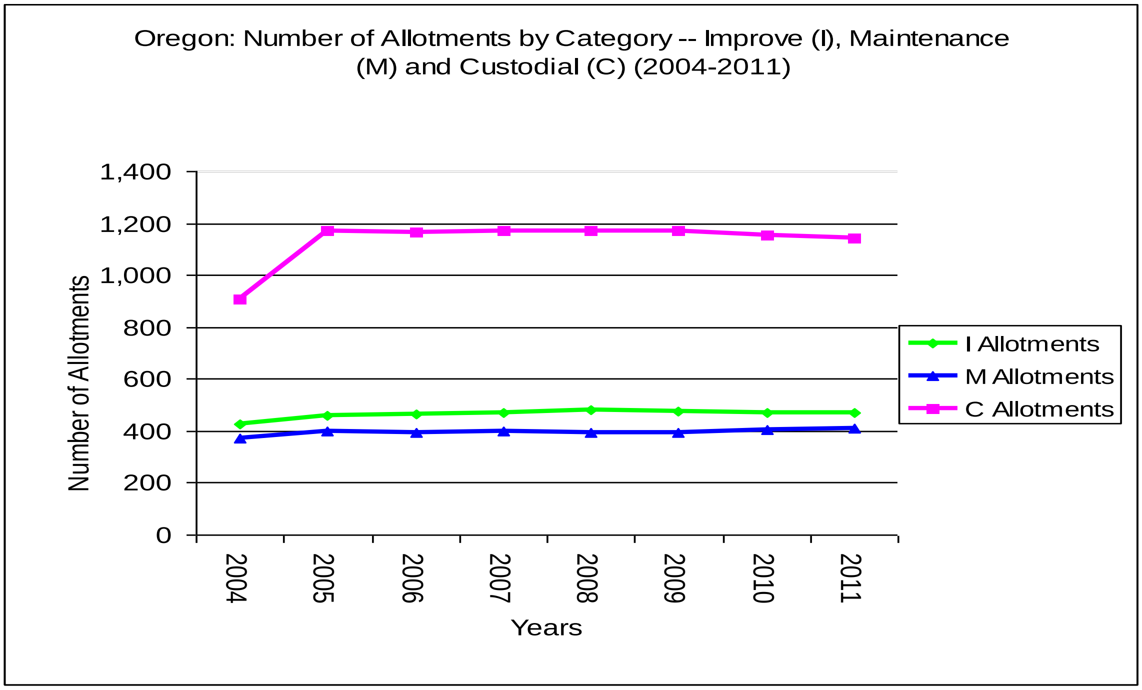
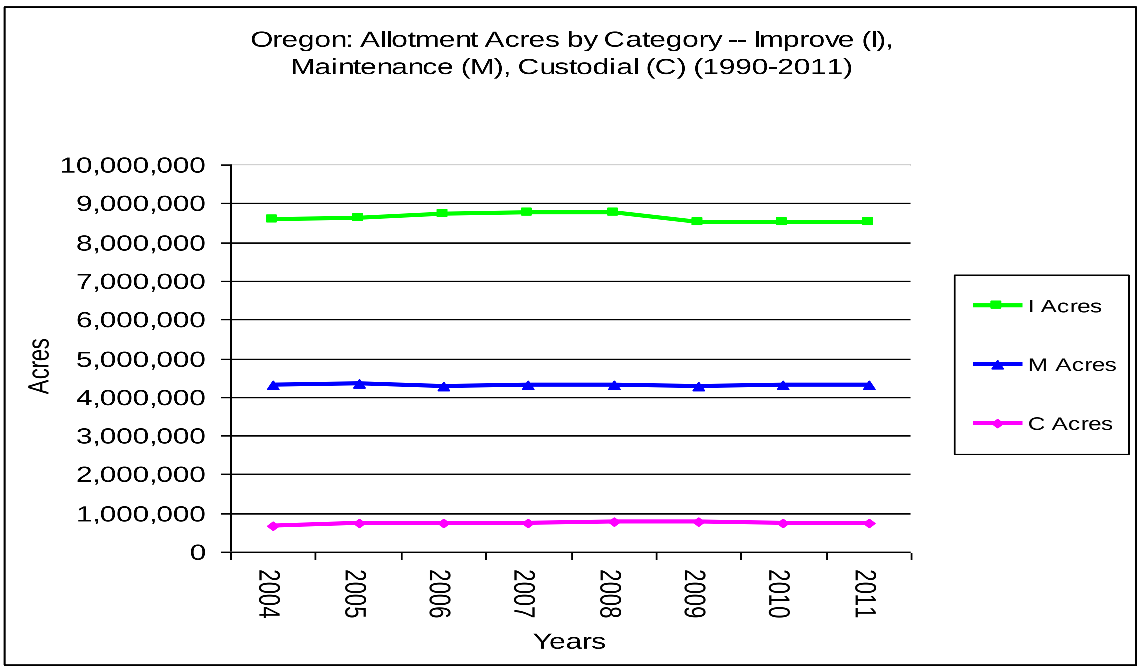


Figure OR-12:



In 2011, the total number of AUMs used for grazing was 815,632. This included 807,526 AUMs for cattle/yearlings/bison, 1,923 for domestic horses and burros, and 6,183 for sheep and goats. The total AUMs for wild horses and burros in Arizona in 2011 was

2702.5,[329] indicating that, statewide, livestock AUMs are 302 times higher than wild horse and burro AUMs. See Figure OR-13.[330] Since 2000, the total for livestock AUMs has been variable, ranging from a low of 702,833 in 2005 to a high of 832,481 in 2000. See Figure OR-14.[331]

Figure OR-13:

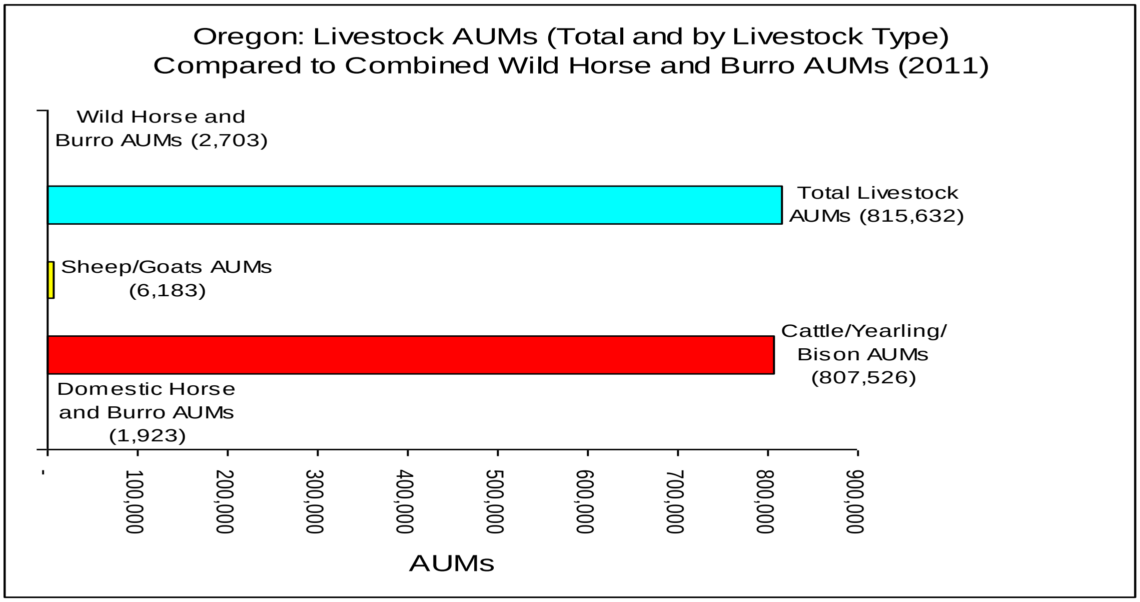
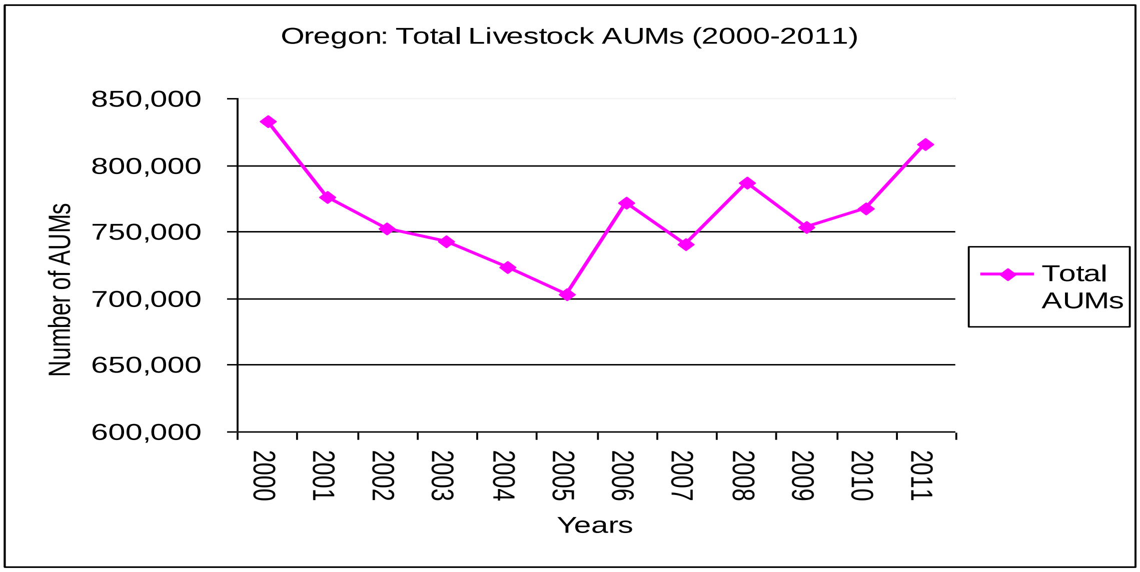


Figure OR-14:

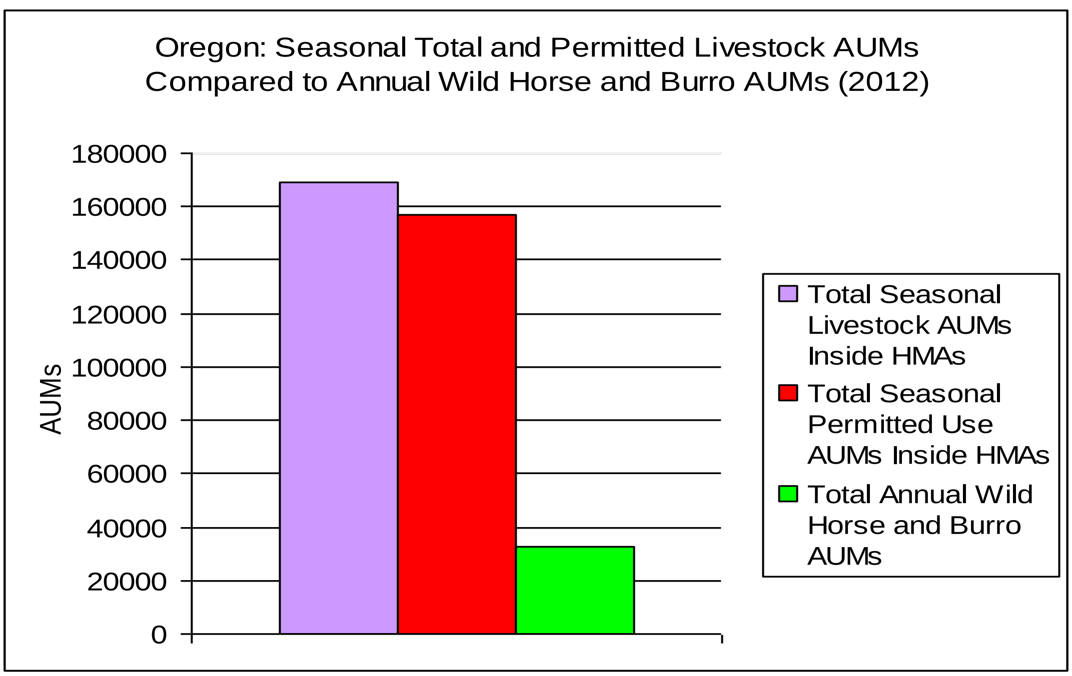


[329] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[330] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm.
[331] *Ibid*.

According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 54,328 (all cattle) were grazed on an estimated 54 allotments wholly or partially within HMAs in Oregon. This corresponds to 54,328 AUMs. The actual number of AUMs depends on the type of livestock grazed and the duration for which they are grazed on public lands. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing for livestock using allotments wholly or partially within HMAs was 281,198, 226,887, 40,275, and 267,162, respectively.[332]

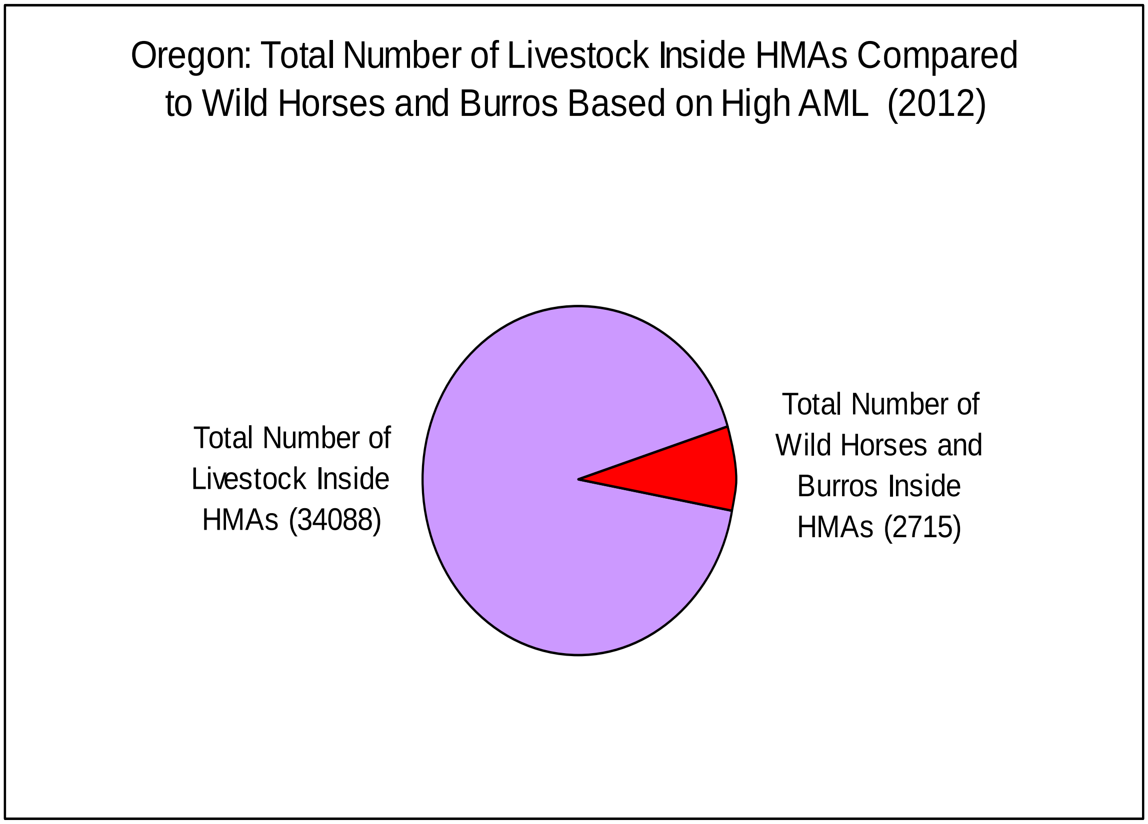
When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[333] the number of livestock grazed within the HMAs is 33,088, corresponding to 16,884 total AUMs and 156,821AUMs permitted for use for seasonal/annual grazing. This compares to a high AML for wild horses and burros of 2,715 (2,690 horses and 25 burros), which equates to an annual AUM of 32,430. See Figures OR-15 and OR-16. Hence, even at the HMA level, permitted use livestock AUMs are nearly five times larger than annual wild horse and burros AUMs. In addition, of the total number of livestock, wild horses, and/or wild burros estimated to use all Oregon HMAs in 2012, 92.6 percent are livestock, 7.3 percent are wild horses, and 0.7 percent are wild burros. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

Figure OR-15:



[332] Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.
[333] This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

Figure OR-16:

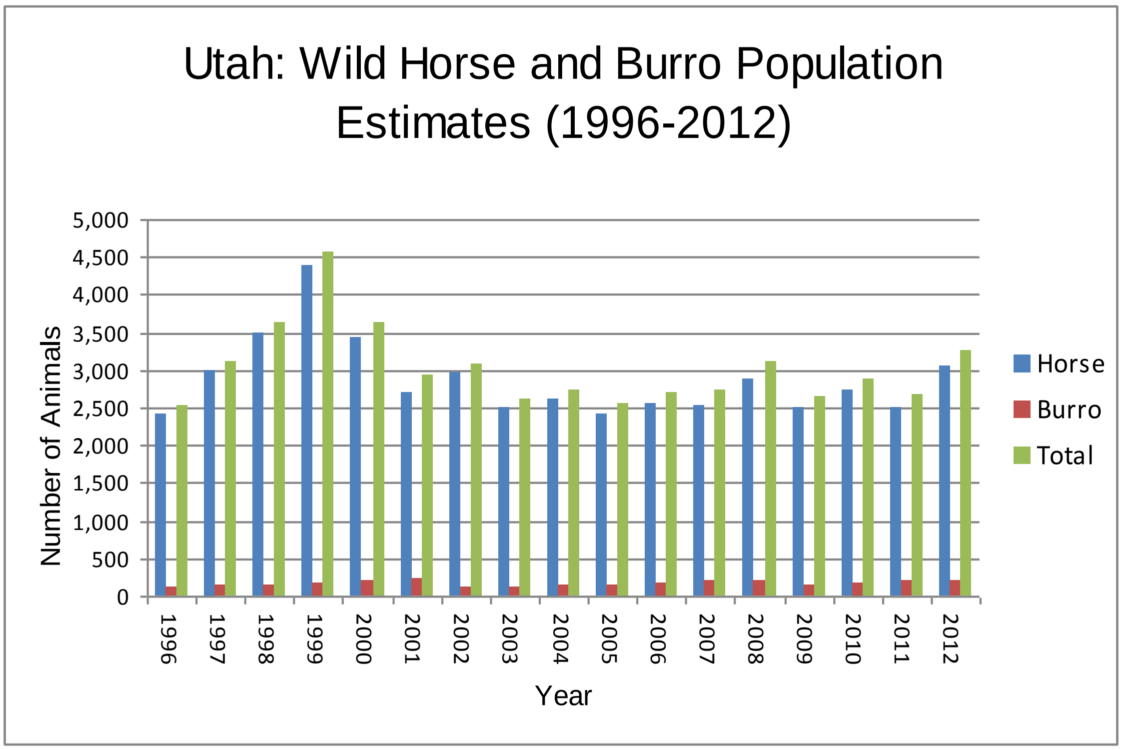


Oregon: Total Number of Livestock Inside HMAs Compared to Wild Horses and Burros Based on High AML (2012)
Total Number of Livestock Inside HMAs (34088)
Total Number of Wild Horses and Burros Inside HMAs (2715)

Utah:

Based on fiscal year 2012 data there are, as of February 29, an estimated 2,494 wild horses and 217 wild burros in Utah occupying a total of 19 HMAs.[334] See Figure UT-1.[335] In addition, there are an estimated 546 wild horses and 0 wild burros on HAs that are not managed for the species.[336] As a result, there are an estimated 3,040 wild horses and 217 wild burros, for a total of 3,257 animals, in Utah.

Figure UT-1:



Wild horses are found in 17 of the 19 HMAs while wild burros are found in two of the 19 HMAs in Utah. The total current high AML[337] for wild horses and burros in the state is 1,786 and 170, respectively, or 1,956 combined. Therefore, as of February 2012, the

[334] BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.

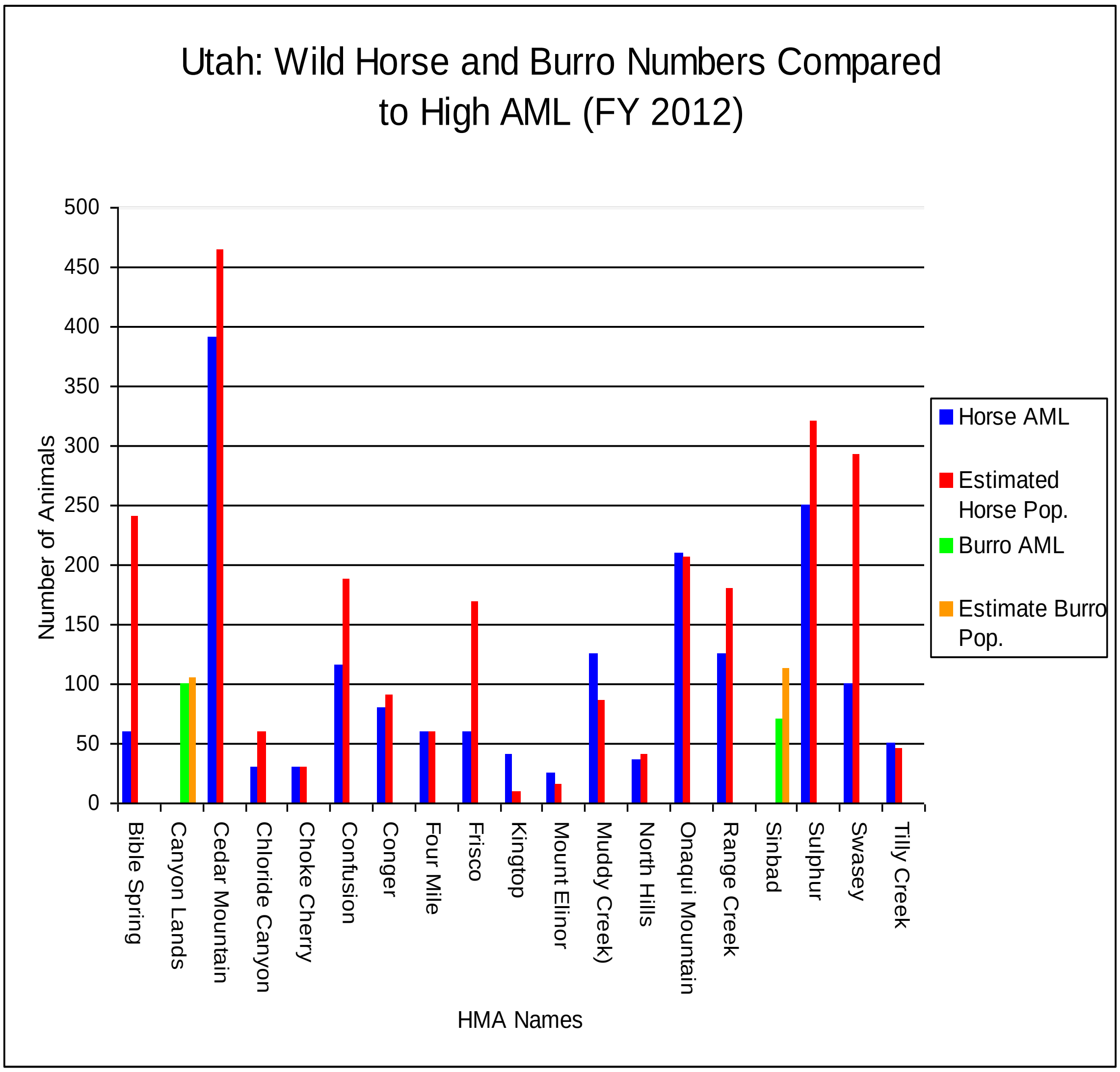
[335] Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

[336] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

[337] The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.

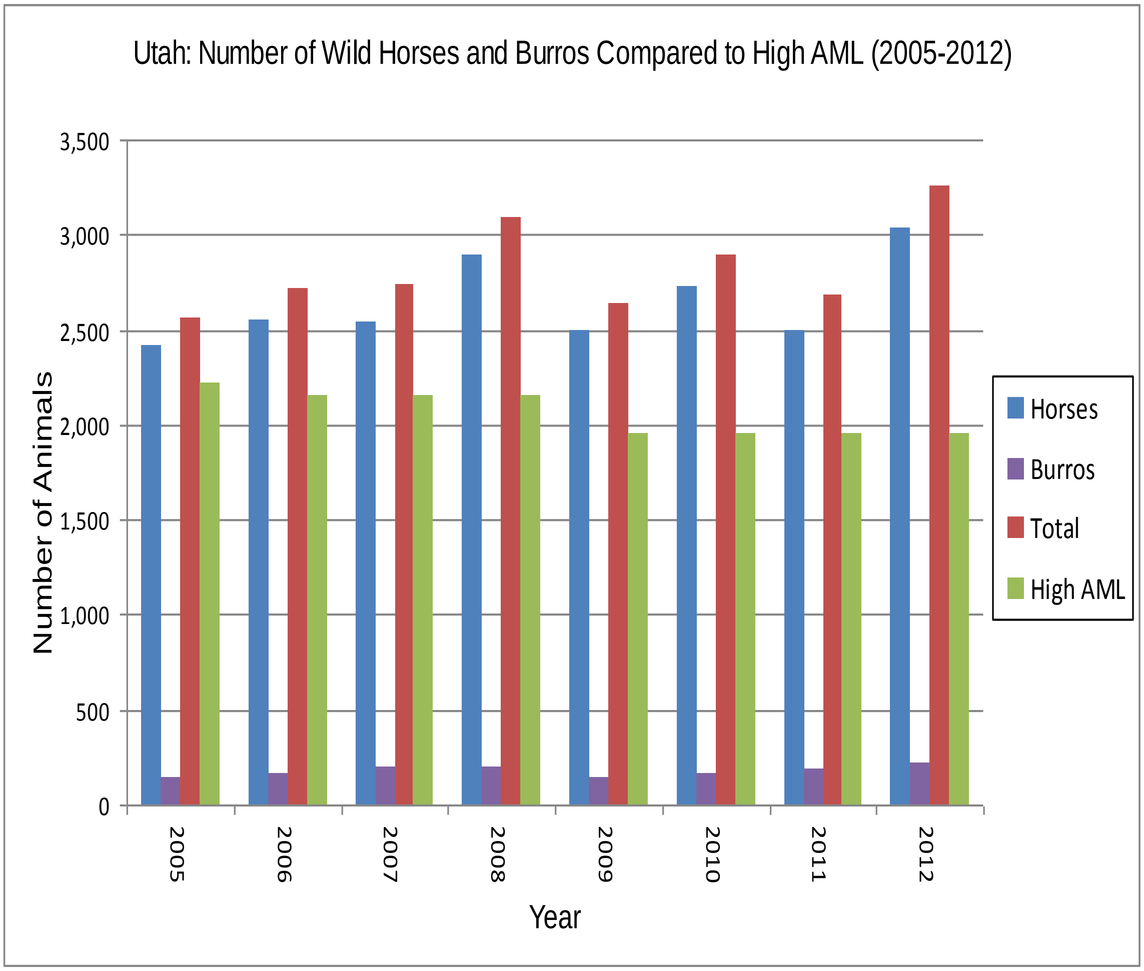
number of wild horses and burros in Utah are an estimated 1,373 over high AML. If the AMLs for wild horses and burros are scientifically justified – which remains highly questionable – wild horses and burros are 1,326 and 47 in excess of their respective high AMLs. See Figure UT-2.[338] This does not mean that these animals must be removed, as the BLM must not only determine in which HMAs the animals exceed AML, but must also conclude that they are preventing attainment of a thriving natural ecological balance in those HMAs. Based on BLM HMA statistics dating back to 2005, the total number of wild horses and burros in Utah has never been below high AML during that period. See Figure UT-3.[339]

Figure UT-2:



[338] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[339] *Ibid*.

Figure UT-3:



In 2011, the BLM removed 359 wild horses and 0 wild burros from in and/or outside of HMAs in Utah. In total, from 1996 to 2011, 8,691 wild horses and 138 wild burros have been captured and removed from the range. See Figures UT-4, UT-5, and UT-6.[340] During that same time period, 3,621 and 424 wild horses and burros, respectively, have been adopted in Utah.[341] See Figure UT-7.[342]

[340] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

[341] This includes wild horses and burros captured and removed from the range in other states.

[342] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

Figure UT-4:

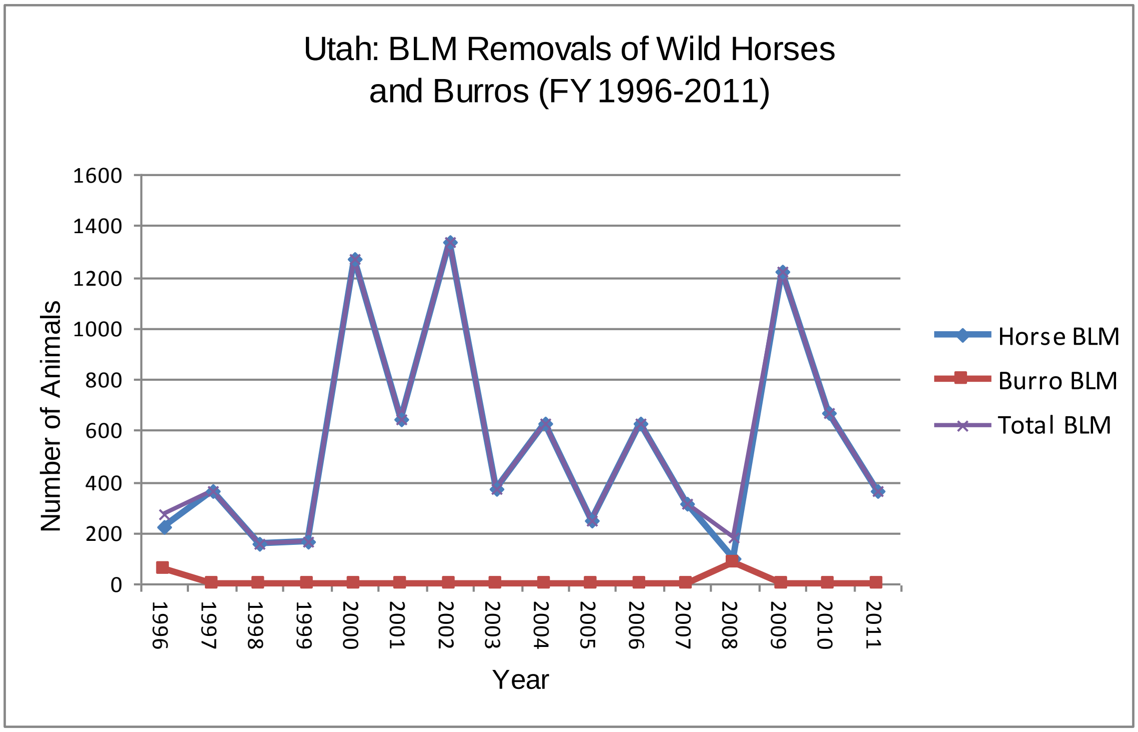


Figure UT-5:

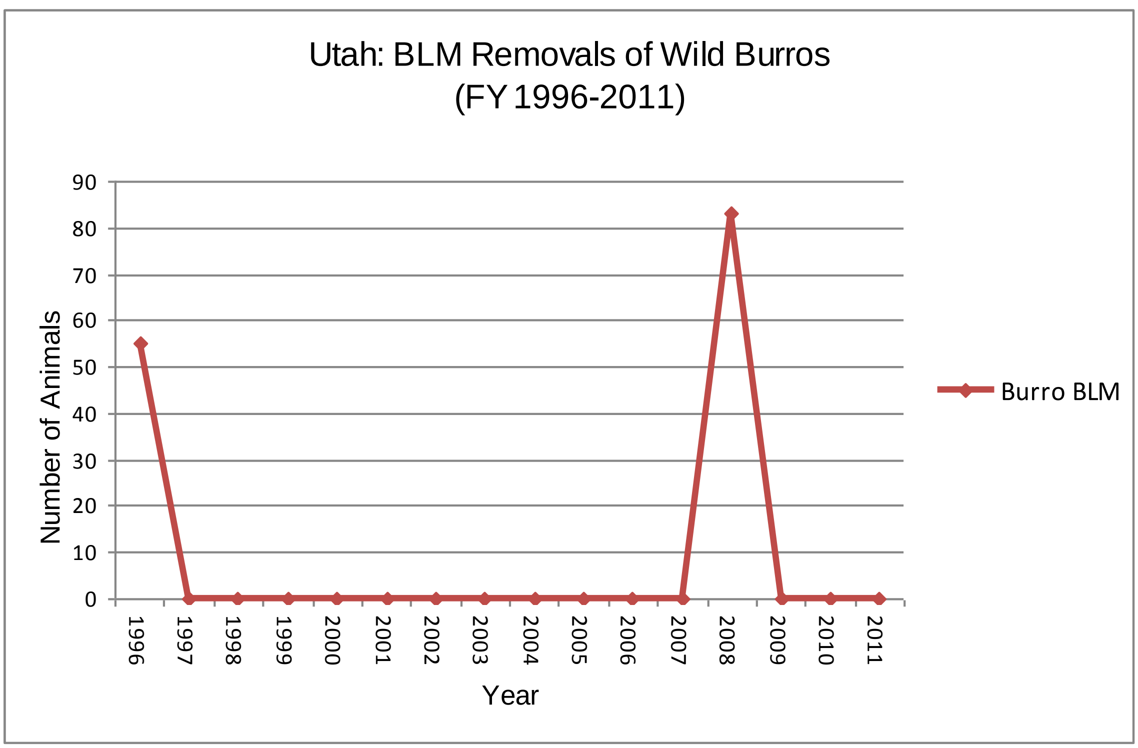


Figure UT-6:

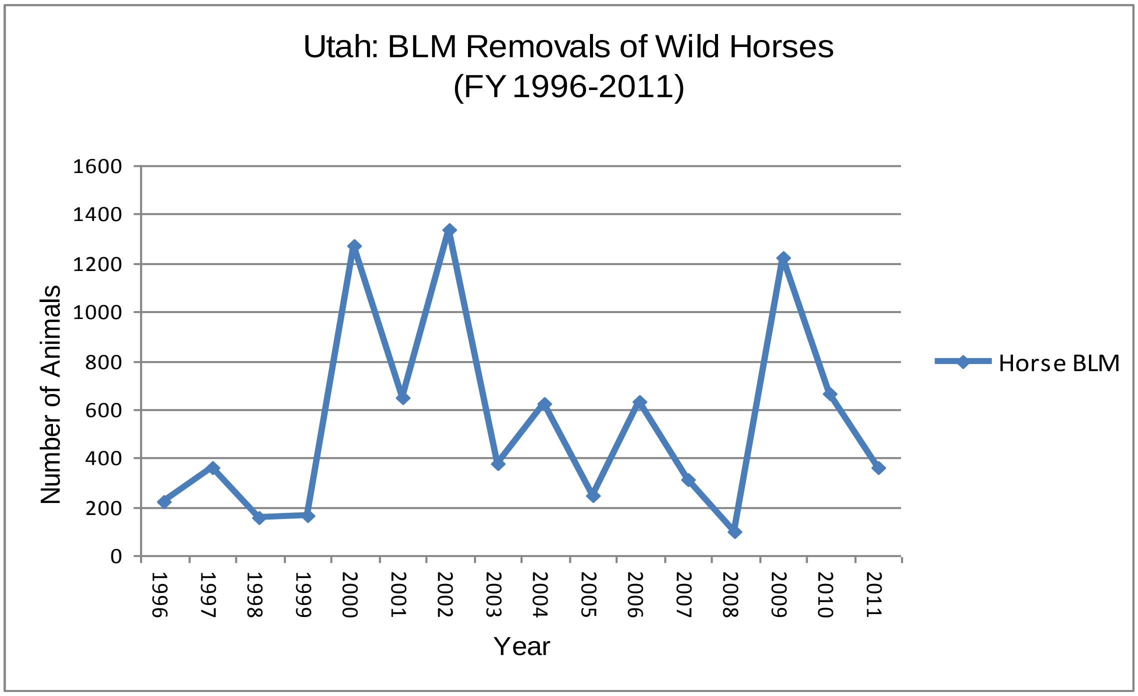
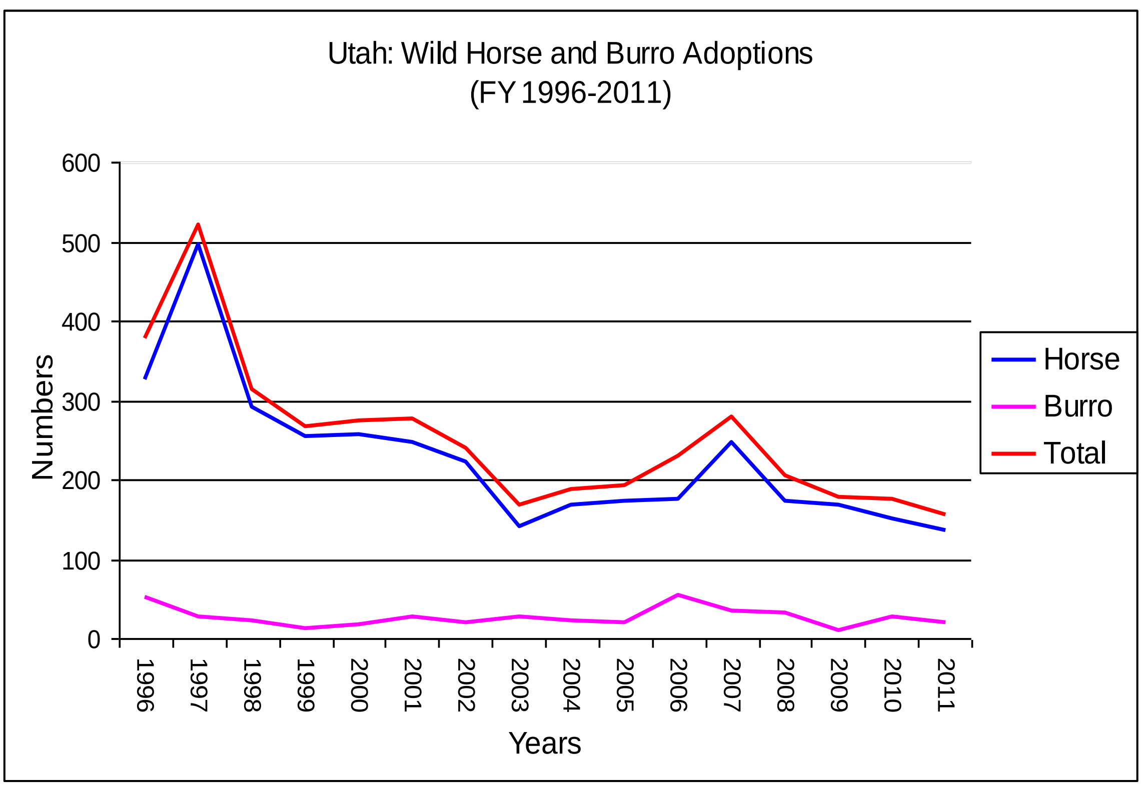
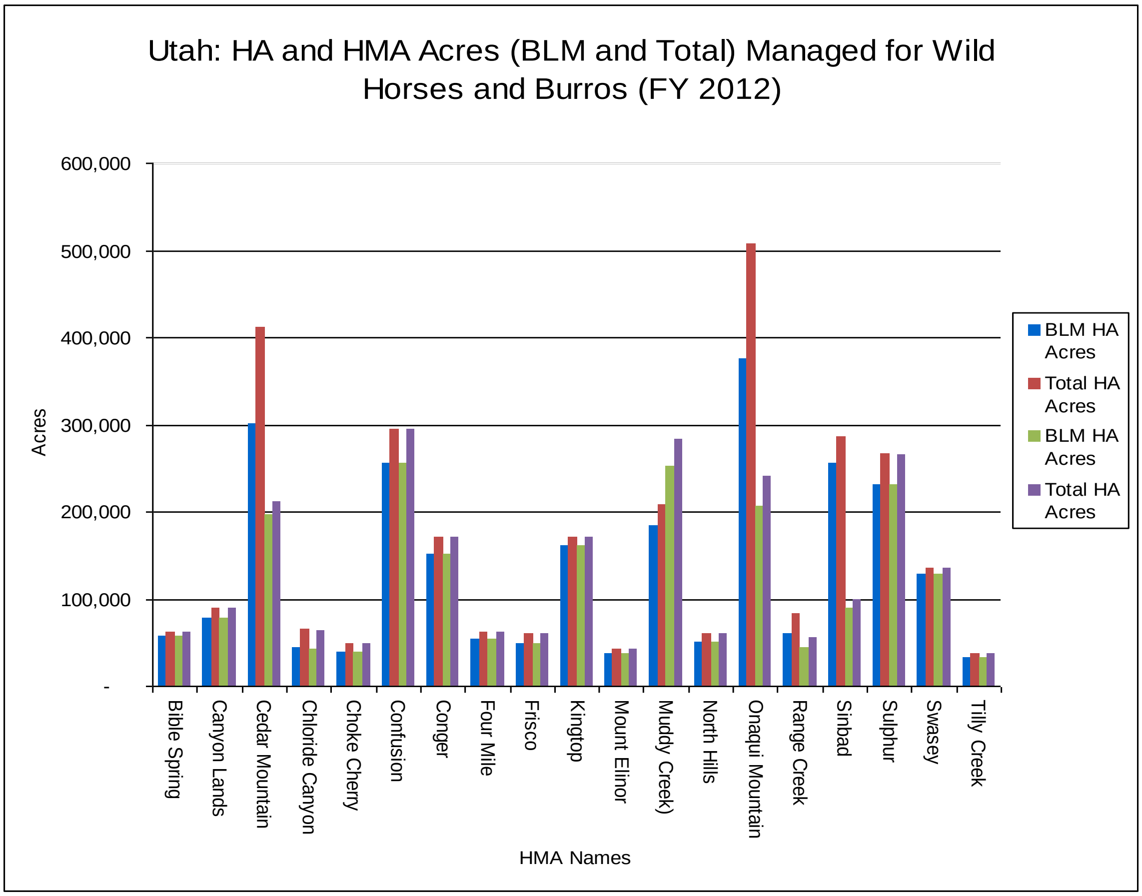


Figure UT-7:



The 19 HMAs in Utah encompass 2,451,227 acres, including 2,154,458 acres of BLM lands. These HMAs are contained within 3,062,086 HA acres, including 2,541,574 acres of BLM lands. This indicates that 610,859 acres of HA habitat – in areas managed for wild horses and burros – is not available to the animals. See Figure UT-8.[343] In addition, since 2005 (annual BLM data prior to 2005 was not available), the acres available to wild horses and/or burros in HMAs have declined by 351,998 acres. See Figure UT-9.[344] Finally, according to BLM data, there are 10 HAs in the state from which wild horses and/or burros have been permanently removed. These 10 HAs encompass 853,601 acres, including 683,317 acres of BLM lands. See Figure UT-10.[345] Consequently, 1,464,460 acres of habitat originally available for wild horses and burros in Utah no longer exists. See Figure UT-11.[346]

Figure UT-8:



[343] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
[344] *Ibid*.
[345] *Ibid*.
[346] *Ibid*.

Figure UT-9:

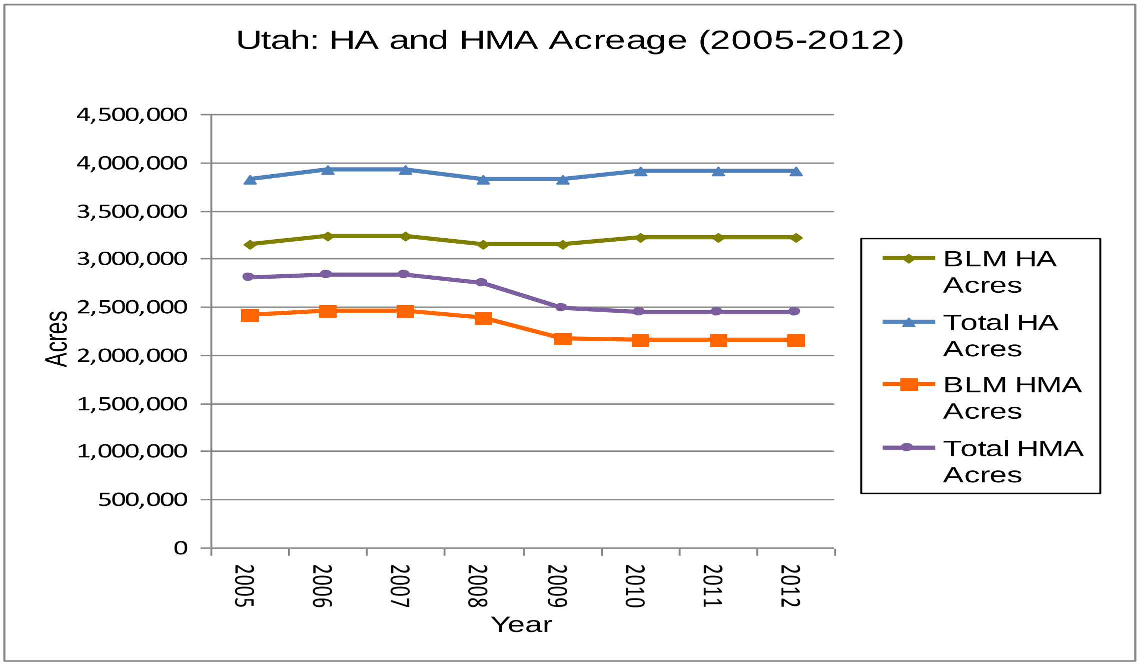


Figure UT-10:

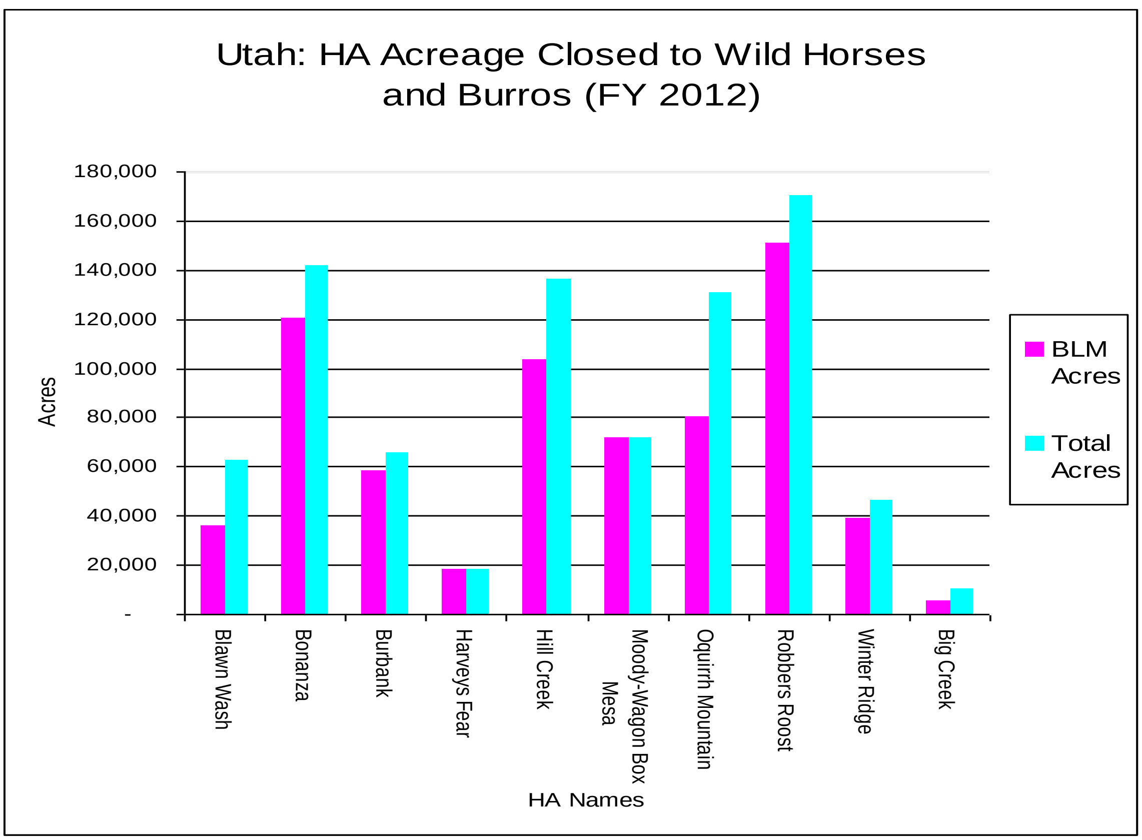
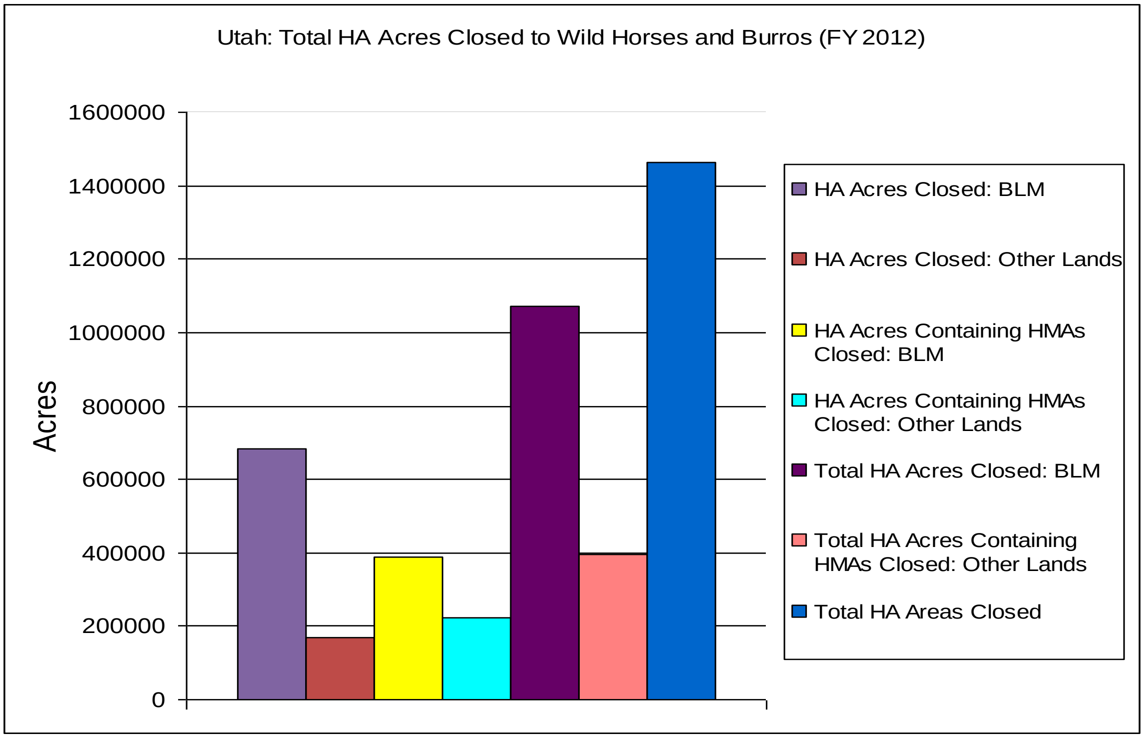


Figure UT-11:



There are 1,390 total public land grazing allotments in Utah, encompassing 21,514,810 acres. Of these acres, in 2011, rangeland monitoring has designated 6,522,017 acres in the "upward" trend, 11,661,343 acres in the "static" trend, 2,936,080 acres in the "downward" trend, and 395,370 acres in the "undetermined" trend.[347] The number of allotments and corresponding acreage in these categories has varied over the years. See Figure UT-12.[348] In 2011, of the 1,390 allotments, 501 have been designated as "I" (improve), 389 as "M" (maintenance), 491 as "C" (custodial), and 9 as "uncategorized."[349] The number of allotments and their corresponding acreage in these categories is subject to variation. See Figures UT-13 and UT-14.[350]

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[347]Trends are designated as "upward" if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as "downward" if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[348] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_ management/rangeland_inventory.html.

[349] The objective for "I" allotments is to "improve the current resource condition." The objective for "M" allotments is to "maintain the current resource condition." The objective for "C" allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-

Figure UT-12:

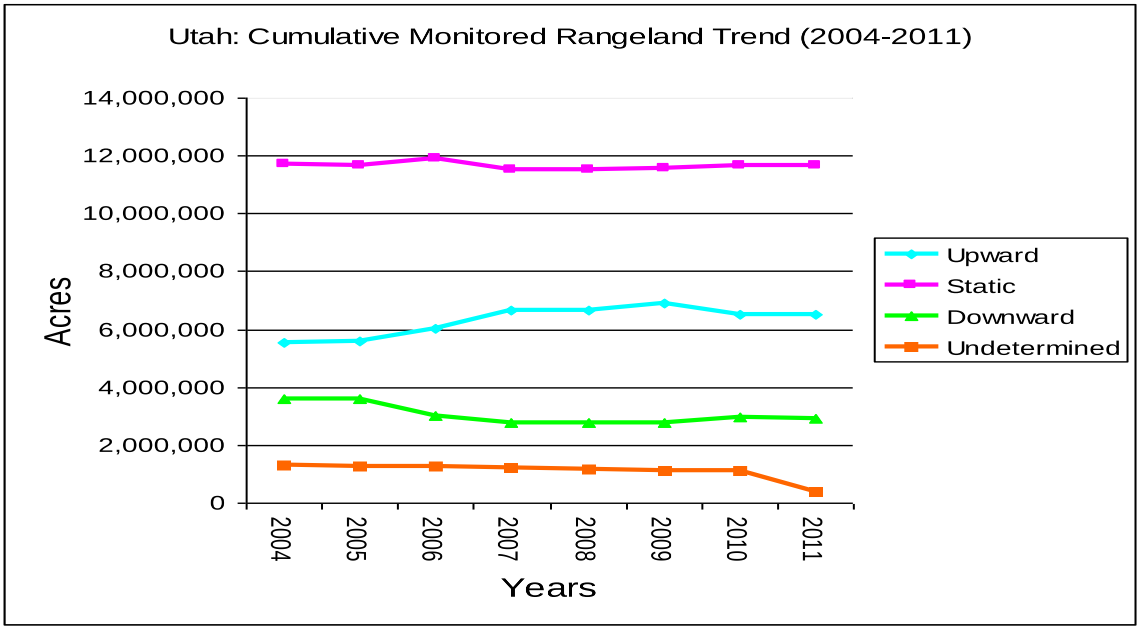
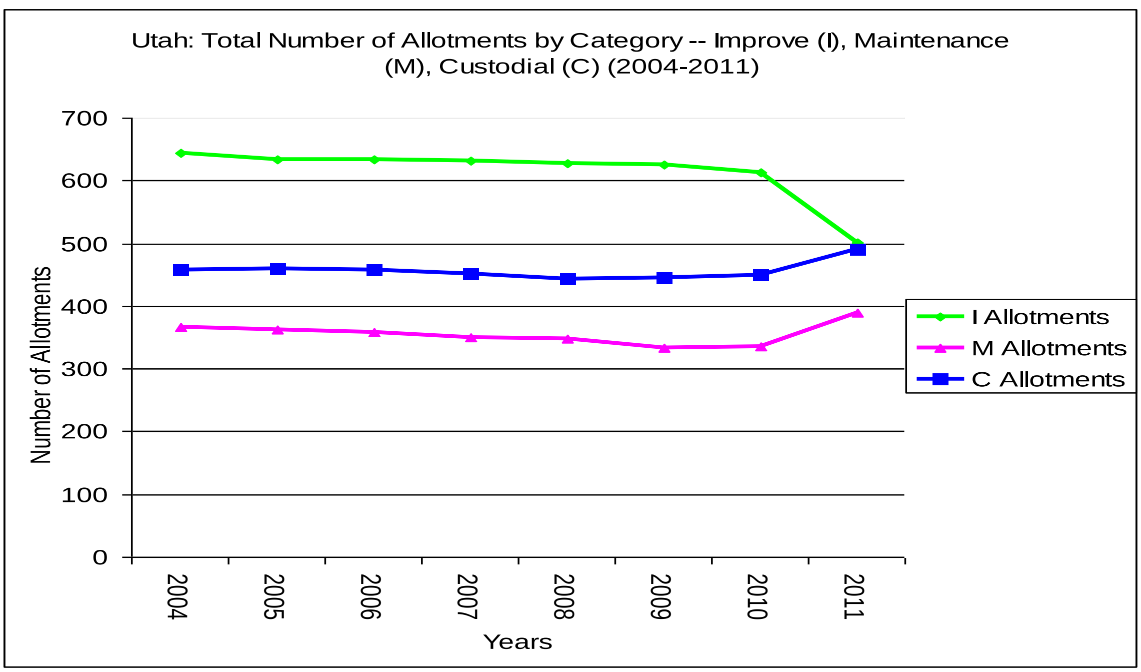


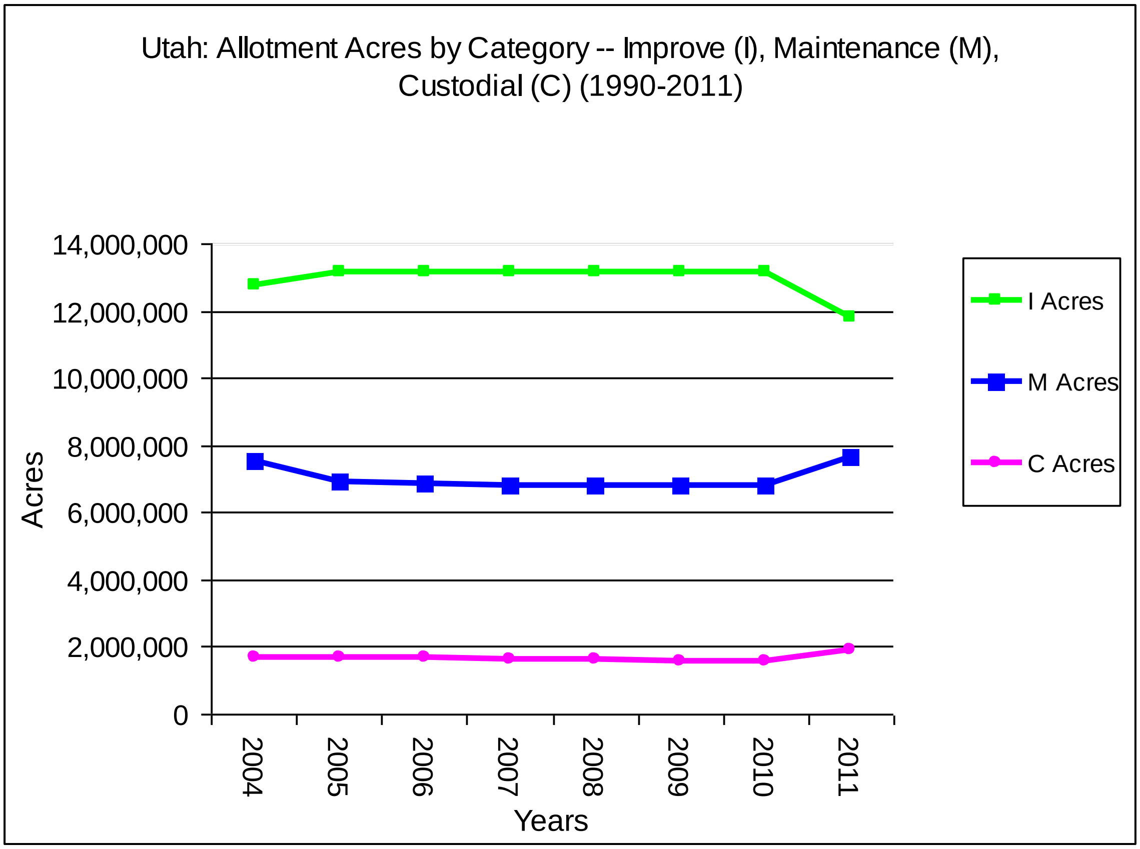
Figure UT-13:



the-ground management efforts to those allotments where grazing management is most needed to improve resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

[350] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_ management/rangeland_inventory.html.

Figure UT-14:



In 2011, the total number of AUMs used for grazing was 813,334. This included 667,684 for cattle/yearlings/bison, 1,451 for domestic horses and burros, and 144,199 for sheep and goats. The total AUMs for wild horses and burros in Utah in 2011 was 1,897, [351] indicating that, statewide, livestock AUMs are 435 times higher than wild horse and burro AUMs. See Figure UT-15.[352] Since 2000, the total for livestock AUMs has been variable, ranging from a low of 1,439,185 in 2003 to a high of 833,715 in 2000. See Figure UT-16.[353]

[351] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[352] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm.
[353] *Ibid.*

Figure UT-15:

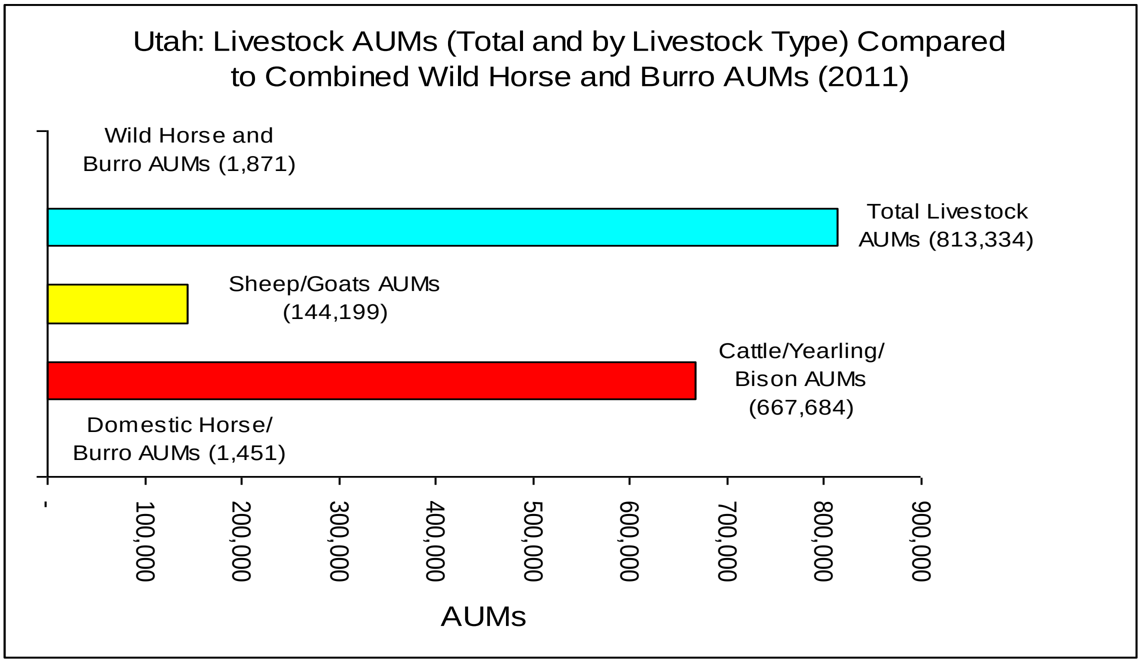
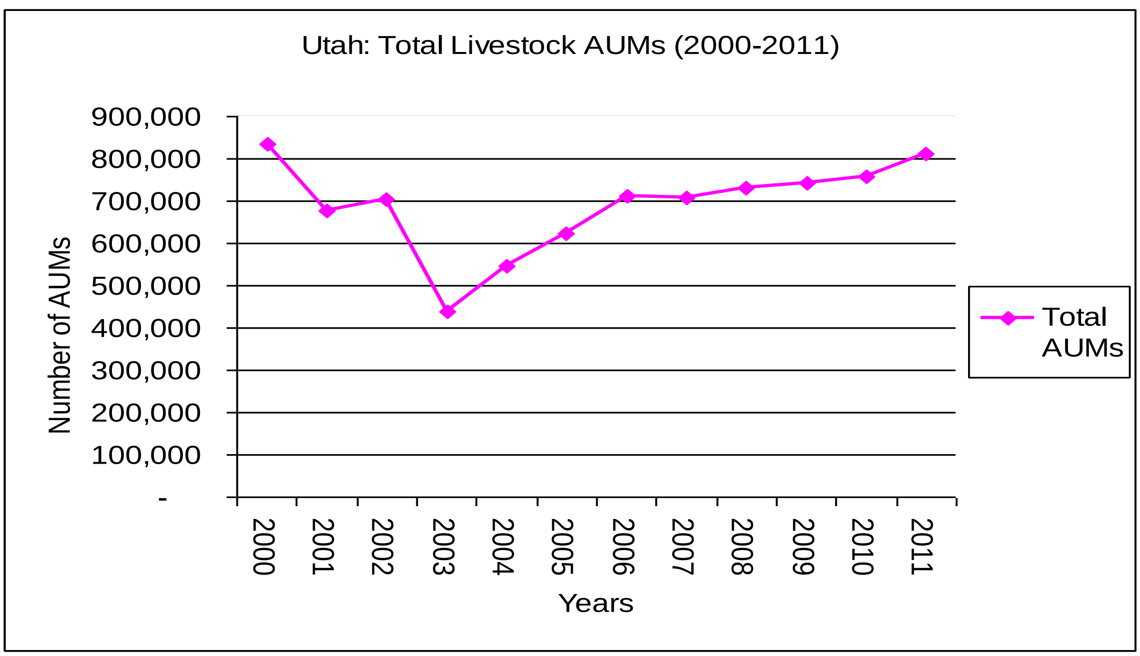


Figure UT-16:

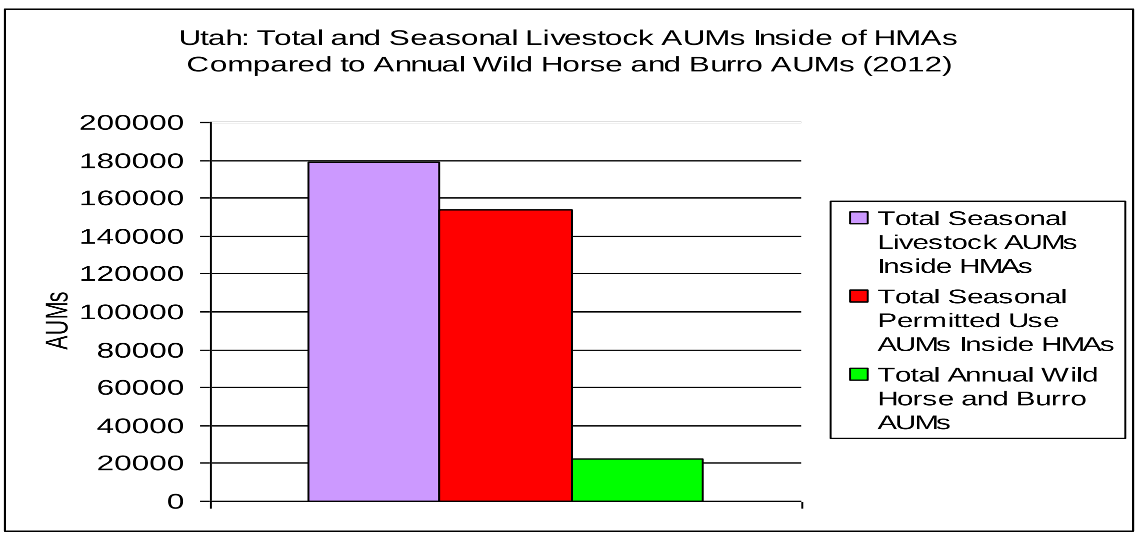


According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 152,587 livestock (48,262 cattle, 97 domestic horses/burros, and 104,228 sheep) were grazed on an estimated126 allotments wholly or partially within

HMAs in Utah.[354] This corresponds to approximately 692,046 AUMs.[355] The total AUMs used annually depends on the type of livestock grazed and the duration for which they are grazed on public lands. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing for livestock using allotments wholly or partially within HMAs was 398,340, 306,293, 66,940, and 358,292, respectively.[356]

When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[357] the number of livestock grazed within the HMAs is 72,951, corresponding to 179,022 total AUMs and 153,536 AUMs permitted for use for seasonal/annual grazing. This compares to a high AML for wild horses and burros of 1,956 (1,786 horses and 170 burros), which equates to an annual AUM of 22,452. See Figures UT-17 and UT-18. Hence, even at the HMA level, permitted use livestock AUMs are nearly 7 times larger than annual wild horse and burros AUMs. In addition, of the total number of livestock, wild horses, and/or burros estimated to use all Utah HMAs in 2012, 97.4 percent are livestock, 2.4 percent are wild horses, and 0.2 percent are wild burros. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

Figure UT-17:



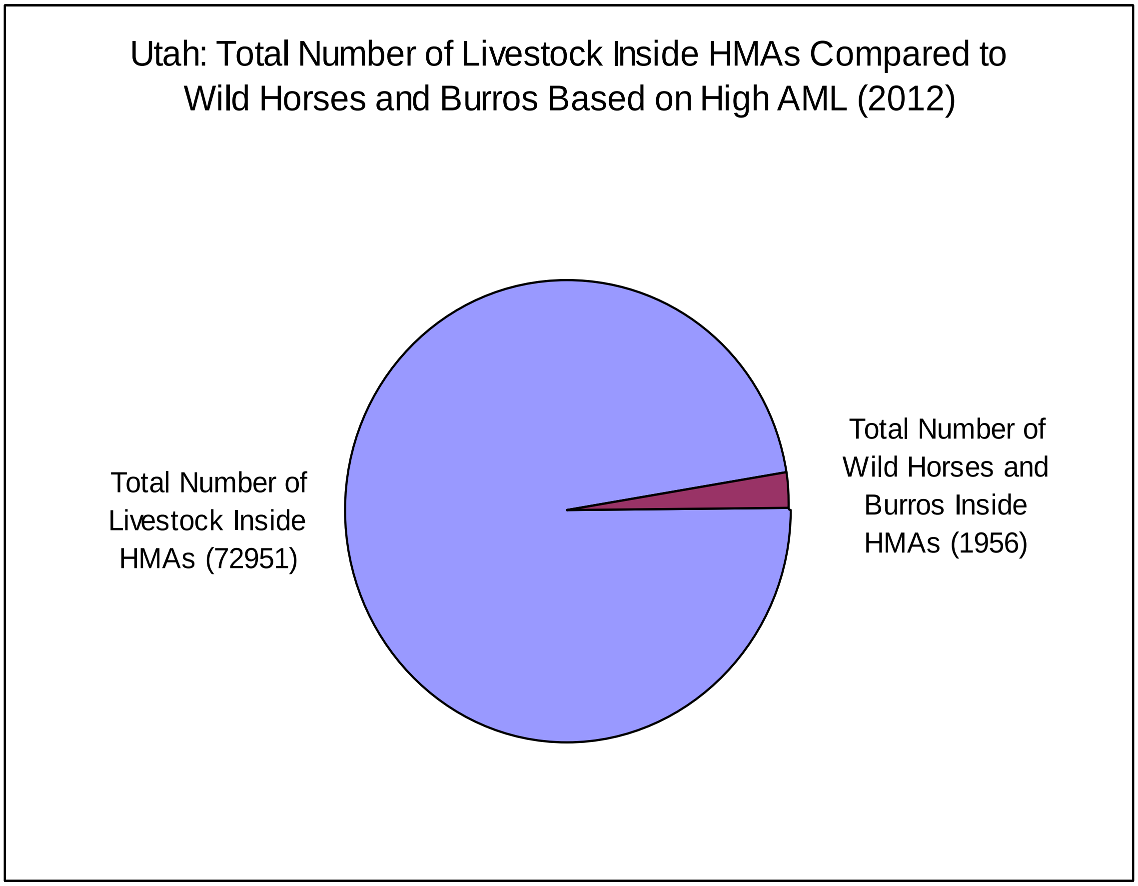
354 Per BLM policy, the BLM is not permitted to allow domestic horses and/or burros to utilize HMAs. It is not known if the 97 domestic horses/burros identified in the RAS database are permitted to graze on lands within HMAs in Utah.

355 The AUMs were calculated using conversion rates of 1 cow = 1 AUM, 1 horse = 1 AUM (domestic horses and burros were combined in the BLM data set so the number of each species is unknown), and .2 sheep = 1 AUM. These conversion rates are consistent with BLM policies or were identified in various agricultural sources found on the Internet.

356 Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.

357 This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

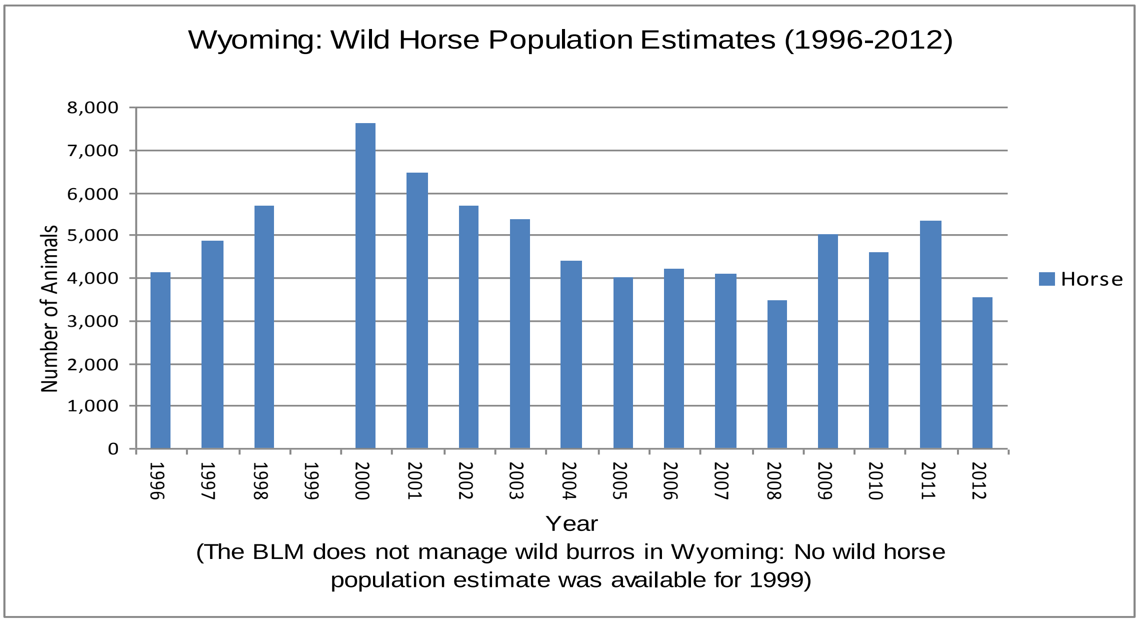
Figure UT-18:


Utah: Total Number of Livestock Inside HMAs Compared to Wild Horses and Burros Based on High AML (2012)
Total Number of Livestock Inside HMAs (72951)
Total Number of Wild Horses and Burros Inside HMAs (1956)

Wyoming:

Based on fiscal year 2012 data there are, as of February 29, an estimated 3,543 wild horses and 0 wild burros in Wyoming occupying a total of 16 HMAs.[358] See Figure WY-1.[359] There were no wild horses or burros on HAs that are not managed for the species.[360] As a result, there are an estimated 3,543 wild horses in Wyoming.[361]

Figure WY-1:



Wild horses are found in all 16 of the HMAs. The total current high AML[362] for wild horses in the state is 3,725. Therefore, as of February 2012, the number of wild horses in Wyoming is 182 below the current high AML for wild horses. Whether the AML for wild horses in Wyoming is accurate or scientifically justified, however, remains highly questionable. See Figure WY-2.[363] Based on BLM HMA statistics dating back to 2005,

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358 BLM wild horse and burro yearly population estimates available at http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html are slightly different than the population estimates reported for individual HMAs found at http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/wild_horses_and_burros/statistics_and_maps.Par.13260.File.dat/HAHMAstats2012Final.pdf. The reason for these minor discrepancies is not known.
359 Data obtained from yearly links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.
360 *Ibid*.
361 It is not known if the BLM ever managed wild burros in Wyoming but no wild burros are currently managed in the state.
362 The BLM only provides the HMA-specific high AML in its wild horse and burro data analysis. AML is set as a range (low to high) with the majority of roundups conducted with the intent to achieve low AML to permit at least four years of population growth before another roundup may be necessary.
363 Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

the total number of wild horses in Wyoming was below the current high AML in 2008 and 2012. See Figure WY-3.[364]

Figure WY-2:

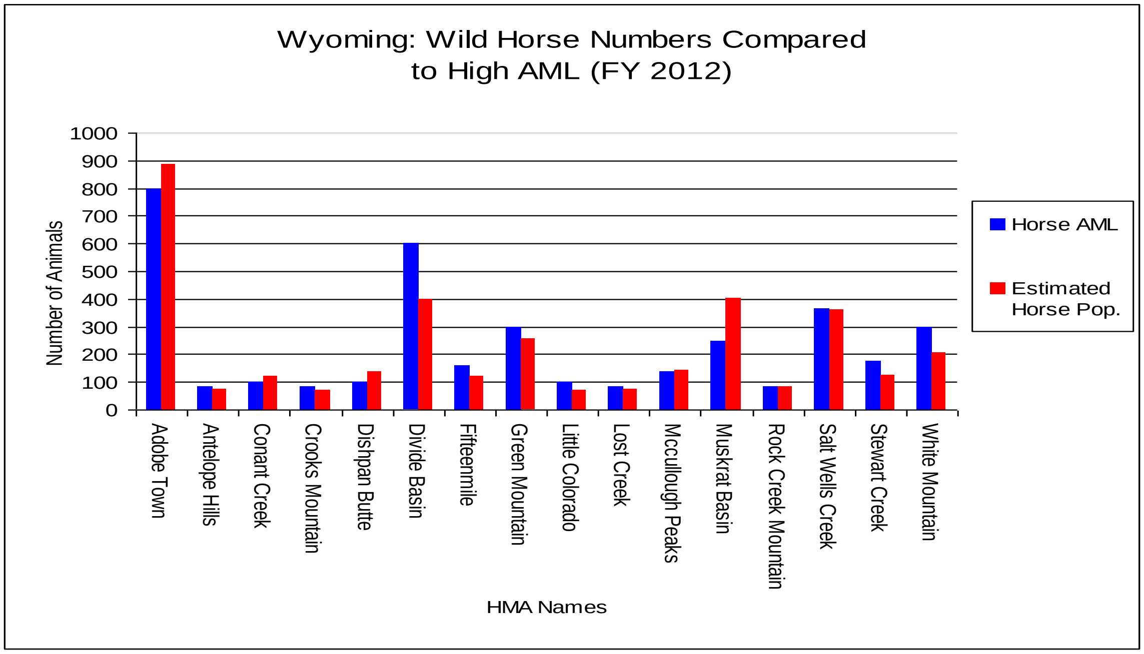
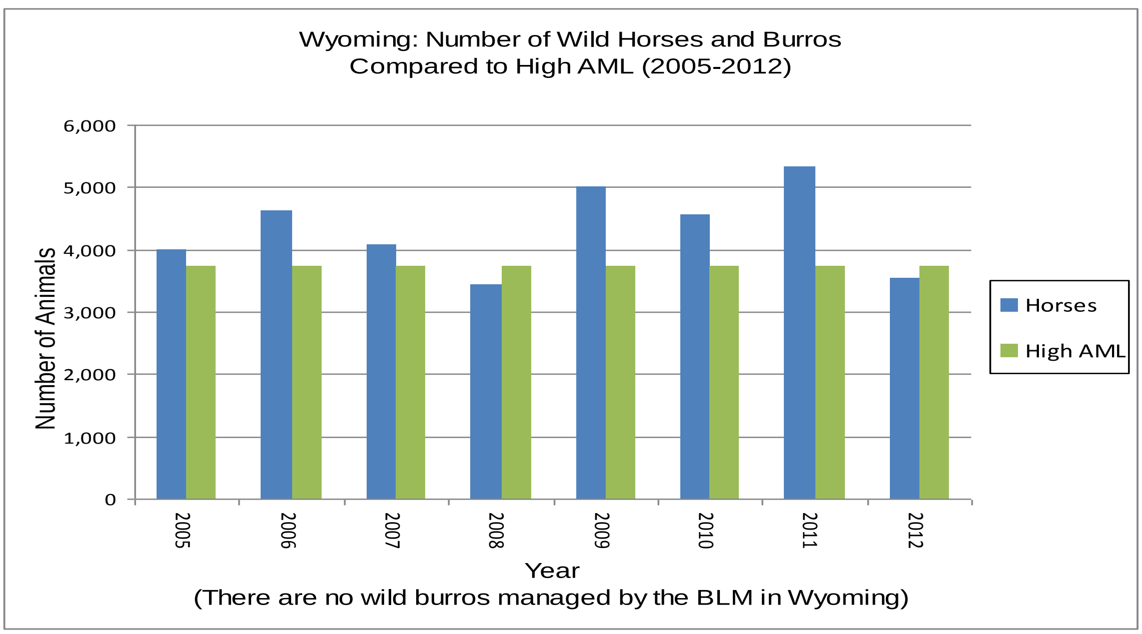


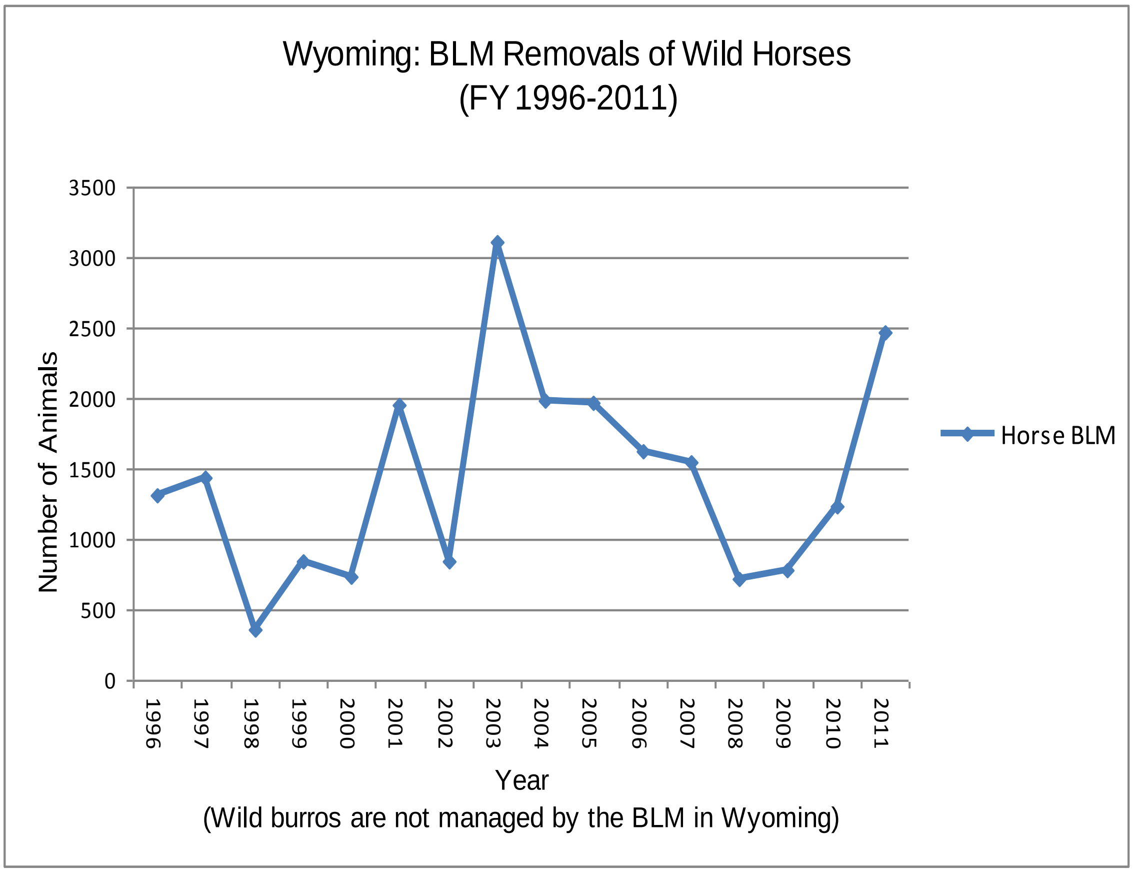
Figure WY-3:



364 Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html

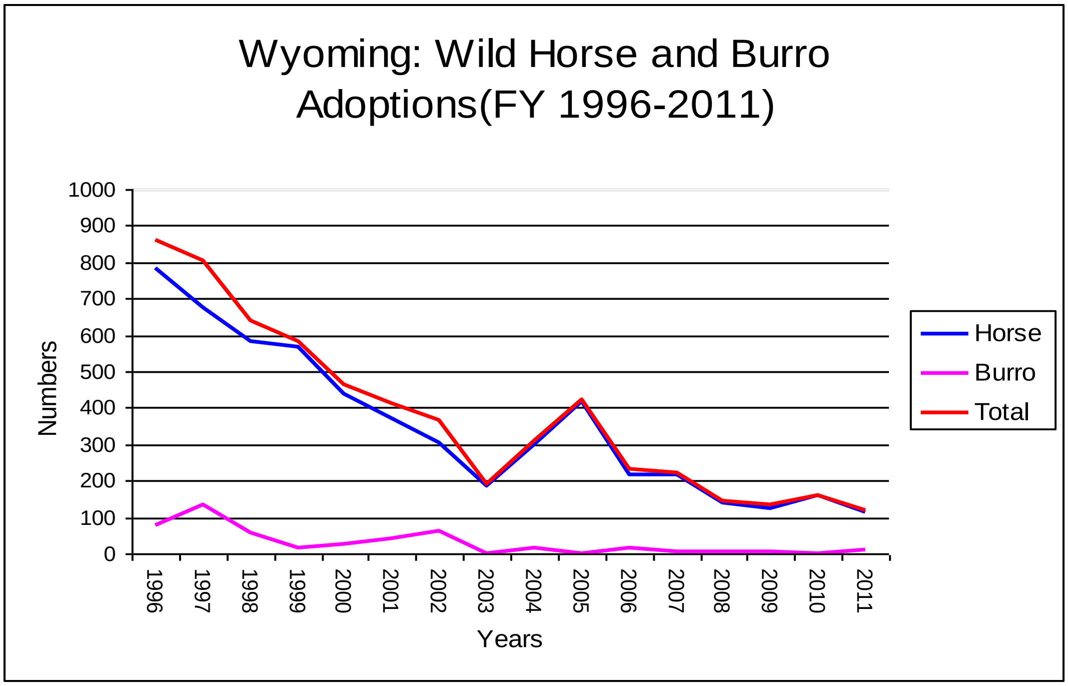
In 2011, the BLM removed 2,467 wild horses from in and/or outside of HMAs in Wyoming. In total, from 1996 to 2011, 22,923 wild horses and 1 wild burro have been captured and removed from the range. See Figure WY-4.[365] During that same time period, 5,590 and 466 wild horses and burros, respectively, have been adopted in Wyoming.[366] See Figure WY-5.[367]

Figure WY-4:



365 Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
366 This includes wild horses and burros captured and removed from the range in other states.
367 Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html.

Figure WY-5:



The 16 HMAs in Wyoming encompass 4,768,682 acres, including 3,633,879 acres of BLM lands. These HMAs are contained within 2,462,186 HA acres, including 2,118247 acres of BLM lands. Unlike most states where the HA acres within which wild horse and burros are managed in HMAs exceed HMA acreage, this is not the case in Wyoming. According to the BLM, the HMA acreage is larger than the HA acreage (for the areas management for wild horses and burros) in Wyoming as a result of the acreage of HMAs created from other HAs not being included in the total HA acreage. As a result, the existing HMAs contain 2,306,496 acres more than their corresponding HAs. See Figure WY-6.[368] Nevertheless, since 2005 (annual BLM data prior to 2005 was not available), the acres available to wild horses in HMAs have decreased by 6,769 acres. See Figure WY-7.[369] Finally, according to BLM data, there are 28 HAs in the state from which wild horses and/or burros have been permanently removed. These 28 HAs encompass 7,882,238 acres, including 5,183,728 acres of BLM lands. See Figure WY-8.[370] Consequently, 5,575,752 acres of habitat originally available for wild horses and burros in Wyoming no longer exists. See Figure WY-9.[371]

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[368] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/whbprogram/herd_management/Data.html
[369] Ibid.
[370] Ibid.
[371] Ibid.

Figure WY-6:

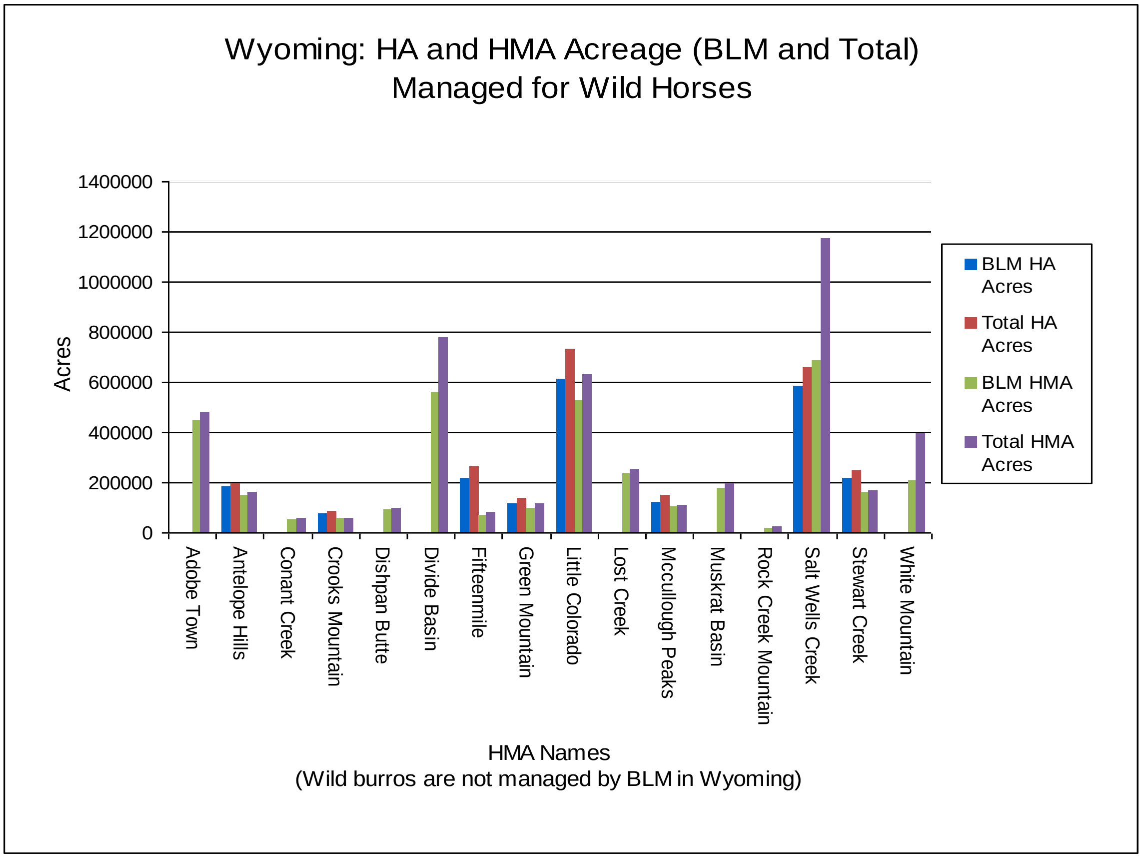

Wyoming: HA and HMA Acreage (BLM and Total) Managed for Wild Horses
Acres
1400000
1200000
1000000
800000
600000
400000
200000
0
Adobe Town
Antelope Hills
Conant Creek
Crooks Mountain
Dishpan Butte
Divide Basin
Fifteenmile
Green Mountain
Little Colorado
Lost Creek
Mccullough Peaks
Muskrat Basin
Rock Creek Mountain
Salt Wells Creek
Stewart Creek
White Mountain
BLM HA Acres
Total HA Acres
BLM HMA Acres
Total HMA Acres
HMA Names
(Wild burros are not managed by BLM in Wyoming)

Figure WY-7:

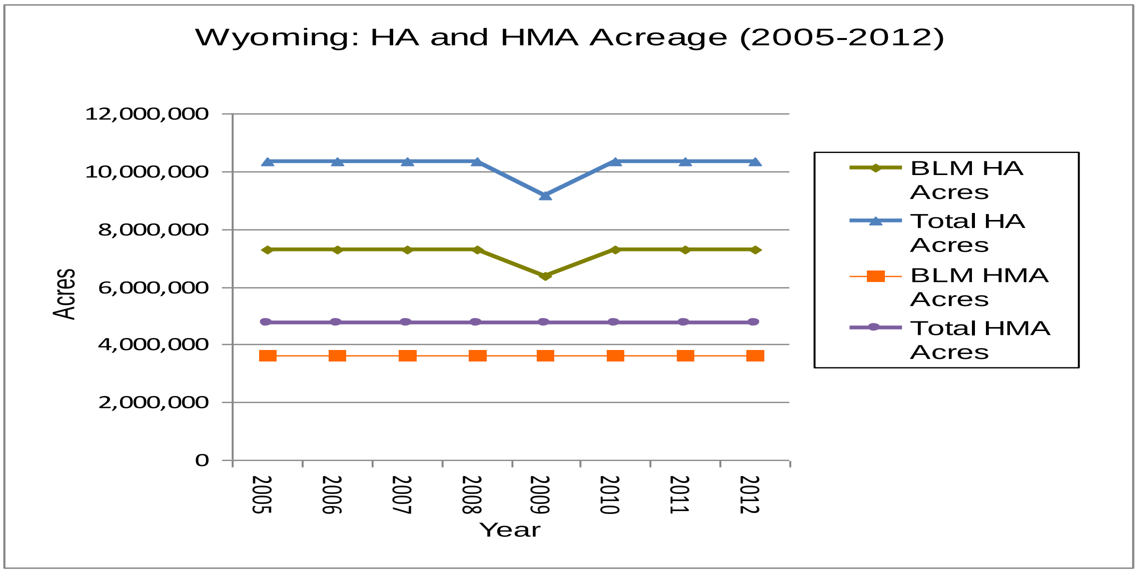


Figure WY-8:

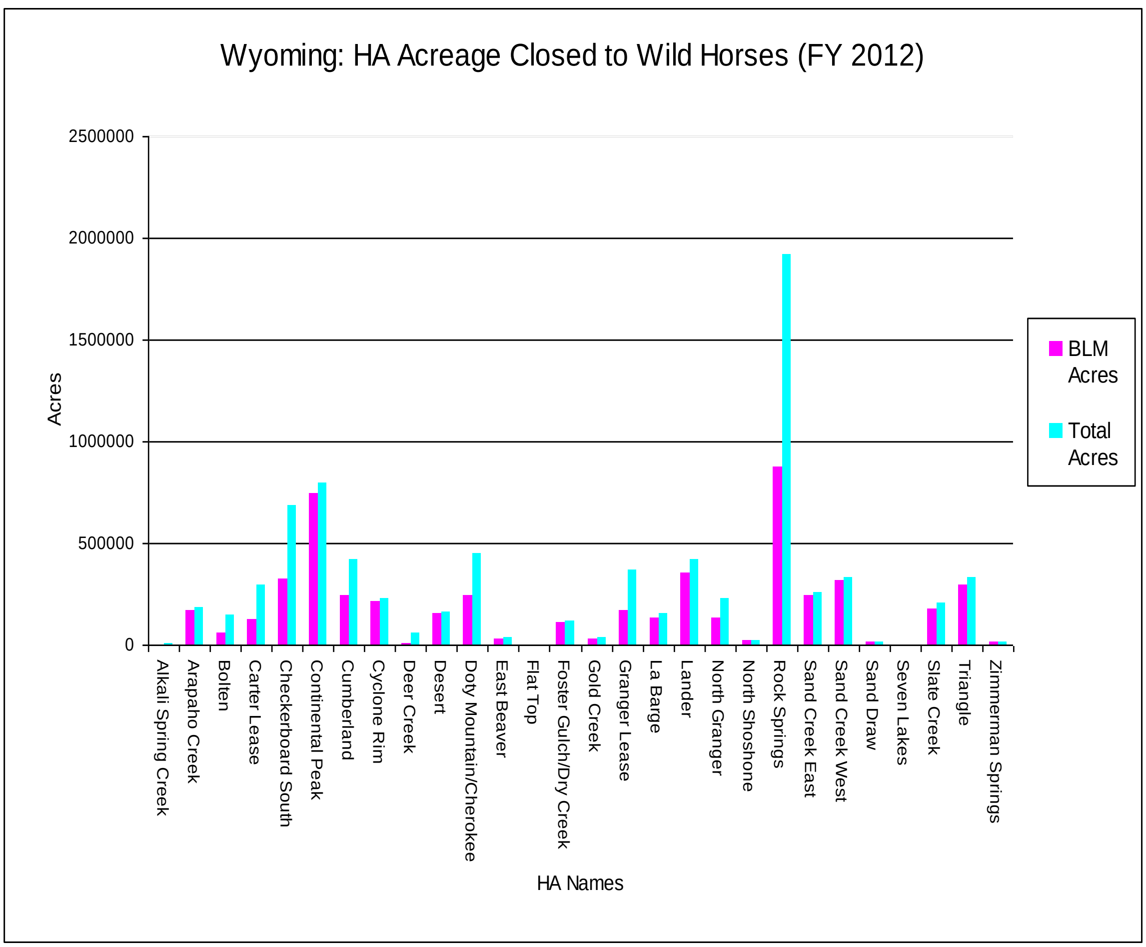
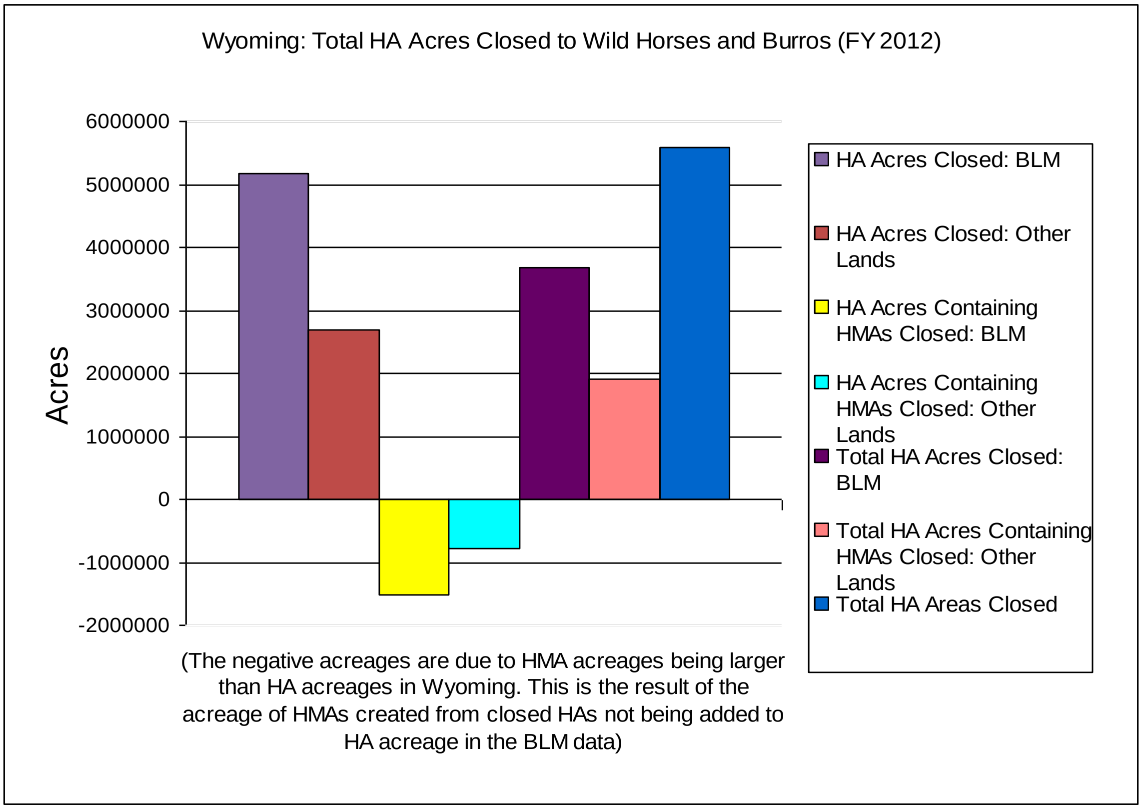


Figure WY-9:



There are 3,530 total public land grazing allotments in Wyoming, encompassing 17,569,131 acres. Of these acres, in 2011, rangeland monitoring has designated 3,002,904 acres in the "upward" trend, 6,956,059 acres in the "static" trend, 1,838,530 acres in the "downward" trend, and 5,771,638 acres in the "undetermined" trend.[372] The number of acres in these categories has varied over the years. See Figure WY-10.[373] In 2011, of the 3,530 allotments, 840 have been designated as "I" (improve), 803 as "M" (maintenance), 1,883 as "C" (custodial), and 4 as "uncategorized."[374] The number of allotments in these

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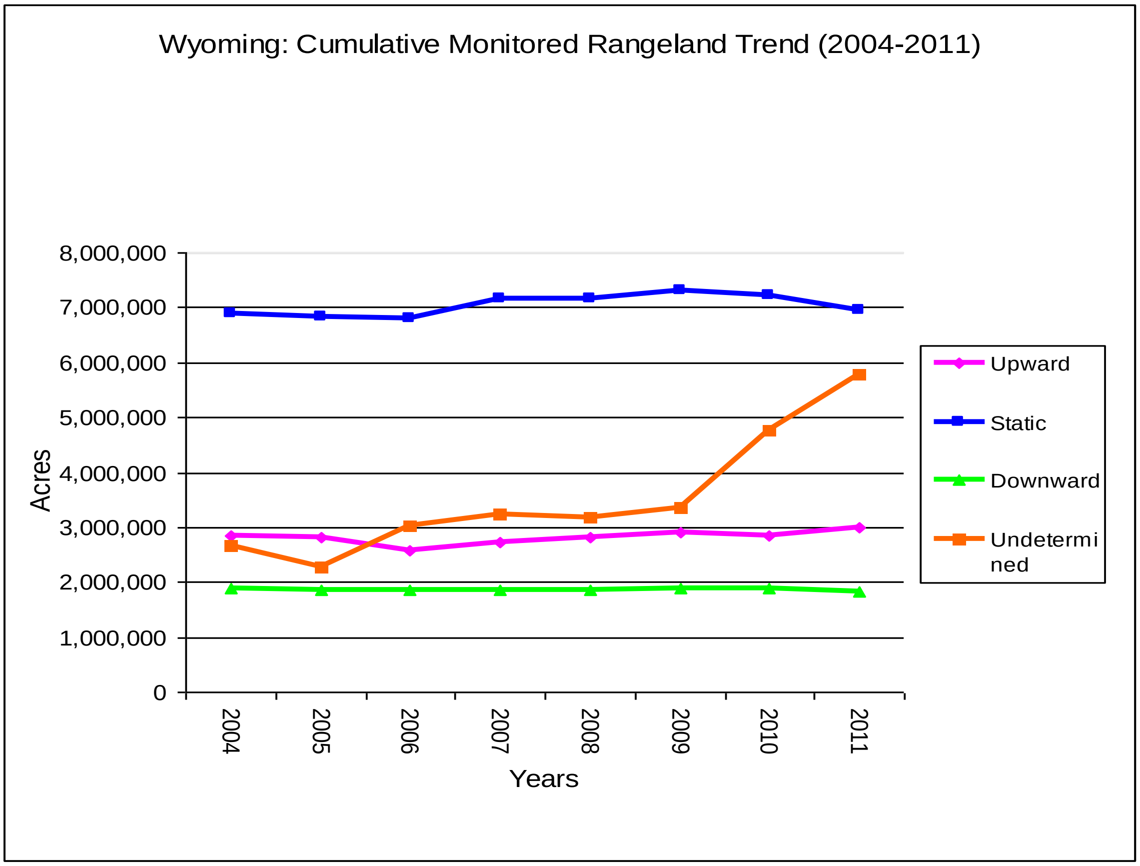
[372]Trends are designated as "upward" if it is concluded that changes in plant species and soils are moving toward achievement of vegetation management objectives. A "static" designation means there is no discernible change toward or away from vegetation management objectives. Trends are characterized as "downward" if it is concluded that changes in plant species and soils are moving away from achievement of vegetation management objectives. Trend characterized as "undetermined" means that vegetation and soils data could not be collected to determine trend (for example on rock outcrop areas) or vegetation and soils data has not yet been collected to determine trend (e.g., areas that do not have trend studies established), or vegetation and soils data have been collected but have not been repeatedly collected over sufficient time to determine trend. Trend information varies in age based on when the vegetation and soils data were collected. Up, static, and down designations represent what the trend was at the time the data/information were analyzed/evaluated. These data are taken from field office records.

[373] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

[374] The objective for "I" allotments is to "improve the current resource condition." The objective for "M" allotments is to "maintain the current resource condition." The objective for "C" allotments is to "custodially manage the existing resource values." Categorization is used to concentrate funding and on-

categories and the acreage so designated is subject to variation. See Figures WY-11 and WY-12.[375]

Figure WY-10:



the-ground management efforts to those allotments where grazing management is most needed to improve resources or resolve resource conflicts. Priority is given to I allotments, where grazing management is most needed to improve resources or resolve resource conflicts, followed by M allotments, and then C allotments.

[375] Data obtained from links accessible at: http://www.blm.gov/wo/st/en/prog/more/rangeland_management/rangeland_inventory.html.

Figure WY-11:

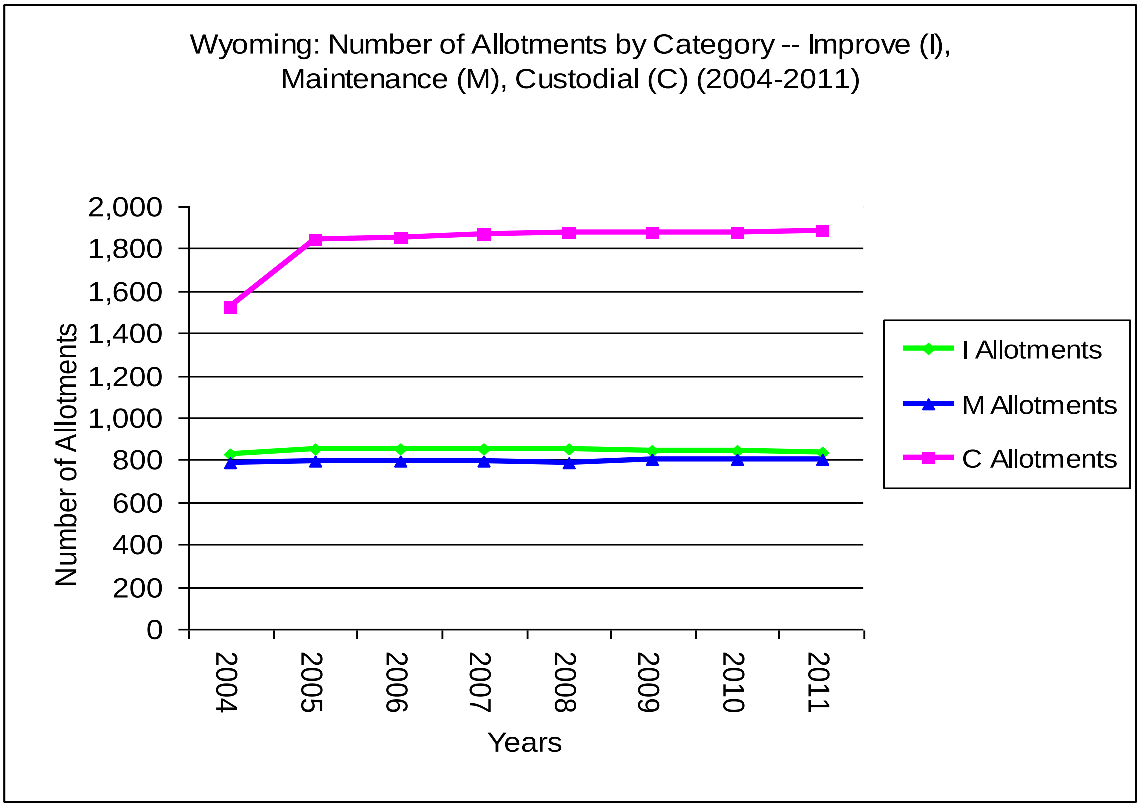
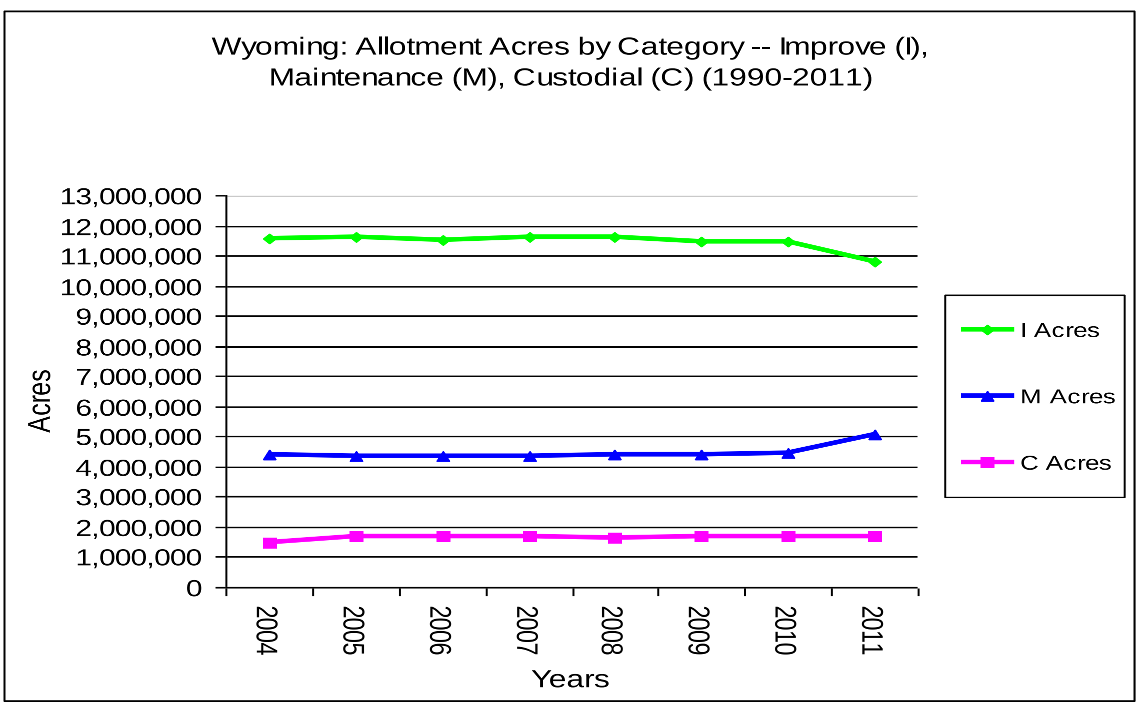
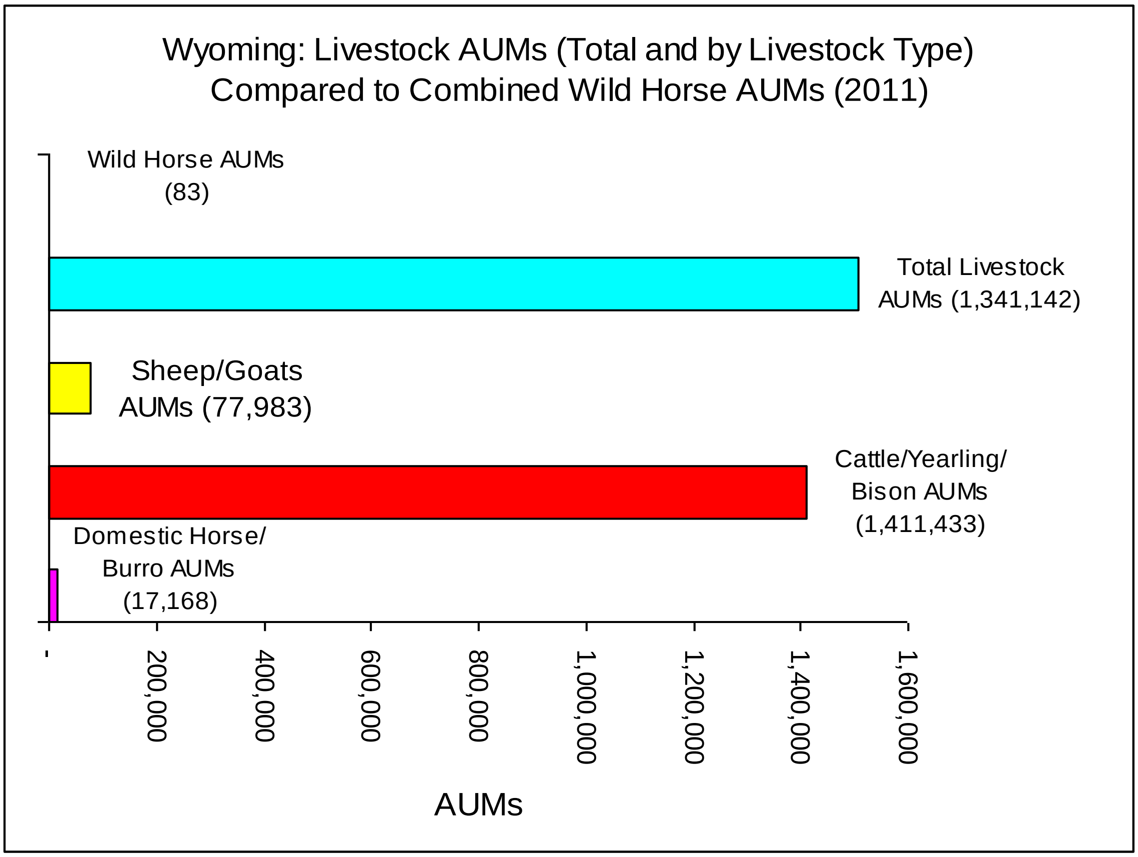


Figure WY-12:



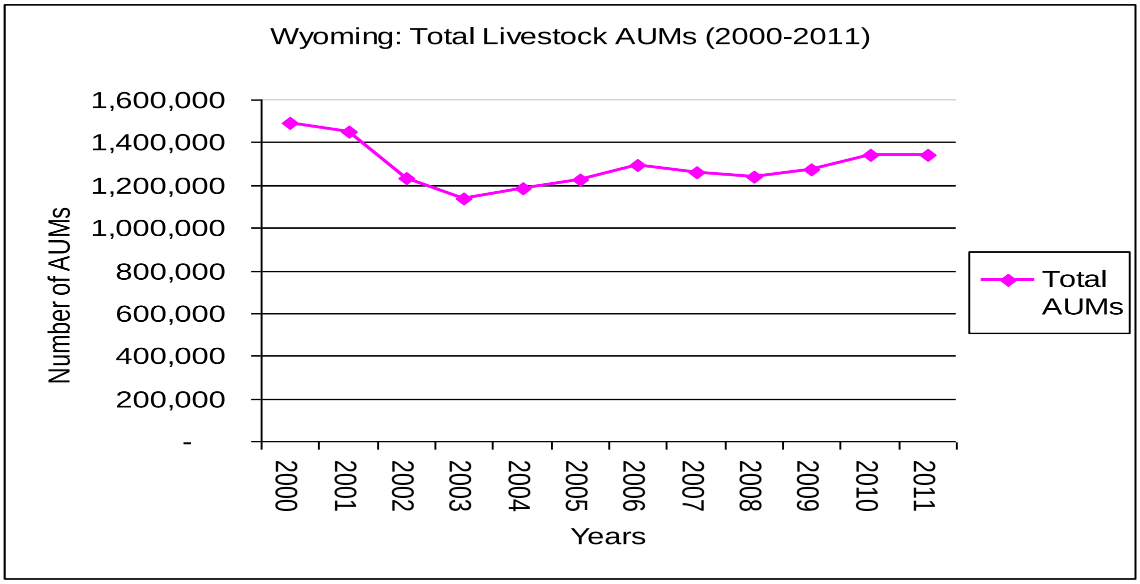
In 2011, the total number of AUMs used for grazing was 1,341,142. This included 1,166,521 for cattle/yearlings/bison, 11,789 for domestic horses and burros, and 162,832 for sheep and goats. The total AUMs for wild horses in Wyoming in 2011 was 3,725, [376] indicating that, statewide, livestock AUMs are 360 times higher than wild horse AUMs. See Figure WY-13.[377] Since 2000, the total for livestock AUMs has been variable, ranging from a low of 1,182,794 in 2004 to a high of 1,491,376 in 2000. See Figure WY-14.[378]

Figure WY-13:



[376] One wild horse AML was equal to one AUM and one wild burro AML was equal to 0.5 AUMs as reported in the BLM Handbook.
[377] Data obtained from links accessible at: http://www.blm.gov/public_land_statistics/index.htm
[378] *Ibid.*

Figure WY-14:



According to the BLM's Rangeland Administration System (RAS) reports, accessed in September 2012, 1,983,141 livestock (176,363 cattle, 124 domestic horses/burros, and 1,806,654 sheep) were grazed on an estimated 61 allotments wholly or partially within HMAs in Wyoming.[379] This corresponds to approximately 537,818 AUMs.[380] The total AUMs used annually depends on the type of livestock grazed and the duration for which they are grazed on public lands. The number of total, active, suspended, or permitted use AUMs for seasonal or annual grazing for livestock using allotments wholly or partially within HMAs was 1,475,199, 832,524, 27,411, and 1,106,599, respectively.[381]

When livestock numbers and AUMs are adjusted to account for the portion of the allotments outside HMA boundaries,[382] the number of livestock grazed within the HMAs is 820,855, corresponding to 560,911 total AUMs and 489,257 AUMs permitted for use for seasonal/annual grazing. This compares to a high AML for wild horses of 3,725, which equates to an annual AUM of 44,700. See Figures WY-15 and WY-16. Hence, even at the HMA level, permitted use livestock AUMs are nearly 11 times larger than

[379] Per BLM policy, the BLM is not permitted to allow domestic horses and/or burros to utilize HMAs. It is not known if the 124 domestic horses/burros identified in the RAS database are permitted to graze on lands within HMAs in Wyoming.

[380] The AUMs were calculated using conversion rates of 1 cow = 1 AUM, 1 horse = 1 AUM (domestic horses and burros were combined in the BLM data set so the number of each species is unknown), and .2 sheep = 1 AUM. These conversion rates are consistent with BLM policies or were identified in various agricultural sources found on the Internet.

[381] Within individual allotments, there are several examples where permitted use AUMs is in excess of total or active AUMs. The reason for this discrepancy is not known.

[382] This assumes that domestic livestock are evenly distributed throughout the relevant grazing allotments. This is not likely to be accurate since livestock tend to remain close to water, particularly during the warmer months, meaning that their distribution is uneven and influenced by, among other factors, location of water sources, forage resources, suitable and preferred habitat, and fences.

annual wild horse AUMs. In addition, of the total number of livestock and wild horses estimated to use all Wyoming HMAs in 2012, 99.5 percent are livestock and 0.45 percent are wild horses. Wild ungulates also utilize these lands, though their numbers in each HMA were not estimated for the purpose of this analysis.

Figure WY-15:

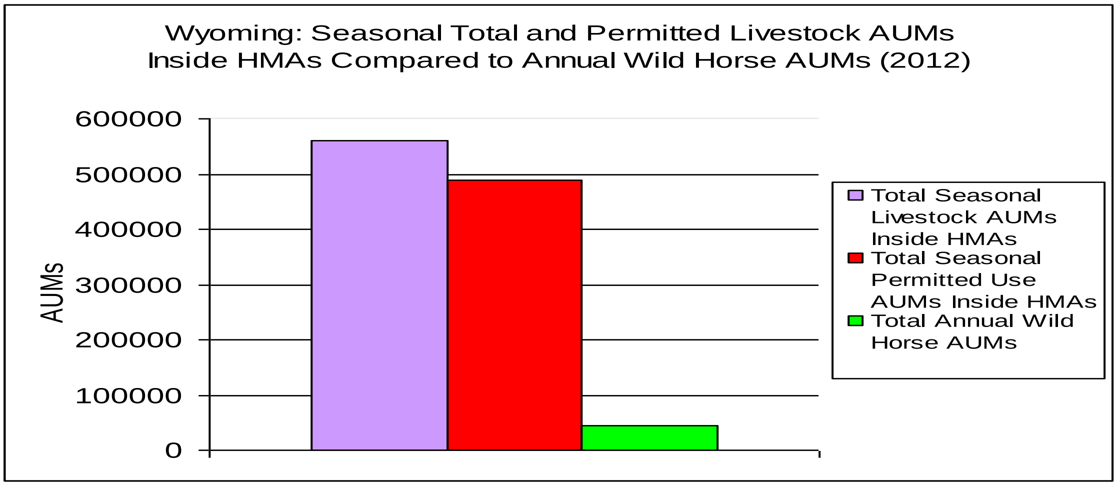
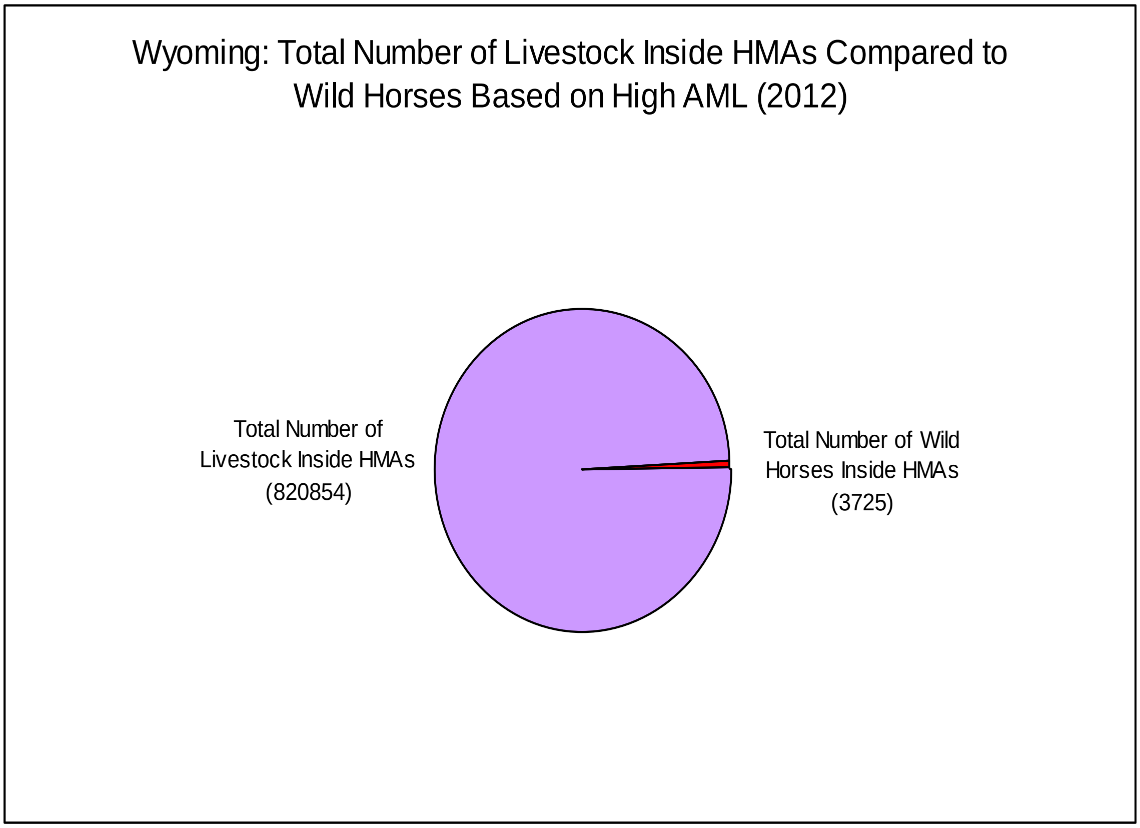


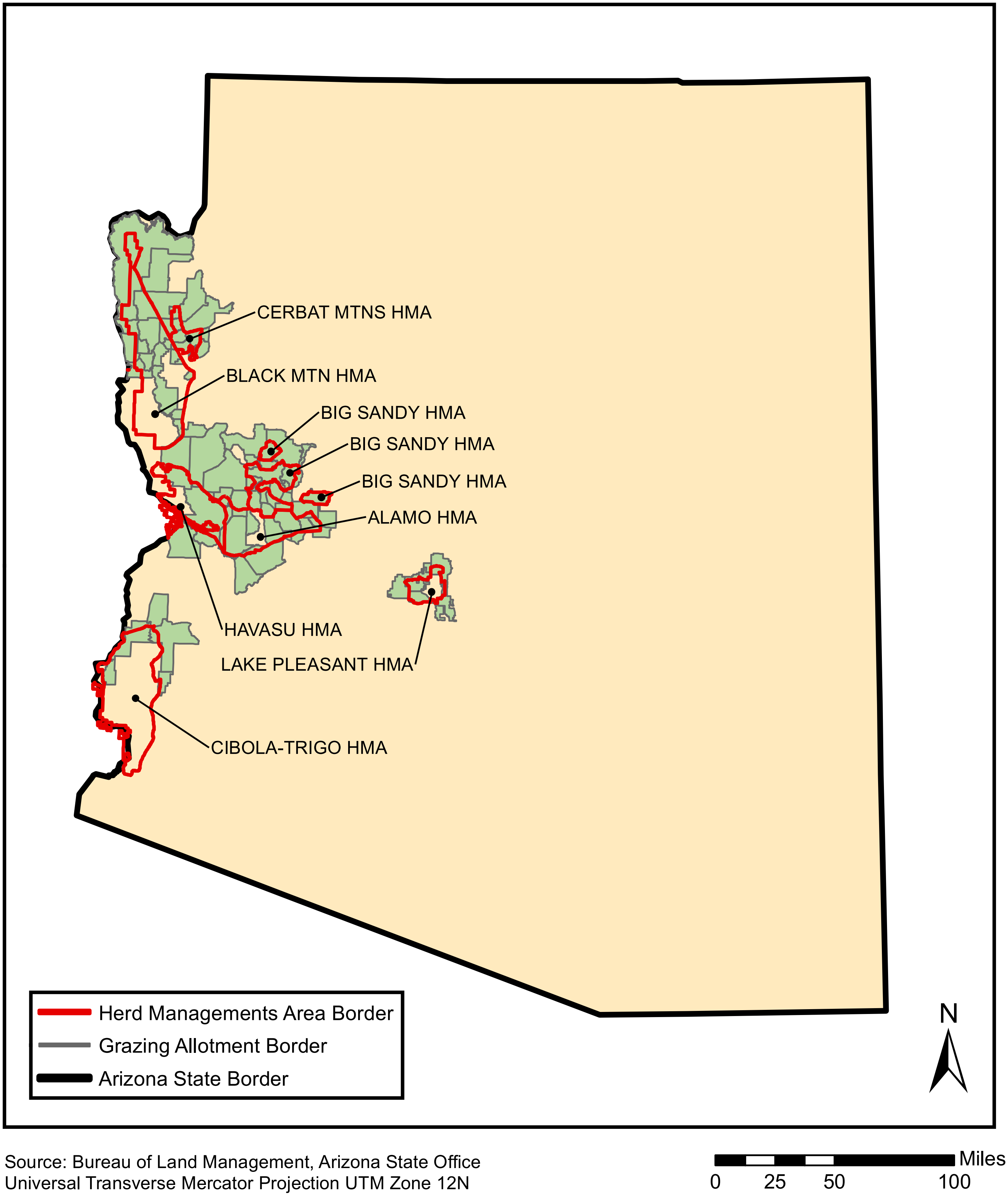
Figure WY-16:



APPENDIX A

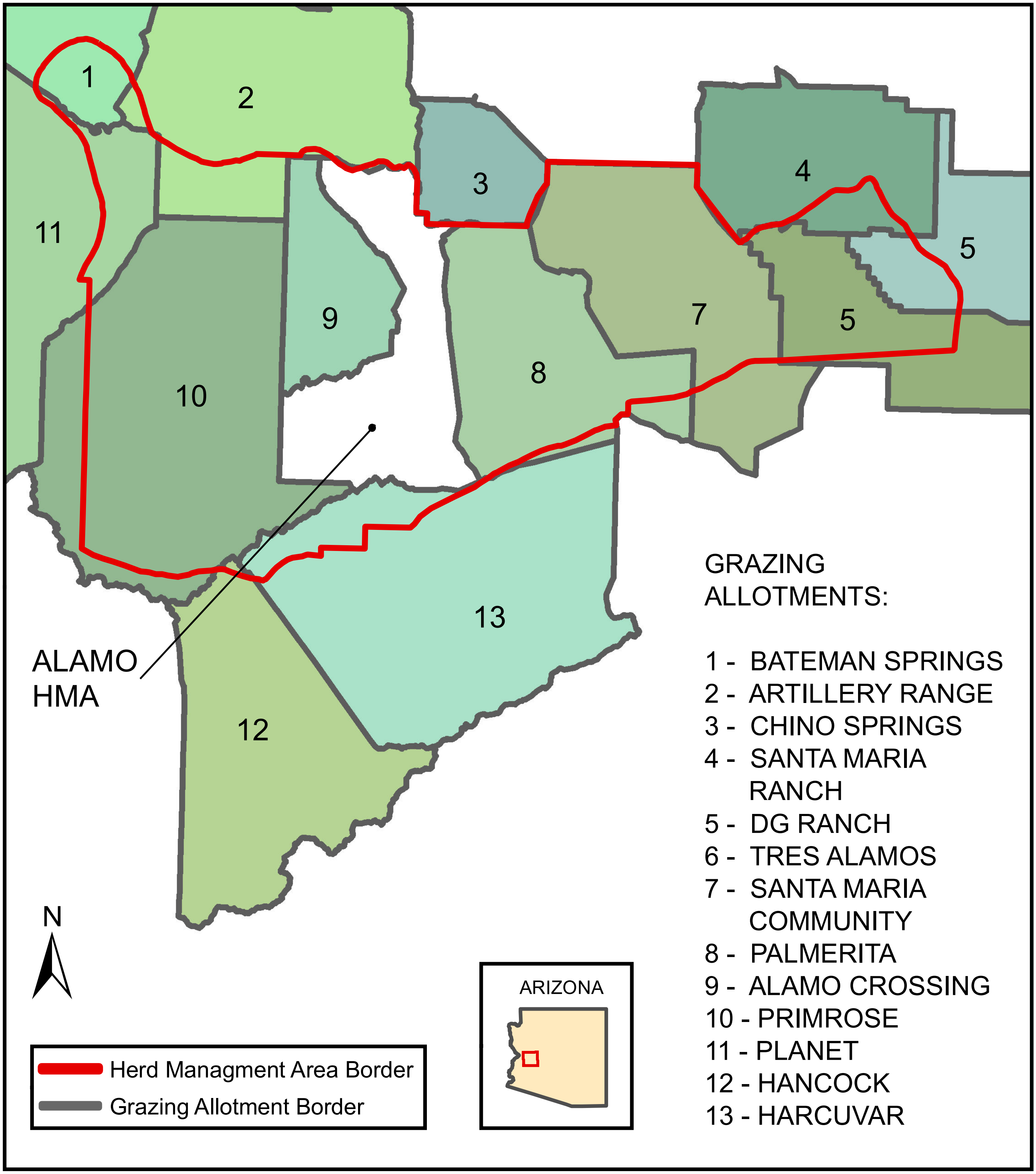
STATE MAPS

Herd Management Areas and Associated Grazing Allotments of Arizona



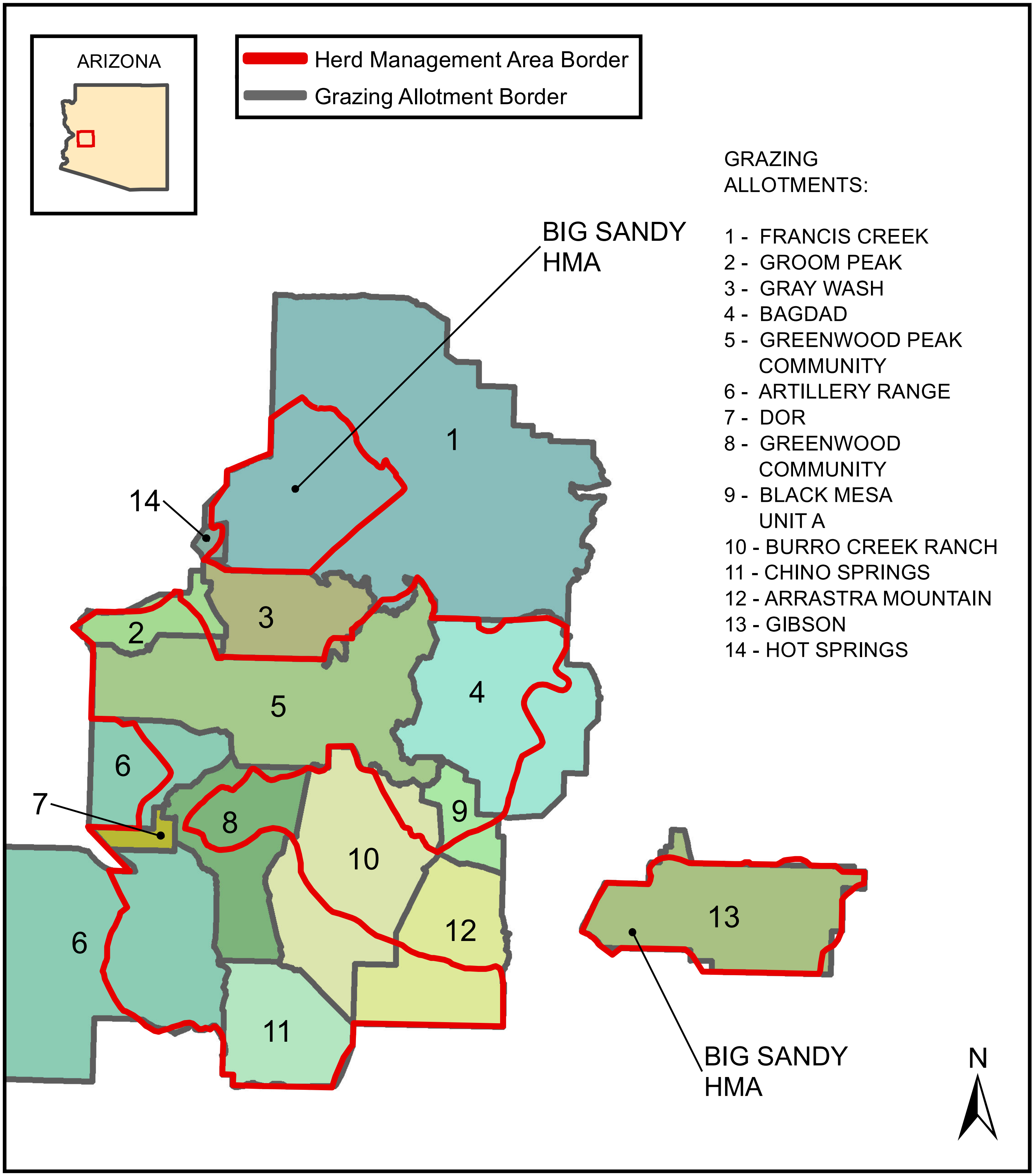
Source: Bureau of Land Management, Arizona State Office
Universal Transverse Mercator Projection UTM Zone 12N

Alamo Herd Management Area and Associated Grazing Allotments of Arizona



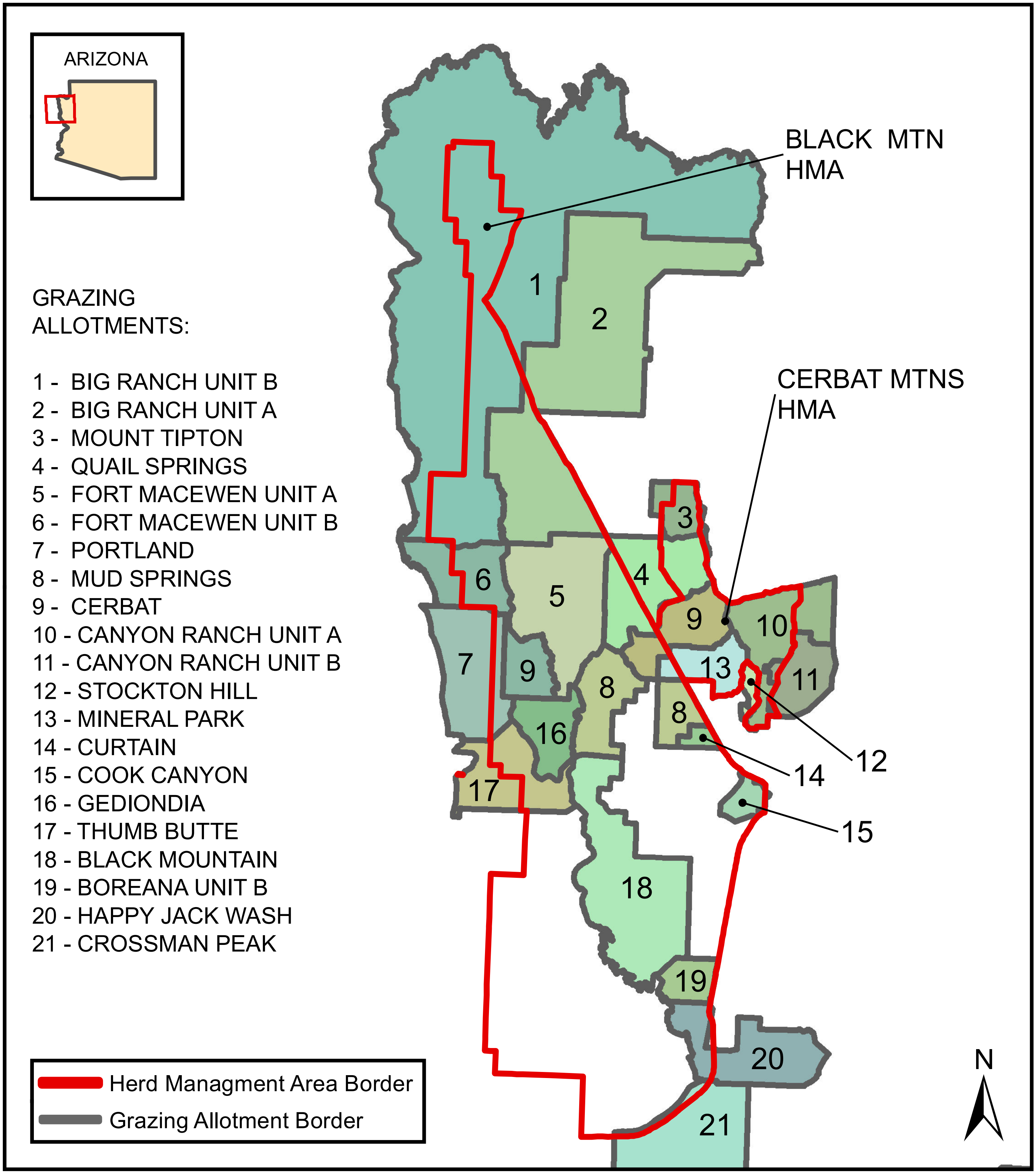
Source: Bureau of Land Management, Arizona State Office
Universal Transverse Mercator Projection UTM Zone 12N

Big Sandy Herd Management Area and Associated Grazing Allotments of Arizona



Source: Bureau of Land Management, Arizona State Office
Universal Transverse Mercator Projection UTM Zone 12N

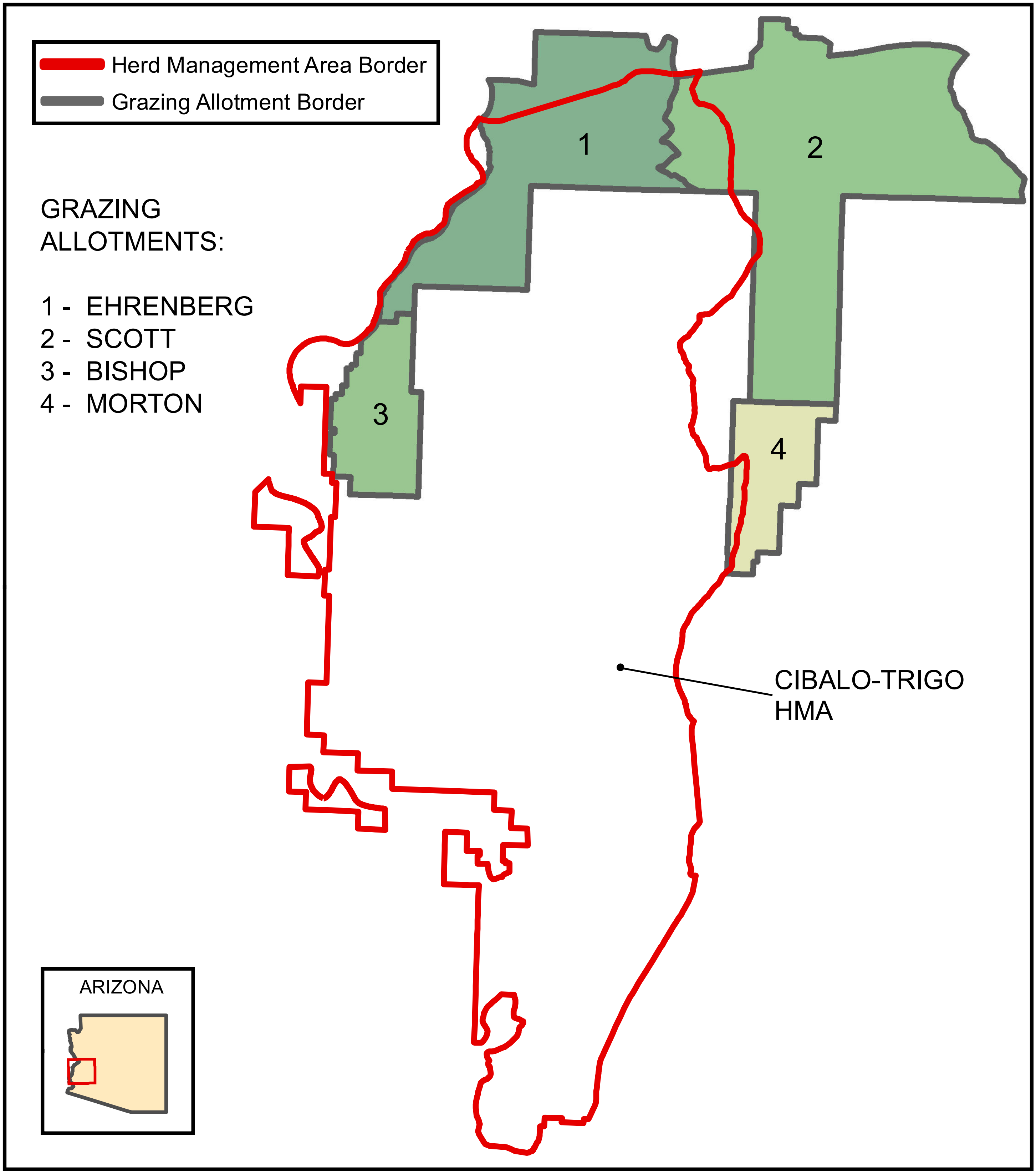
Cerbat Mountain and Black Mountains Herd Management Areas and Associated Grazing Allotments of Arizona



Source: Bureau of Land Management, Arizona State Office
Universal Transverse Mercator Projection UTM Zone 12N

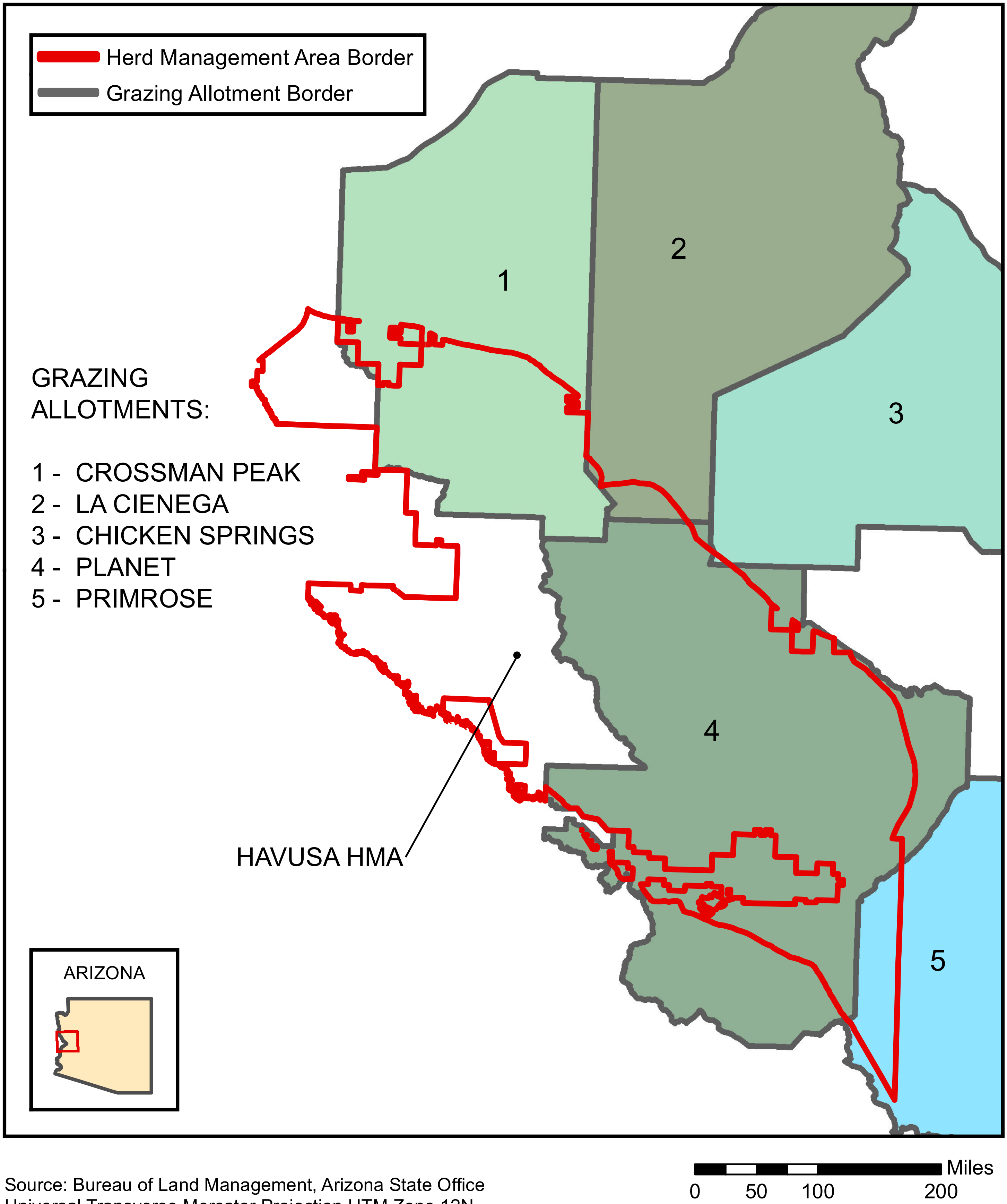
Miles
0 50 100 200

Cibola-Trigo Herd Management Area and Associated Grazing Allotments of Arizona



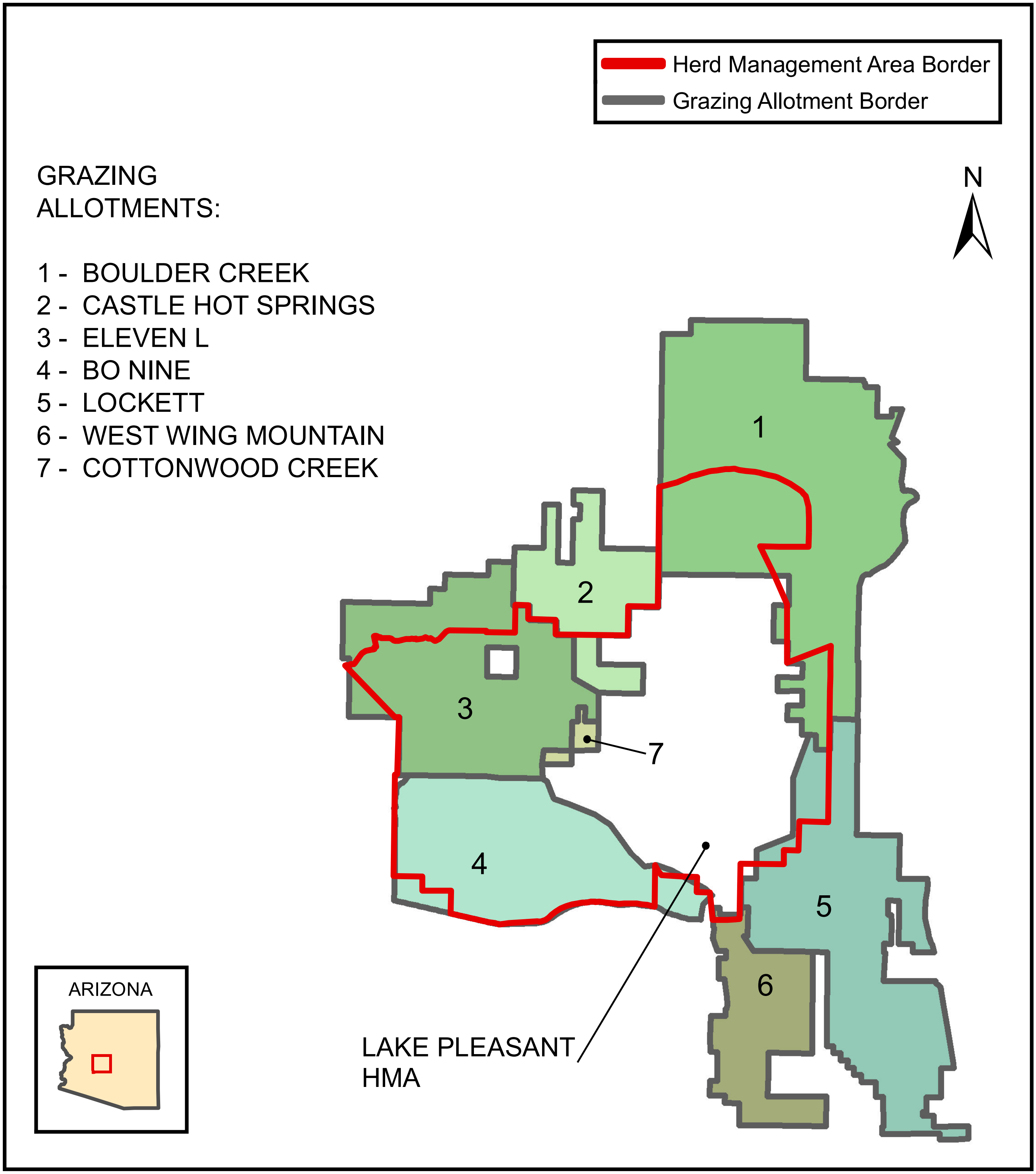
Source: Bureau of Land Management, Arizona State Office
Universal Transverse Mercator Projection UTM Zone 12N

Havusa Herd Management Area and Associated Grazing Allotments of Arizona



Source: Bureau of Land Management, Arizona State Office
Universal Transverse Mercator Projection UTM Zone 12N

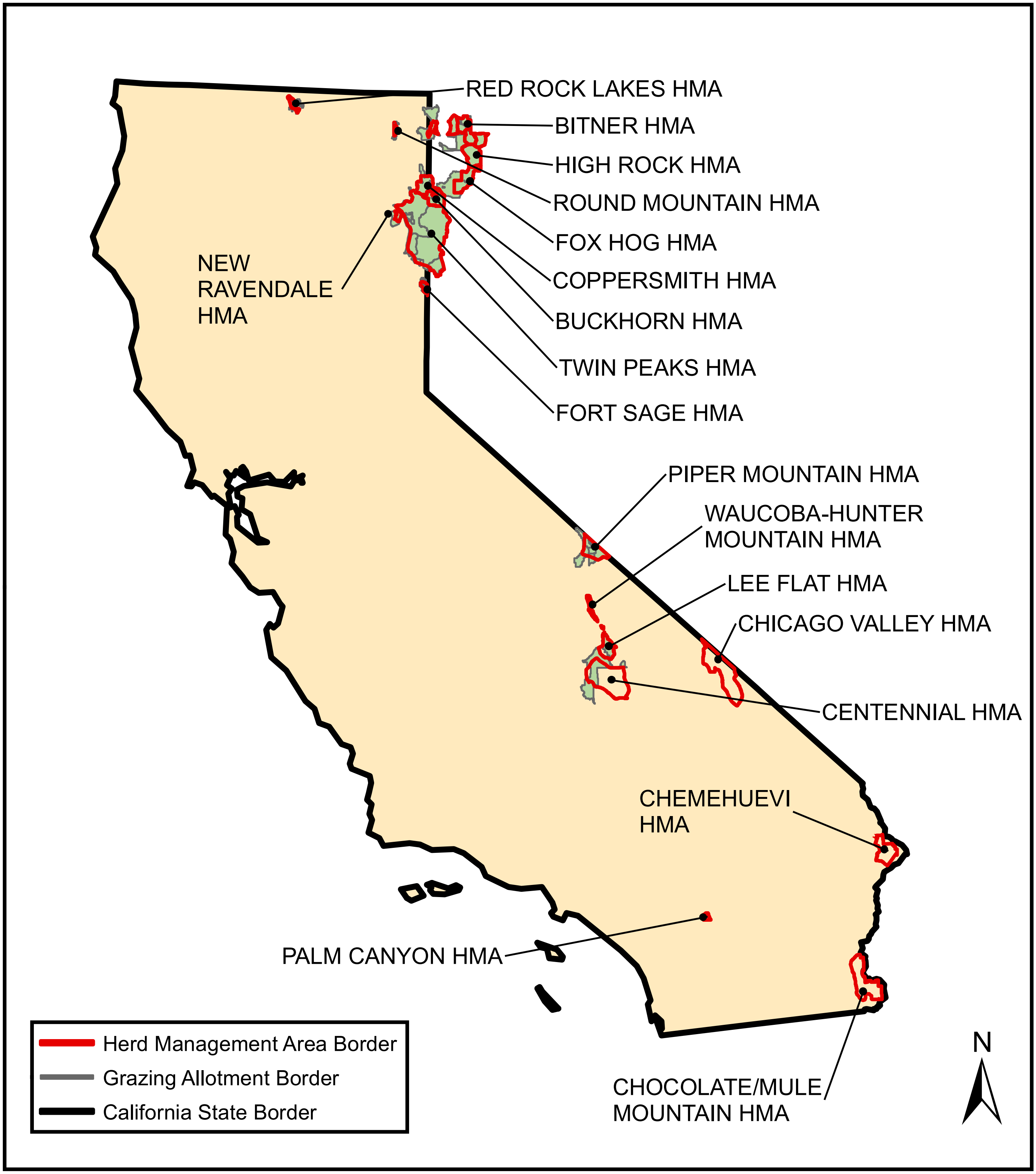
Lake Pleasant Herd Management Area and Associated Grazing Allotments of Arizona



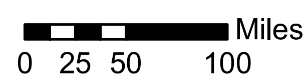
Source: Bureau of Land Management, Arizona State Office
Universal Transverse Mercator Projection UTM Zone 12N

Miles
0 50 100 200

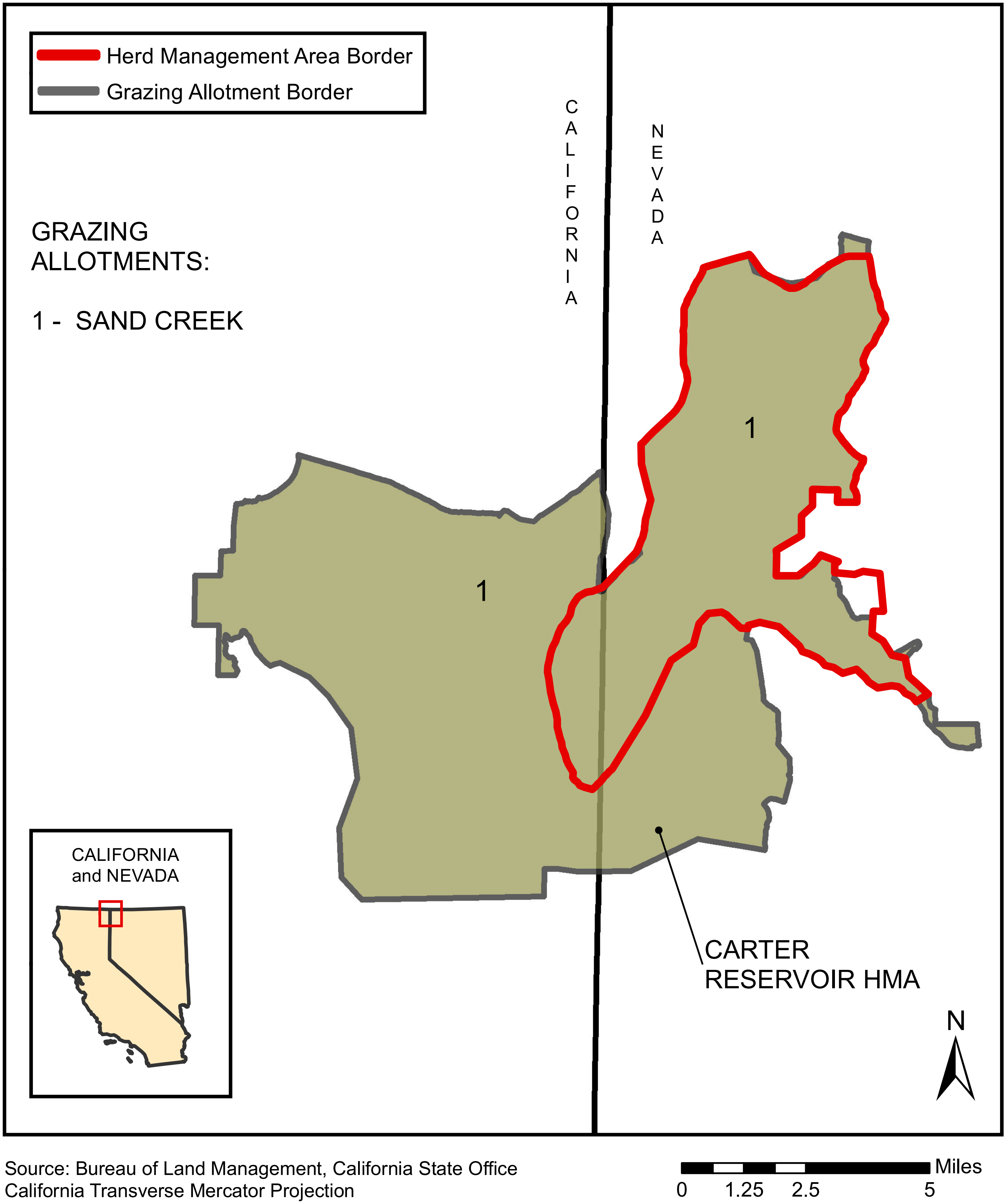
Herd Management Areas and Associated Grazing Allotments of California



Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

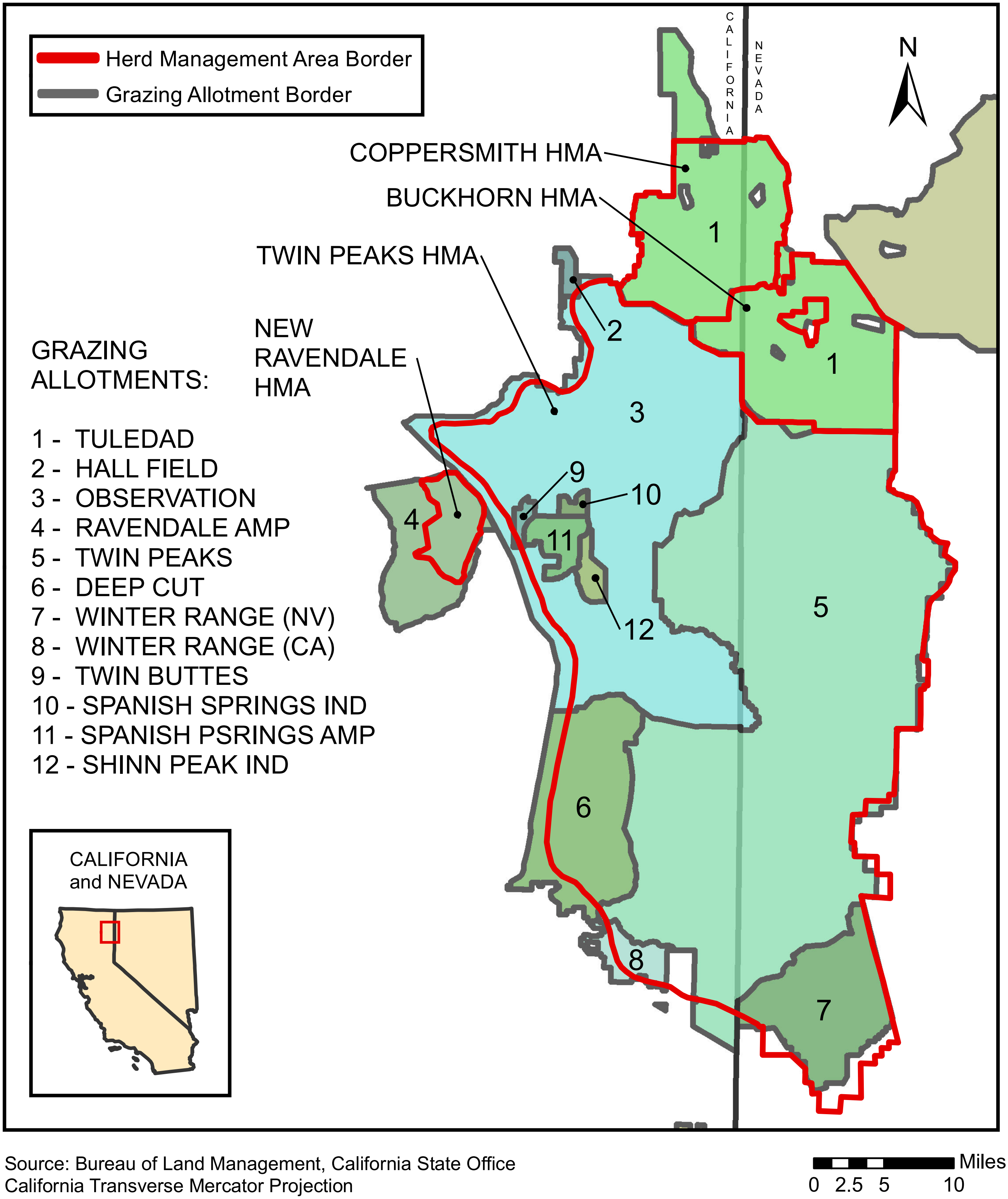


Carter Reservoir Herd Management Area and Associated Grazing Allotments of California



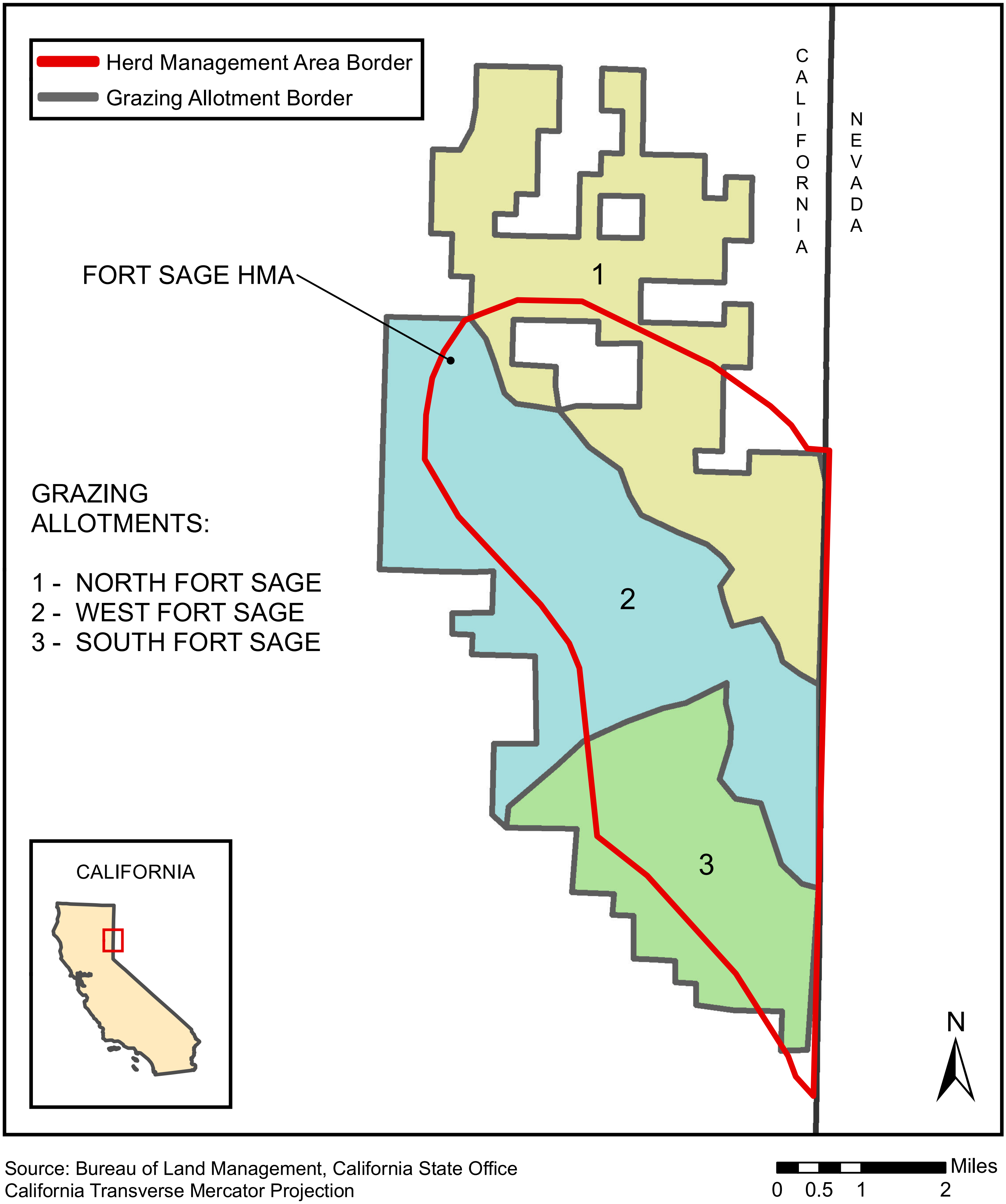
Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

Coppersmith, Buckhorn, Twin Peaks and New Ravendale Herd Management Areas and Associated Grazing Allotments of California



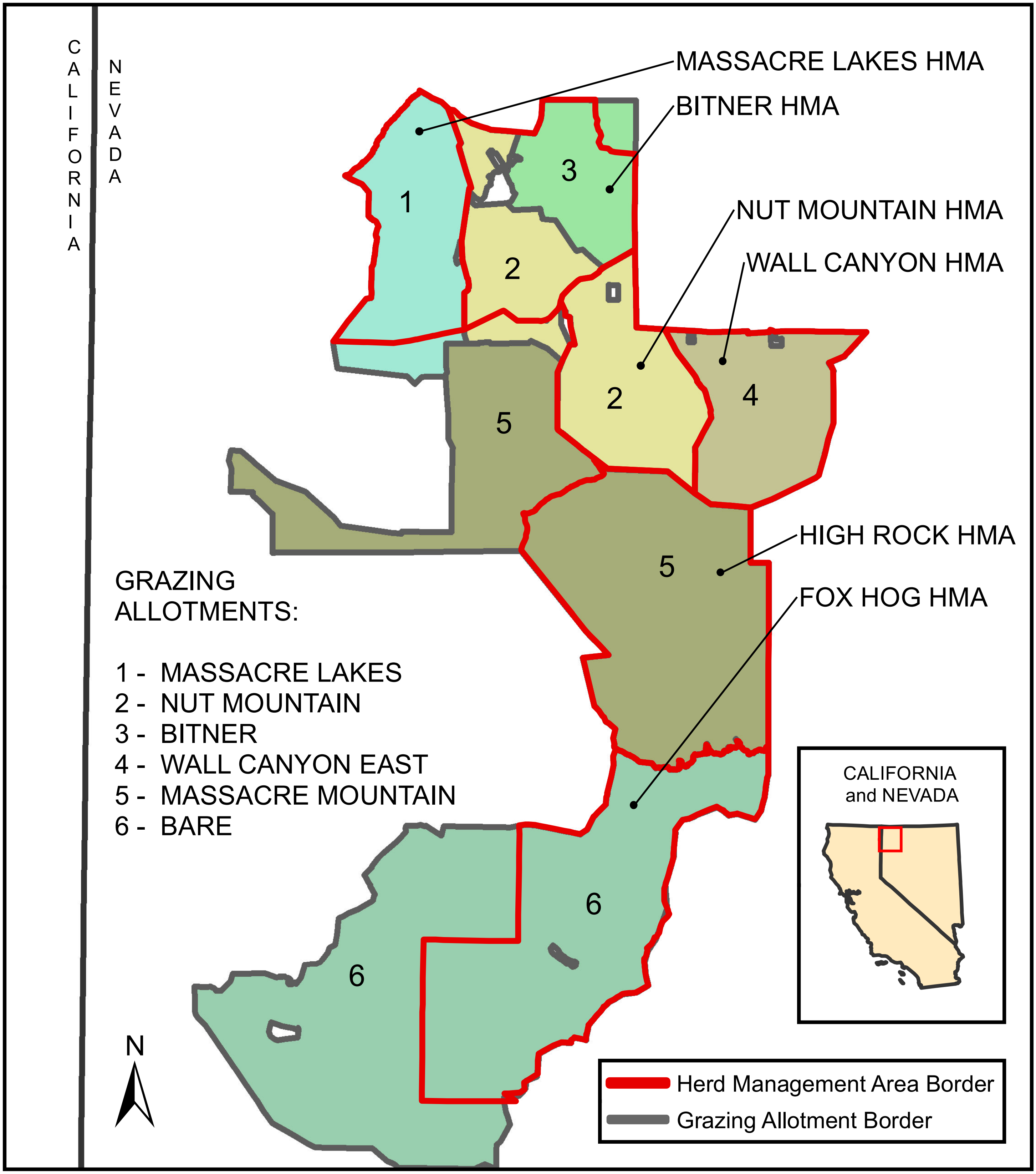
Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

Fort Sage Herd Management Area and Associated Grazing Allotments of California



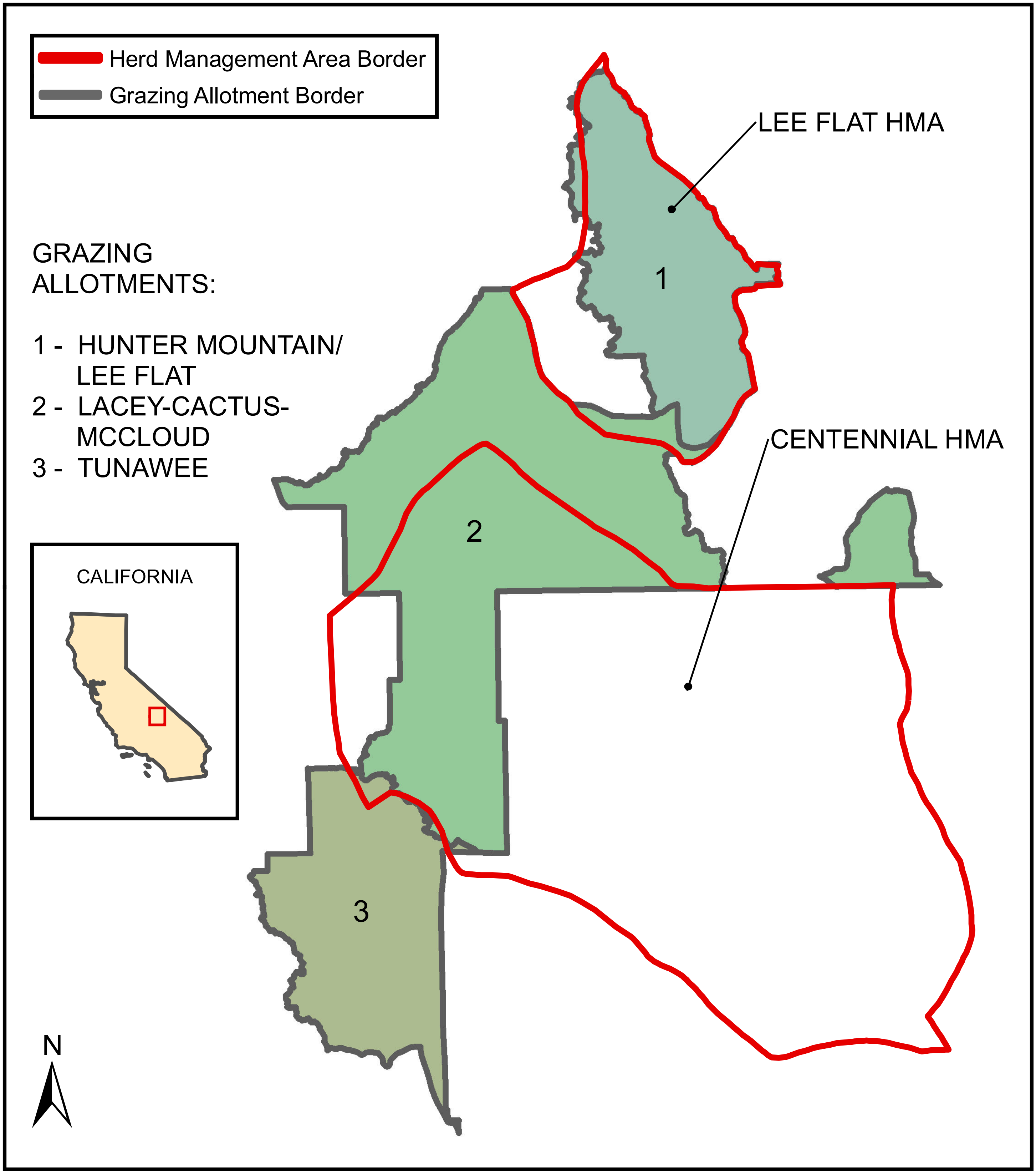
Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

Massacre Lakes, Bitner, Nut Mountain, High Rock and Fox Hog Herd Management Areas and Associated Grazing Allotments of California



Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

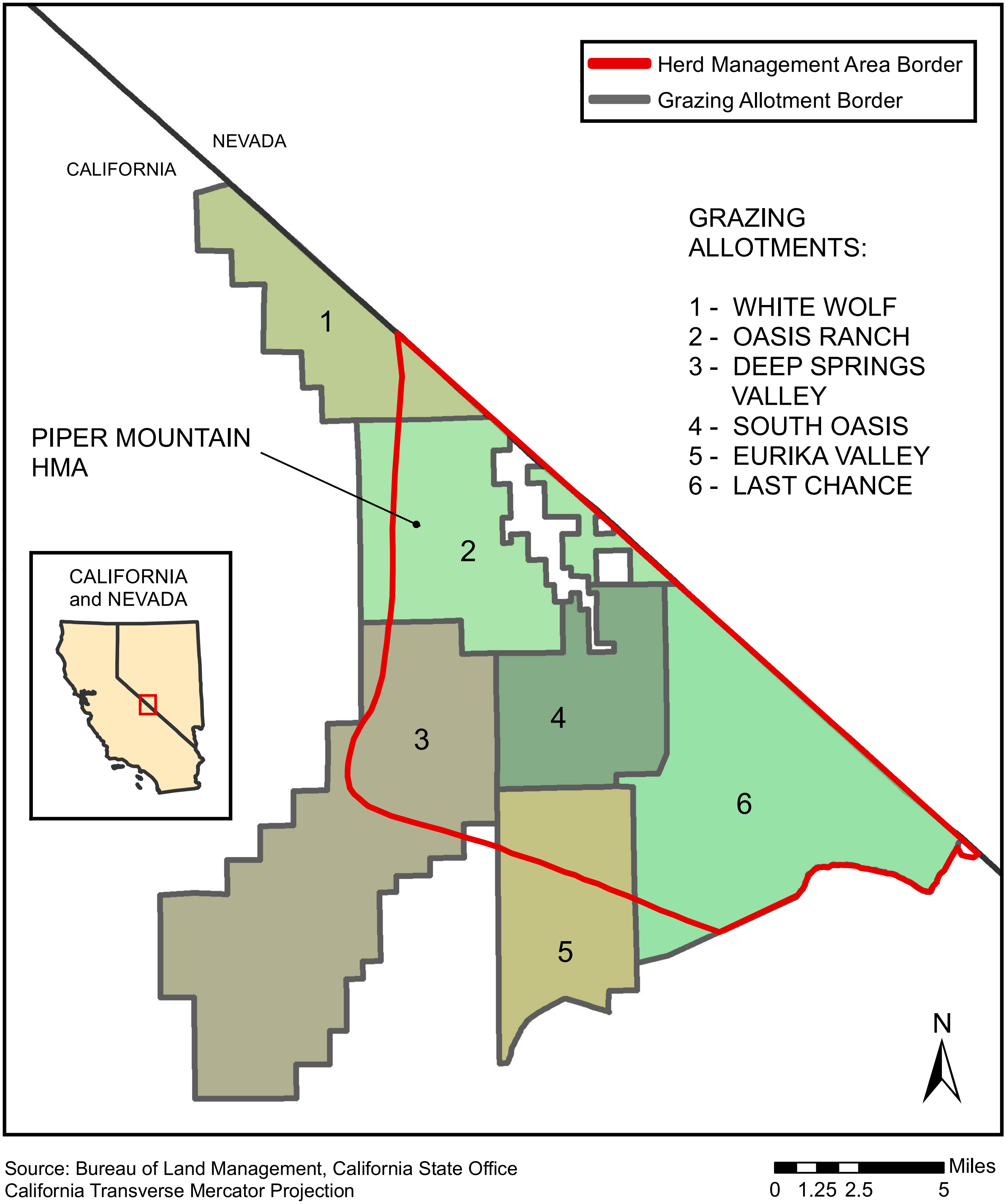
Lee Flat and Centennial Herd Management Areas and Associated Grazing Allotments of California



Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

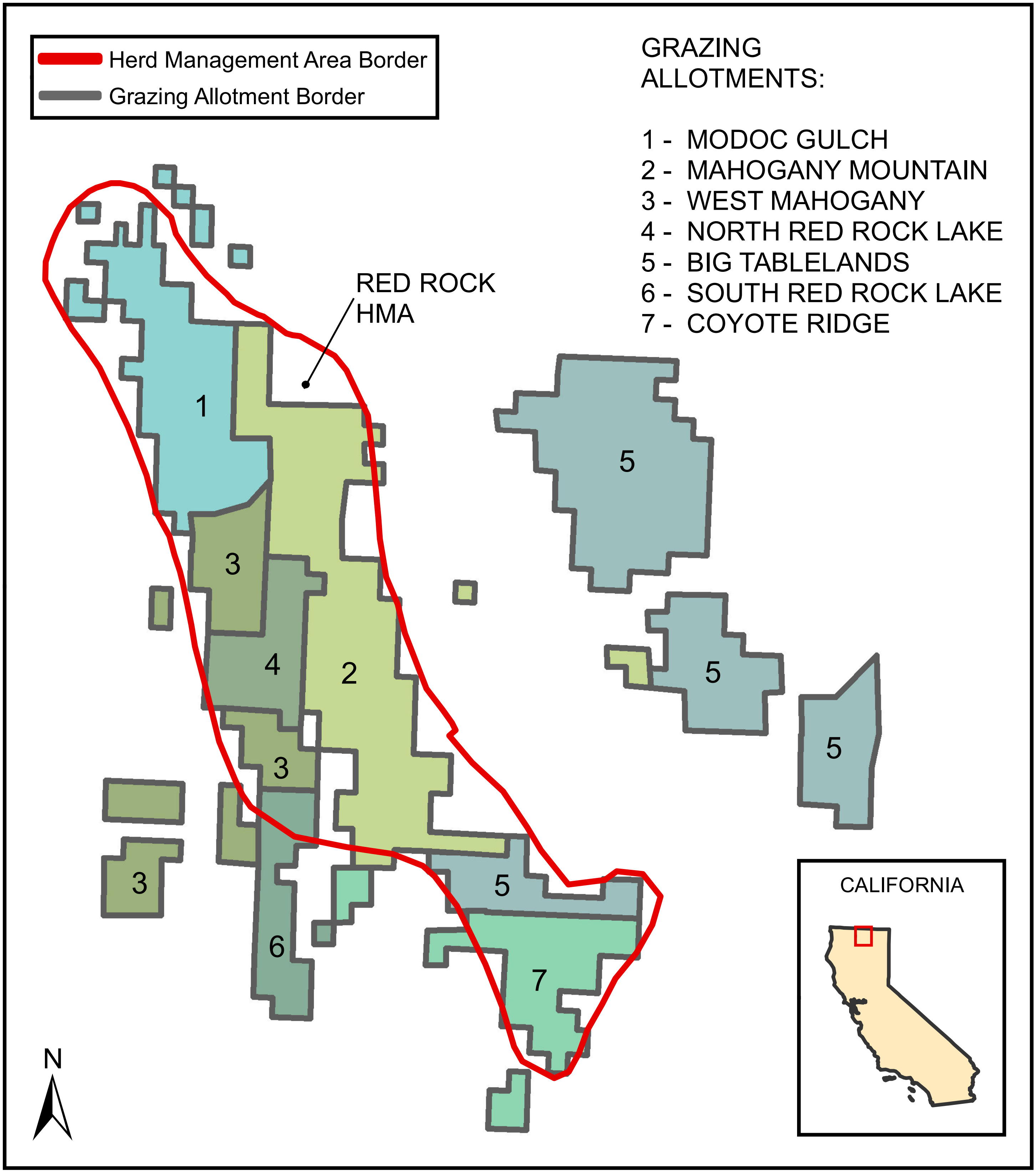
Miles 0 2.5 5 10

Piper Mountain Herd Management Area and Associated Grazing Allotments of California



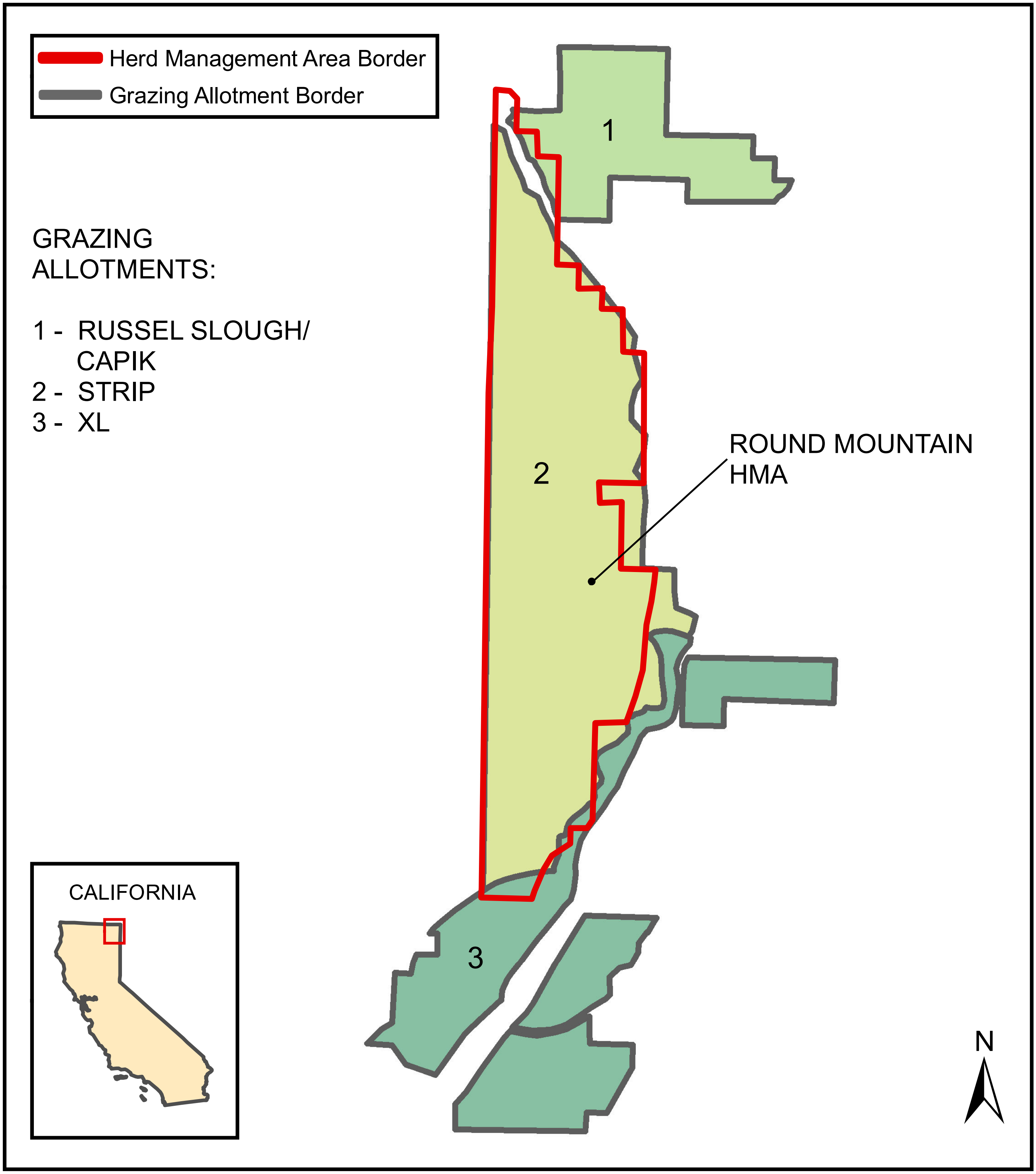
Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

Red Rock Lakes Herd Management Area and Associated Grazing Allotments of California



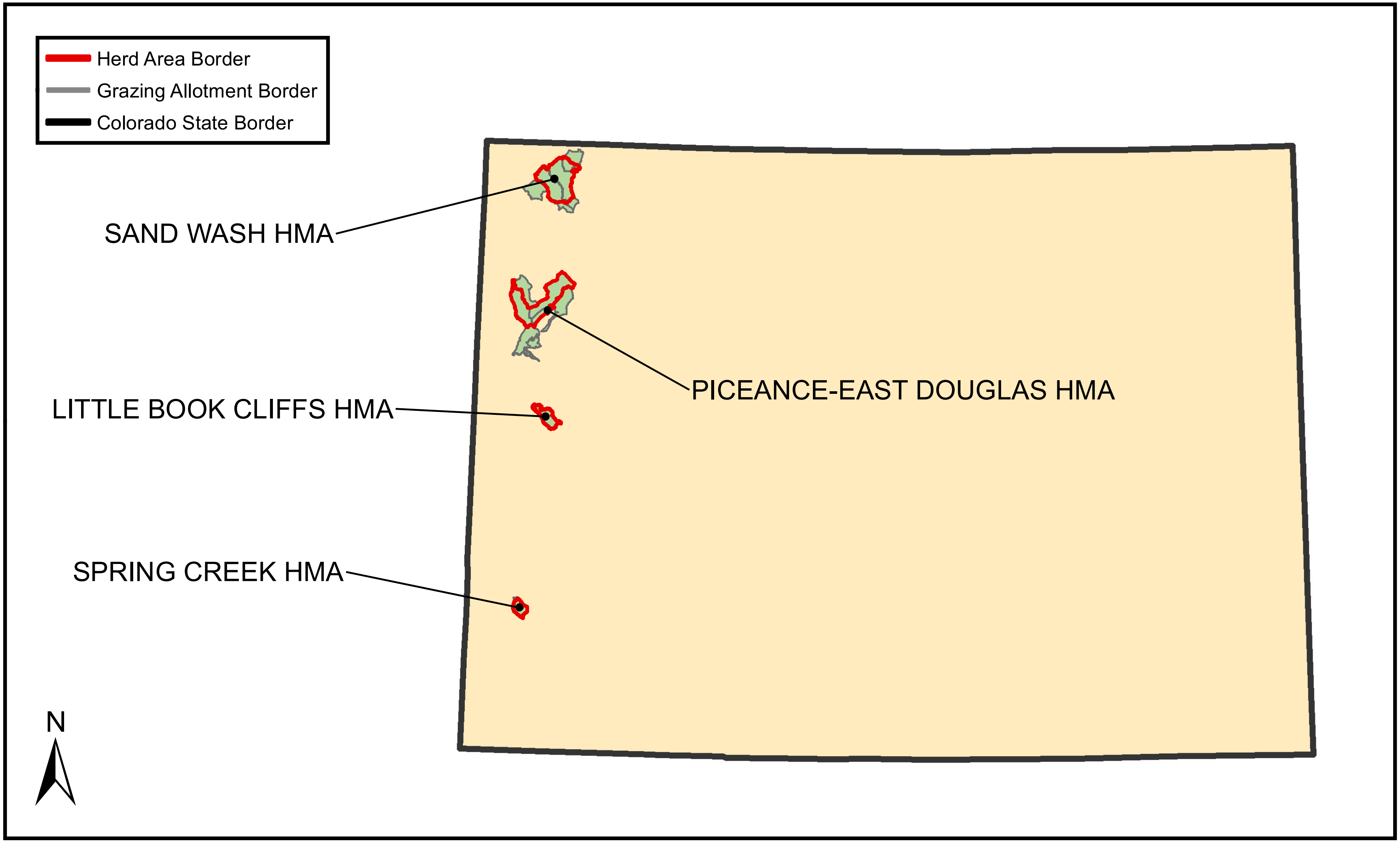
Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

Round Mountain Herd Management Area and Associated Grazing Allotments of California



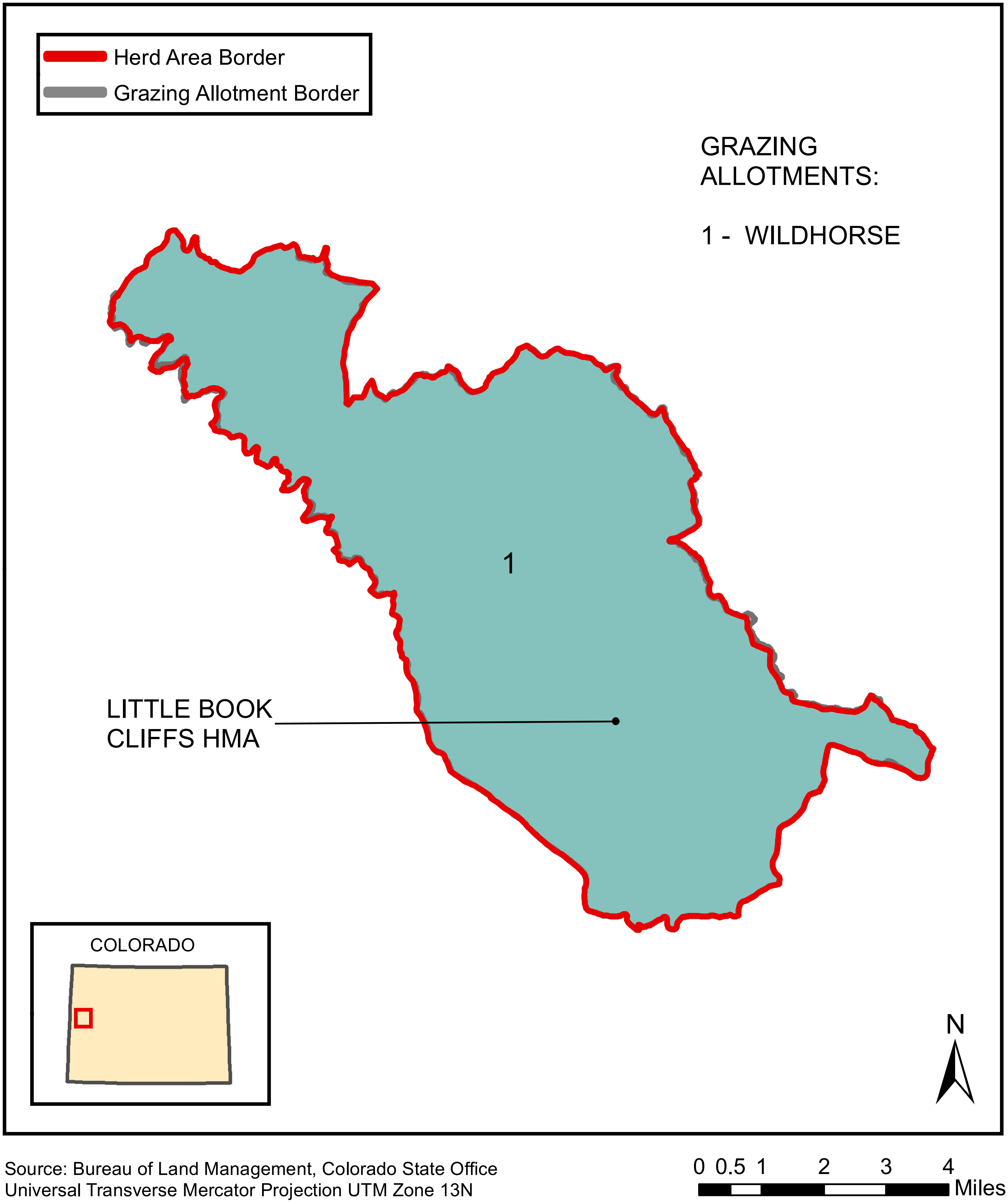
Source: Bureau of Land Management, California State Office
California Transverse Mercator Projection

Herd Management Areas and Associated Grazing Allotments of Colorado



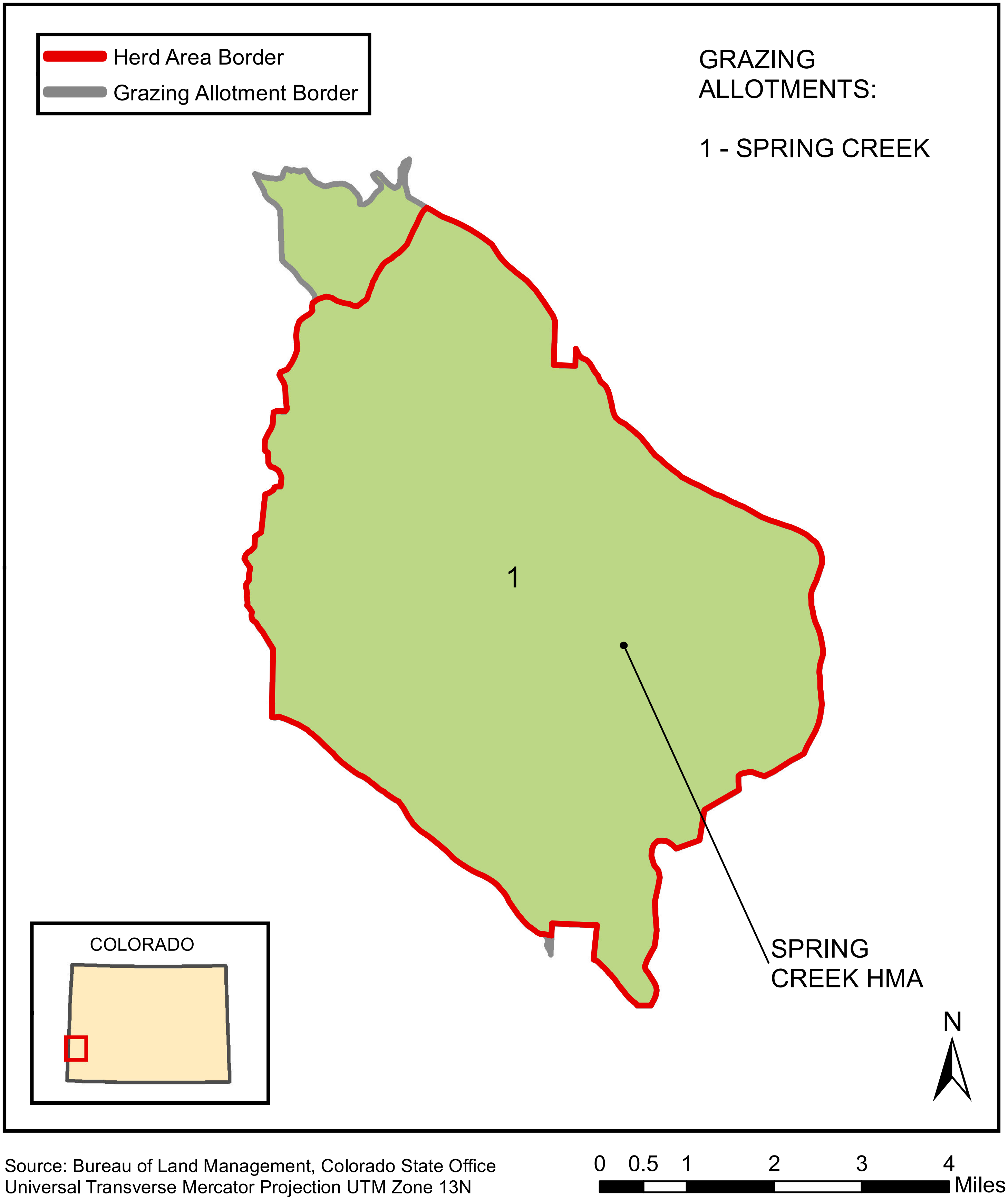
Source: Bureau of Land Management, Colorado State Office
Universal Transverse Mercator Projection UTM Zone 13N

Little Book Cliffs Herd Management Area and Associated Grazing Allotments of Colorado



Source: Bureau of Land Management, Colorado State Office
Universal Transverse Mercator Projection UTM Zone 13N

Spring Creek Basin Herd Management Area and Associated Grazing Allotments of Colorado



Source: Bureau of Land Management, Colorado State Office
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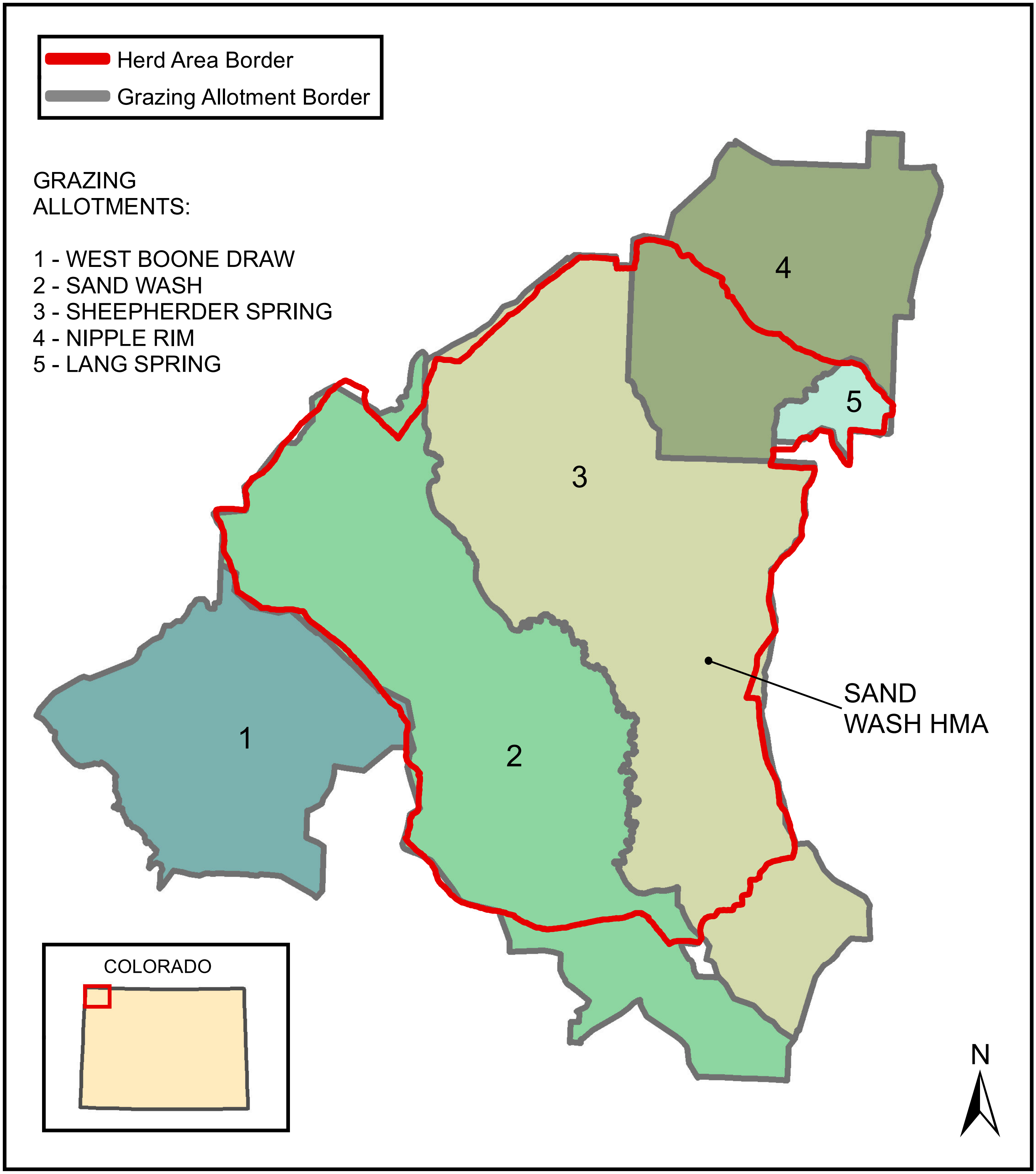
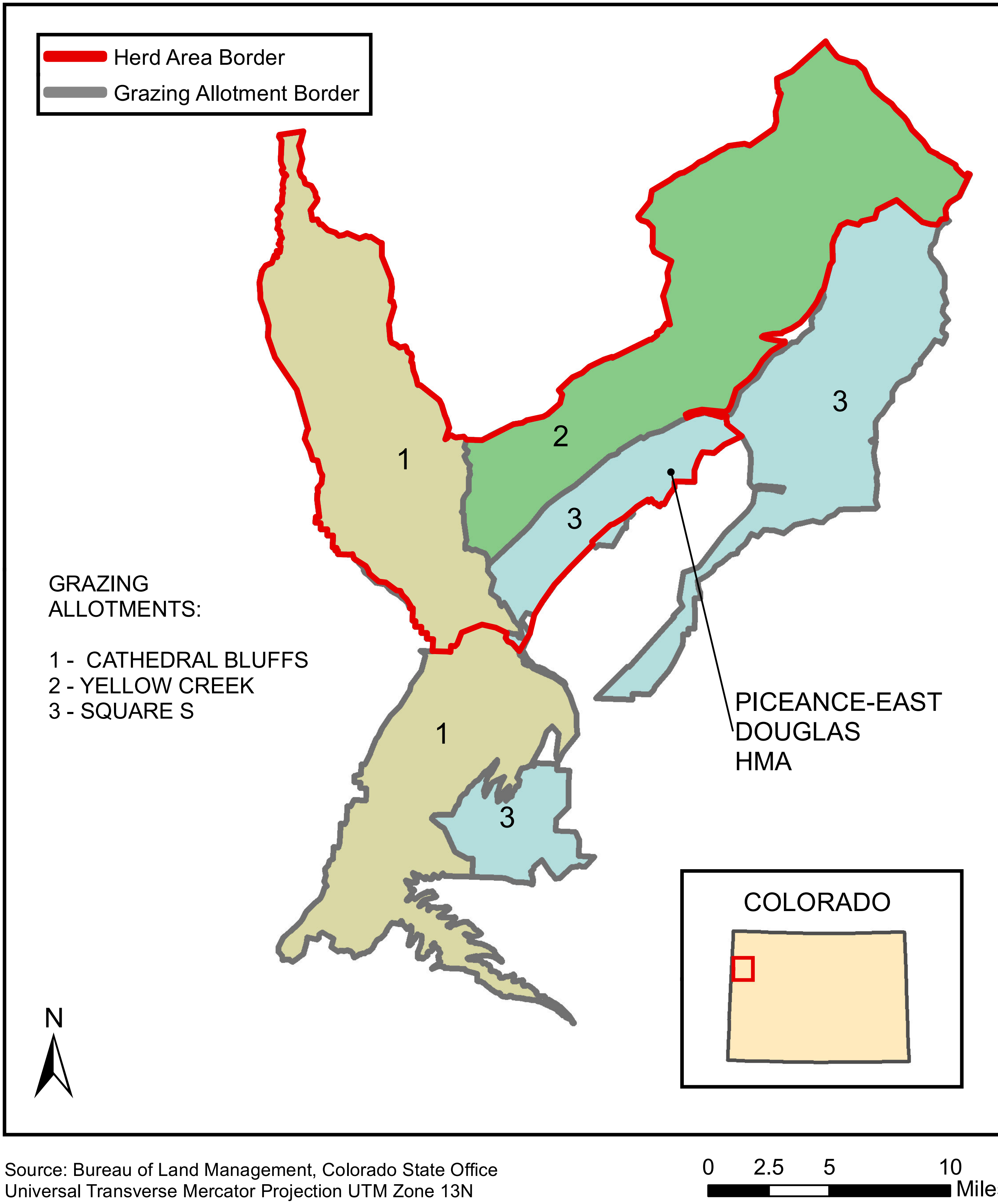
Sand Wash Herd Management Area and Associated Grazing Allotments of Colorado



Source: Bureau of Land Management, Colorado State Office
Universal Transverse Mercator Projection UTM Zone 13N

0 1.25 2.5 5 7.5 10 Miles

Piceance/East Douglas Herd Management Areas and Associated Grazing Allotments of Colorado



Source: Bureau of Land Management, Colorado State Office
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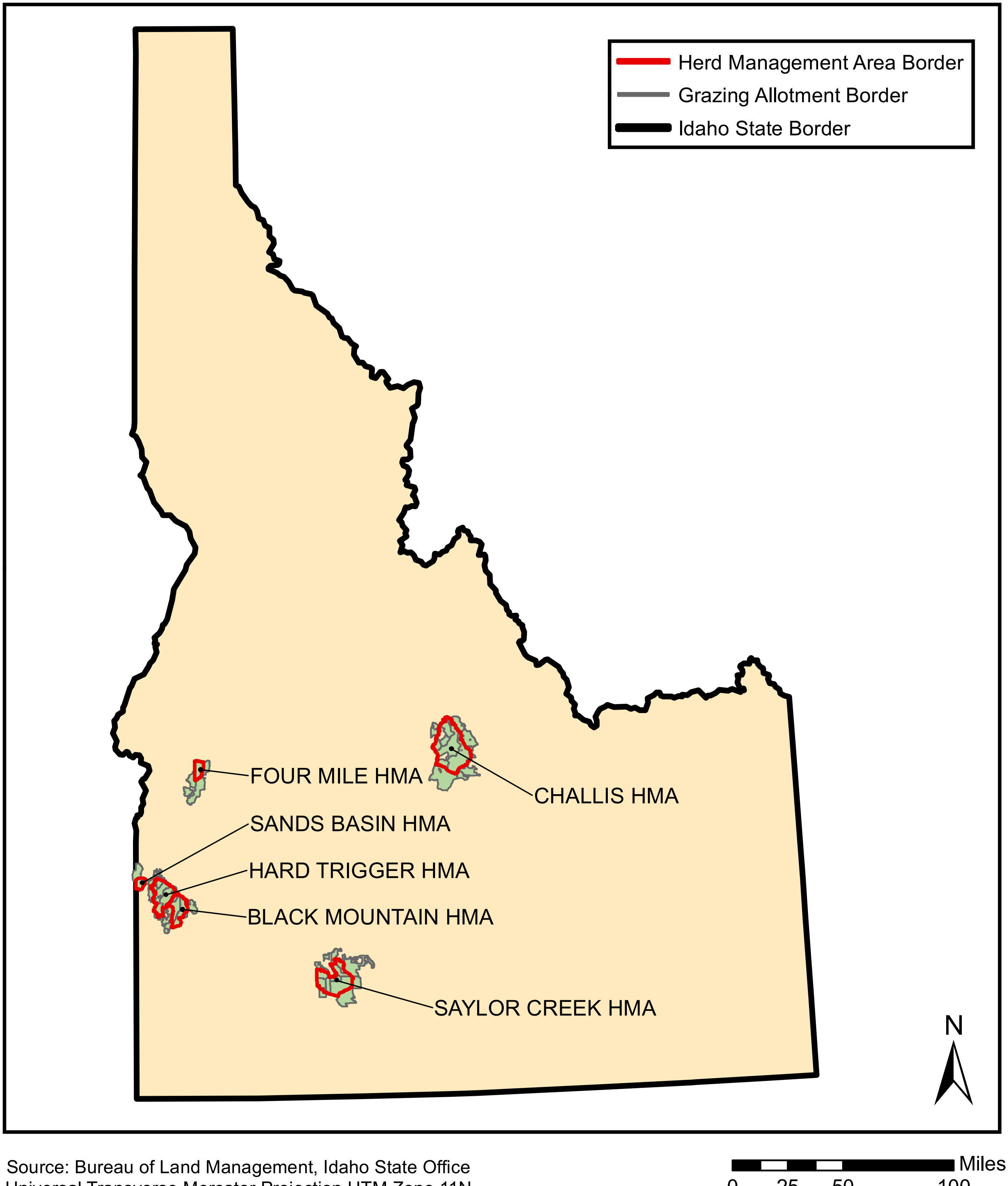
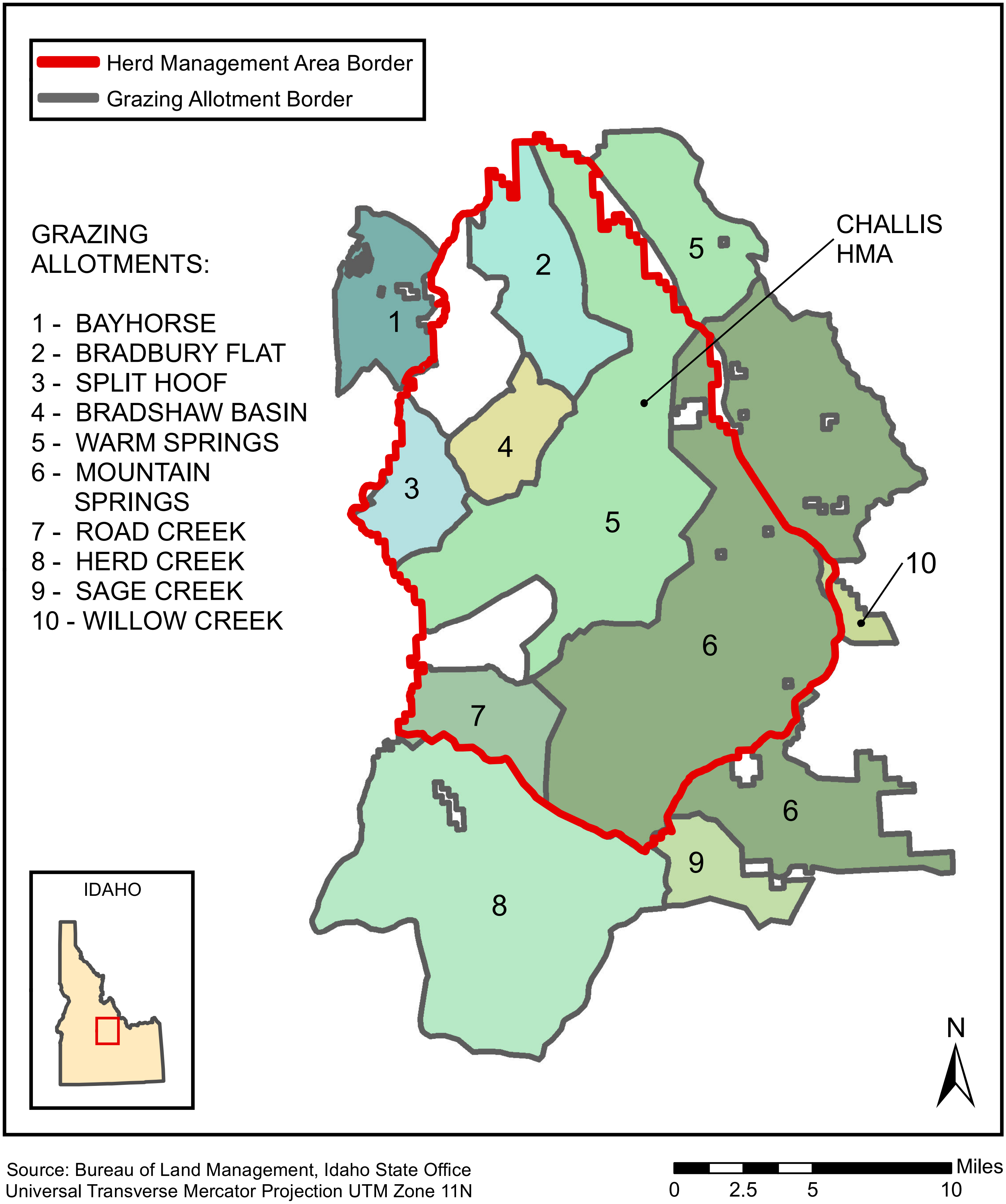
Herd Management Areas and Associated Grazing Allotments of Idaho



Source: Bureau of Land Management, Idaho State Office
Universal Transverse Mercator Projection UTM Zone 11N

Challis Herd Management Area and Associated Grazing Allotments of Idaho



Source: Bureau of Land Management, Idaho State Office
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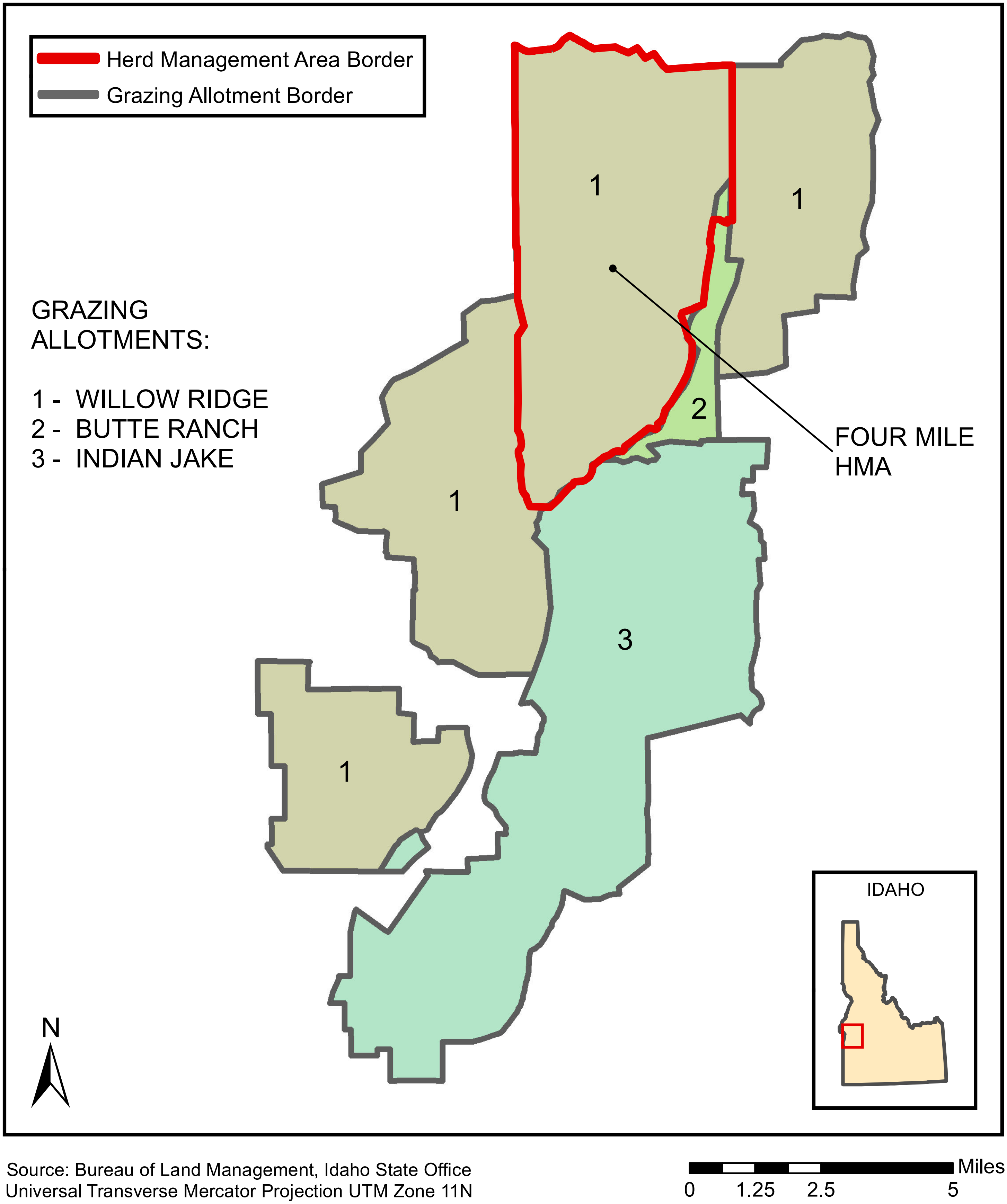
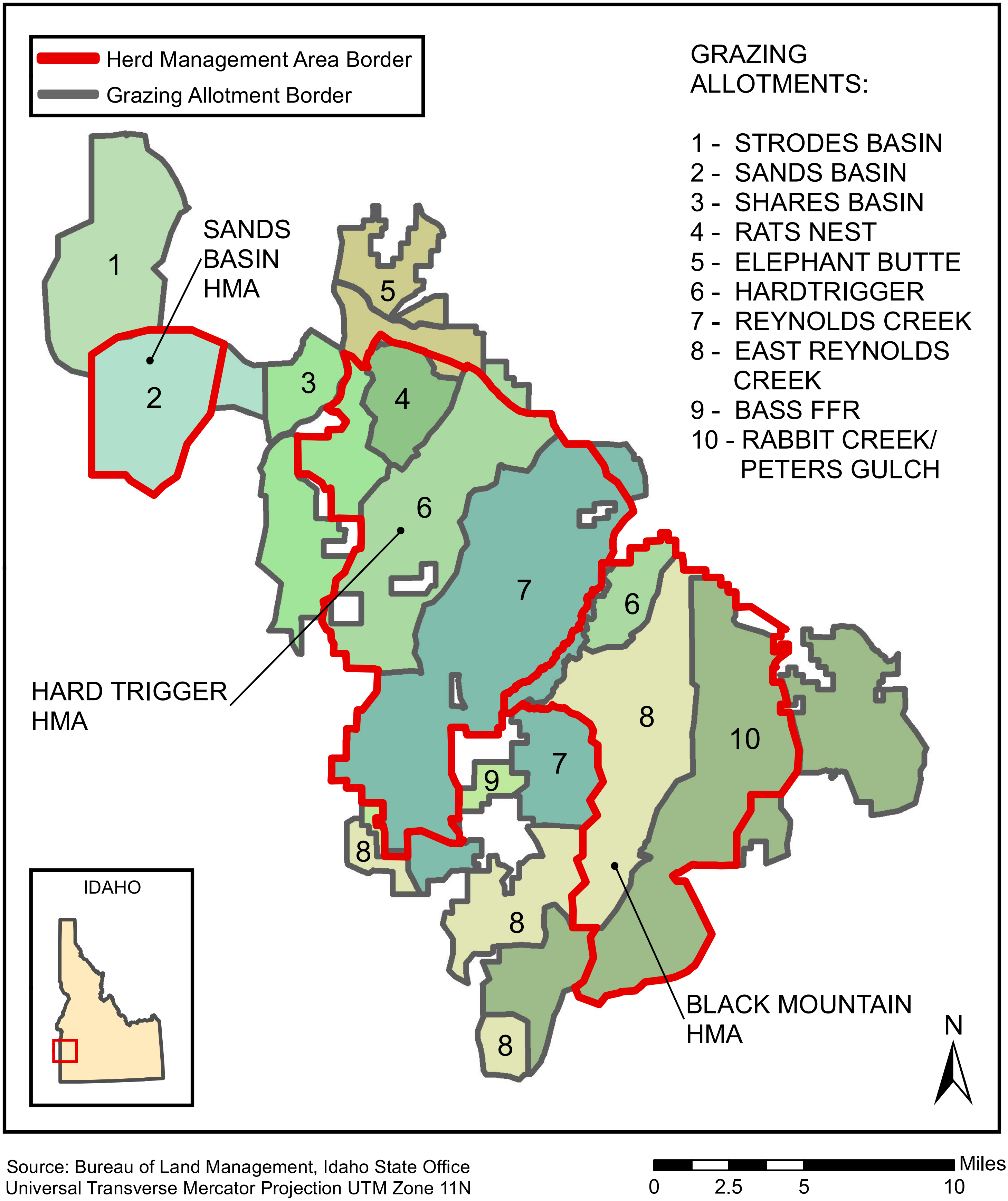
Four Mile Herd Management Area and Associated Grazing Allotments of Idaho



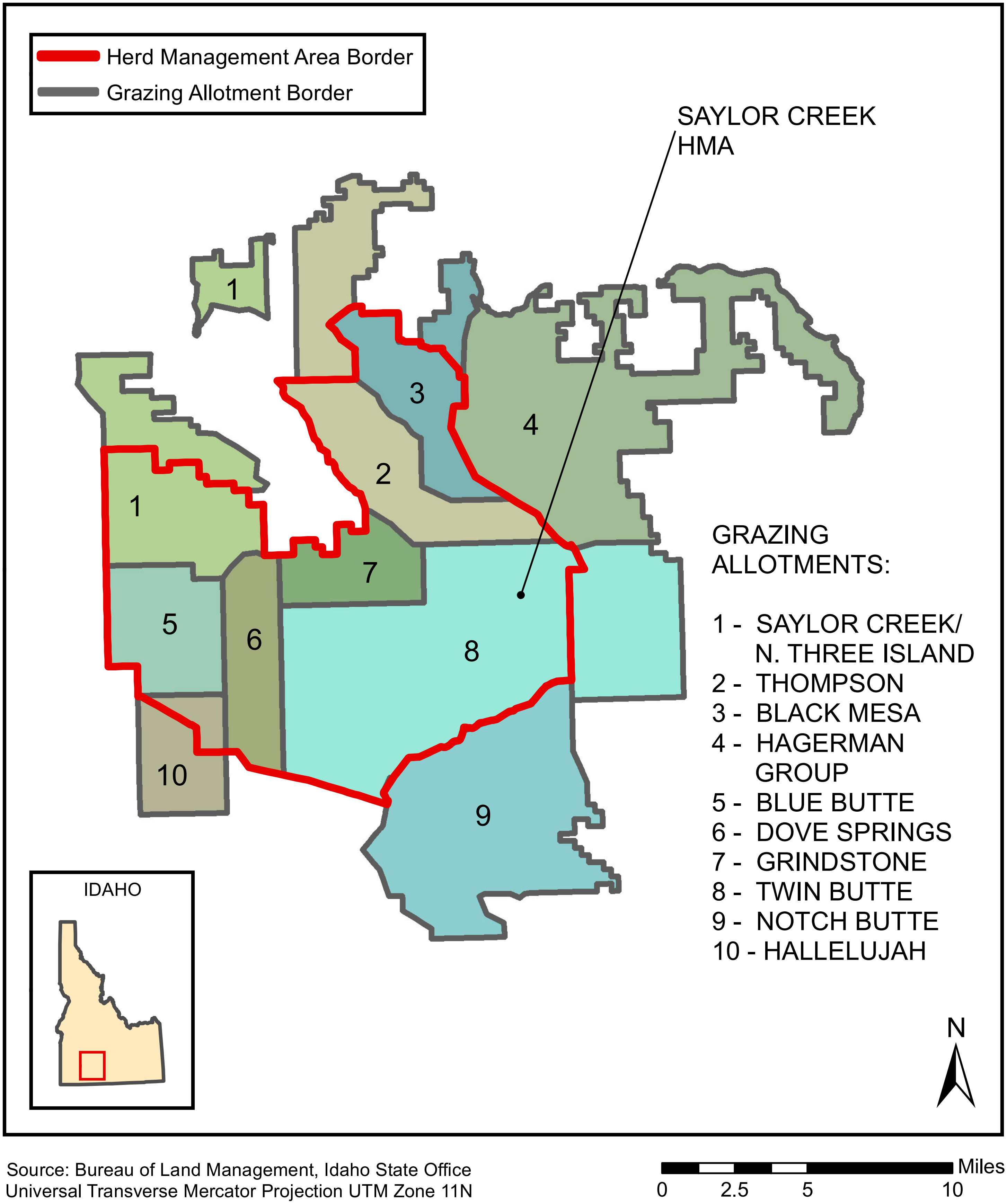
Source: Bureau of Land Management, Idaho State Office
Universal Transverse Mercator Projection UTM Zone 11N

Sands Basin, Balck Mountain and Hard Trigger Herd Management Areas and Associated Grazing Allotments of Idaho



Source: Bureau of Land Management, Idaho State Office
Universal Transverse Mercator Projection UTM Zone 11N

Saylor Creek Herd Management Area and Associated Grazing Allotments of Idaho



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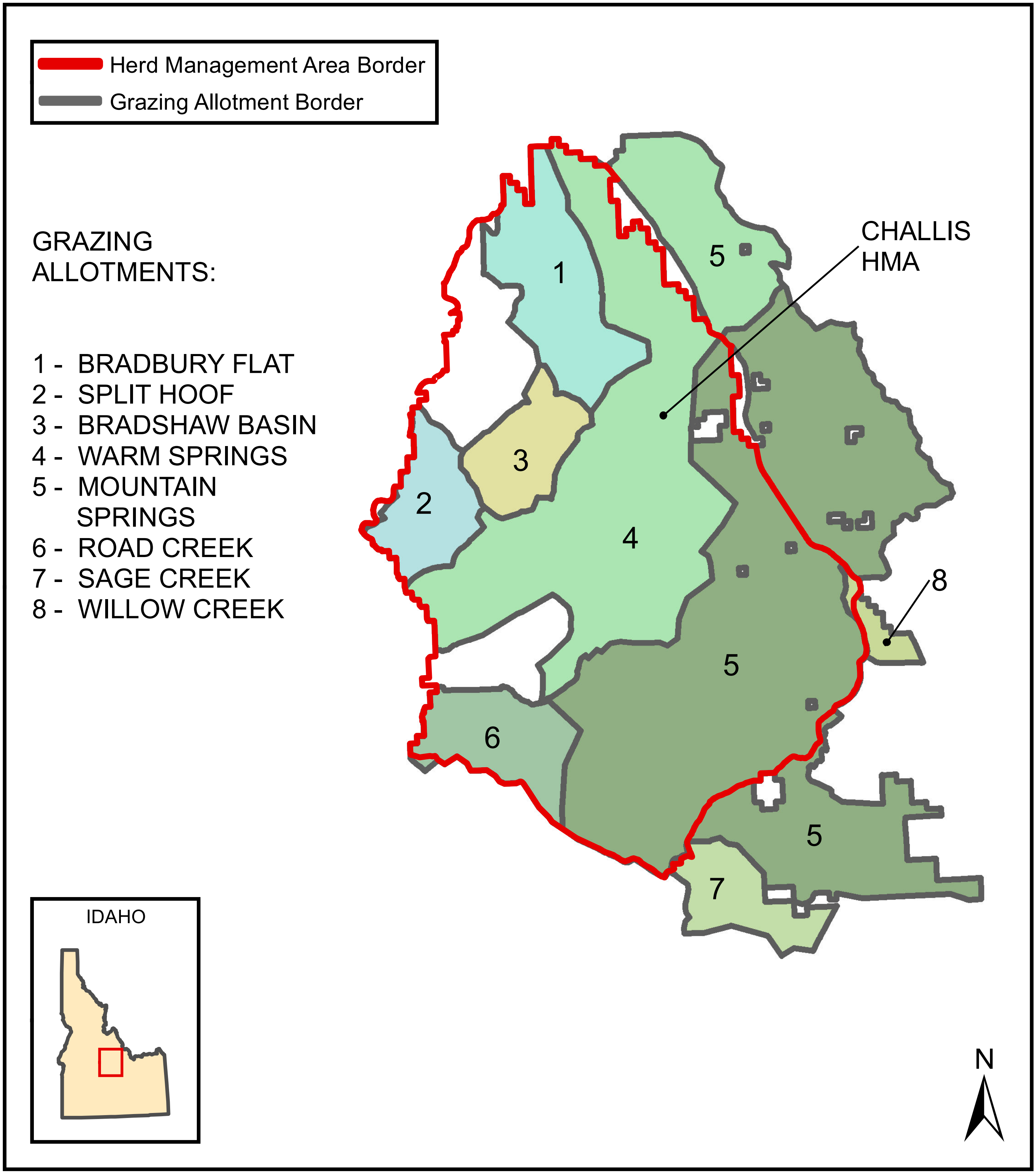
Universal Transverse Mercator Projection UTM Zone 11N

Challis Herd Management Area and Associated Grazing Allotments of Idaho



Source: Bureau of Land Management, Idaho State Office
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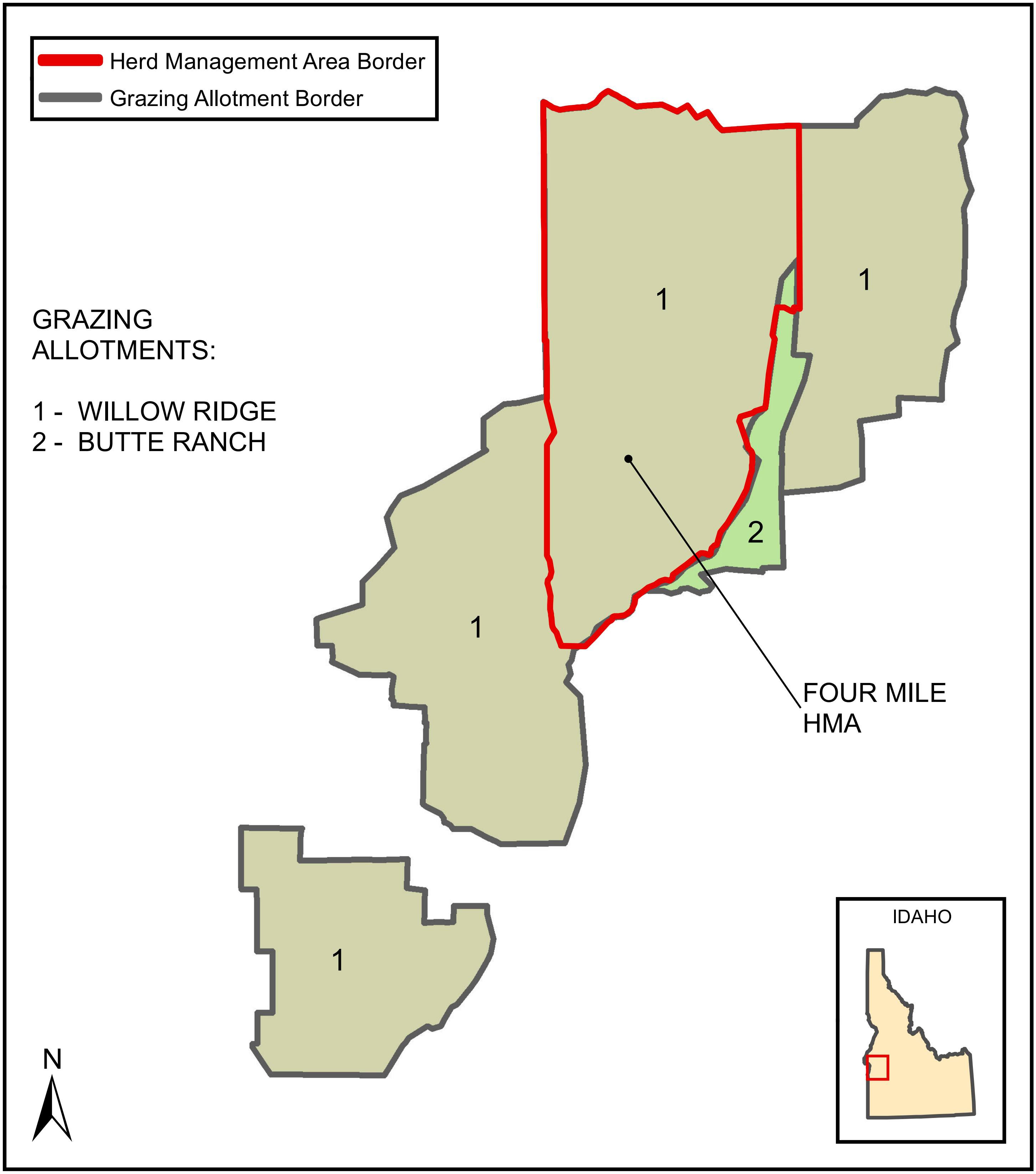
Miles
0 2.5 5 10

Four Mile Herd Management Area and Associated Grazing Allotments of Idaho



Source: Bureau of Land Management, Idaho State Office
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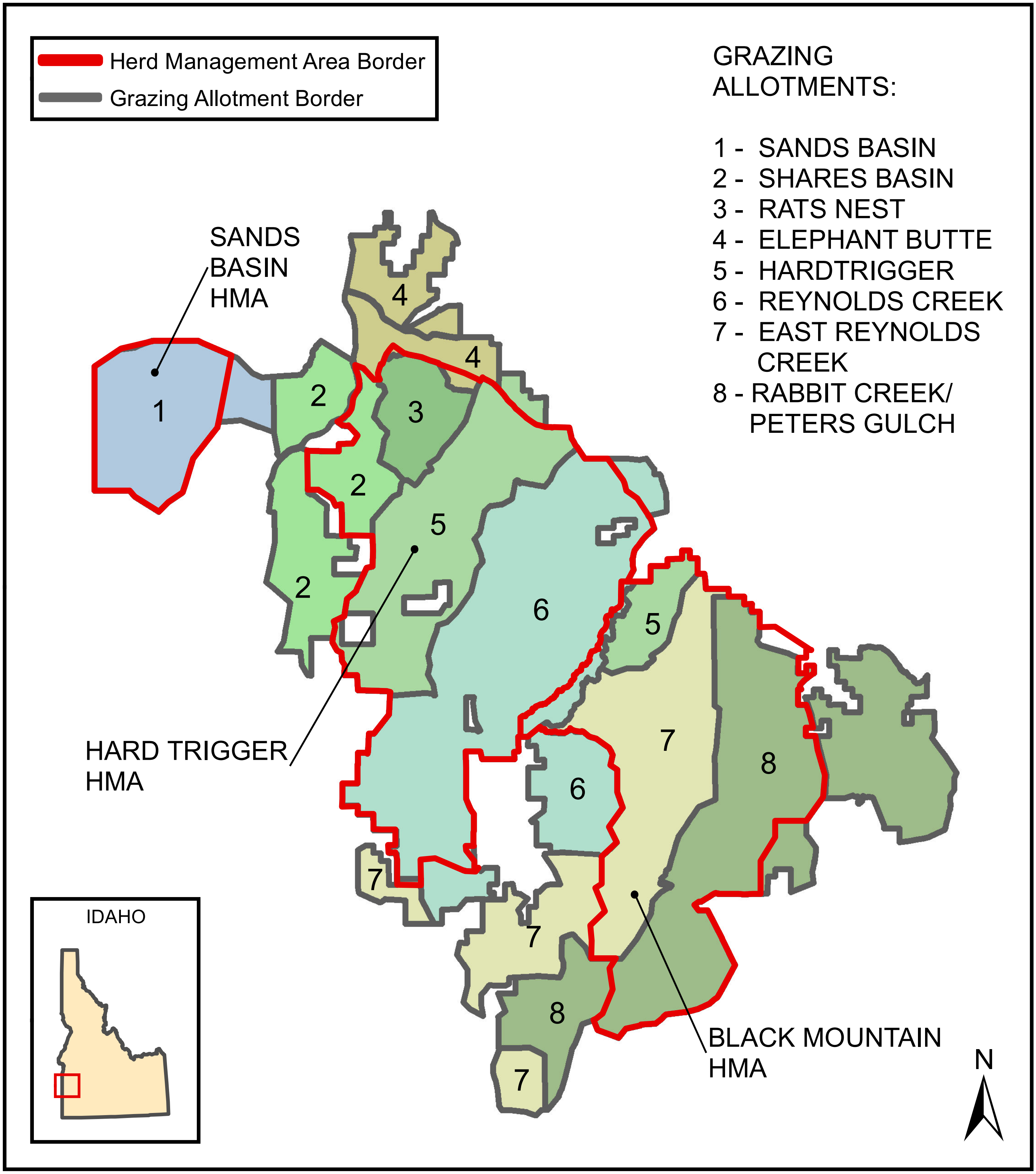
Miles
0 1 2 4

Sands Basin, Black Mountain and Hard Trigger Herd Management Areas and Associated Grazing Allotments of Idaho



Source: Bureau of Land Management, Idaho State Office
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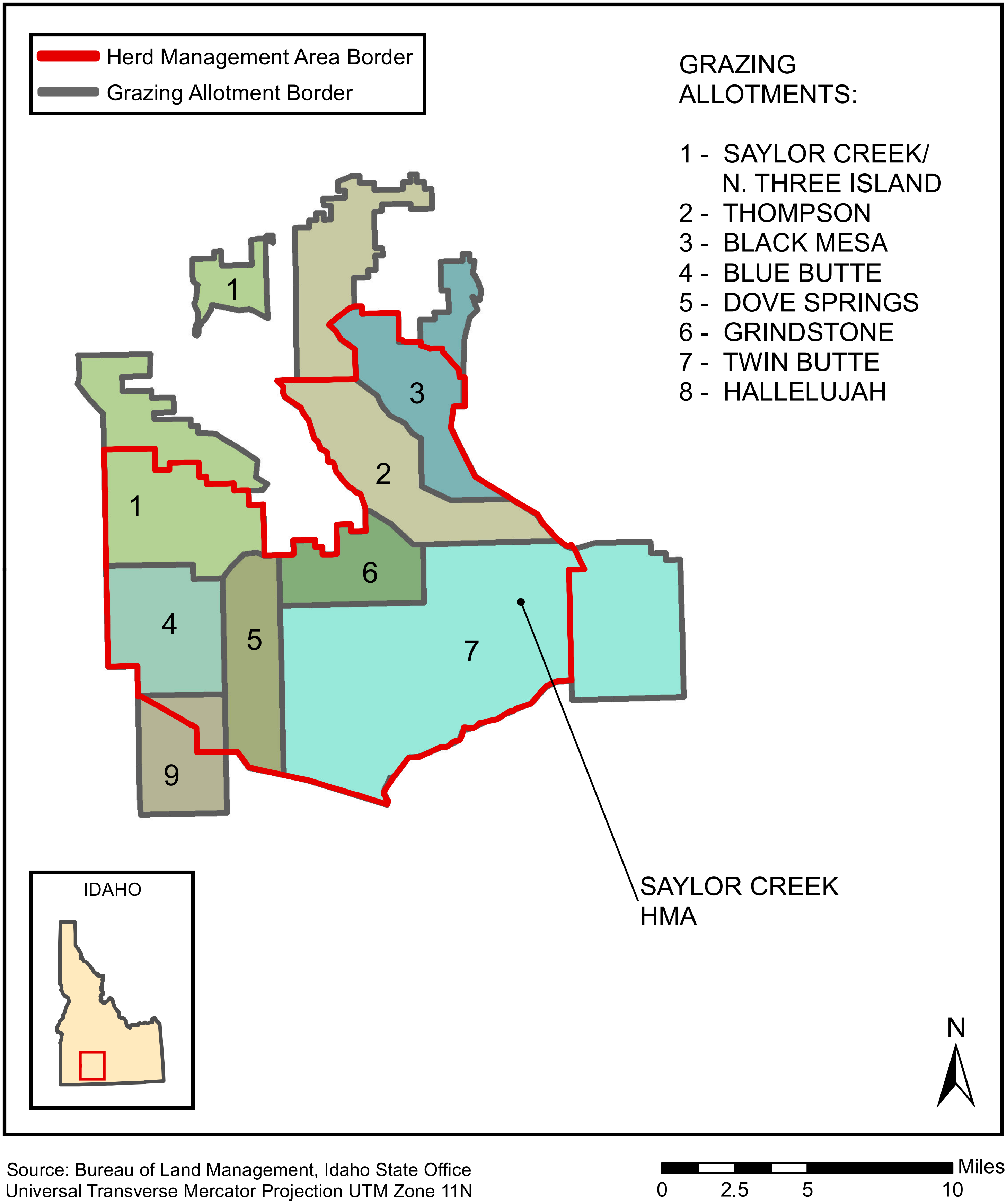
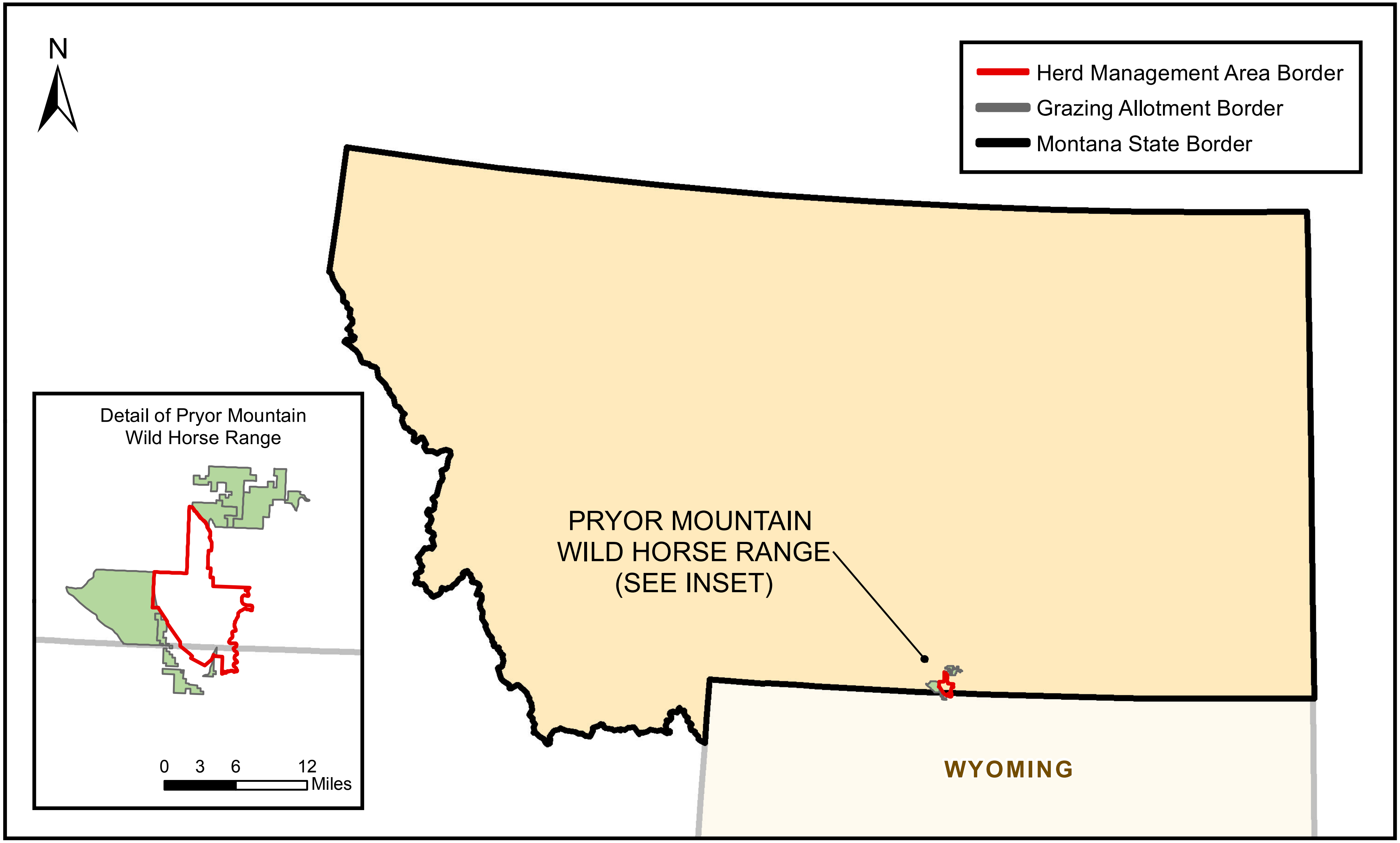
Saylor Creek Herd Management Area and Associated Grazing Allotments of Idaho



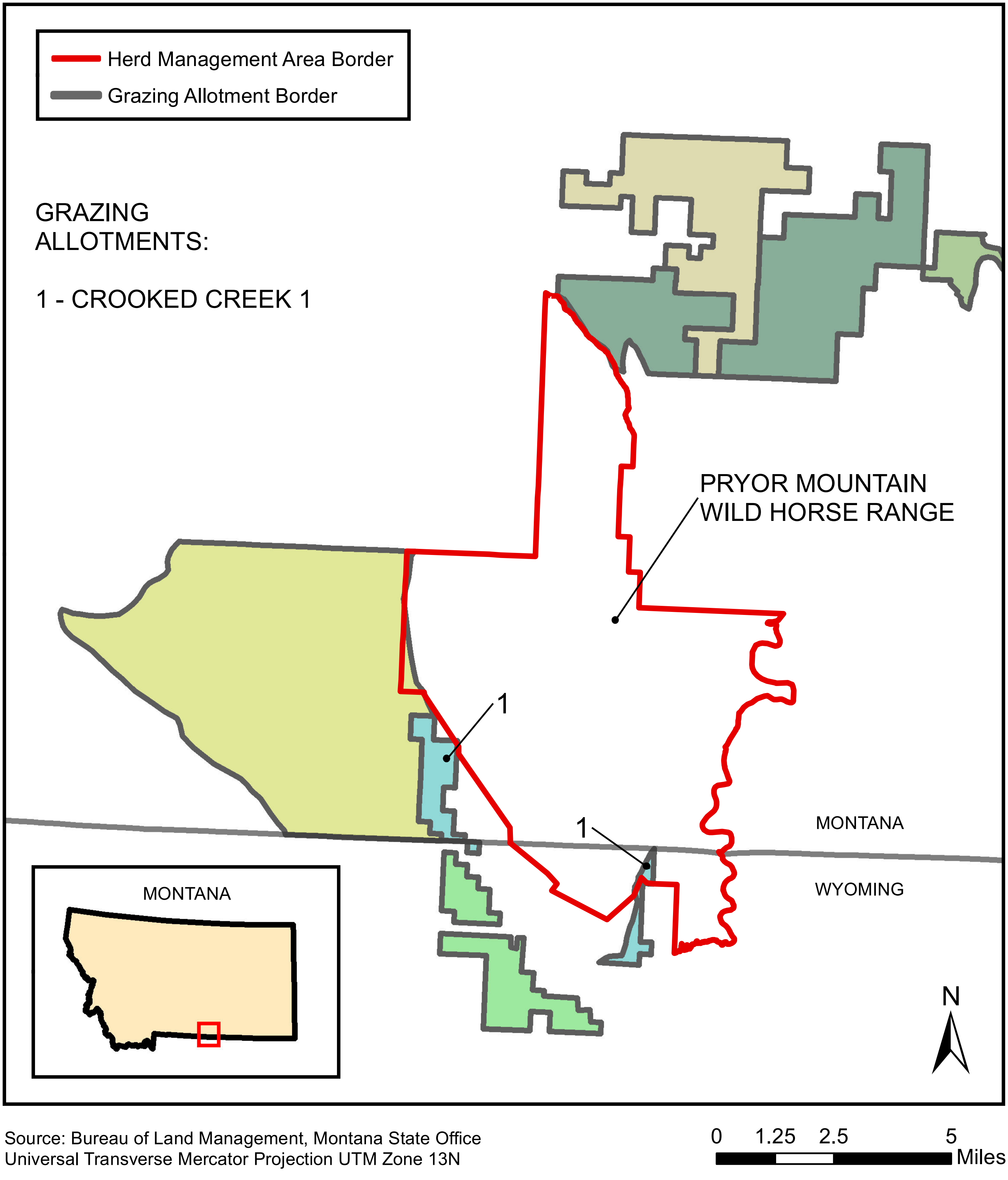
Source: Bureau of Land Management, Idaho State Office
Universal Transverse Mercator Projection UTM Zone 11N

Herd Management Areas and Associated Grazing Allotments of Montana



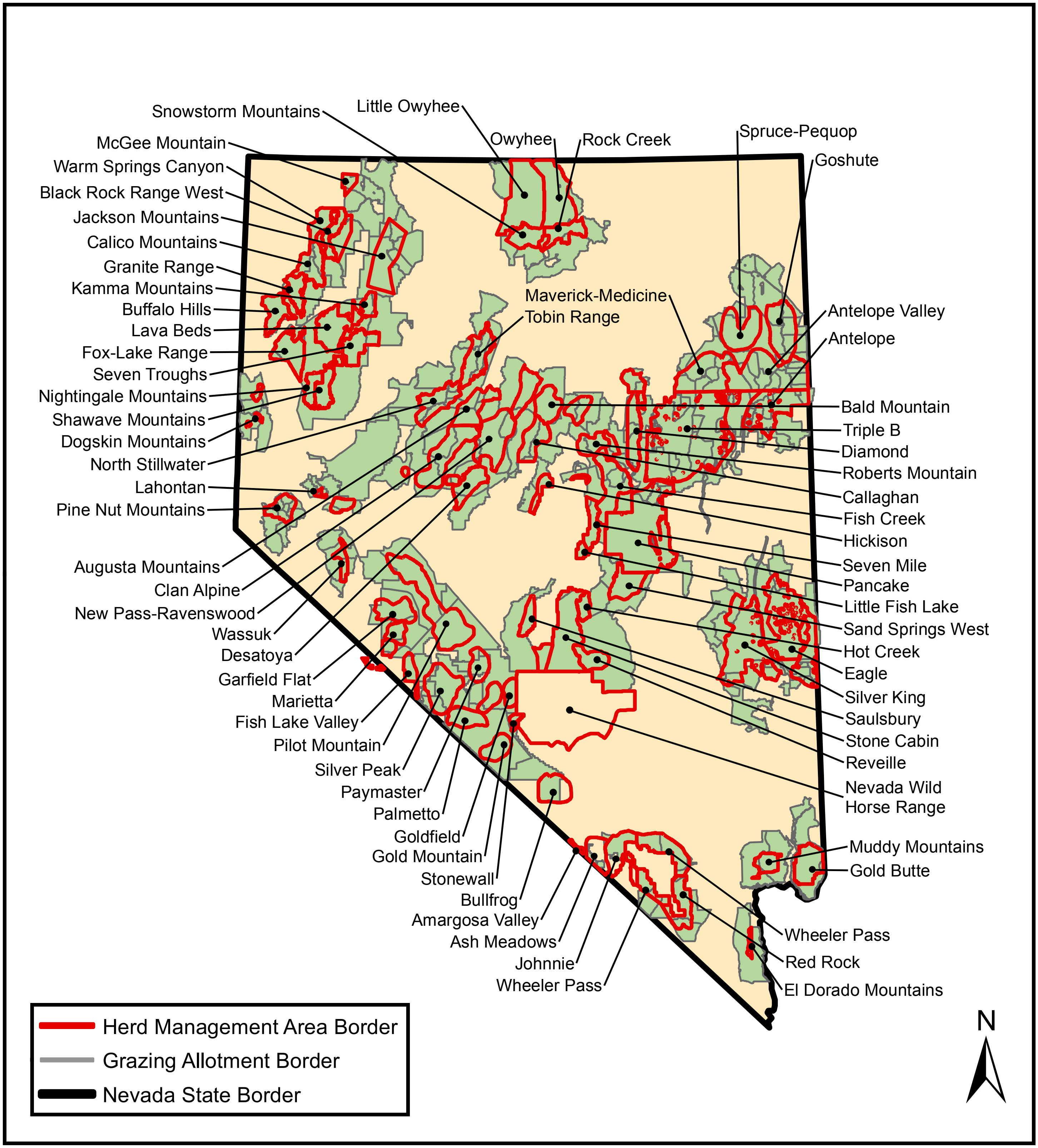
Source: Bureau of Land Management, Montana State Office
Universal Transverse Mercator Projection UTM Zone 13N

Pryor Mountain Wild Horse Range and Associated Grazing Allotments of Montana



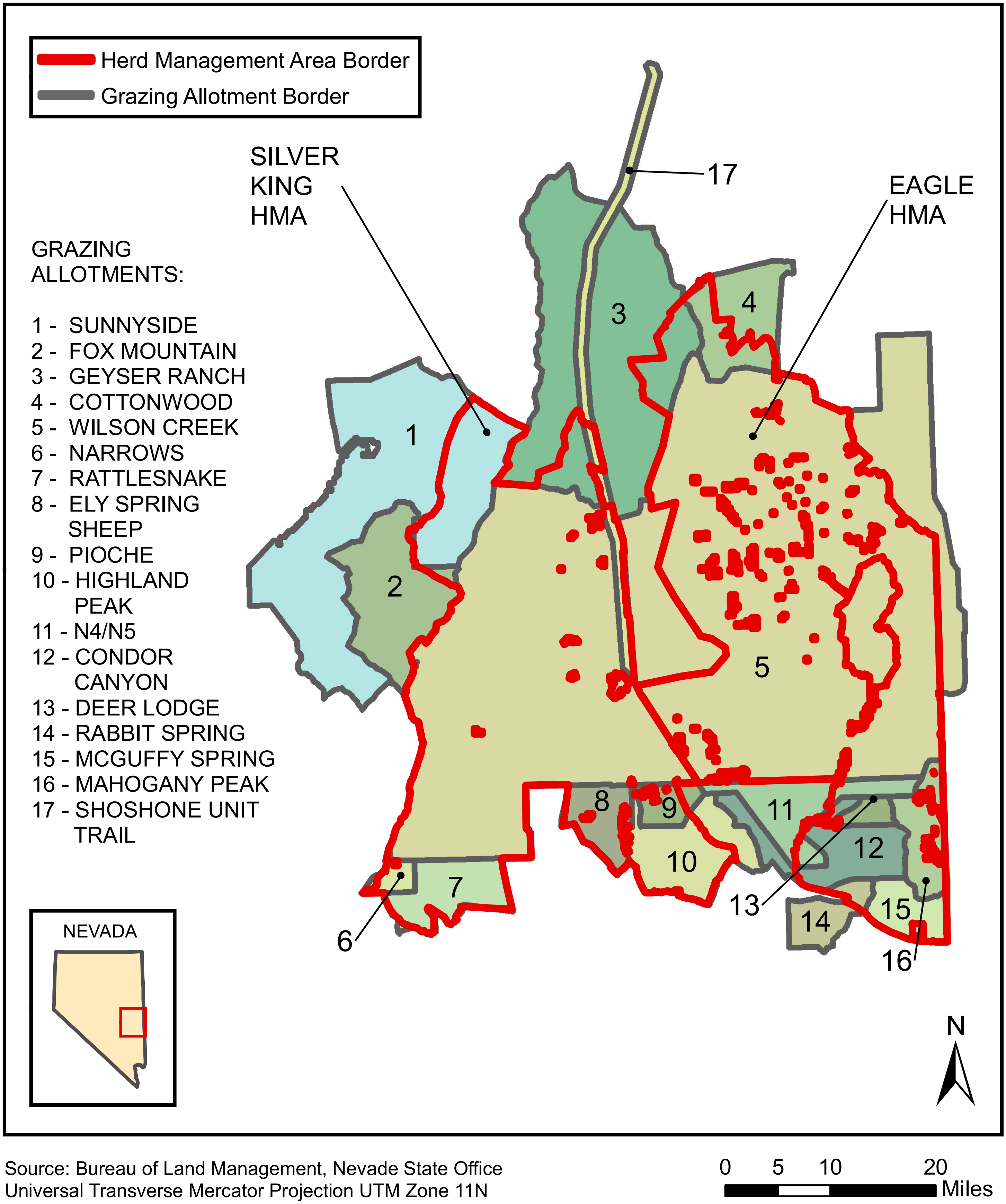
Source: Bureau of Land Management, Montana State Office
Universal Transverse Mercator Projection UTM Zone 13N

Herd Management Areas and Associated Grazing Allotments of Nevada



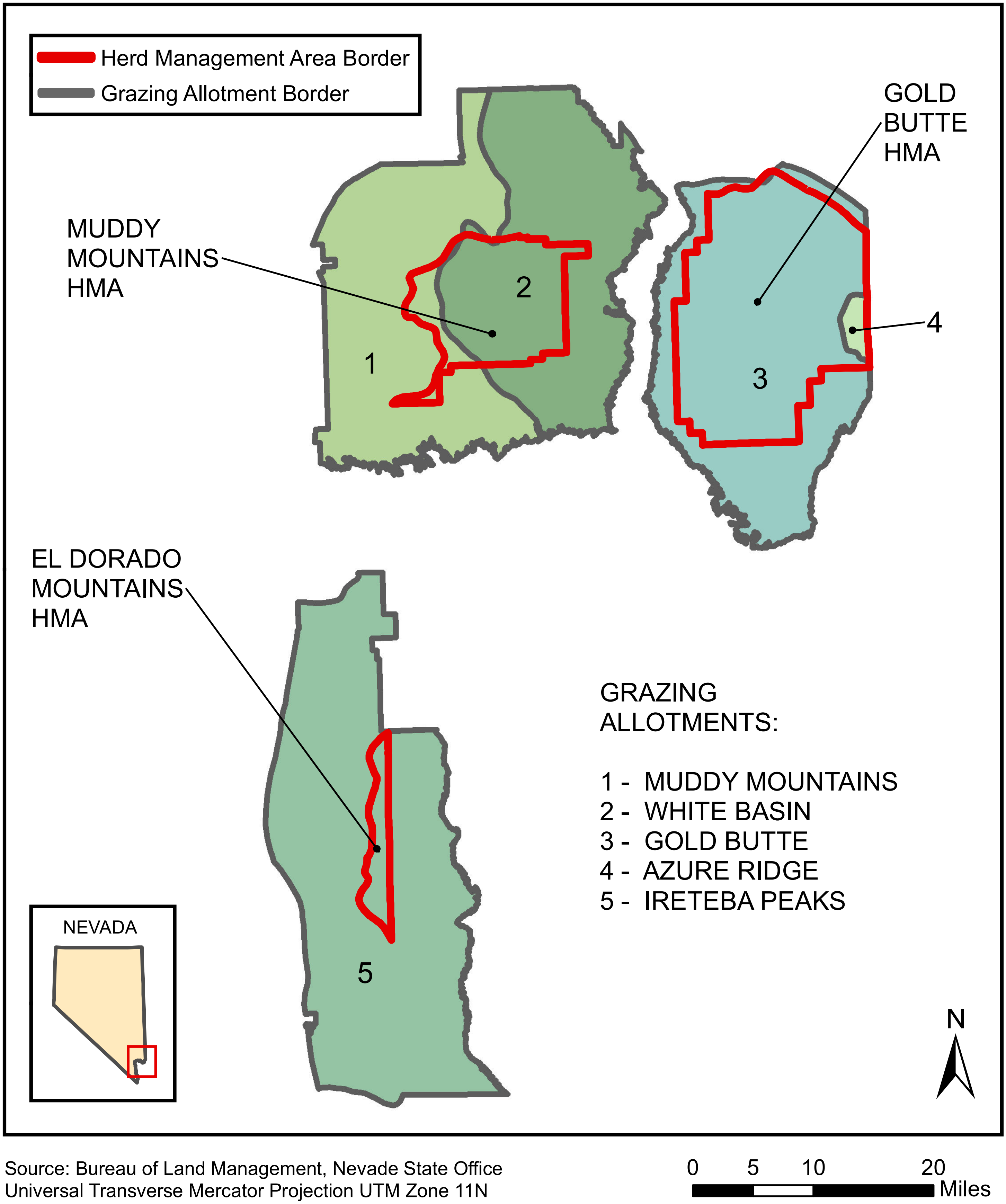
Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

Silver King and Eagle Herd Management Areas and Associated Grazing Allotments of Nevada



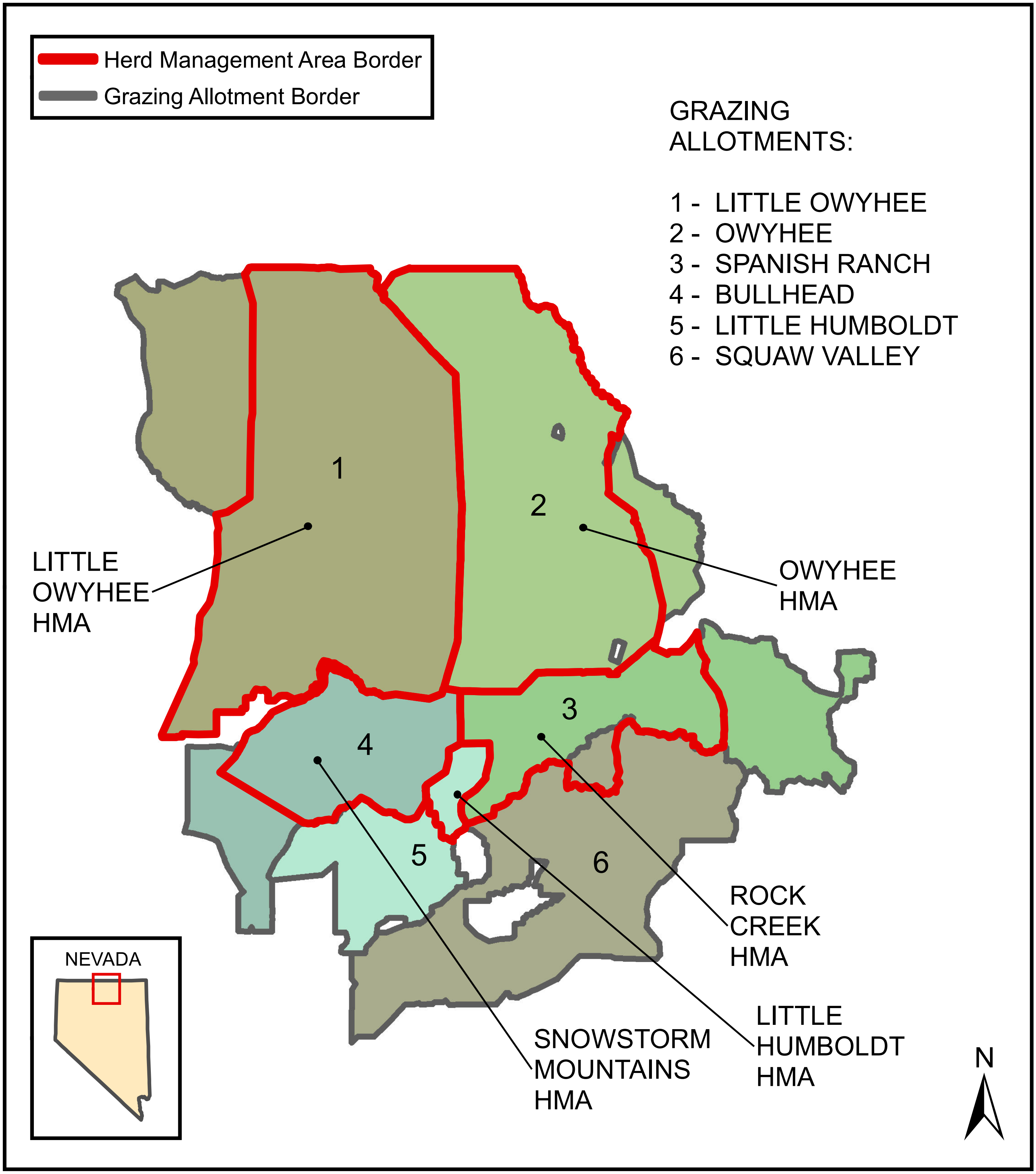
Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

Muddy Mountains, Gold Butte and El Dorado Mountains Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

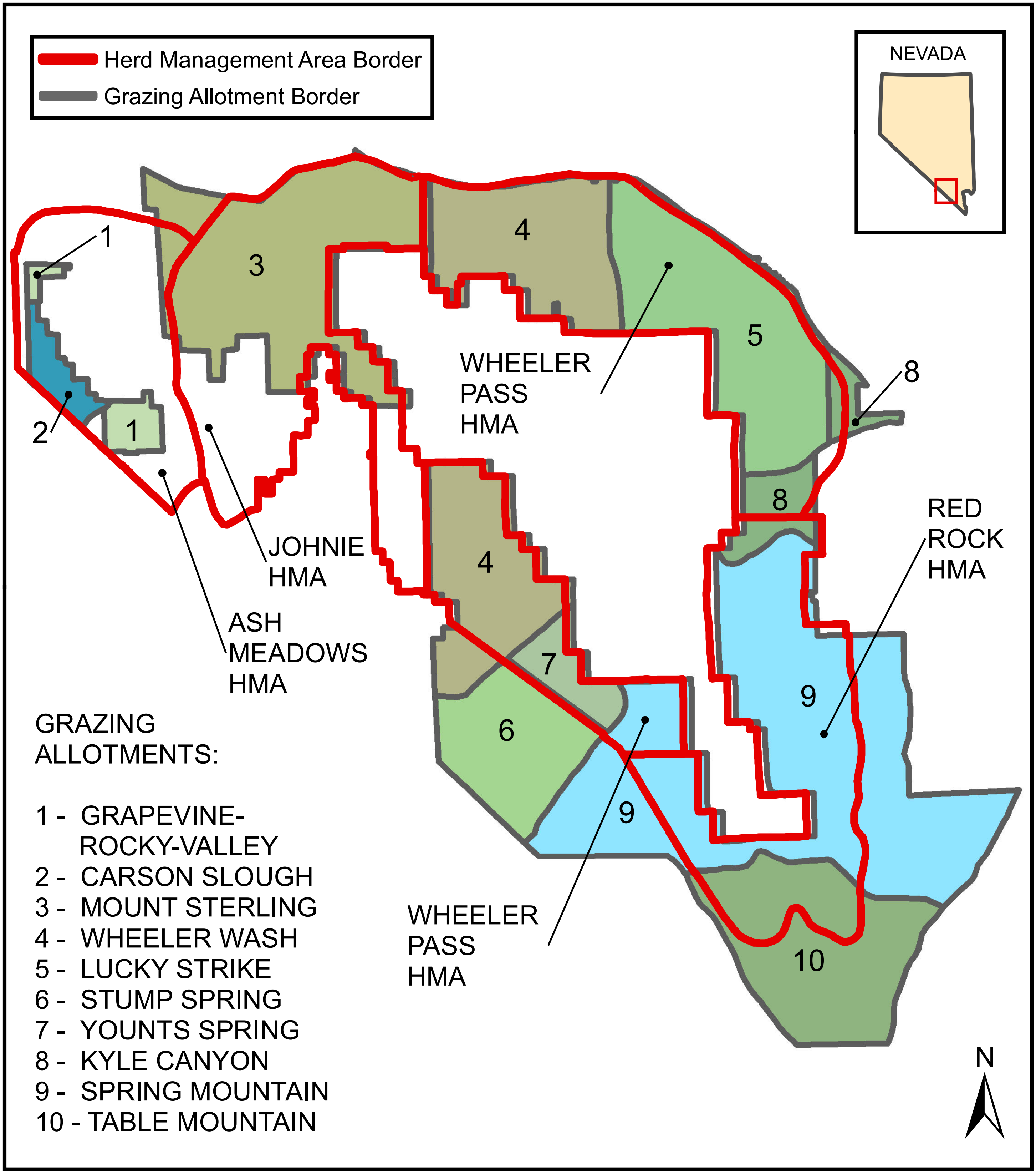
Owyhee, Little Owyhee, Snowstorm Mountains, Rock Creek and Little Humboldt Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 5 10 20 Miles

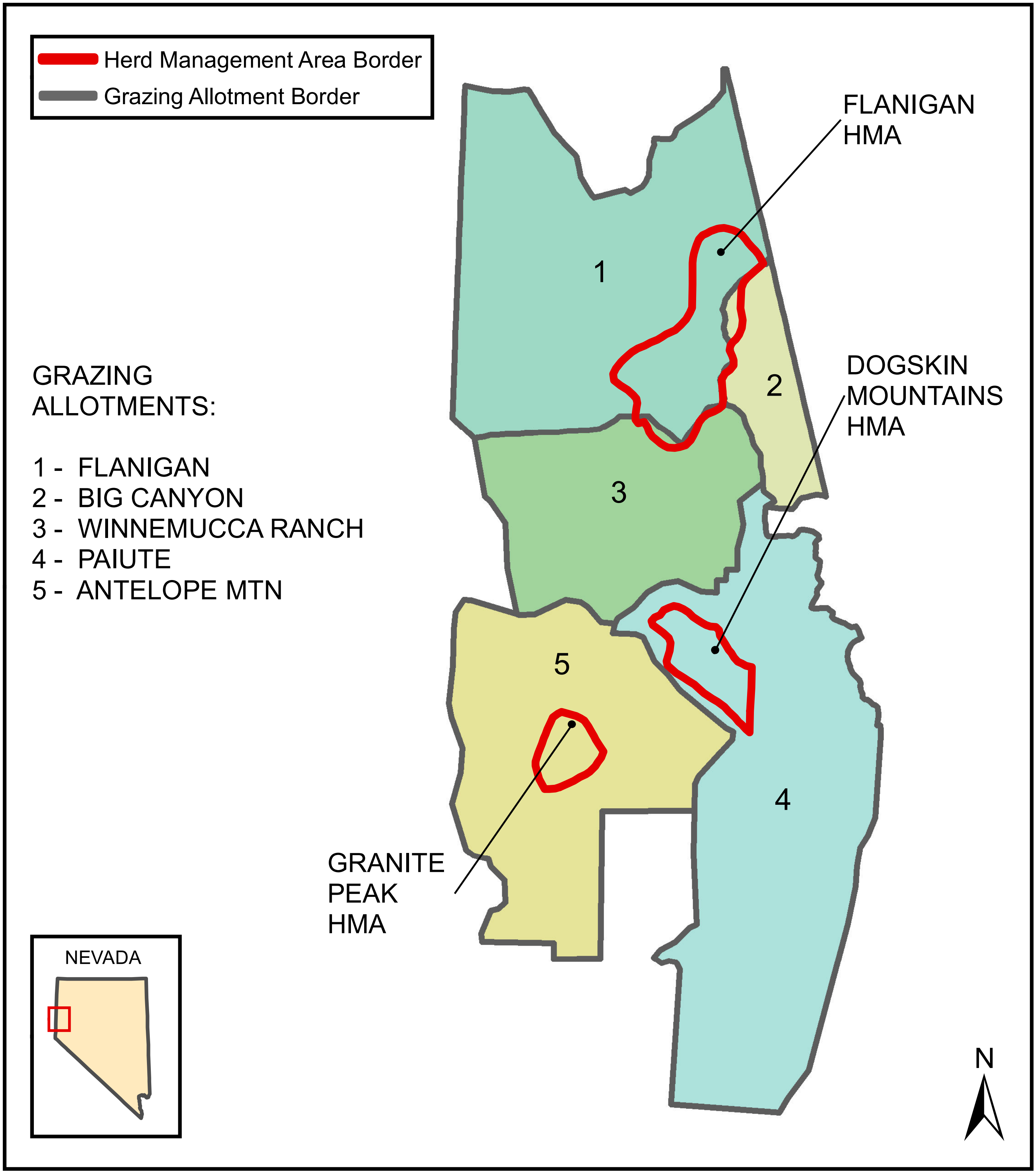
Ash Meadows, Johnnie, Wheeler Pass and Red Rock Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

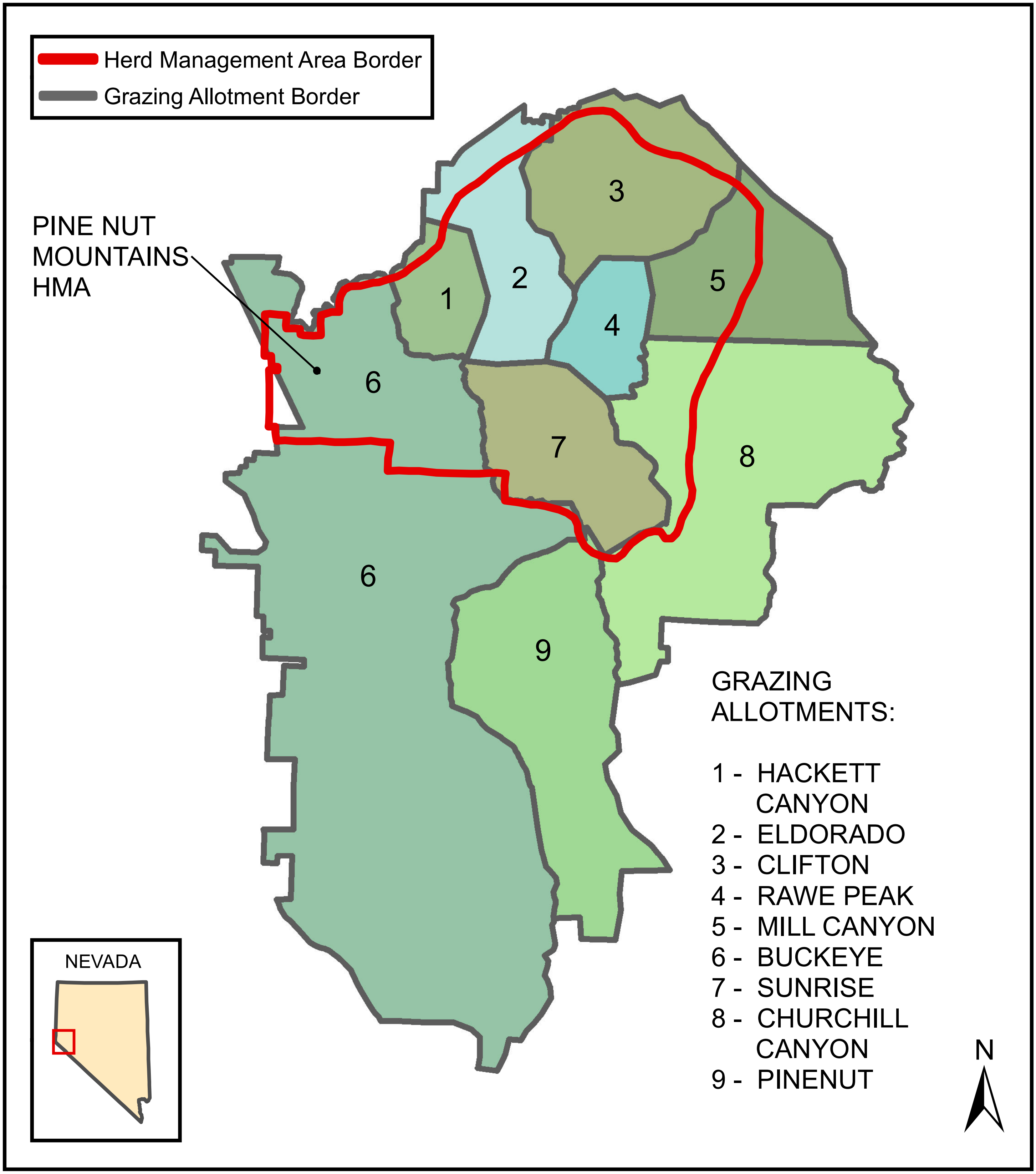
0 5 10 20 Miles

Flanigan, Dogskin Mountains and Granite Peak Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

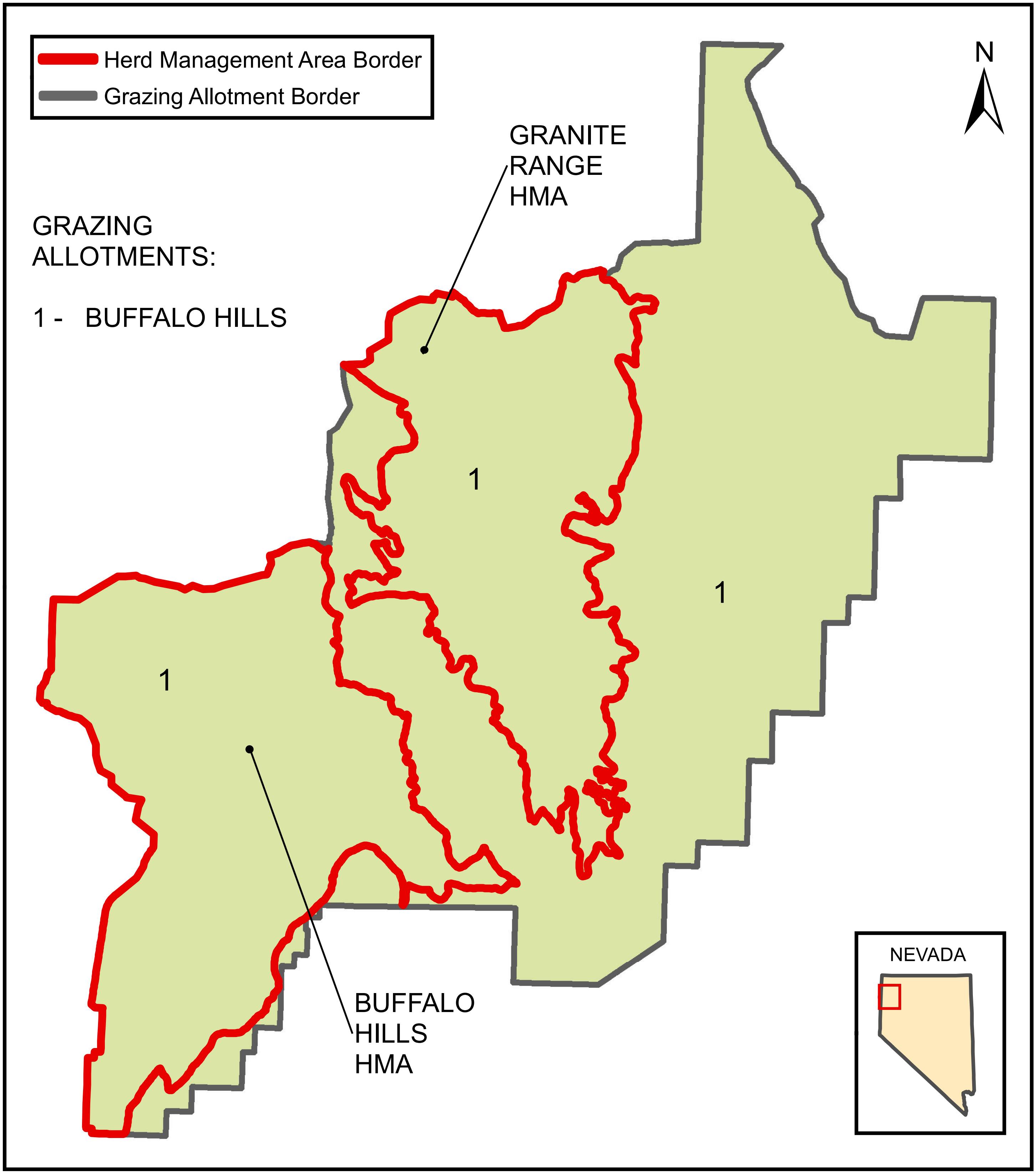
Pine Nut Mountains Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 2.5 5 10 Miles

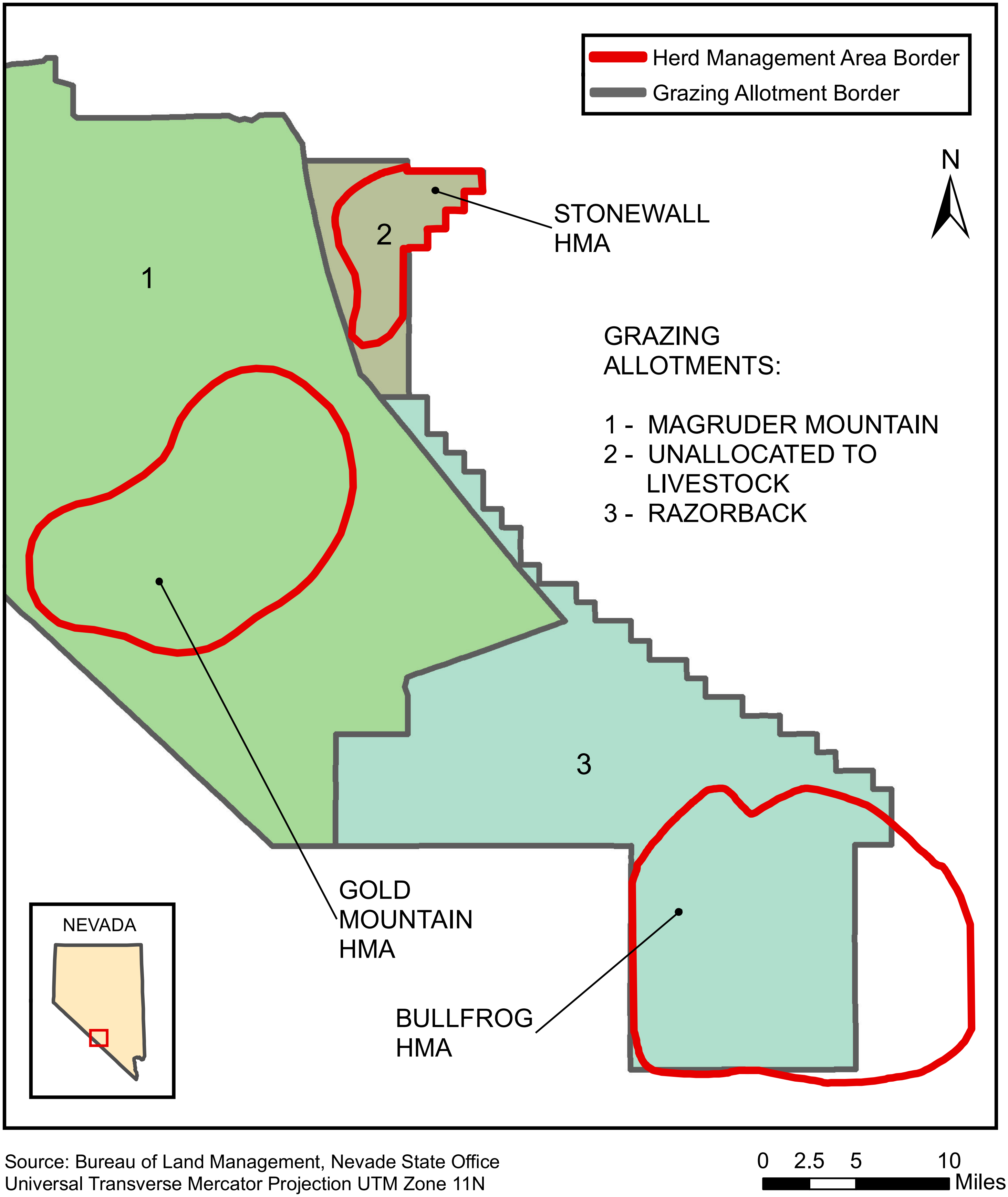
Granite Range and Buffalo Hills Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

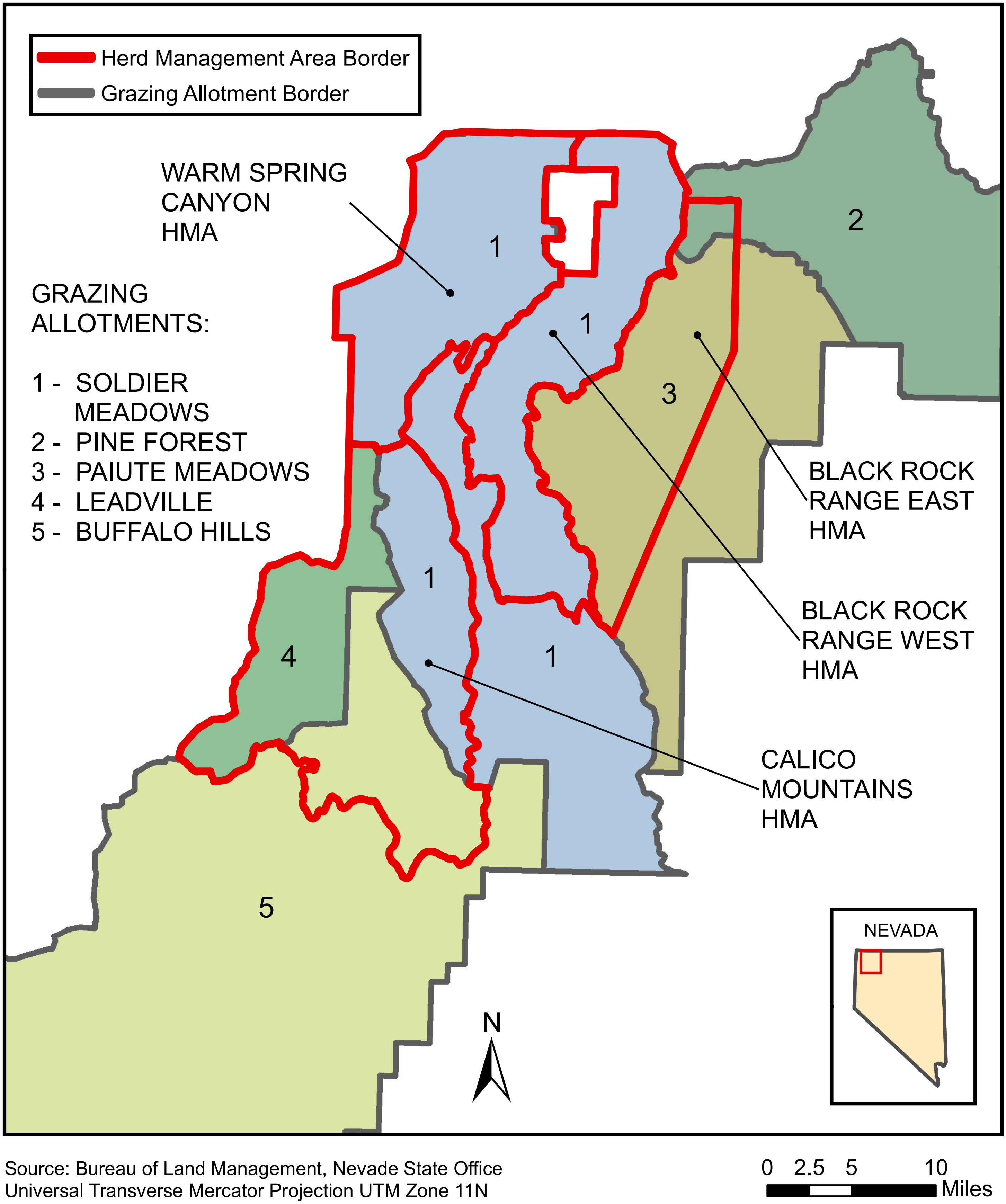
0 2.5 5 10 Miles

Bullfrog, Stonewall and Gold Mountain Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

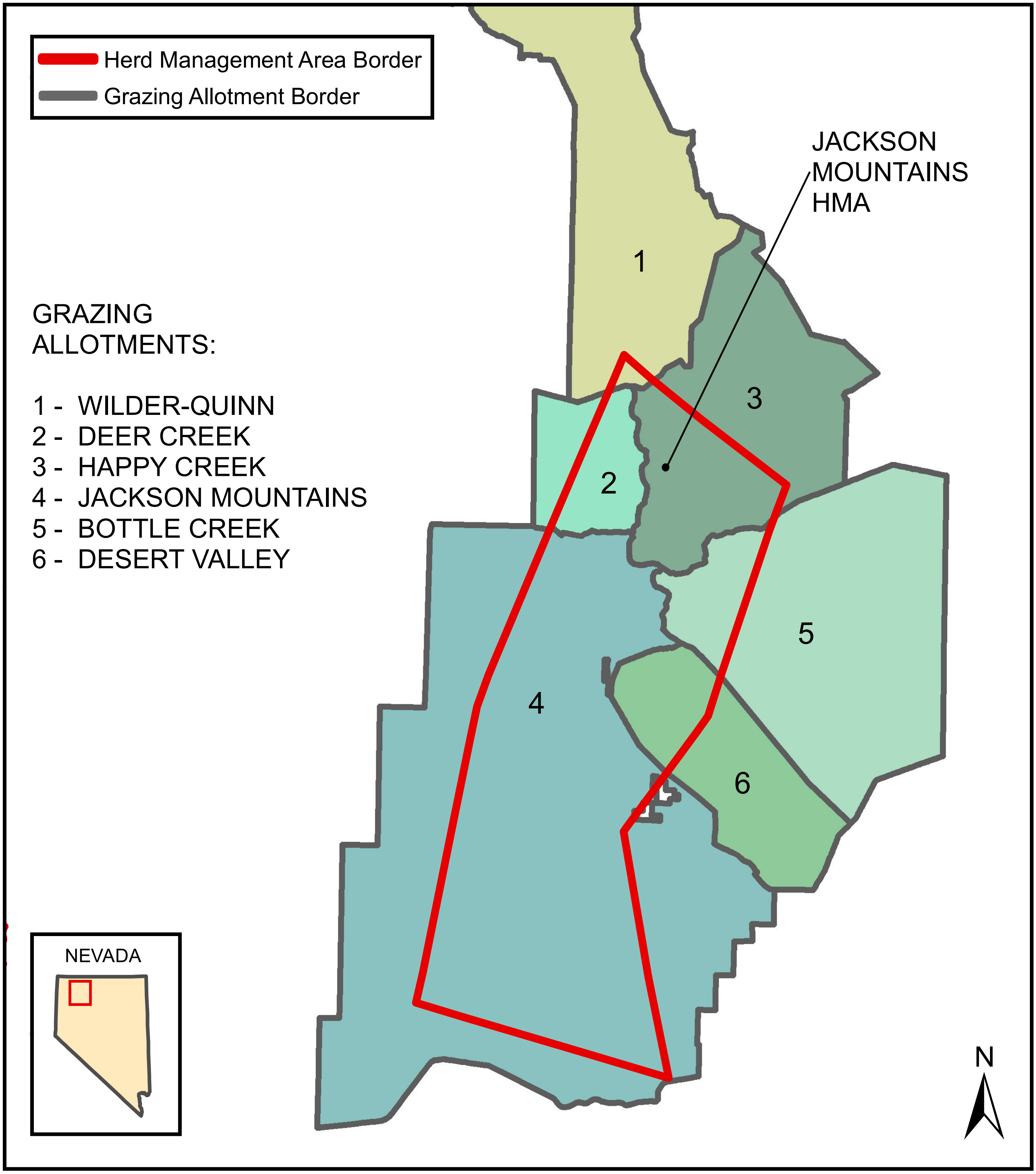
Warm Springs Canyon, Calico Mountains, Black Rock Range East & Black Rock Range West Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 2.5 5 10 Miles

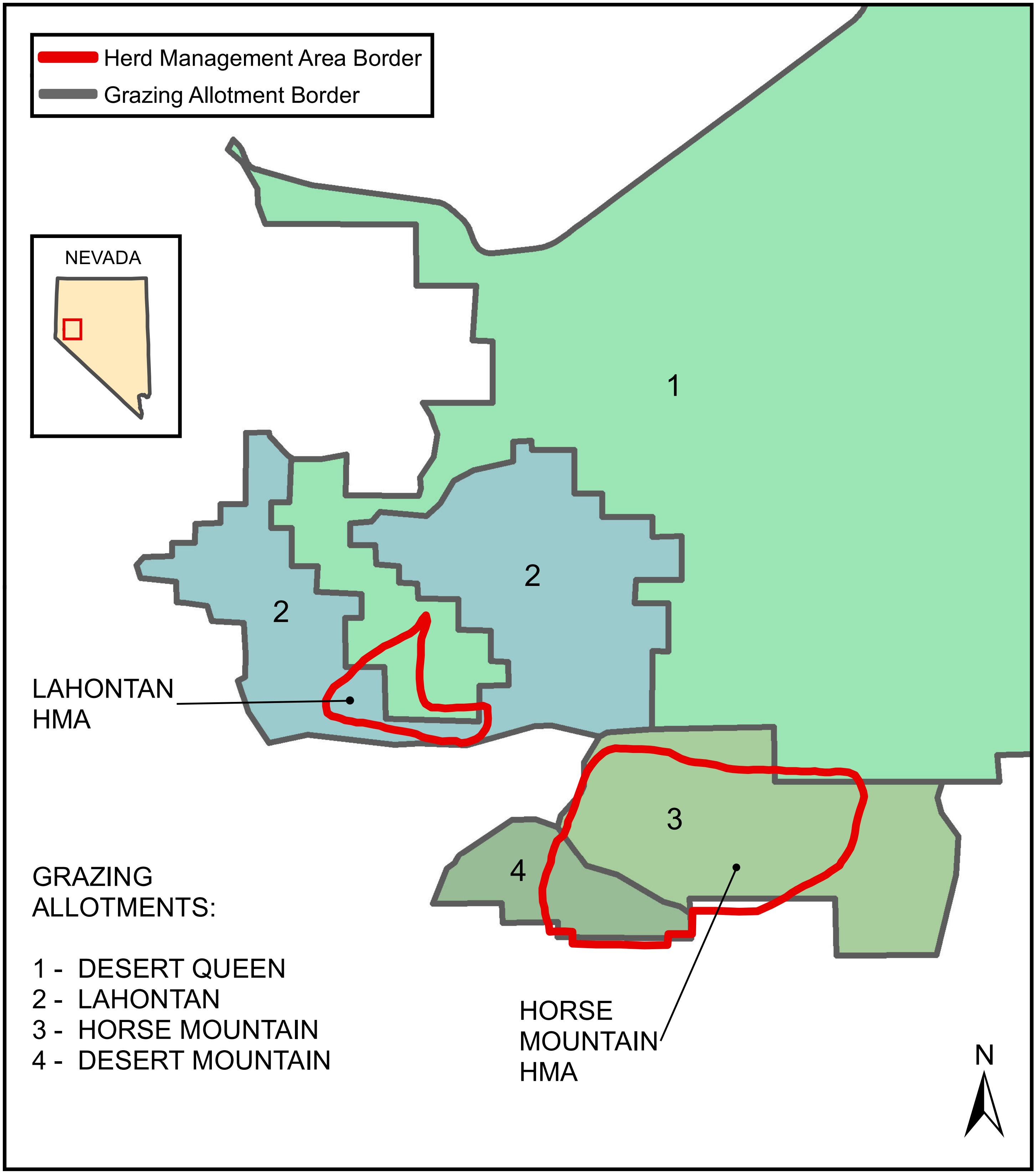
Jackson Mountains Herd Management Area and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 2.5 5 10 Miles

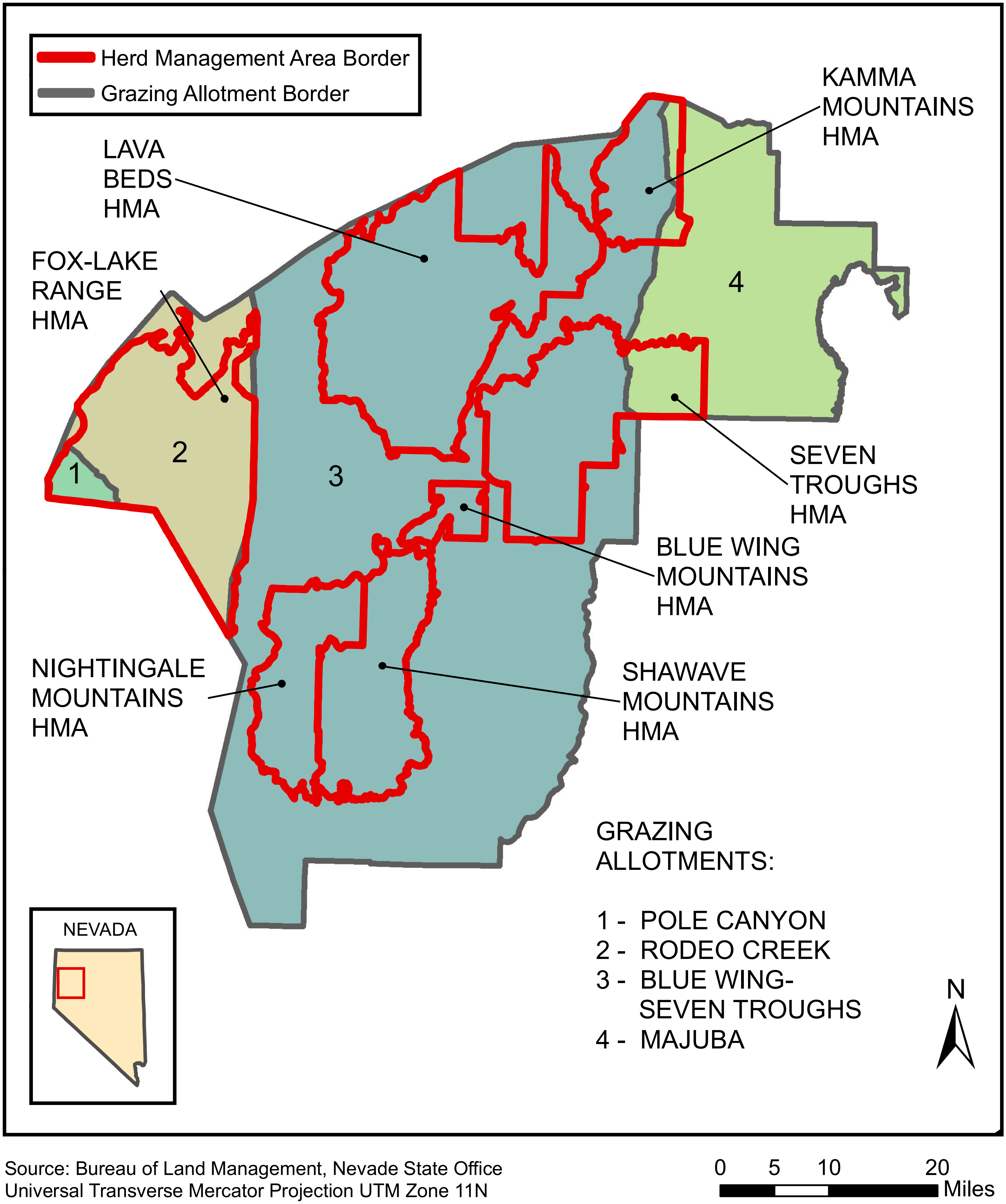
Lahontan and Horse Mountain Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

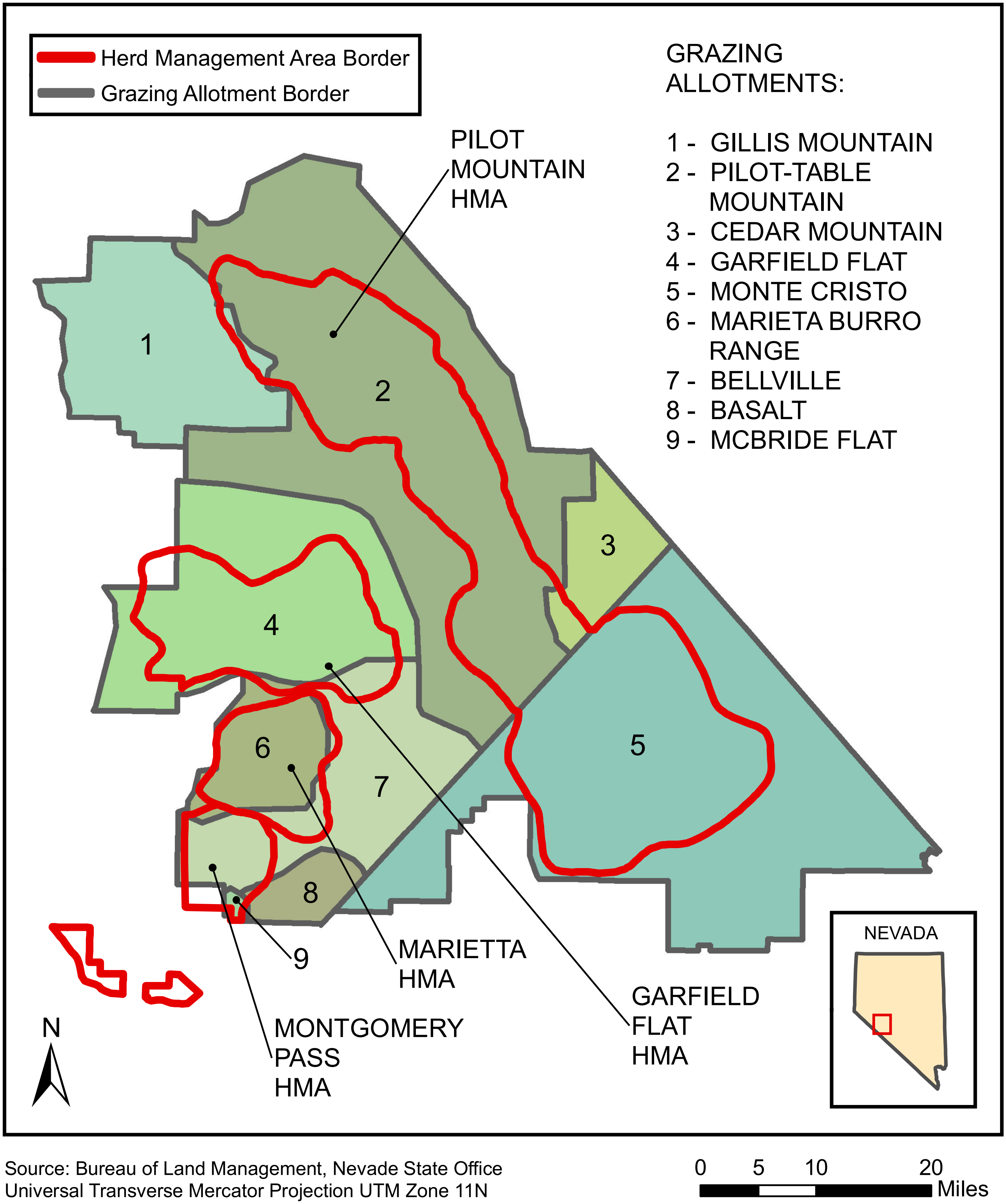
0 2.5 5 10 Miles

Lava Beds, Kamma Mountains, Fox-Lake Range, Seven Troughs, Nightingale Mountains, Blue Wing Mountains and Shawave Mountains Herd Management Areas and Associated Grazing Allotments of Nevada



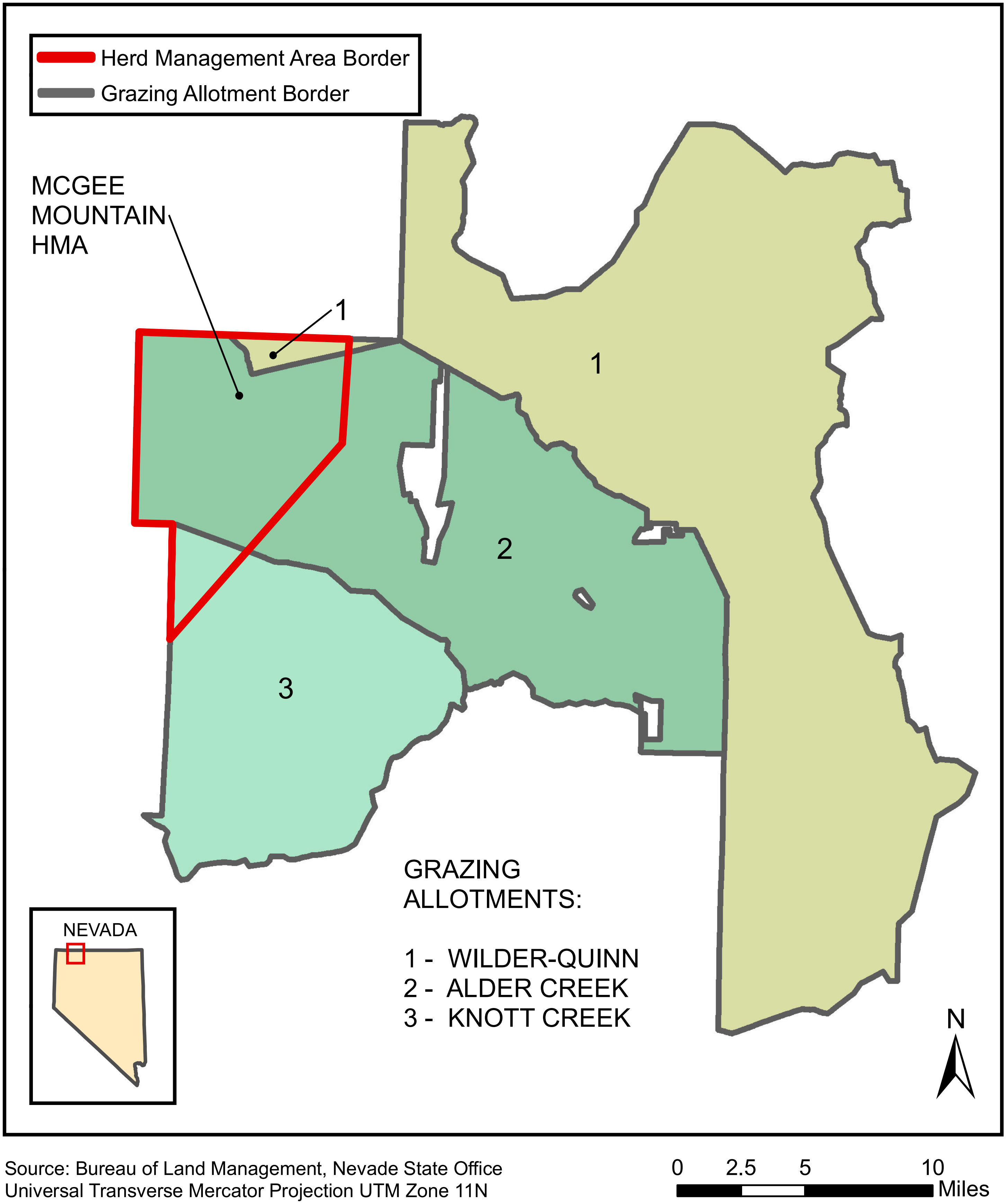
Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

Pilot Mountain, Montgomery Pass, Marietta and Garfield Flat Herd Management Areas and Associated Grazing Allotments of Nevada



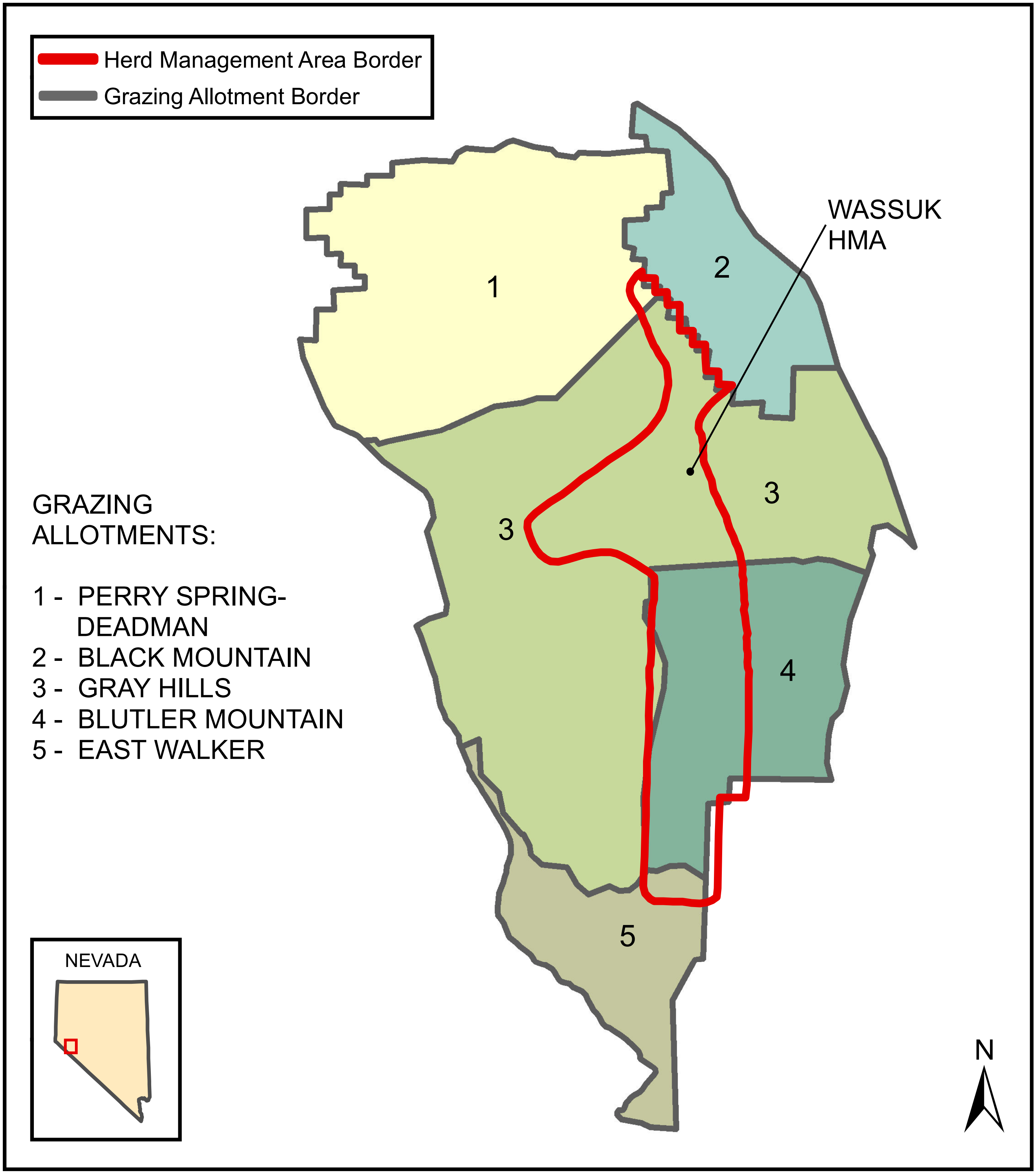
Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

McGee Mountain Herd Management Area and Associated Grazing Allotments of Nevada



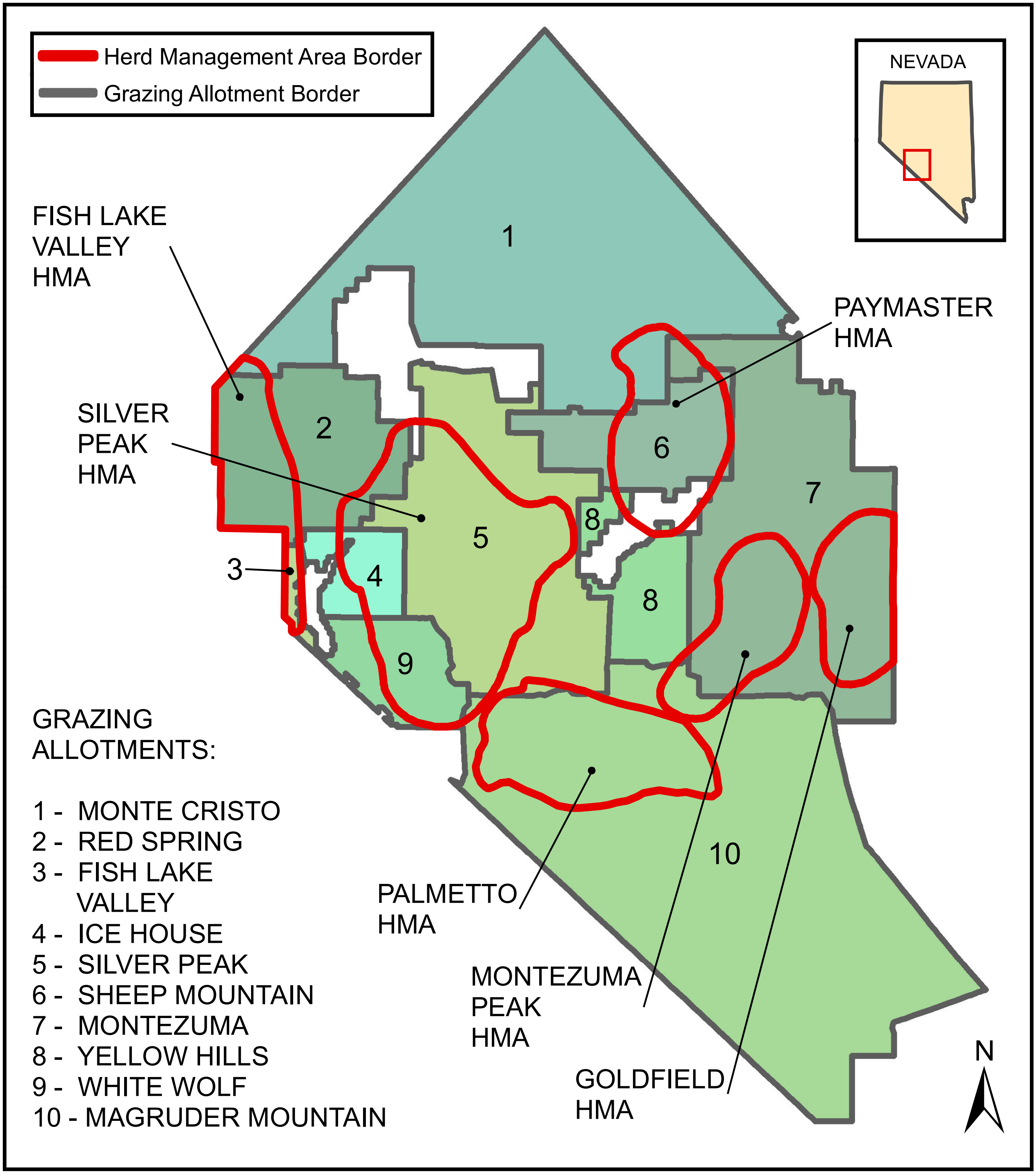
Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

Wassuk Herd Management Area and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

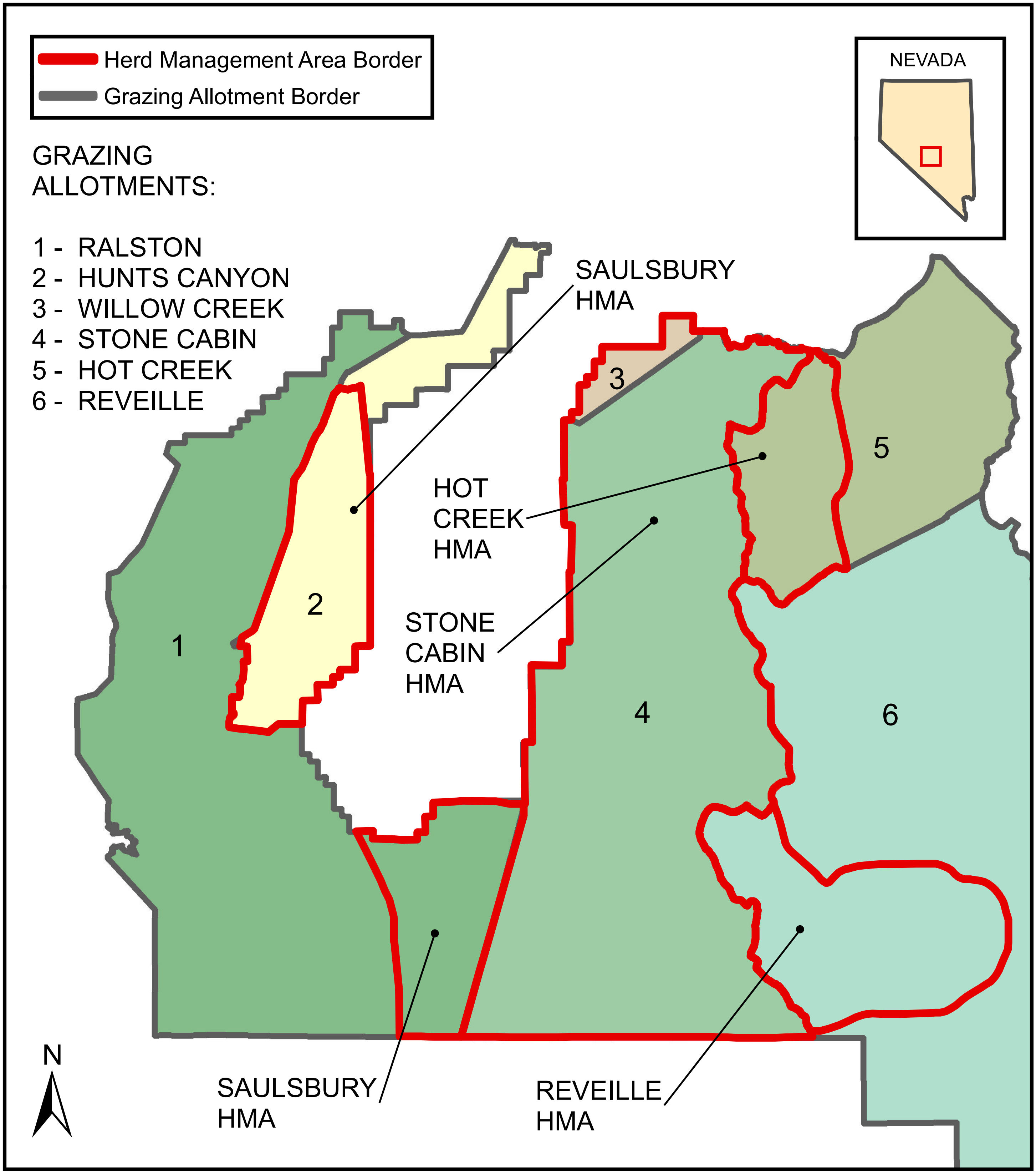
Fish Lake Valley, Silver Peak, Paymaster, Palmetto, Montezuma Peak and Goldfield Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 5 10 20 Miles

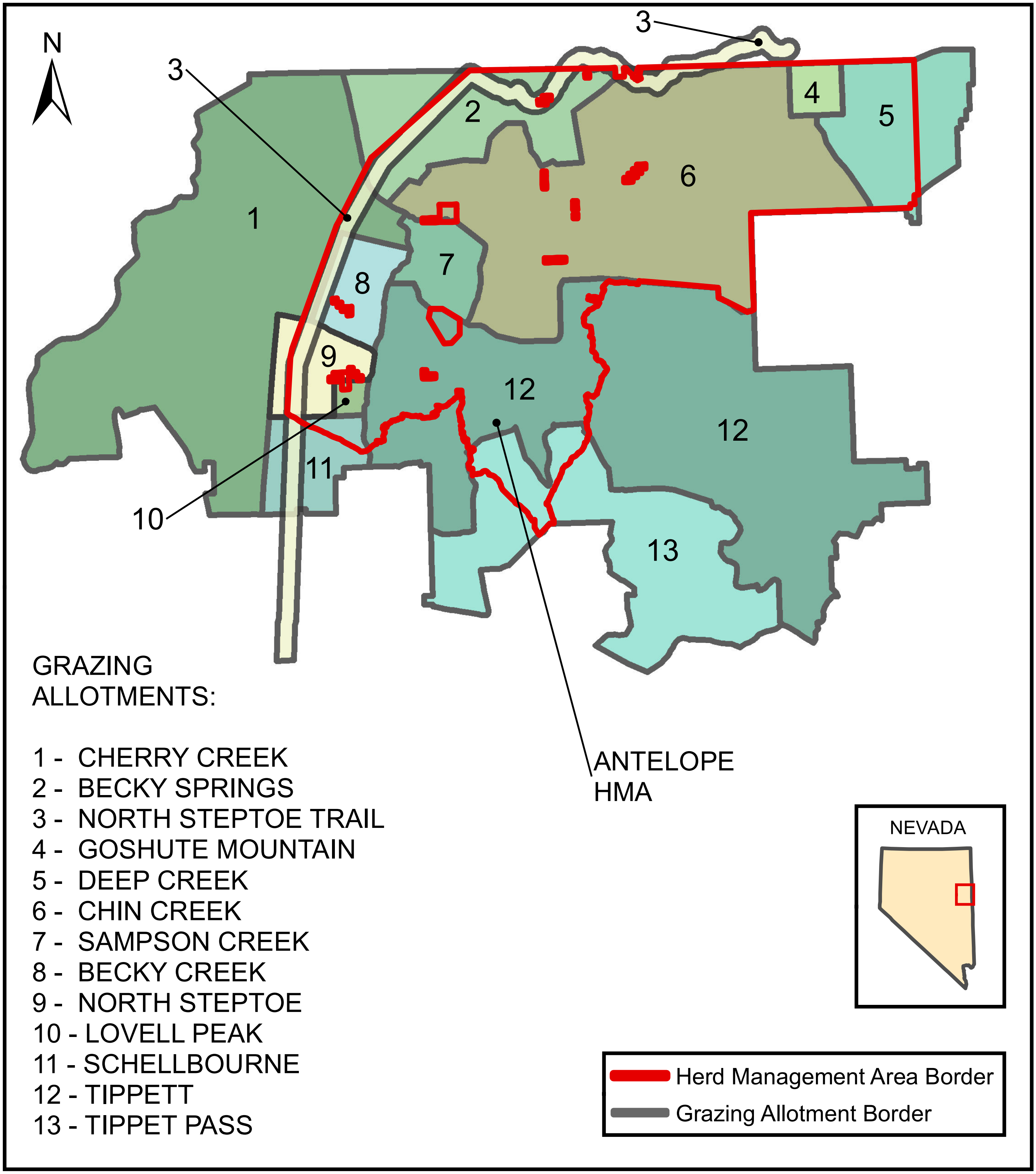
Saulsbury, Hot Creek, Stone Cabin and Reveille Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 2.5 5 10 Miles

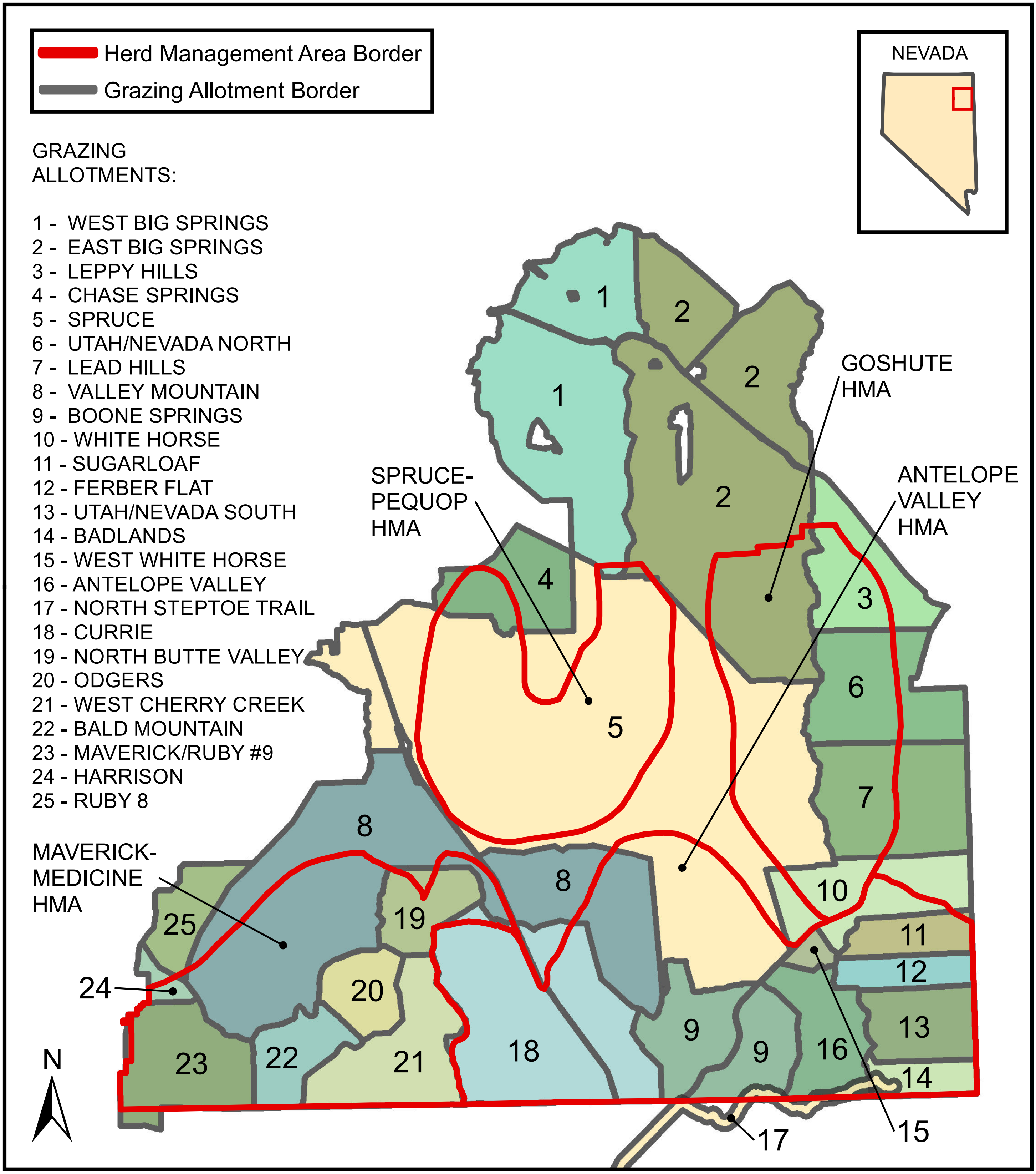
Antelope Herd Management Area and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 2.5 5 10 Miles

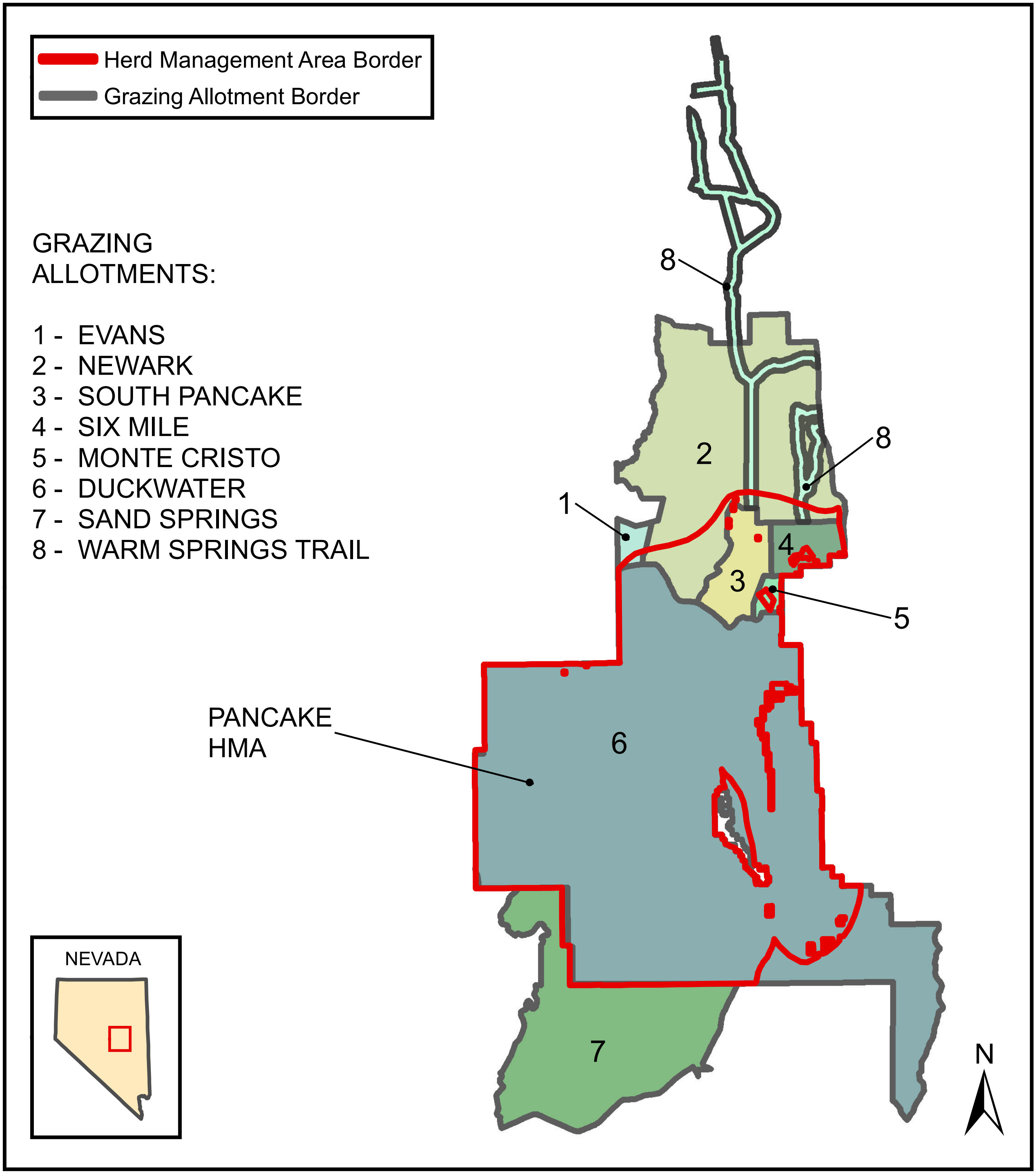
Maverick-Medicine, Antelope Valley, Goshute and Spruce-Pequop Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 5 10 20 Miles

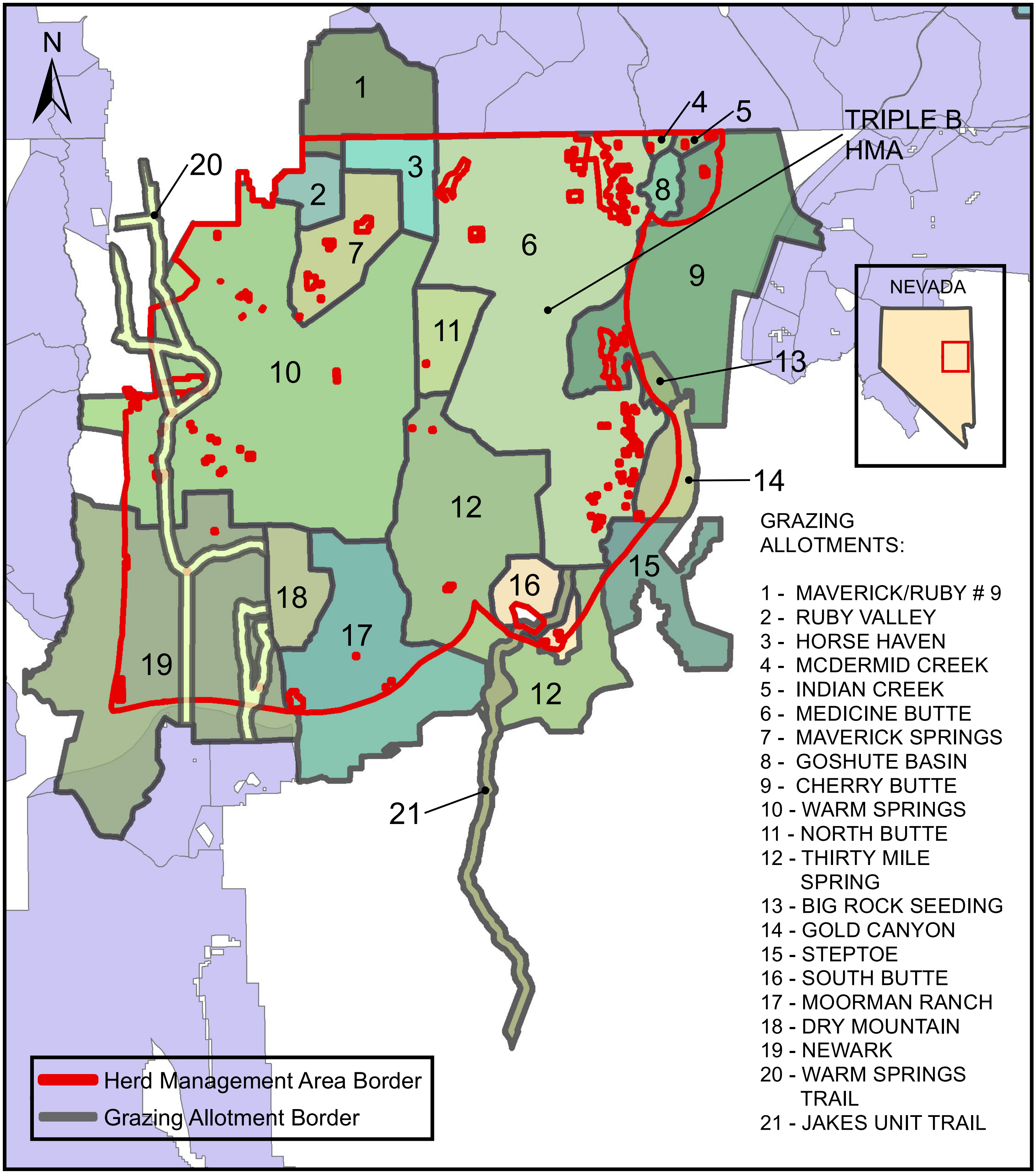
Pancake Herd Management Area and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

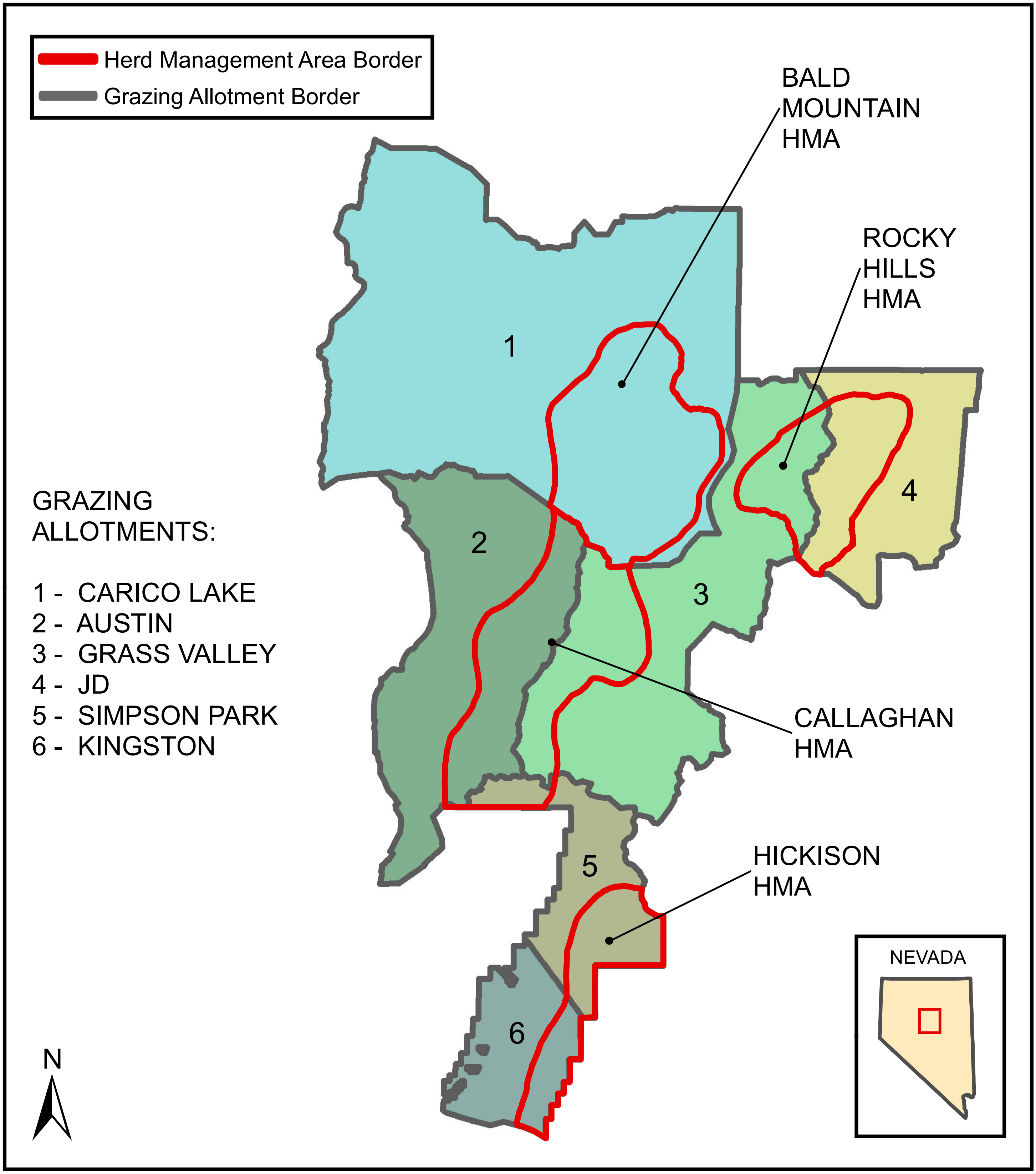
0 5 10 20 Miles

Triple B Herd Management Area and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

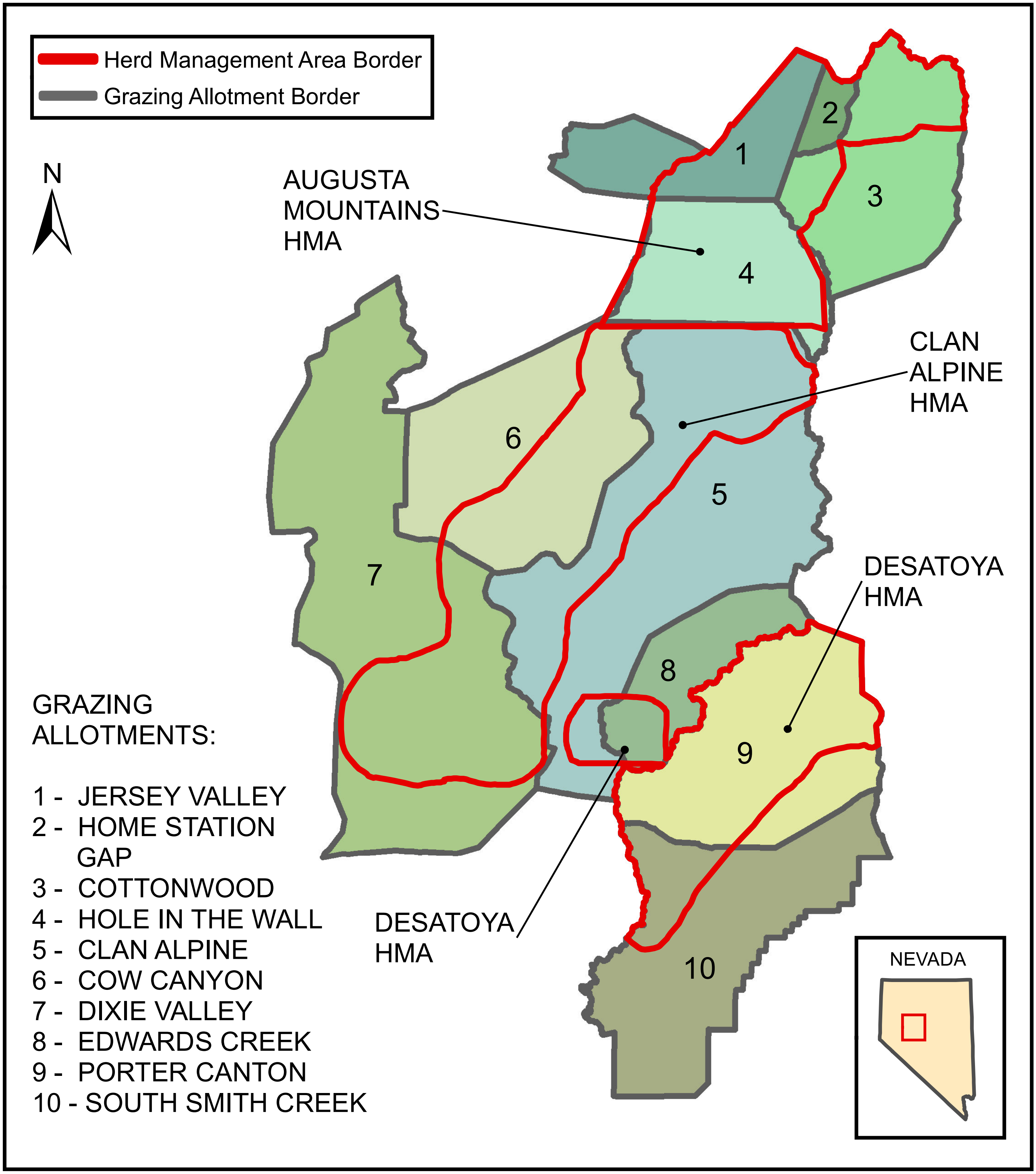
Bald Mountain, Hickison, Callaghan and Rocky Hills Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

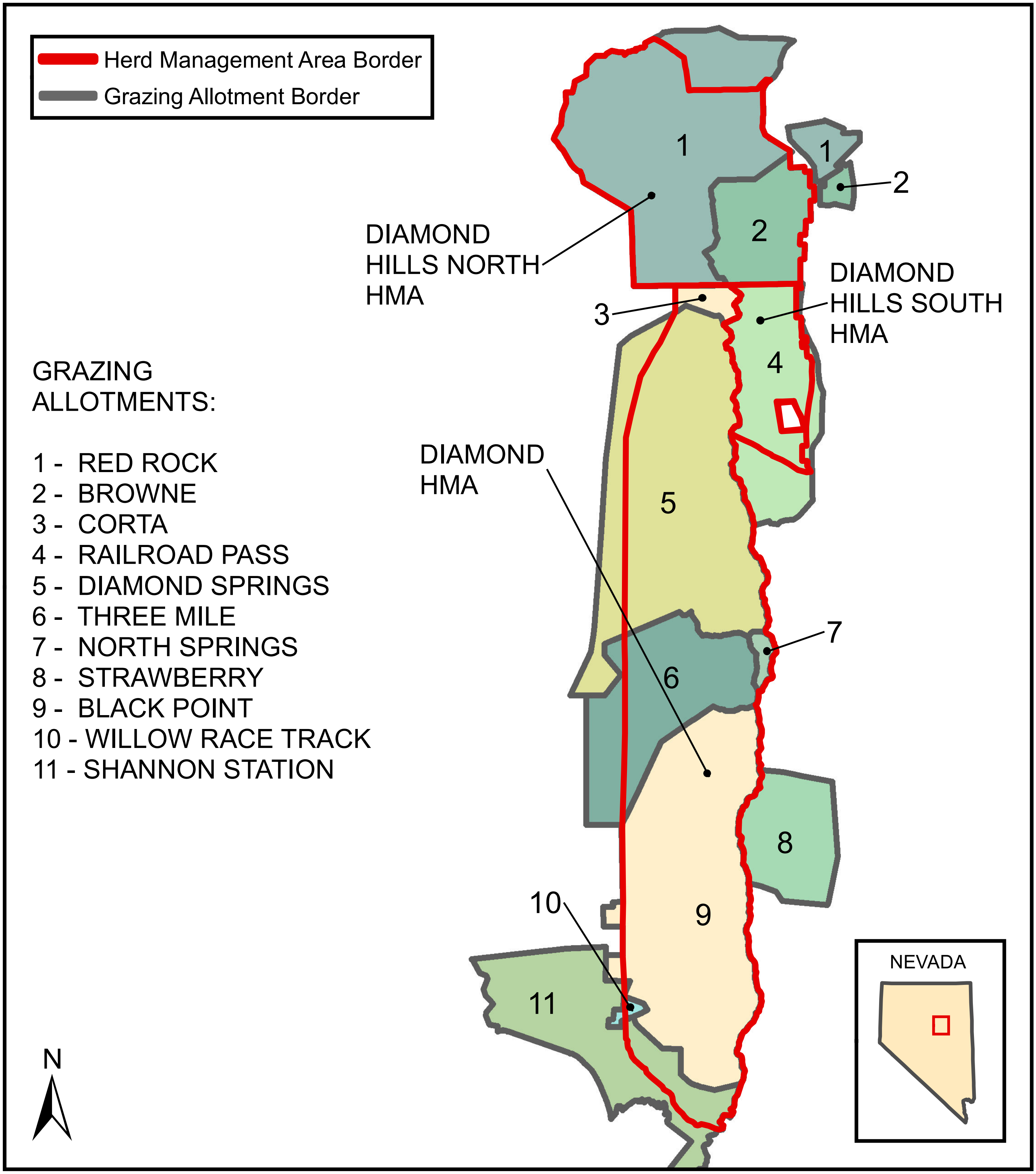
0 5 10 20 Miles

Clan Alpine, Augusta Mountains and Desatoya Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

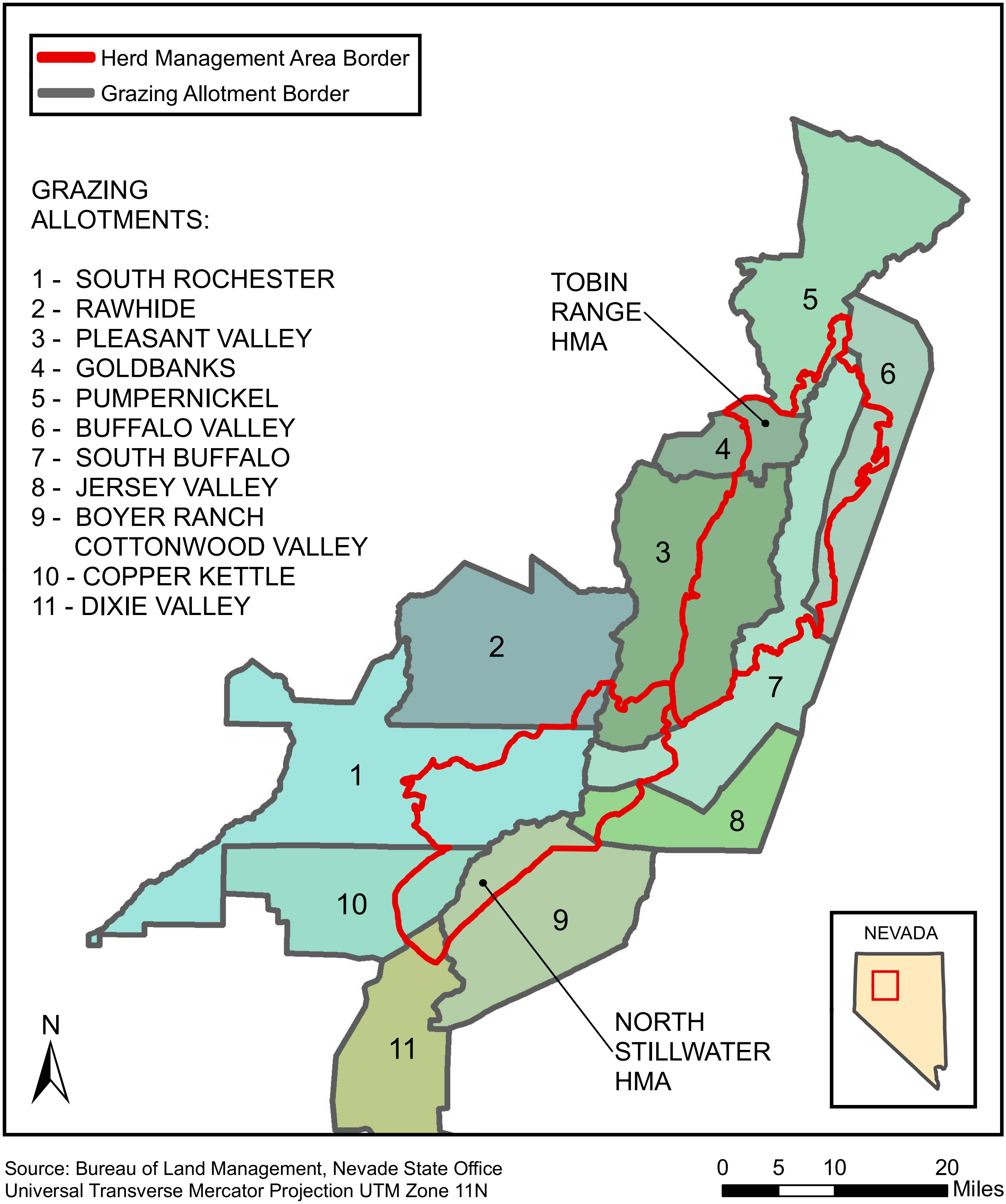
Diamond, Diamond Hills North and Diamond Hills South Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

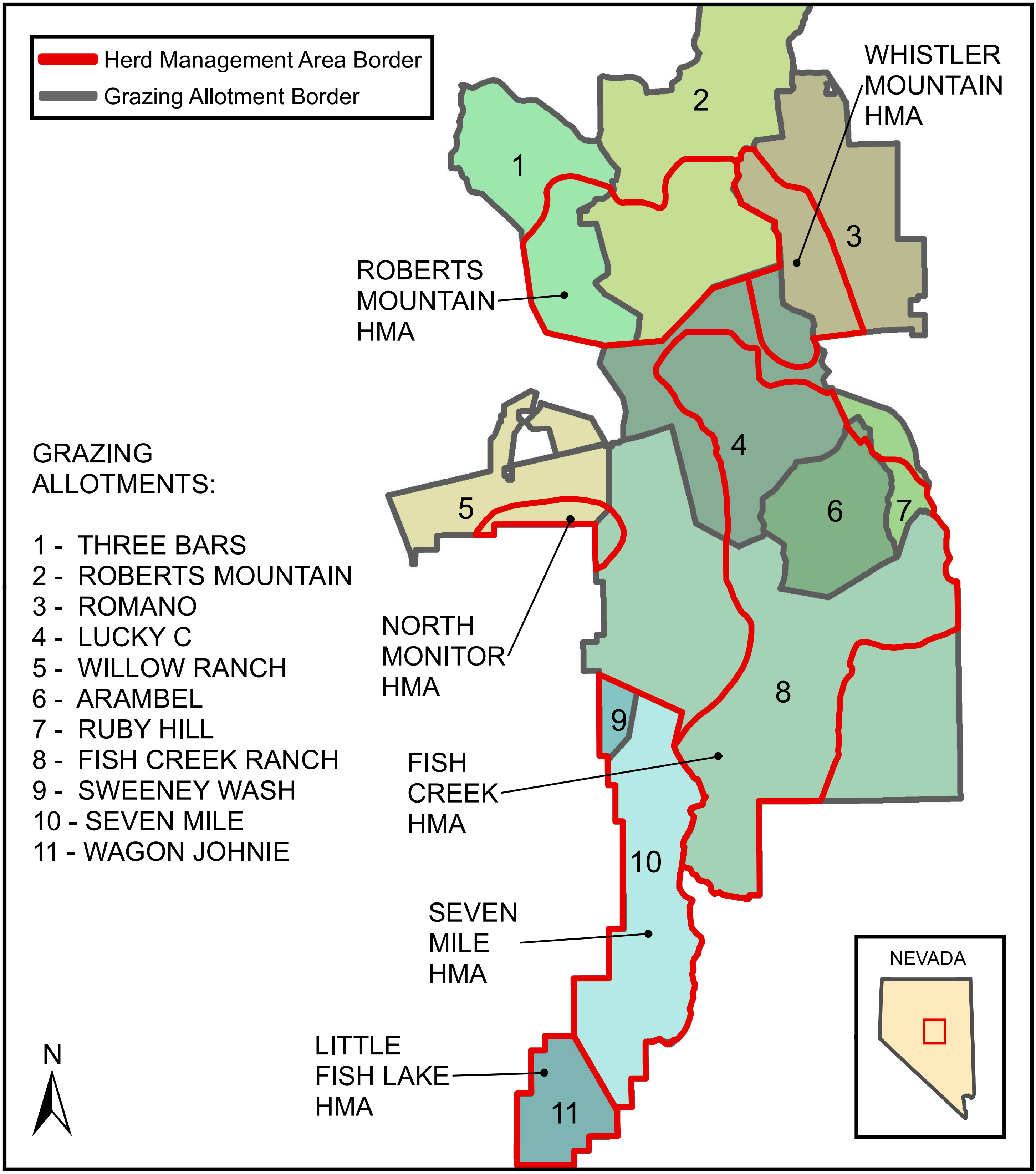
0 2.5 5 10 Miles

Tobin Range and North Stillwater Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

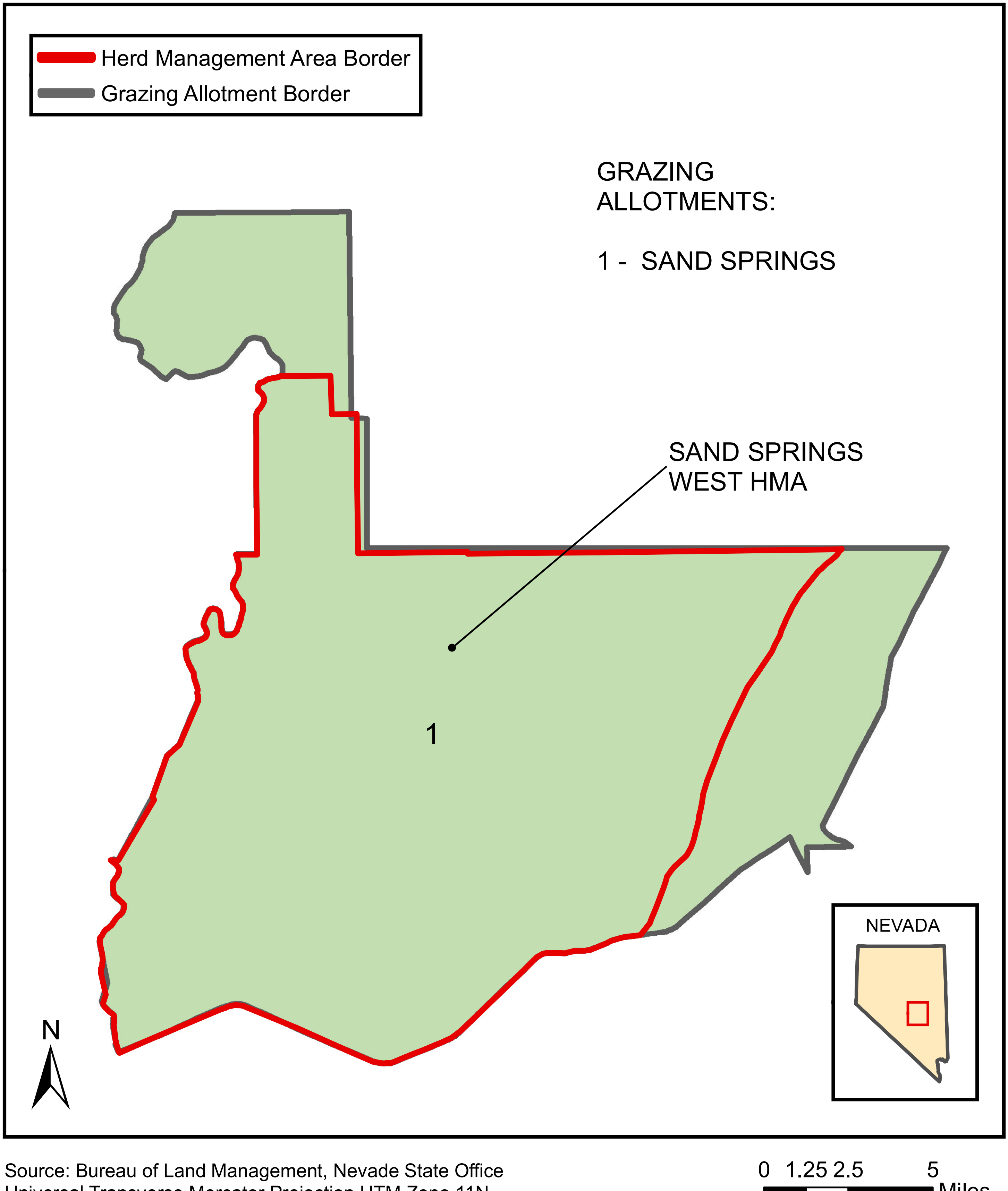
Roberts Mountain, Whistler Mountain, Fish Creek, Little Fish Lake, North Monitor and Seven Mile Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

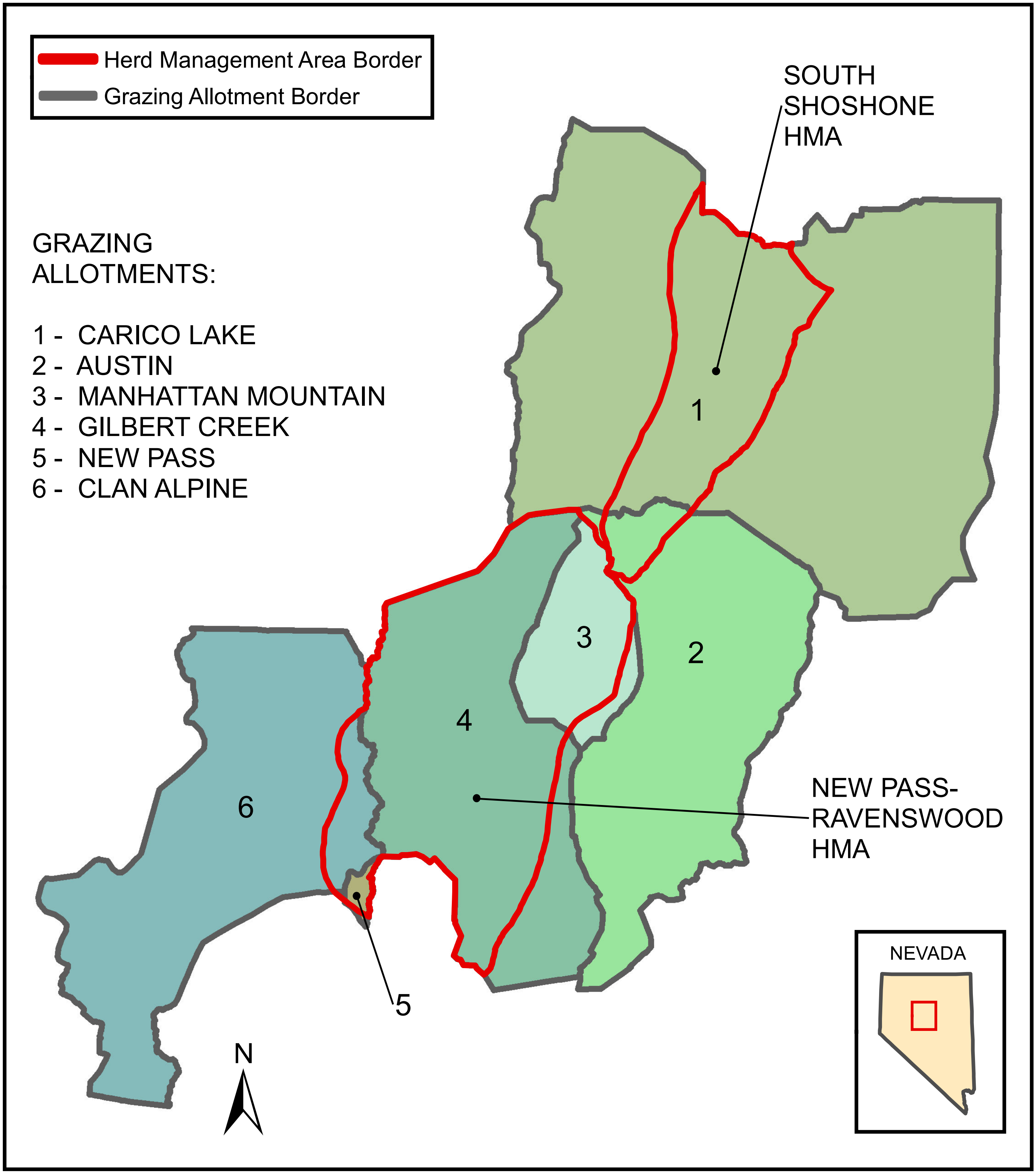
0 2.5 5 10 Miles

Sand Springs West Herd Management Area and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

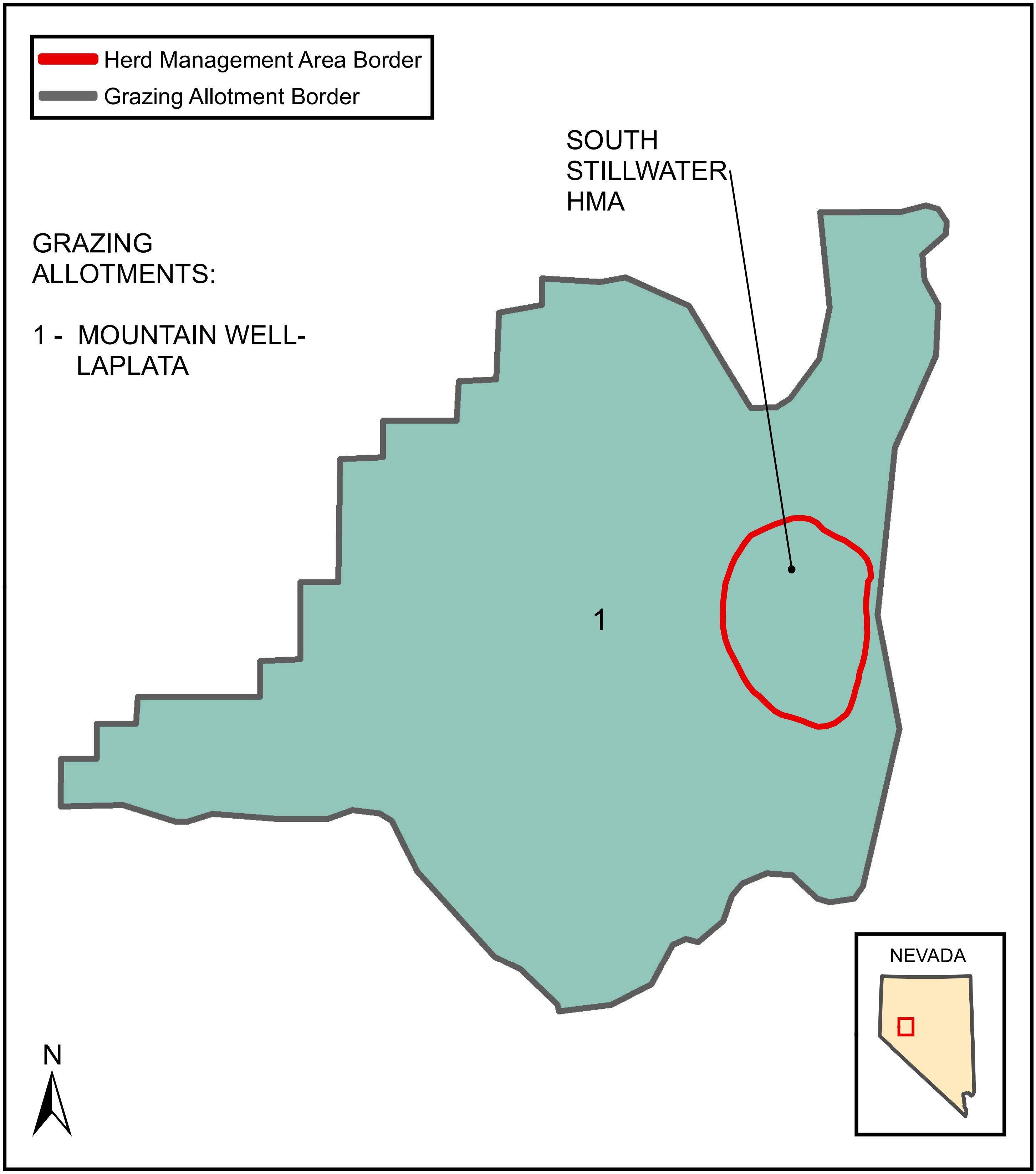
South Shoshone and New Pass-Ravenswood Herd Management Areas and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

0 5 10 20 Miles

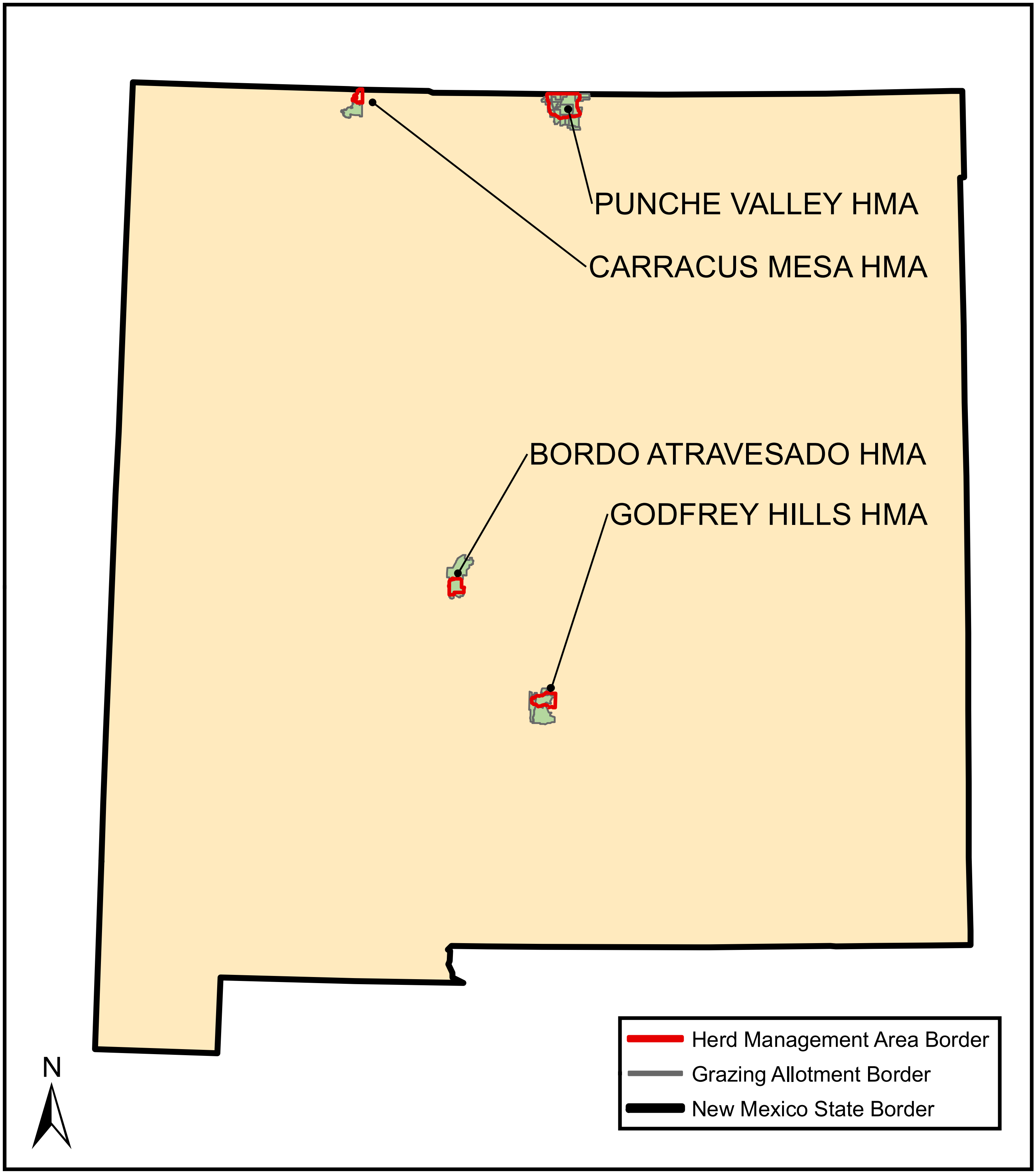
South Stillwater Herd Management Area and Associated Grazing Allotments of Nevada



Source: Bureau of Land Management, Nevade State Office
Universal Transverse Mercator Projection UTM Zone 11N

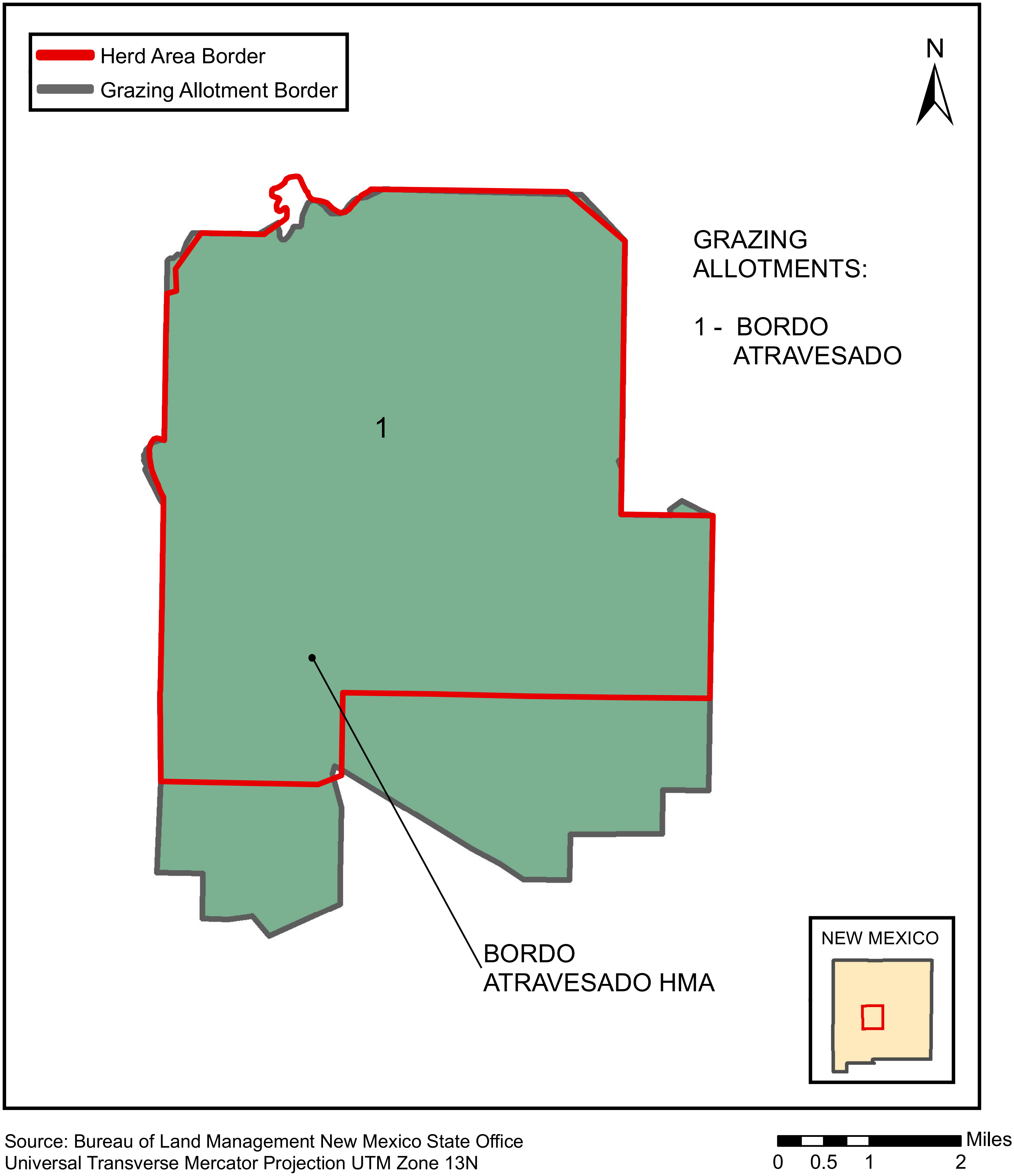
0 1.25 2.5 5 Miles

Herd Management Areas and Associated Grazing Allotments of New Mexico



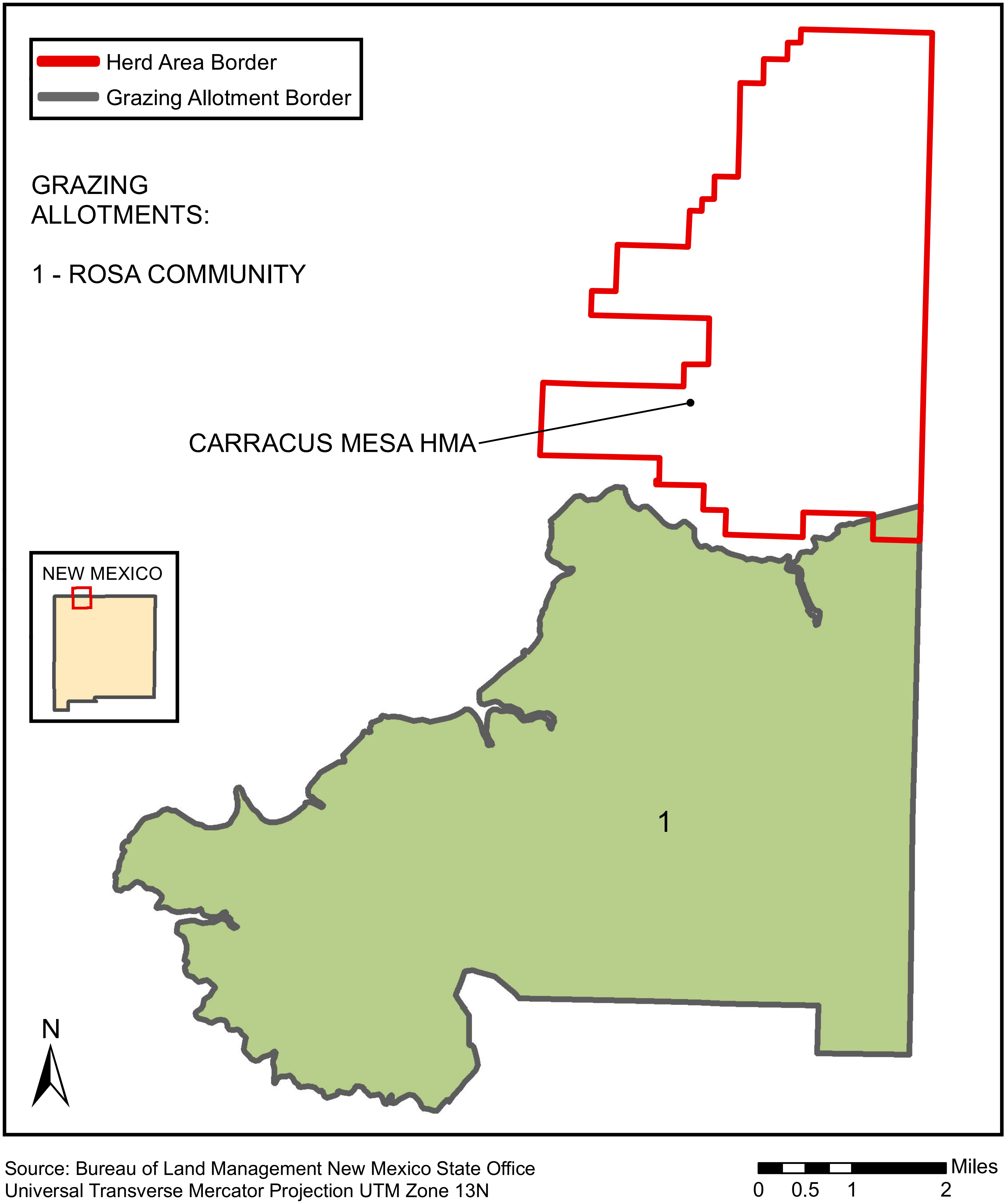
Source: Bureau of Land Management New Mexico State Office
Universal Transverse Mercator Projection UTM Zone 13N

Bordo Atravesado Herd Management Area and Associated Grazing Allotments of New Mexico



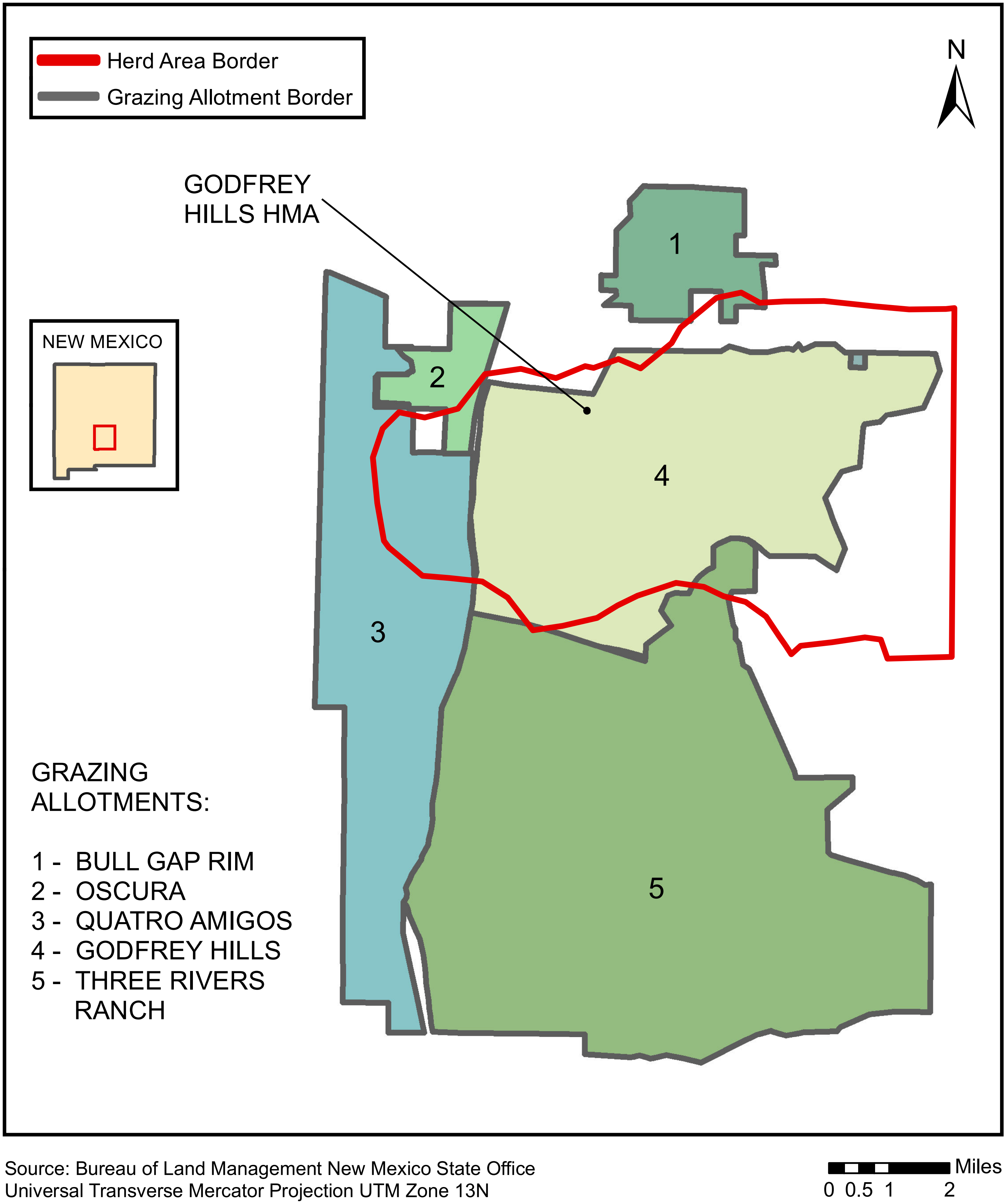
Source: Bureau of Land Management New Mexico State Office
Universal Transverse Mercator Projection UTM Zone 13N

Carracus Mesa Herd Management Area and Associated Grazing Allotments of New Mexico



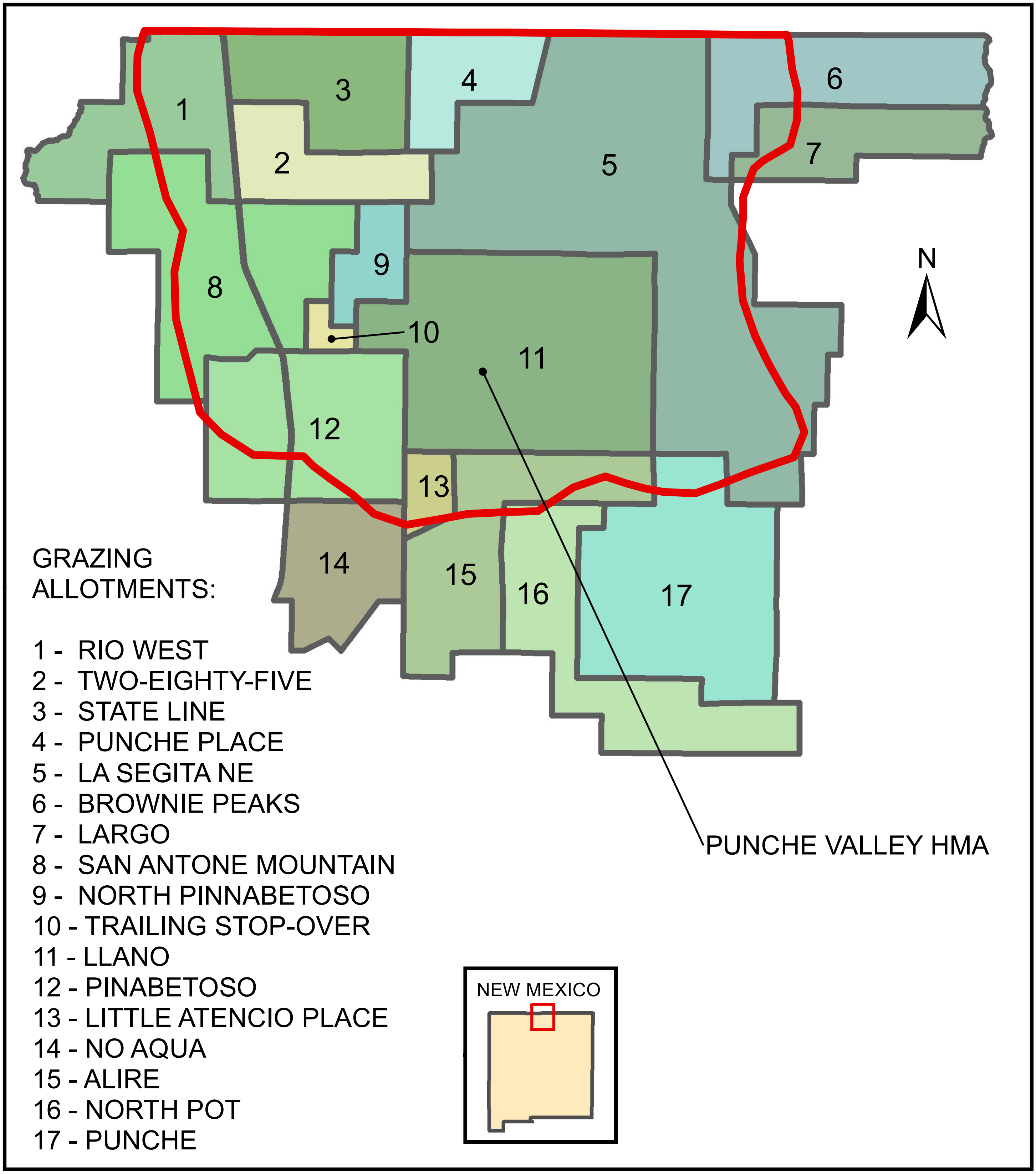
Source: Bureau of Land Management New Mexico State Office
Universal Transverse Mercator Projection UTM Zone 13N

Godfrey Hills Herd Management Area and Associated Grazing Allotments of New Mexico



Source: Bureau of Land Management New Mexico State Office
Universal Transverse Mercator Projection UTM Zone 13N

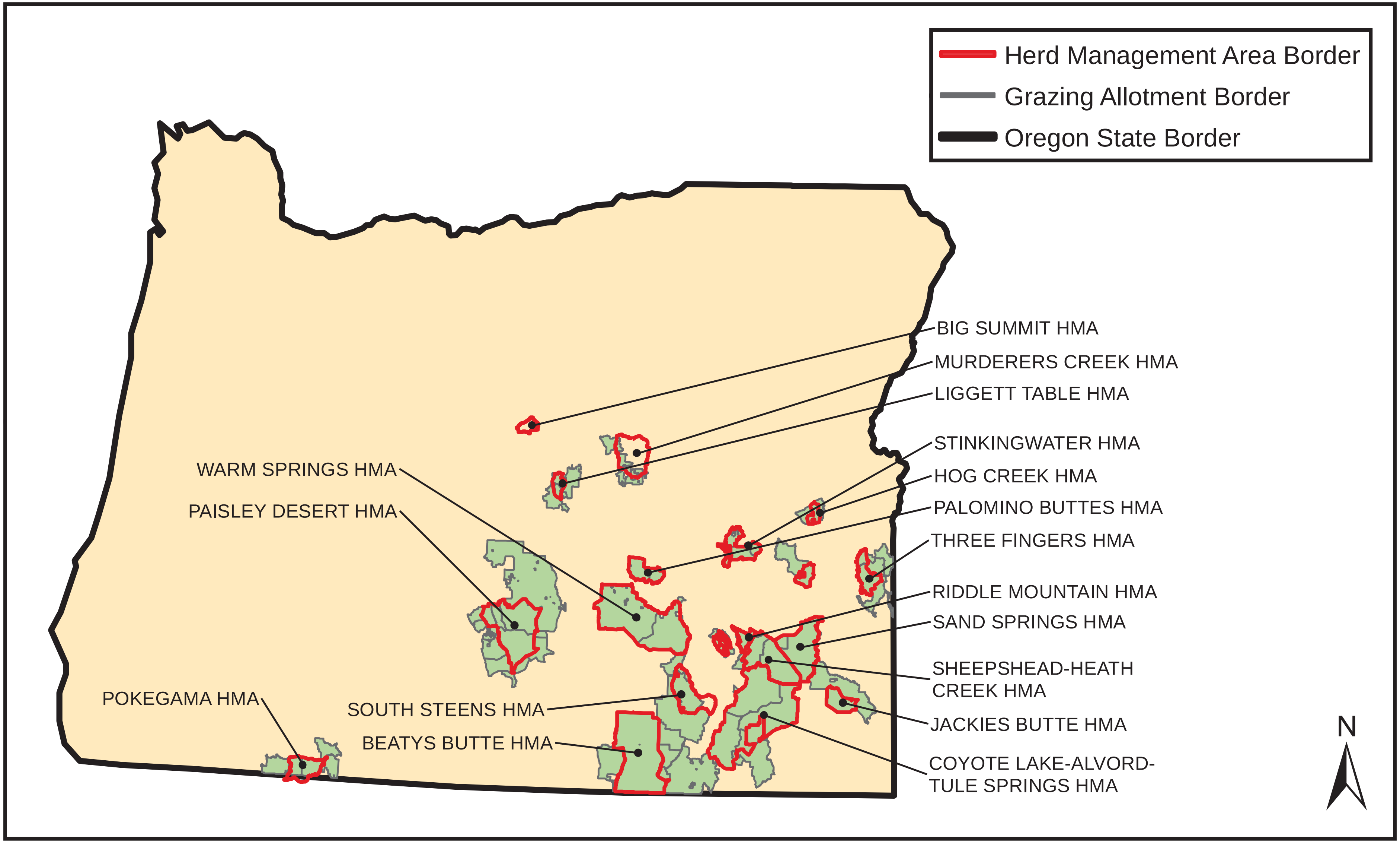
Punche Valley Herd Management Area and Associated Grazing Allotments of New Mexico



Source: Bureau of Land Management New Mexico State Office
Universal Transverse Mercator Projection UTM Zone 13N

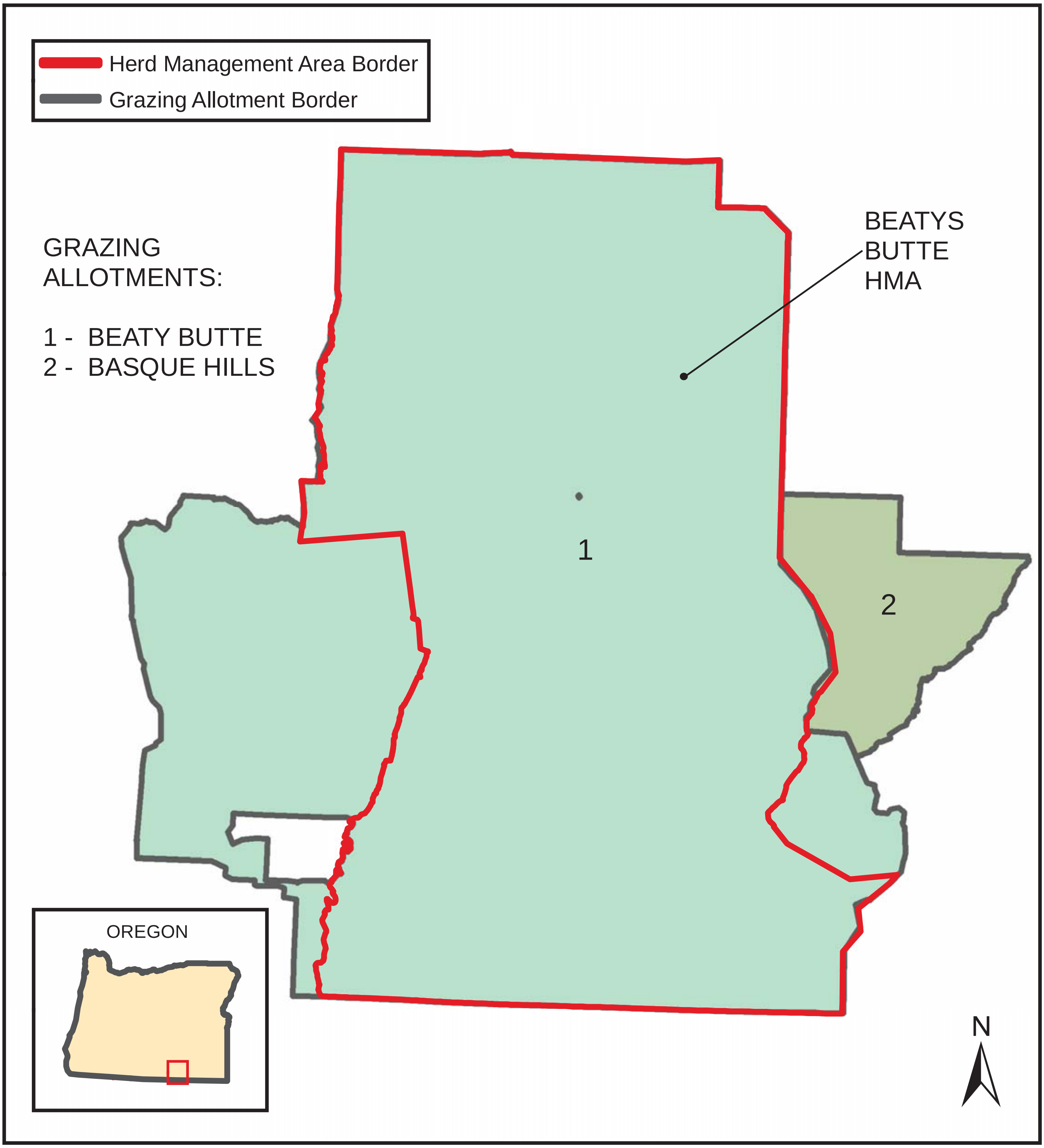
Miles
0 1.25 2.5 5

Herd Management Areas and Associated Grazing Allotments of Oregon



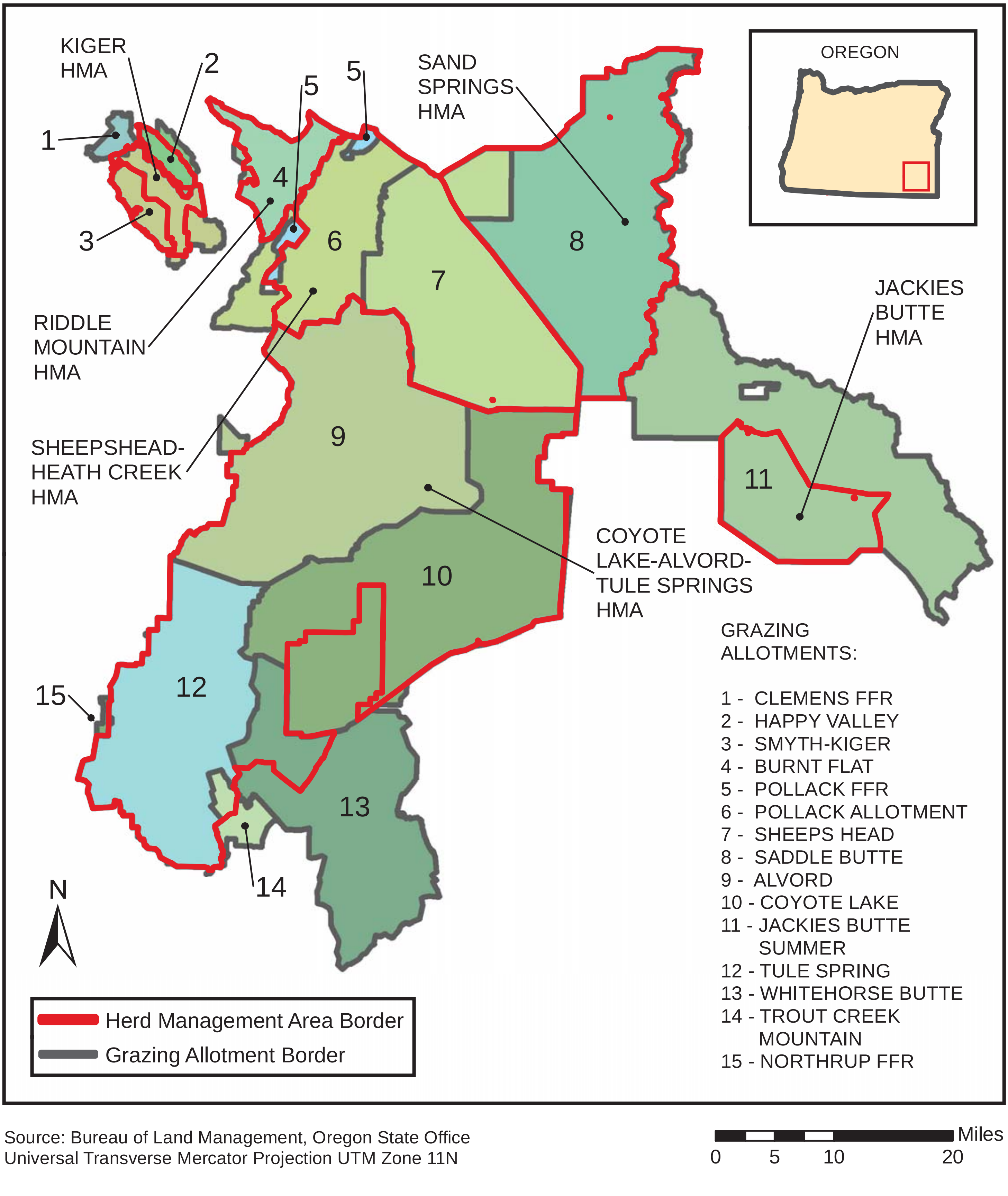
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Beatys Butte Herd Management Area and Associated Grazing Allotments of Oregon



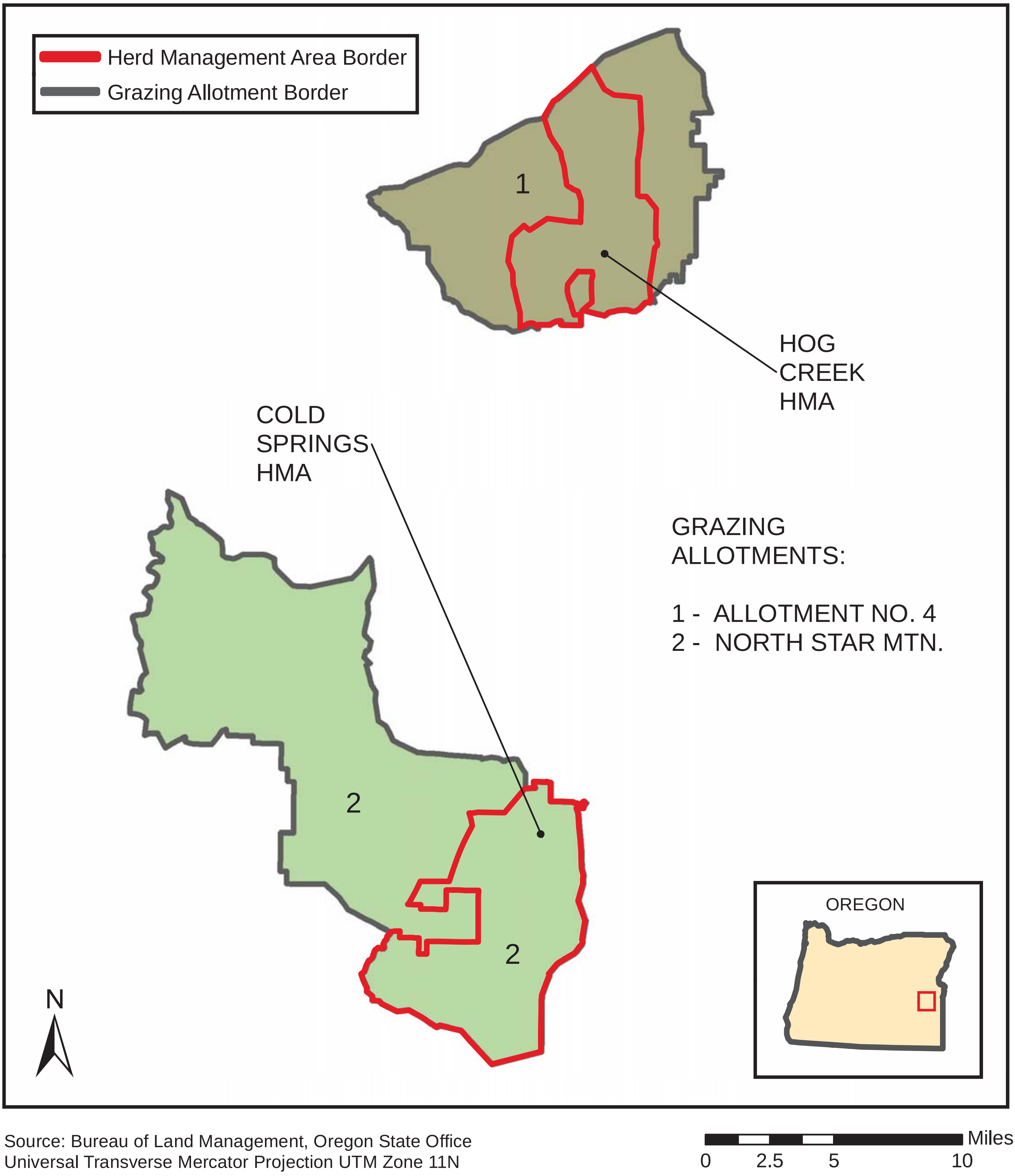
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Kiger, Sheepshead-Heath Creek, Sand Springs, Riddle Mountain, Jackies Butte, and Coyote Lake-Alvord-Tule Springs Herd Management Areas and Associated Grazing Allotments of Oregon



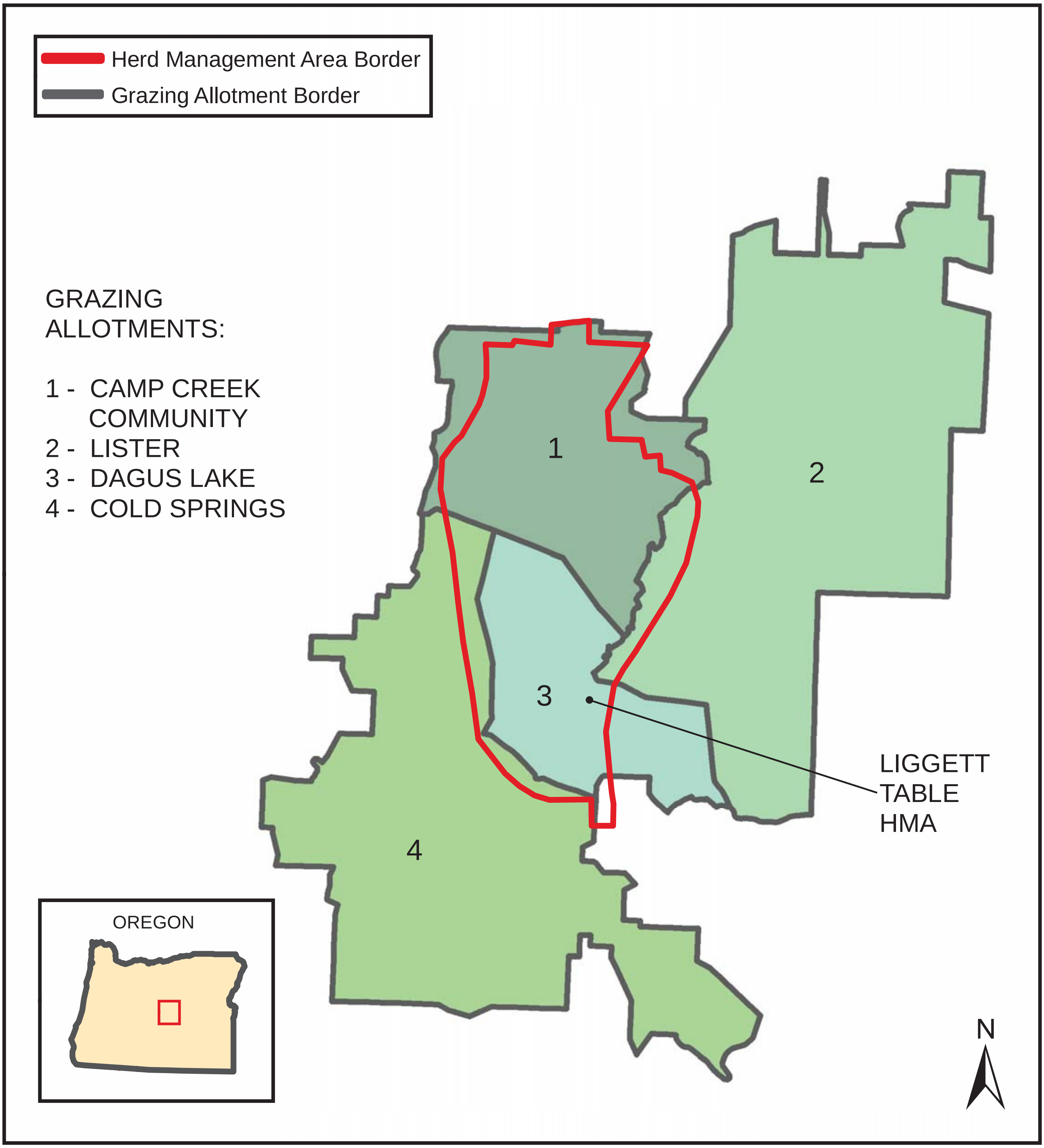
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Hog Creek and Cold Springs Herd Management Areas and Associated Grazing Allotments of Oregon



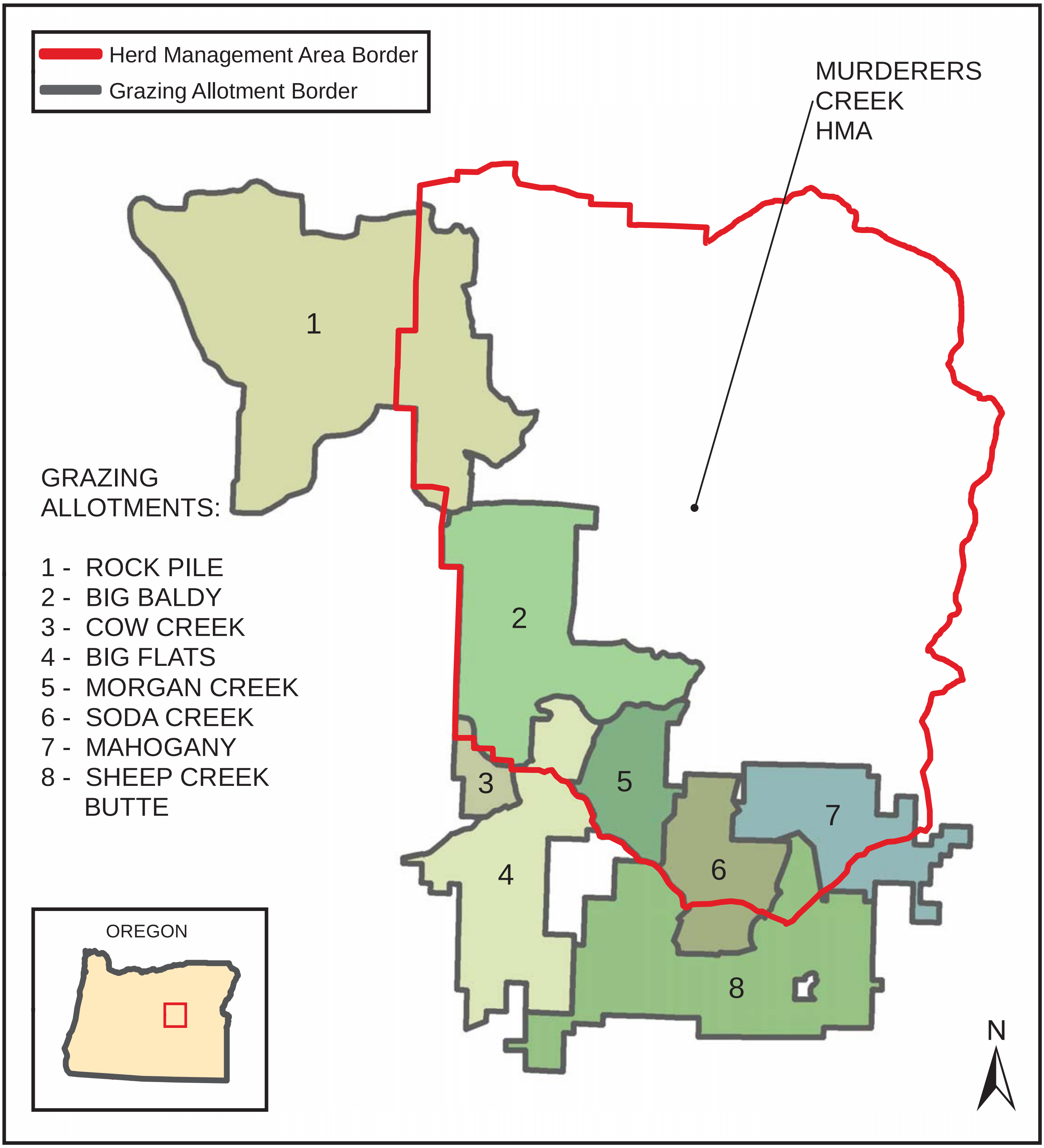
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Liggett Table Herd Management Area and Associated Grazing Allotments of Oregon



Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Murderers Creek Herd Management Area and Associated Grazing Allotments of Oregon



Source: Bureau of Land Management, Oregon State Office
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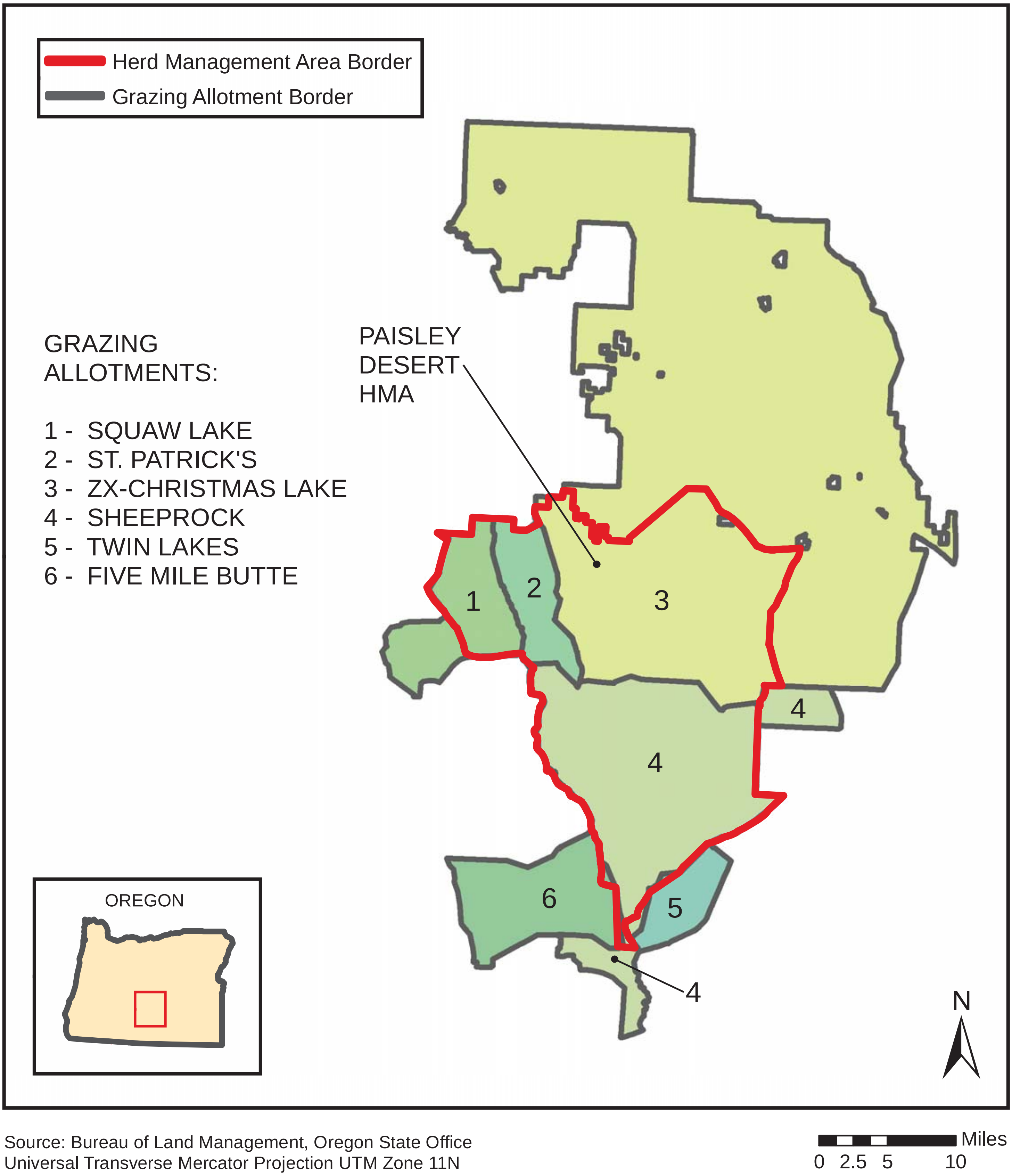
Paisley Desert Herd Management Area and Associated Grazing Allotments of Oregon



Source: Bureau of Land Management, Oregon State Office
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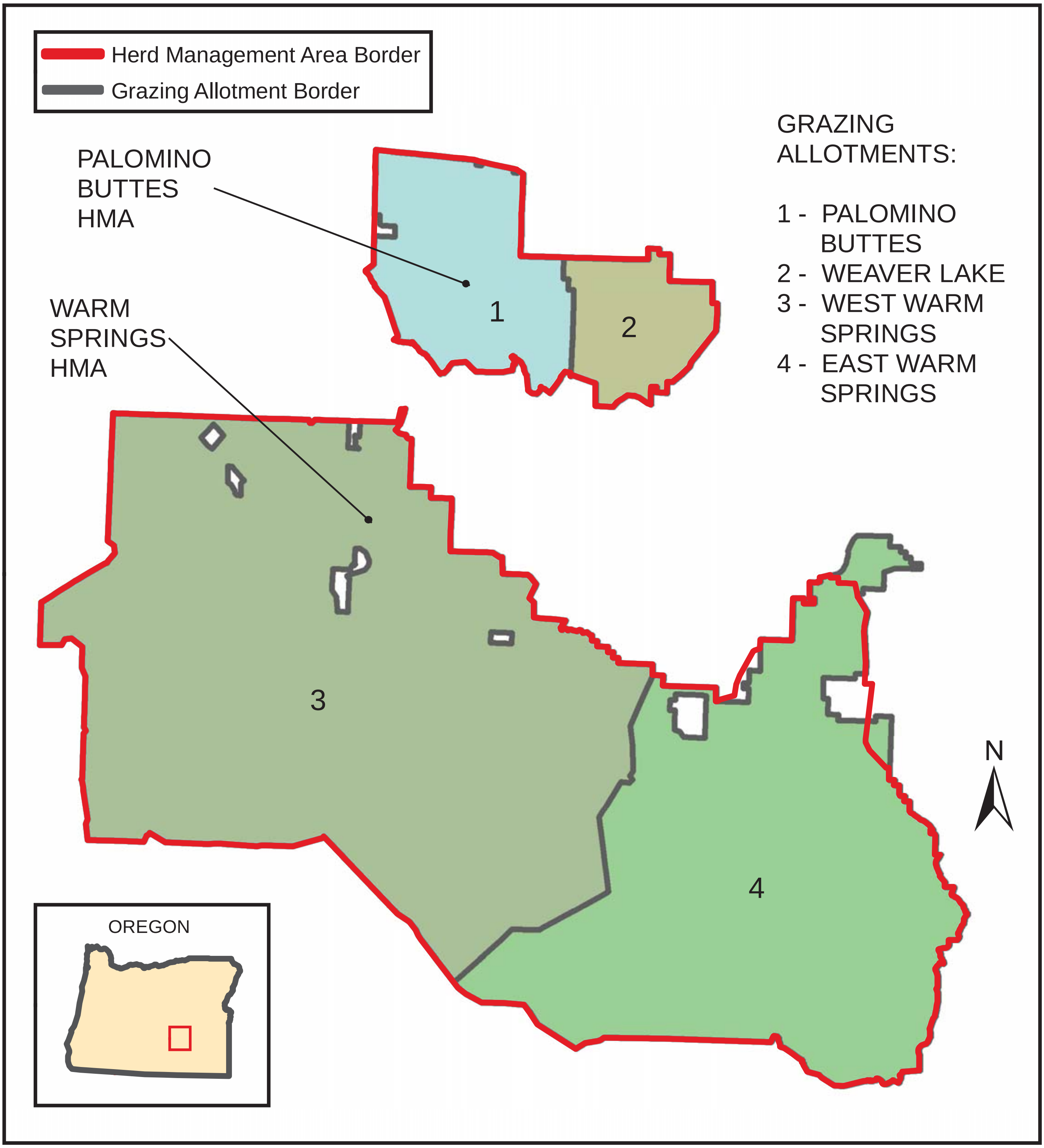
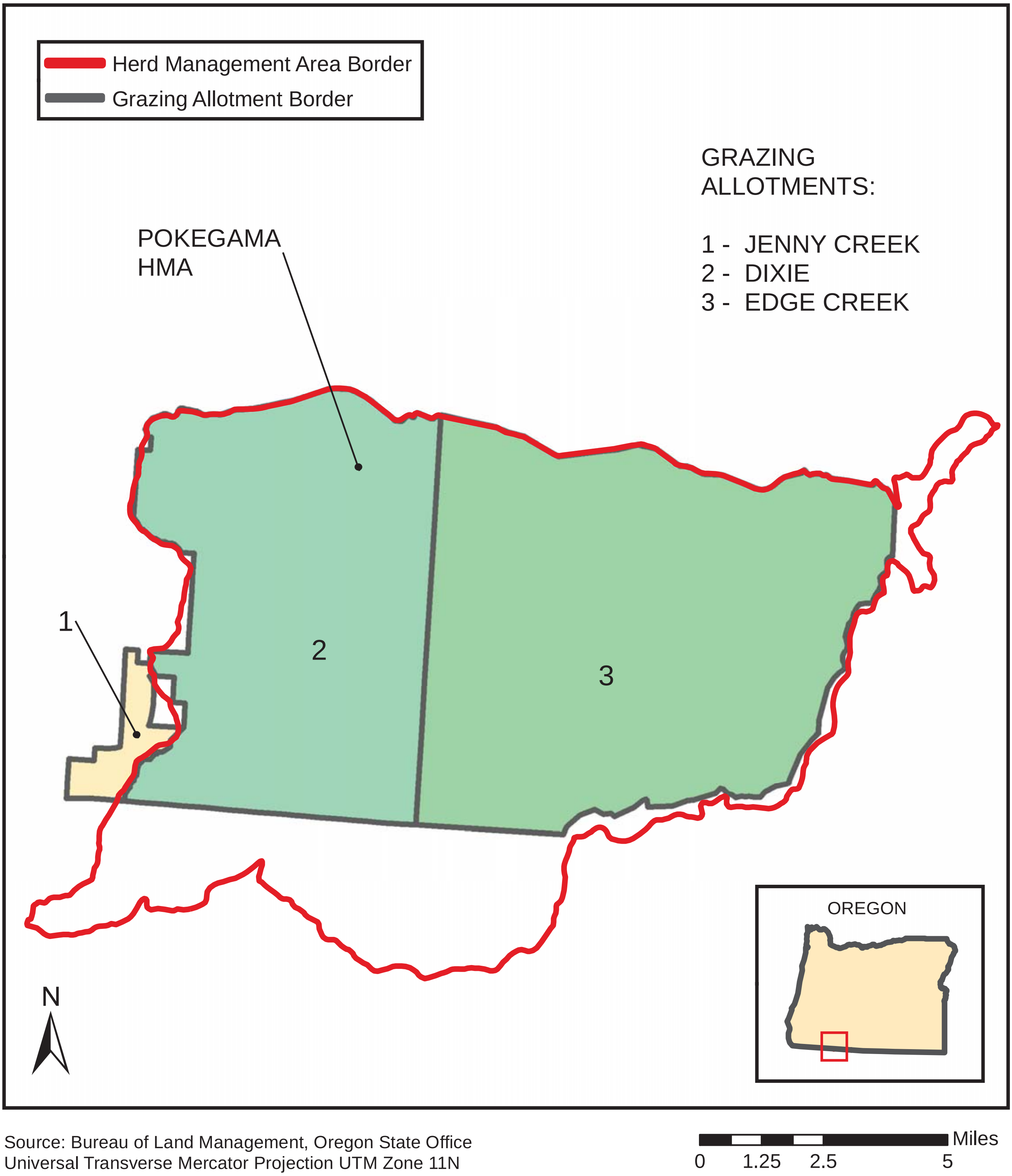
Palomino Buttes and Warm Springs Herd Management Areas and Associated Grazing Allotments of Oregon



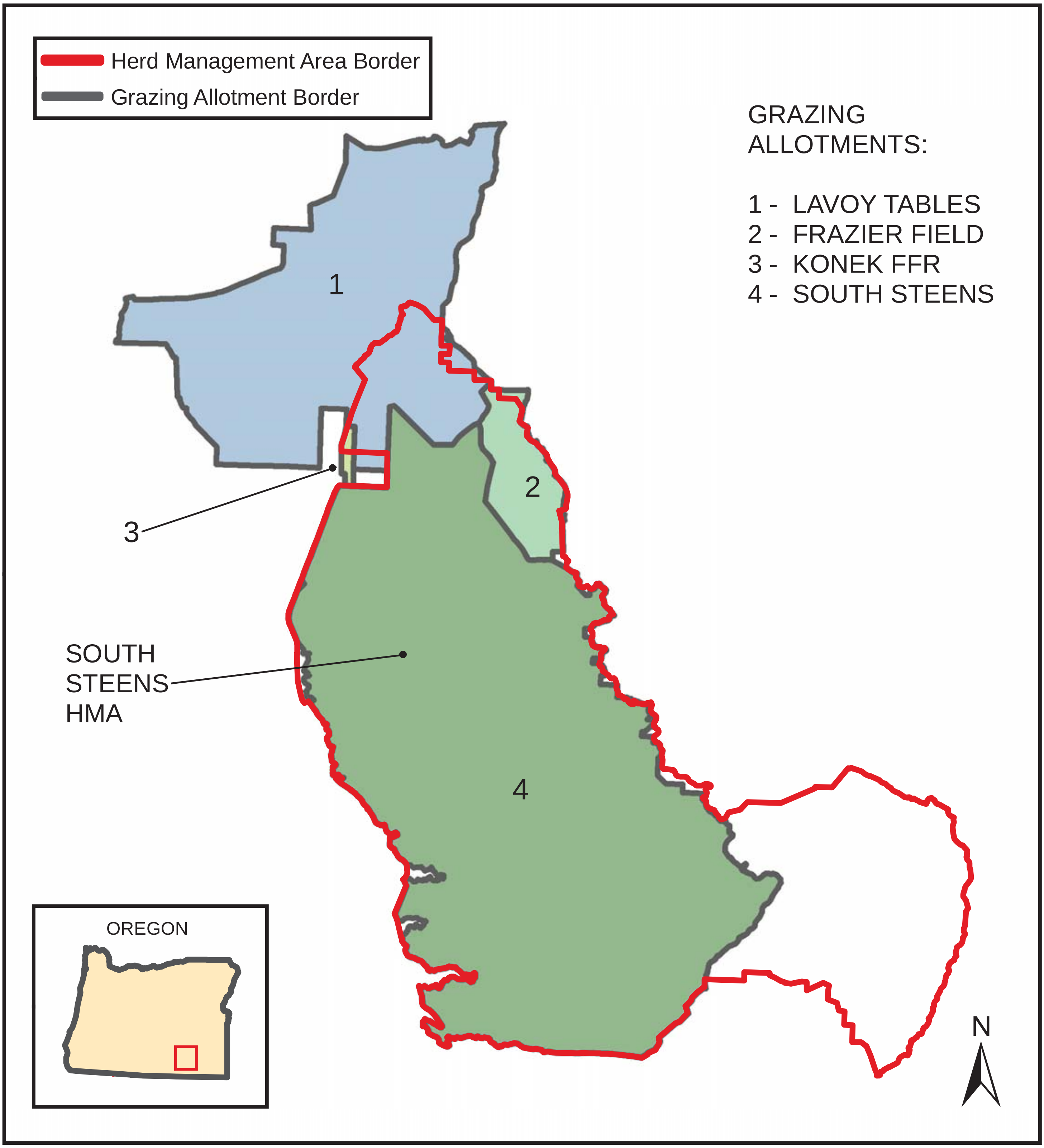
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Pokegama Herd Management Area and Associated Grazing Allotments of Oregon



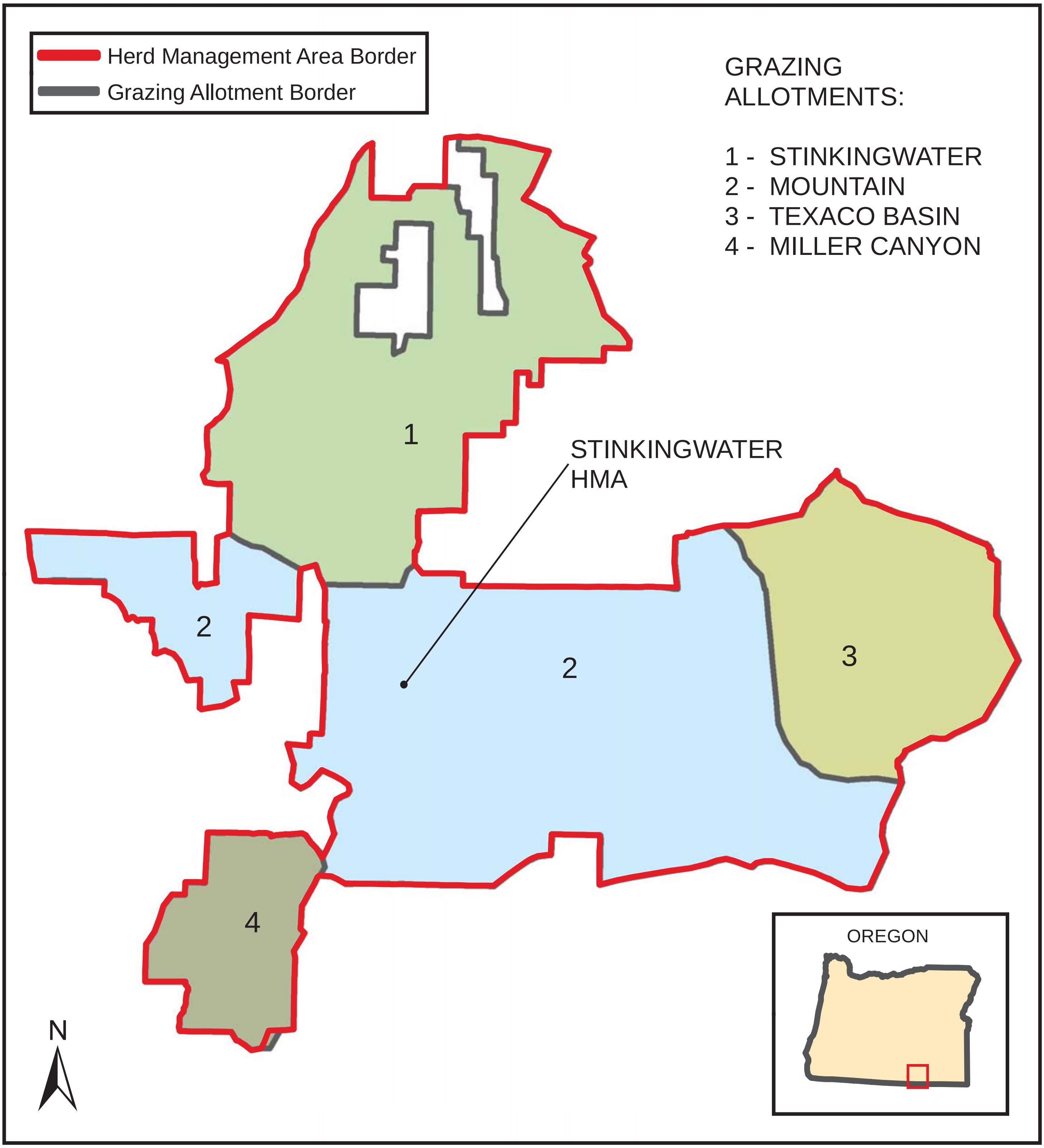
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

South Steens Herd Management Area and Associated Grazing Allotments of Oregon



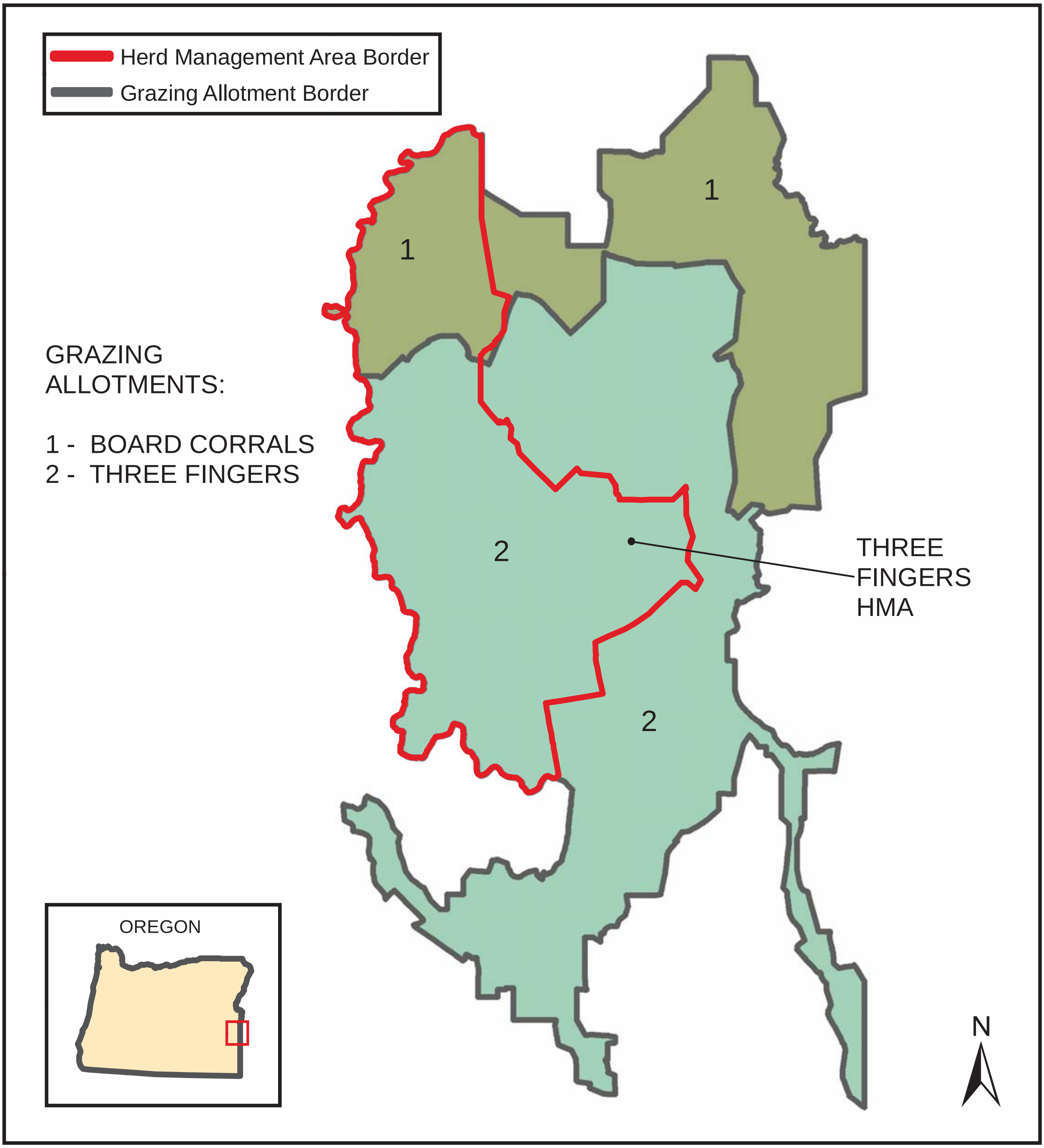
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Stinkingwater Herd Management Area and Associated Grazing Allotments of Oregon



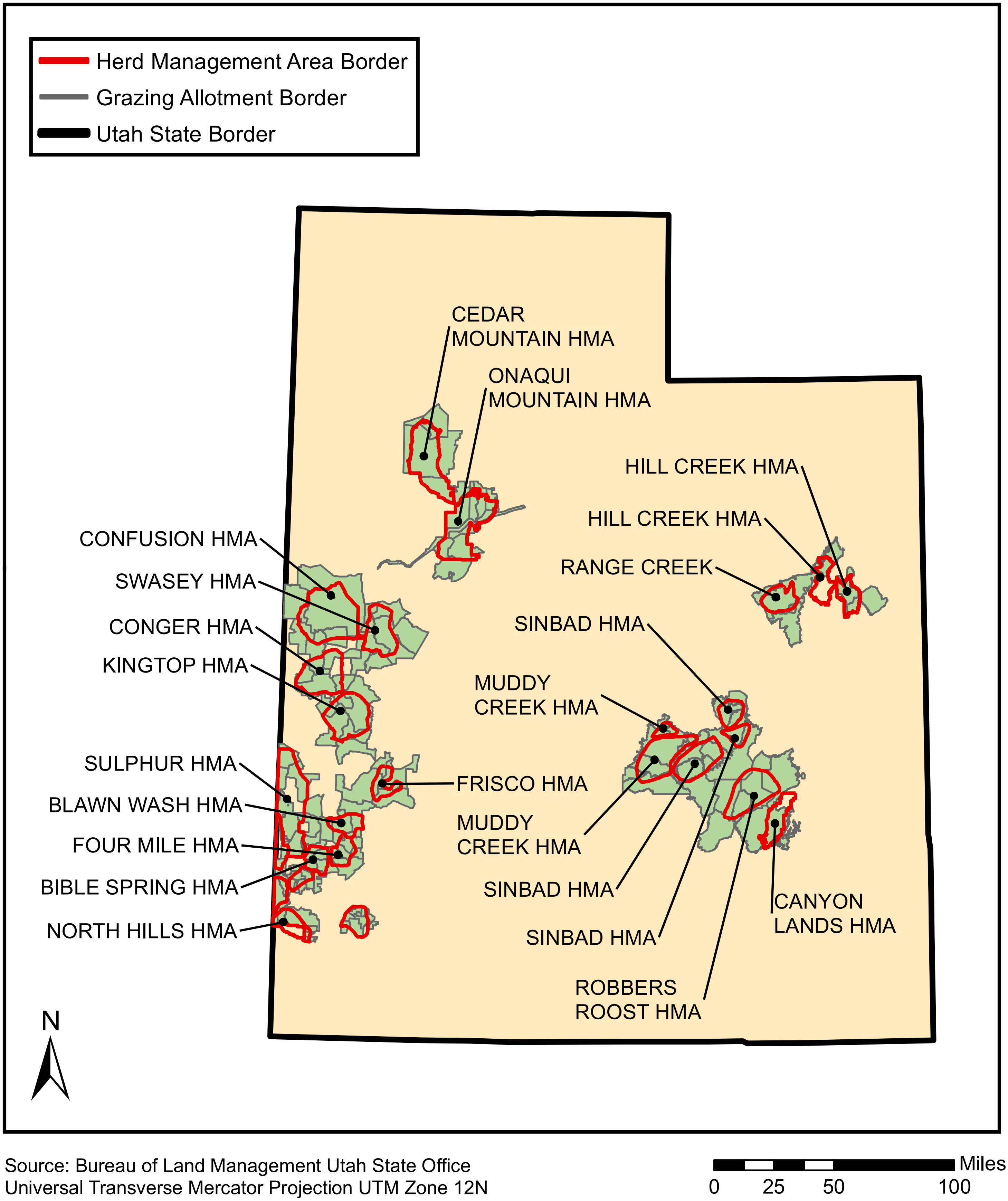
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Three Fingers Herd Management Area and Associated Grazing Allotments of Oregon



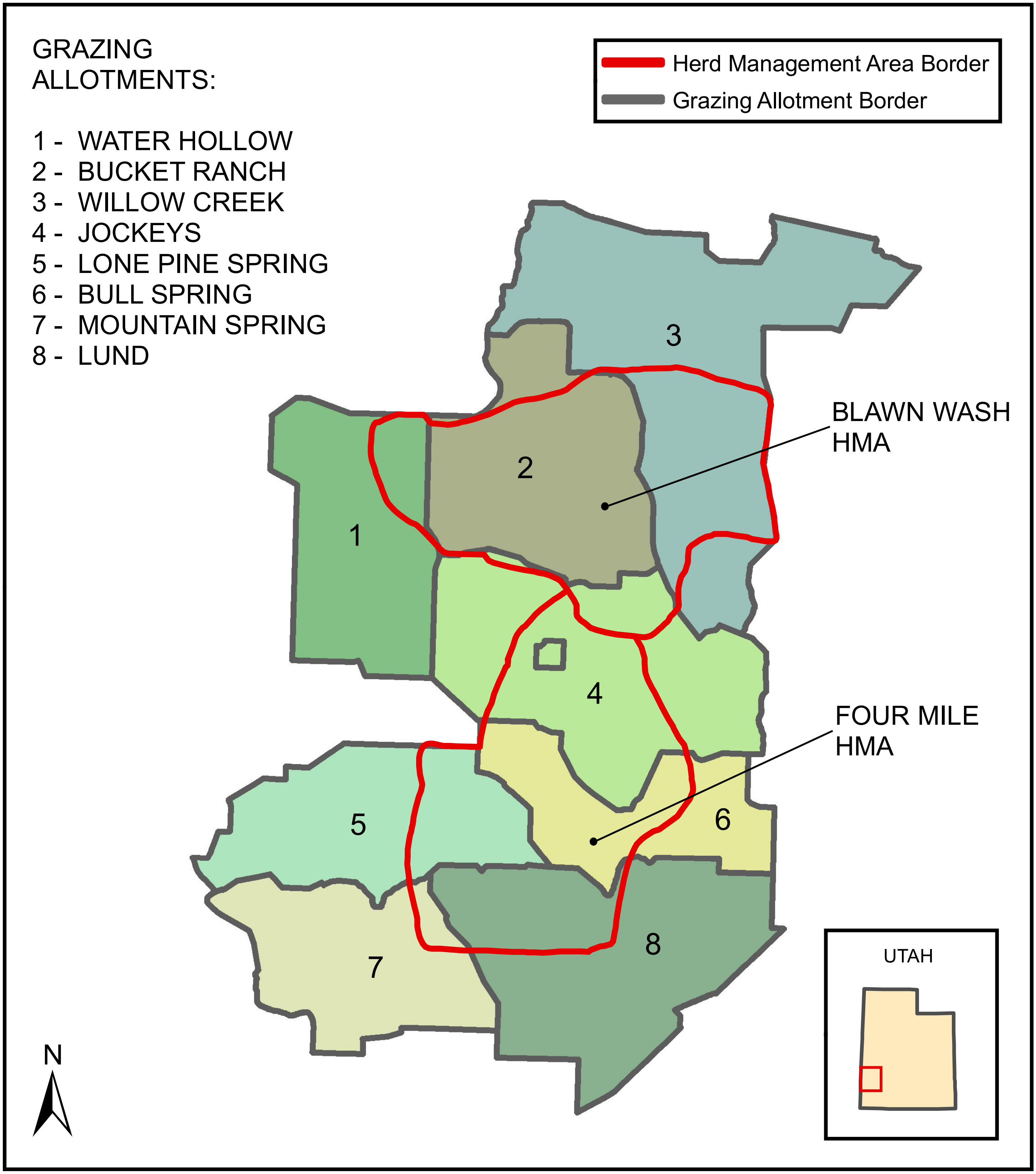
Source: Bureau of Land Management, Oregon State Office
Universal Transverse Mercator Projection UTM Zone 11N

Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

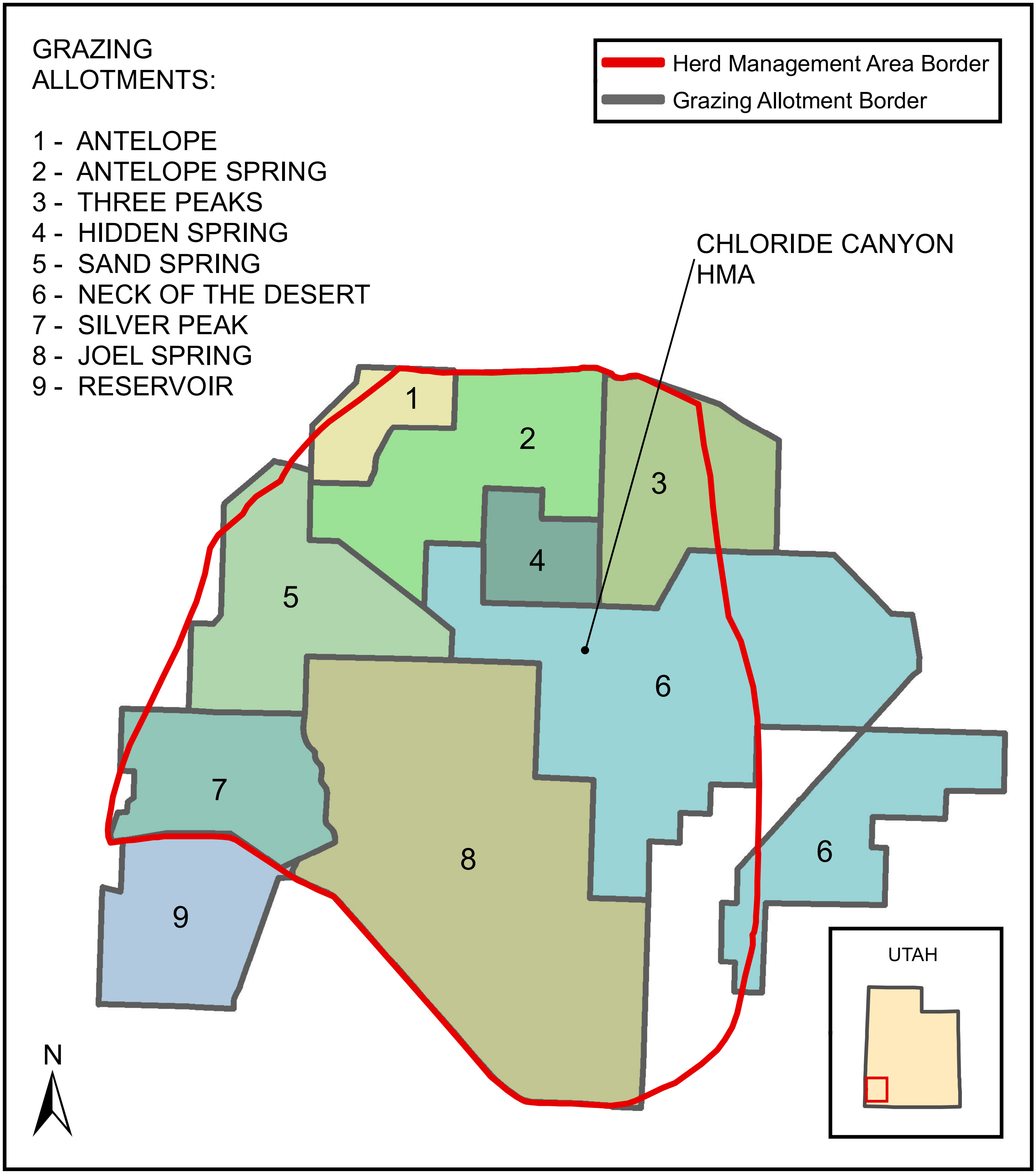
Blawn Wash and Four Mile Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

0 2.5 5 10 Miles

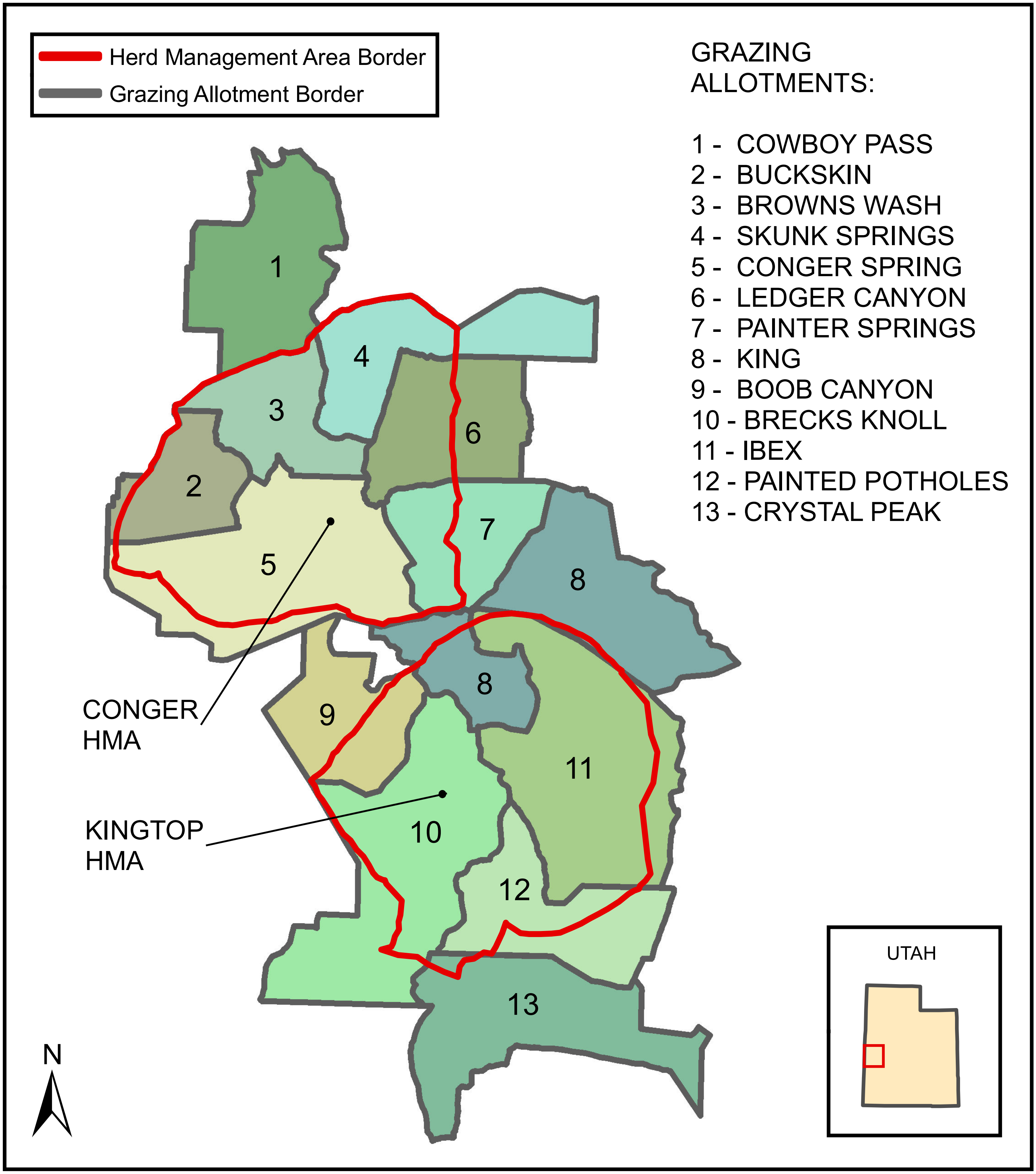
Chloride Canyon Herd Management Area and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

Miles: 0 | 1.25 | 2.5 | 5

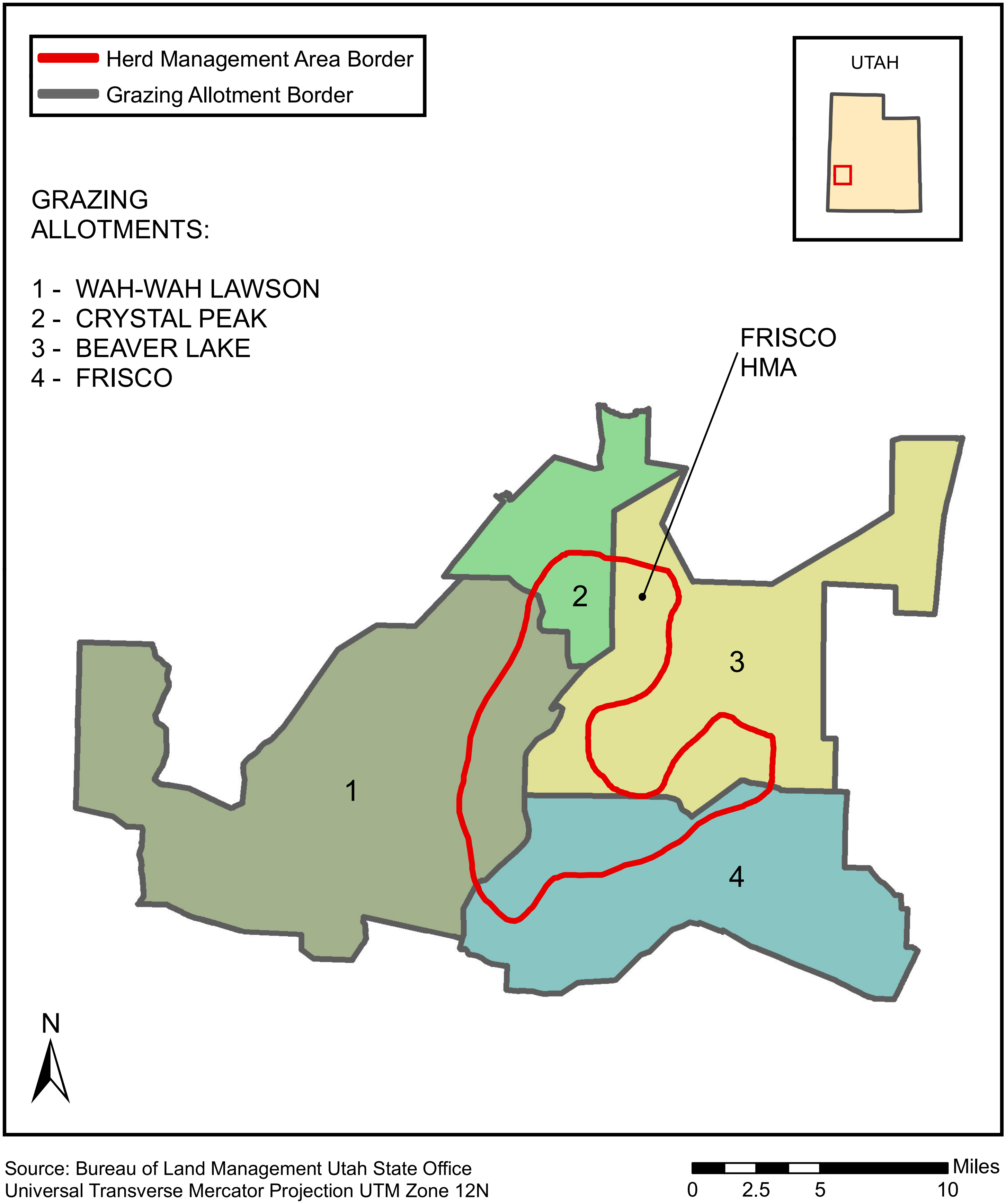
Conger and Kingtop Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

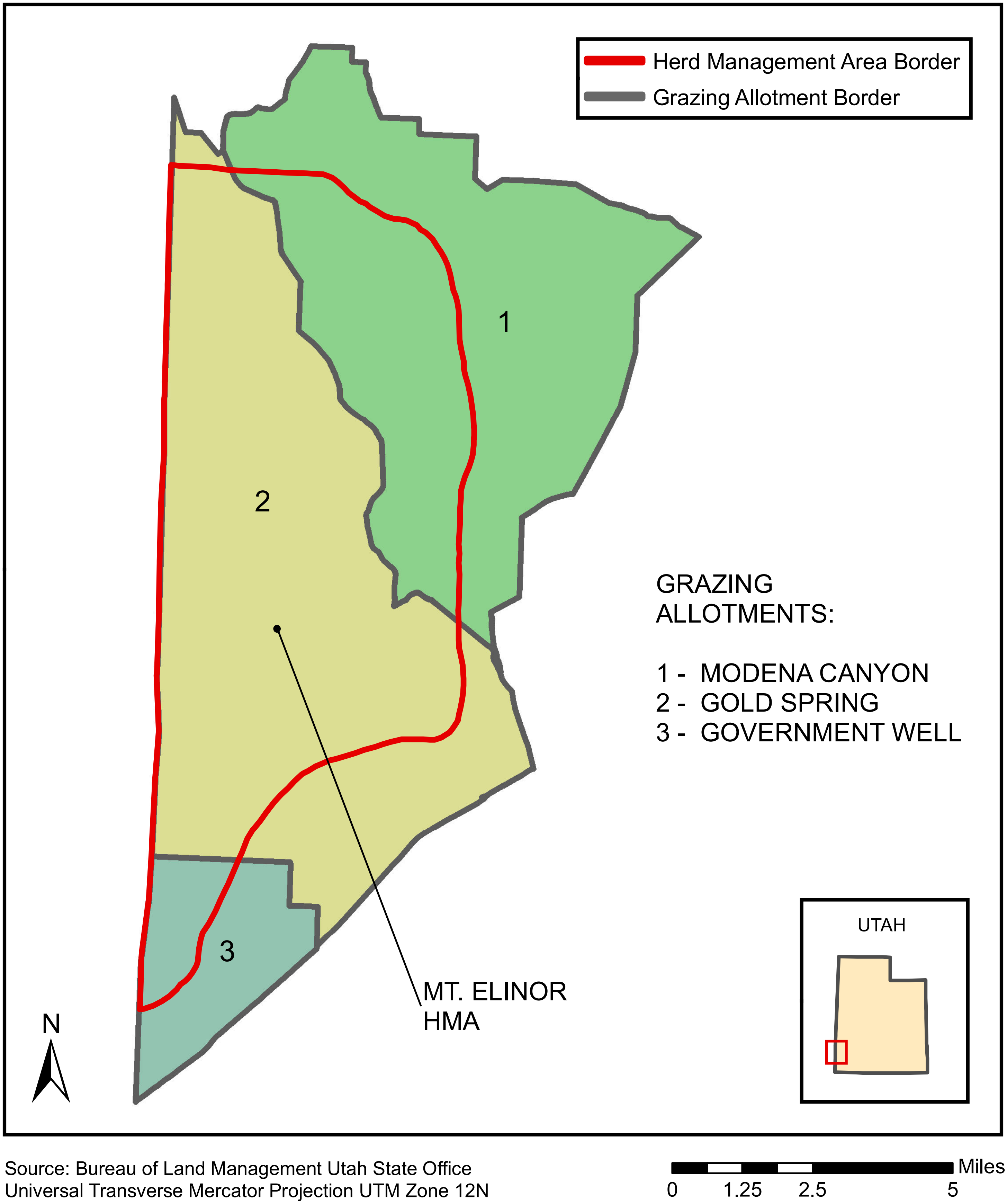
Miles
0 2.5 5 10

Frisco Herd Management Area and Associated Grazing Allotments of Utah



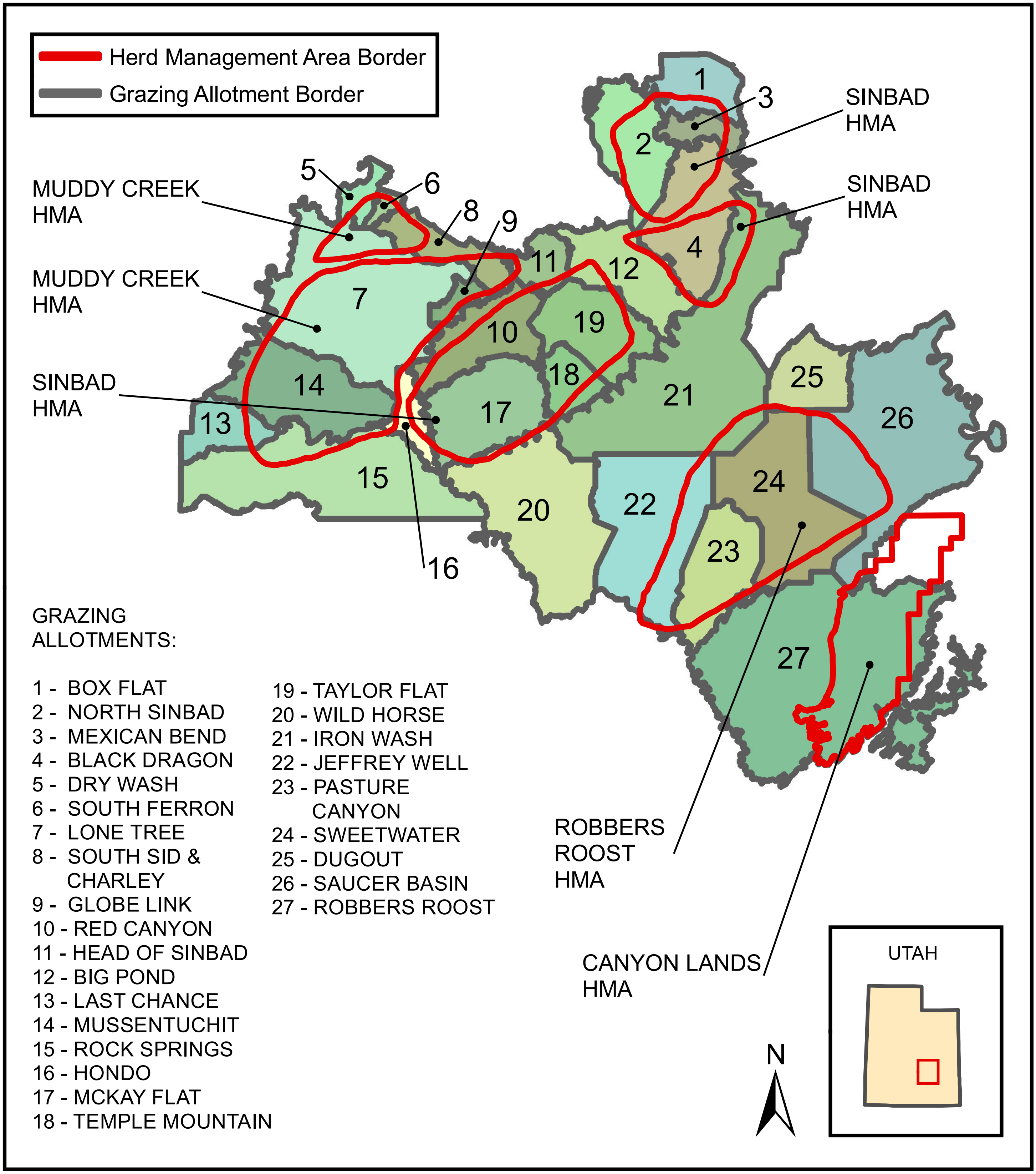
Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

Mt. Elinor Herd Management Area and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

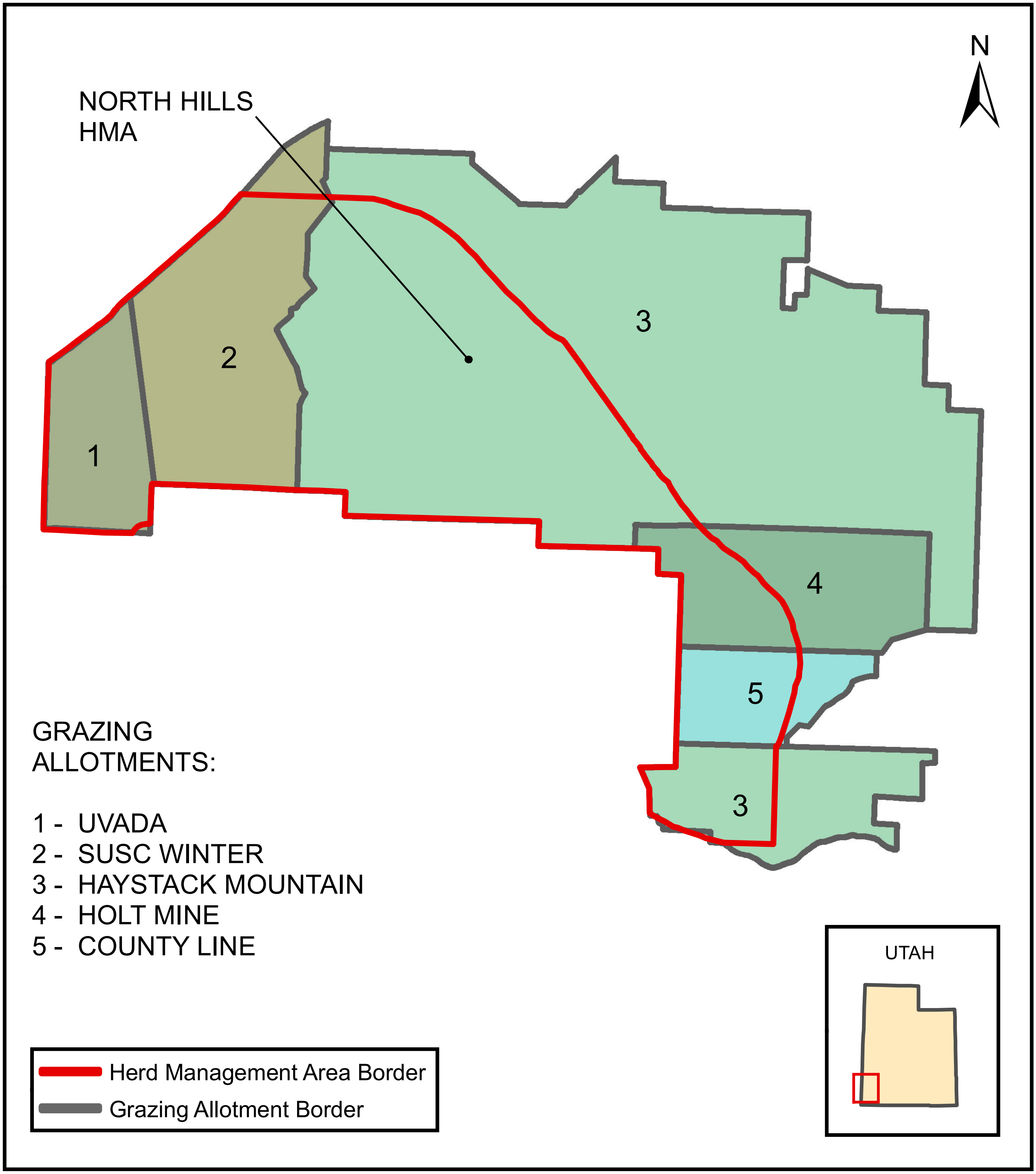
Muddy Creek, Sinbad, Robbers Roost and Canyon Lands Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

Miles
0 5 10 20

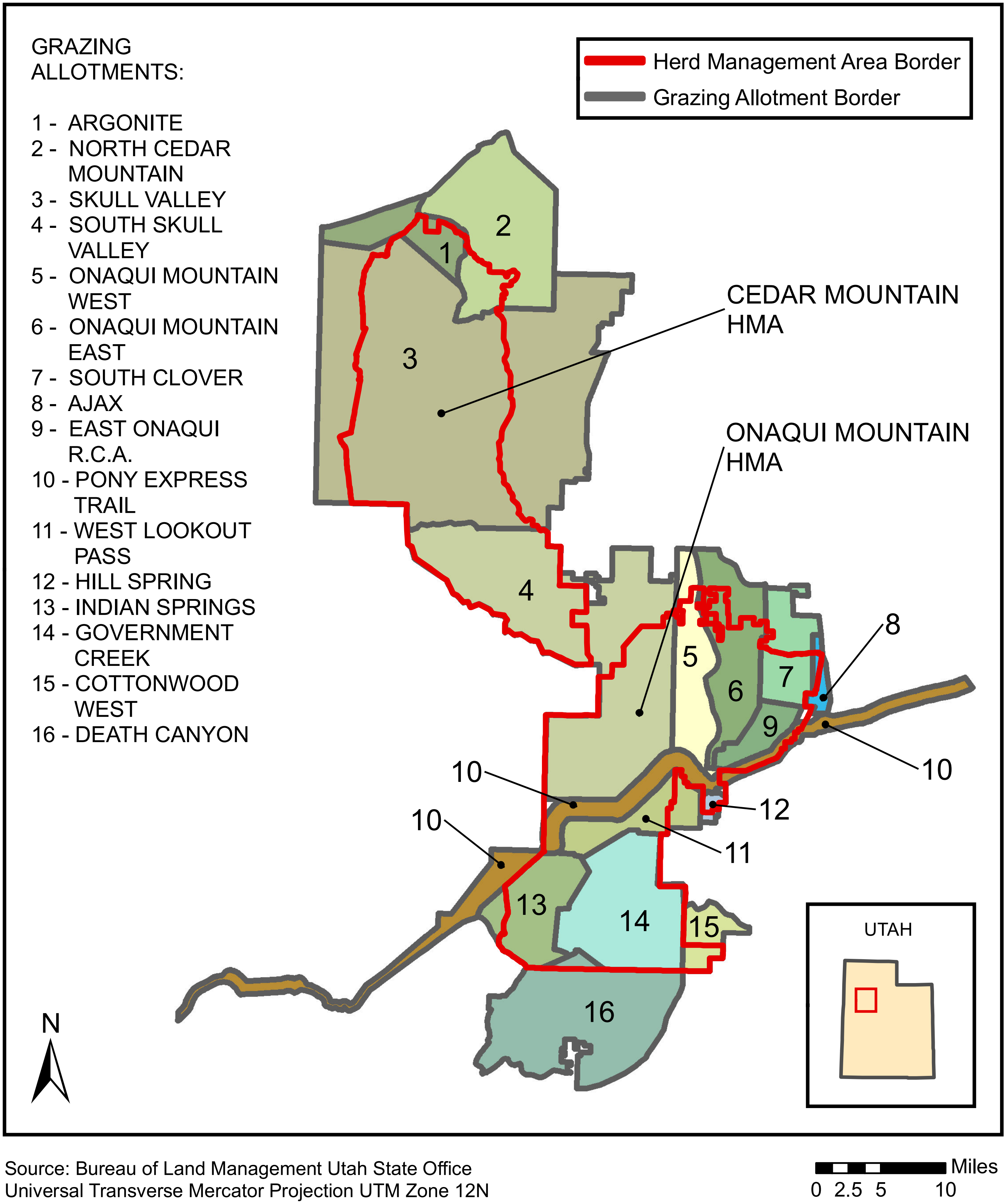
North Hills Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

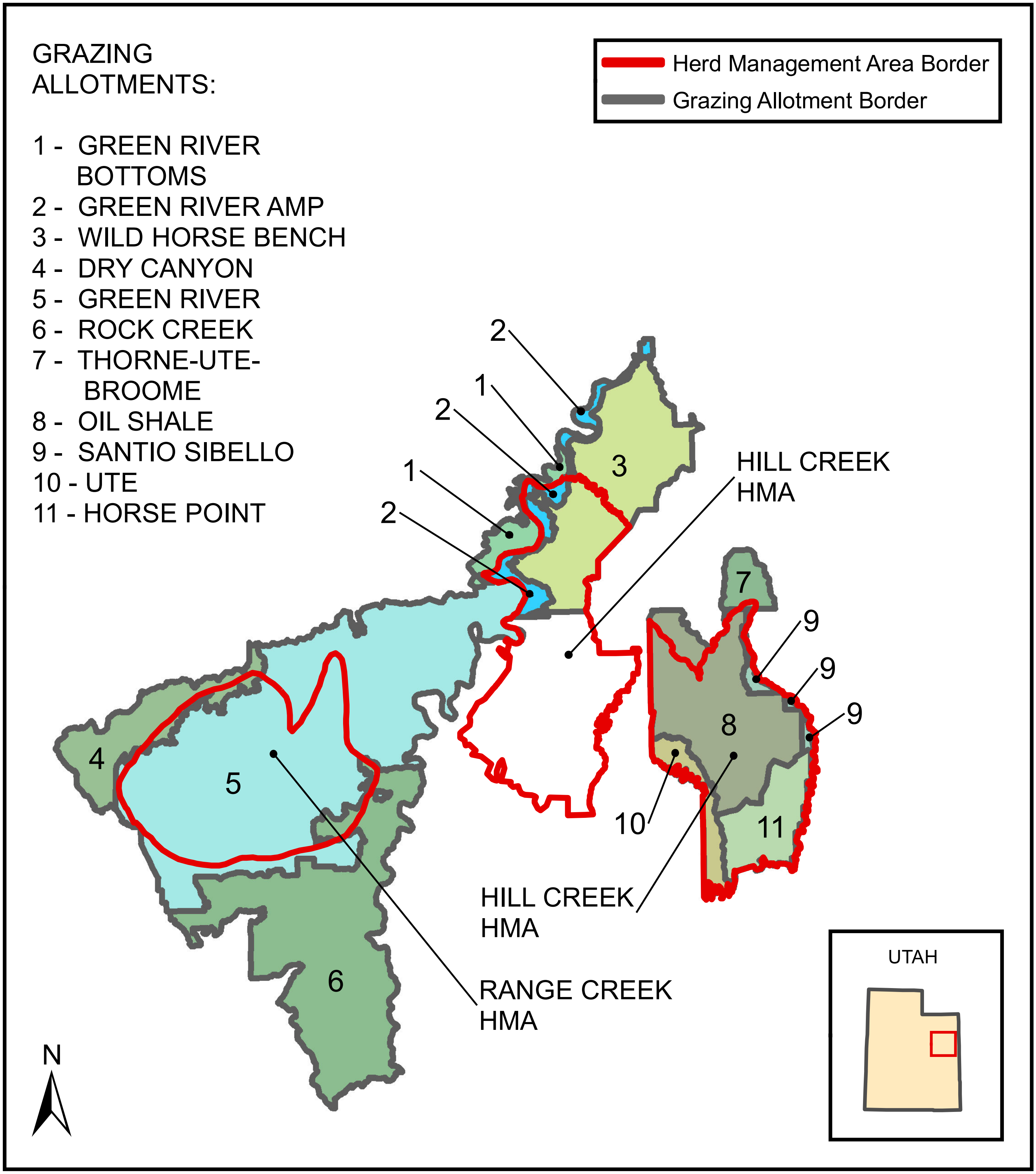
Miles 0 1.25 2.5 5

Onaqui Mountain and Cedar Mountain Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

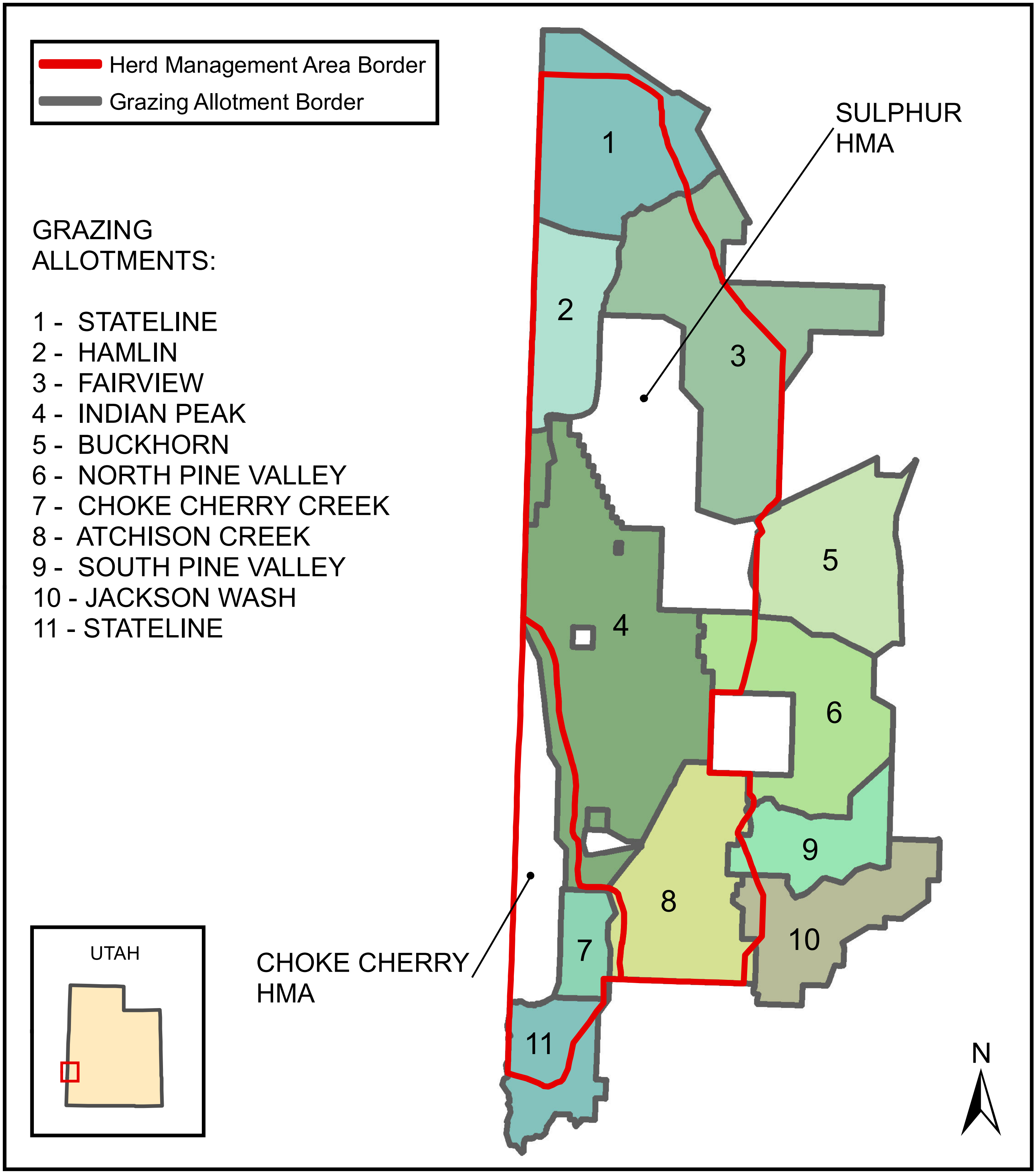
Range Creek and Hill Creek Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

Miles: 0 2.5 5 10

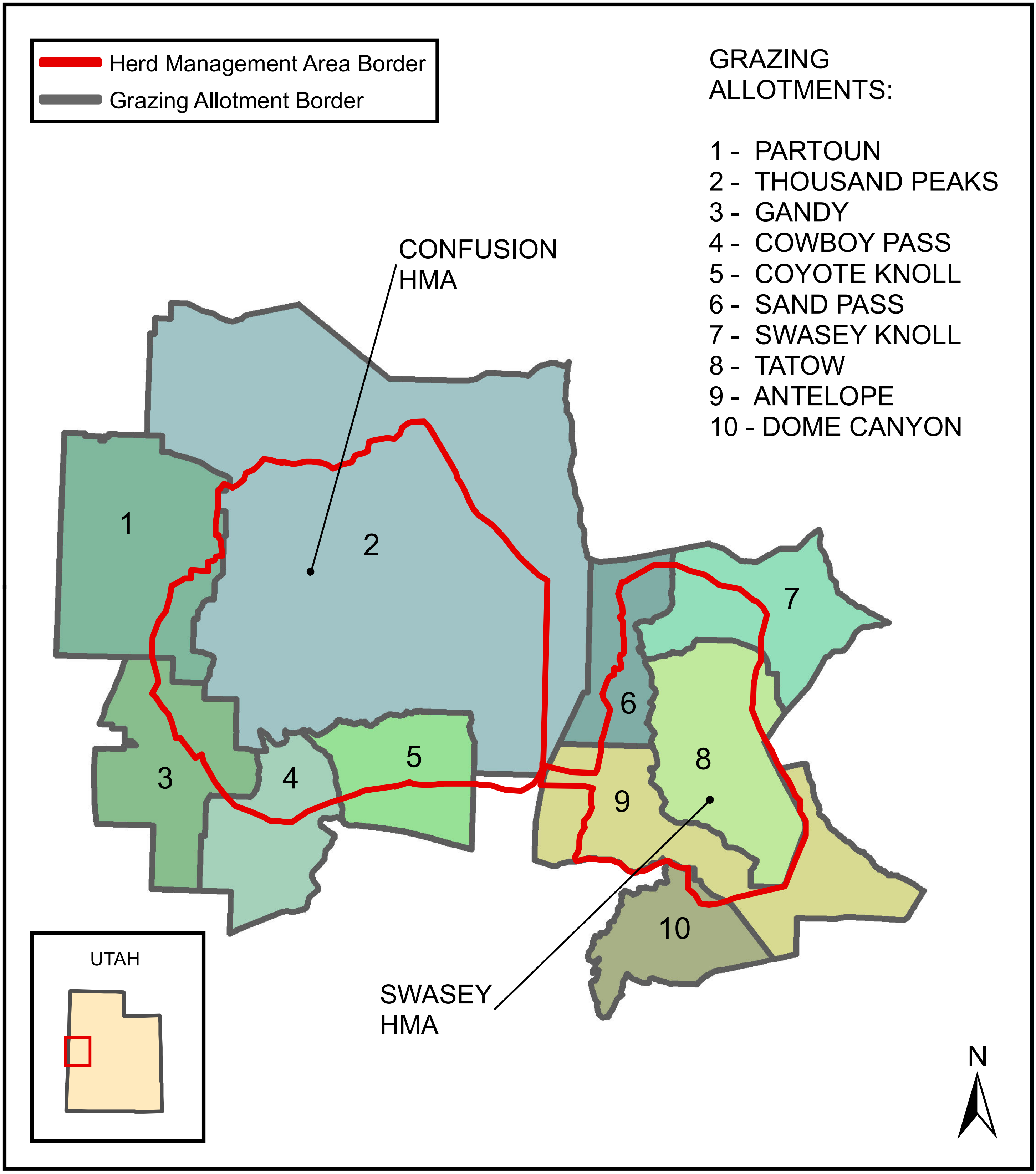
Choke Cherry and Sulphur Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

Miles
0 2.5 5 10

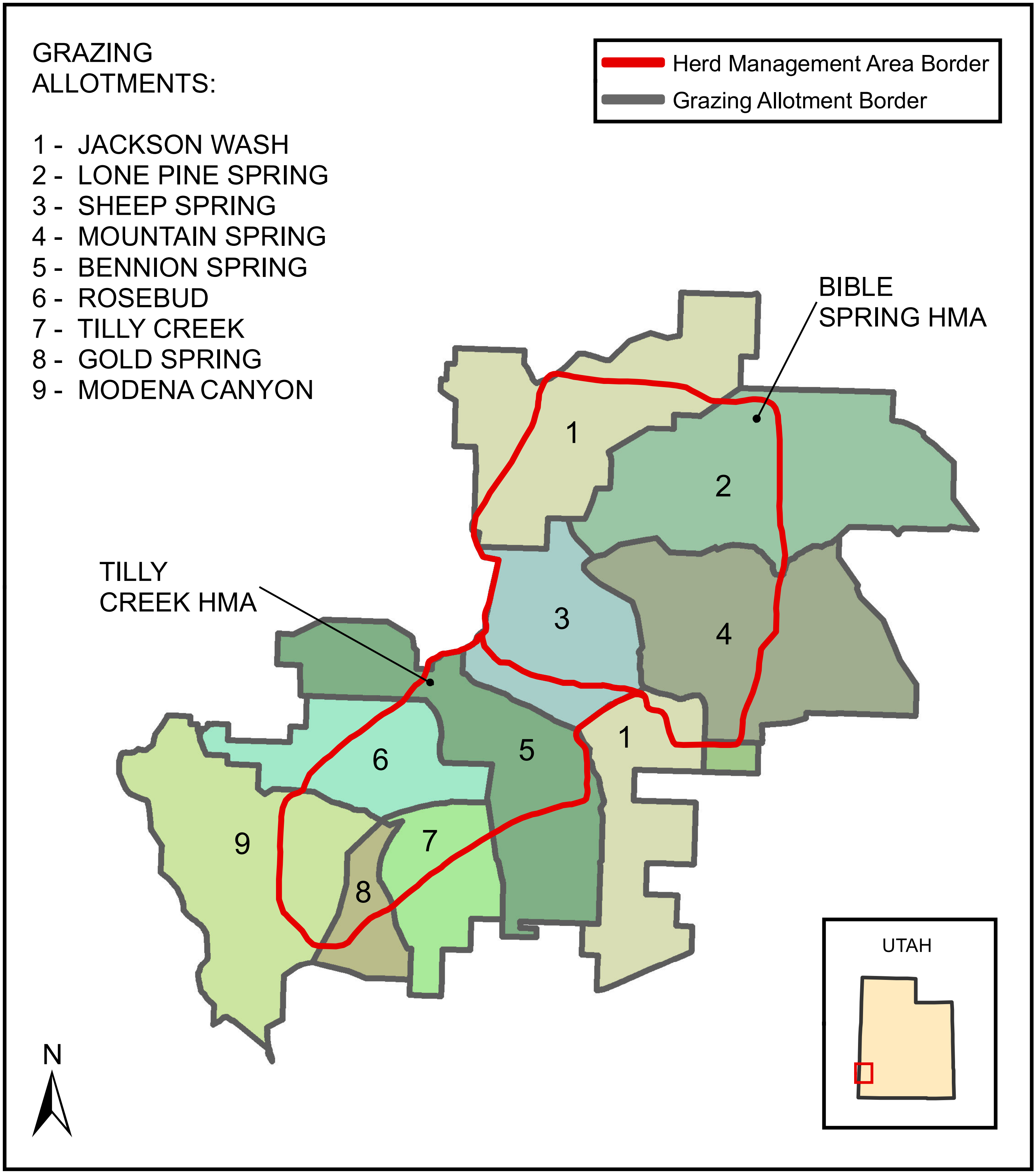
Swasey and Confusion Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

Miles 0 2.5 5 10

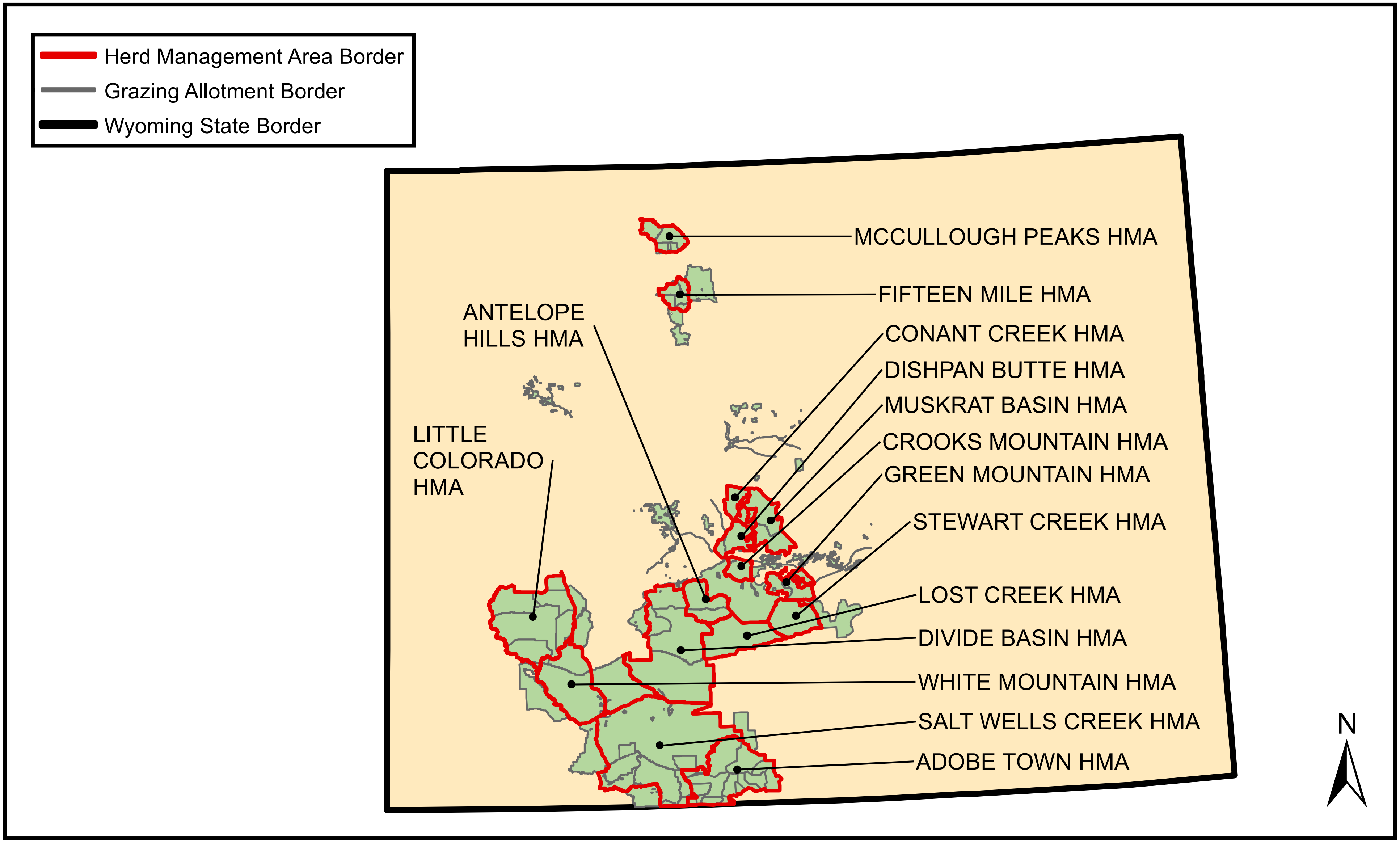
Tilly Creek and Bible Spring Herd Management Areas and Associated Grazing Allotments of Utah



Source: Bureau of Land Management Utah State Office
Universal Transverse Mercator Projection UTM Zone 12N

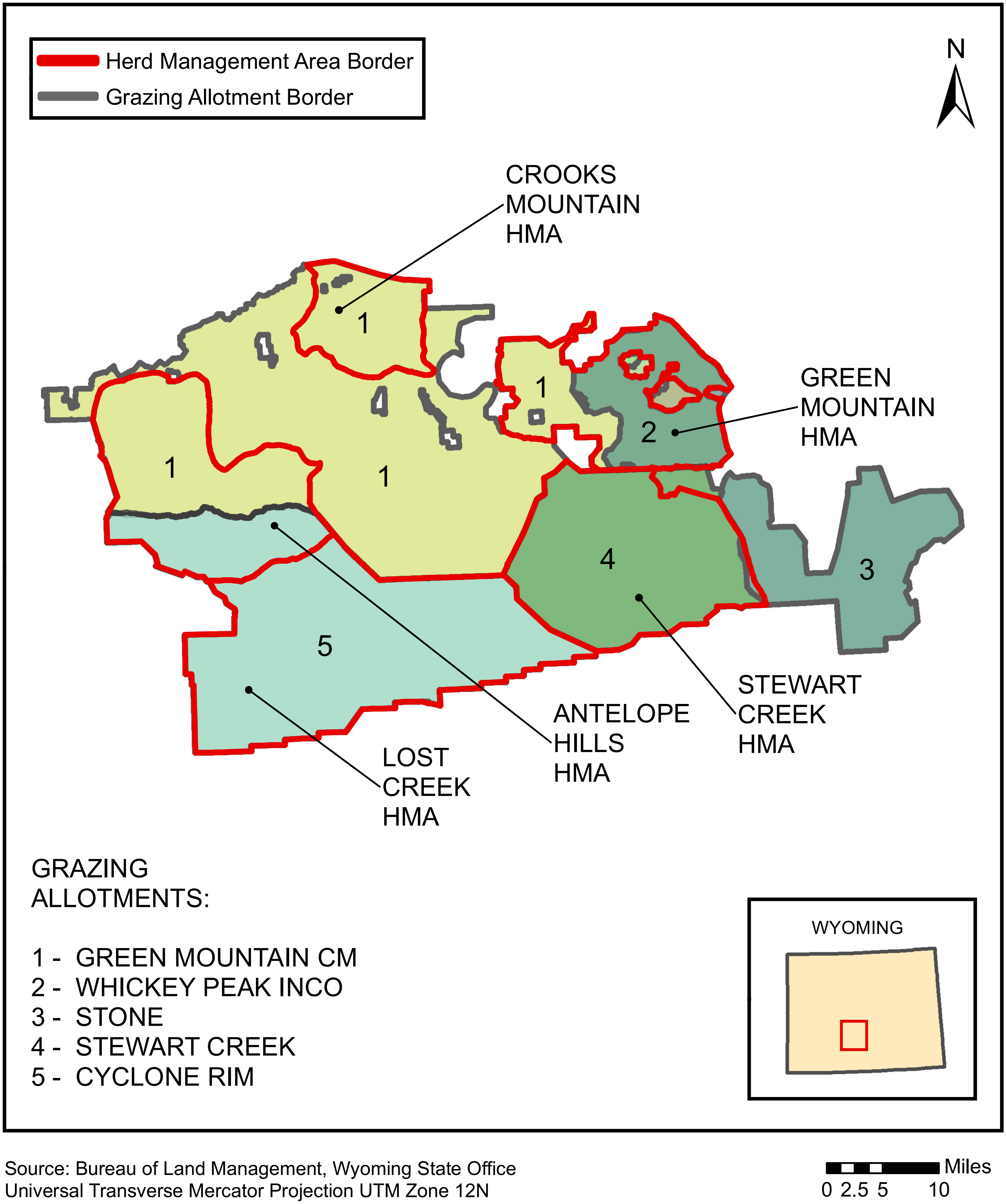
Miles 0 2.5 5 10

Herd Management Areas and Associated Grazing Allotments of Wyoming



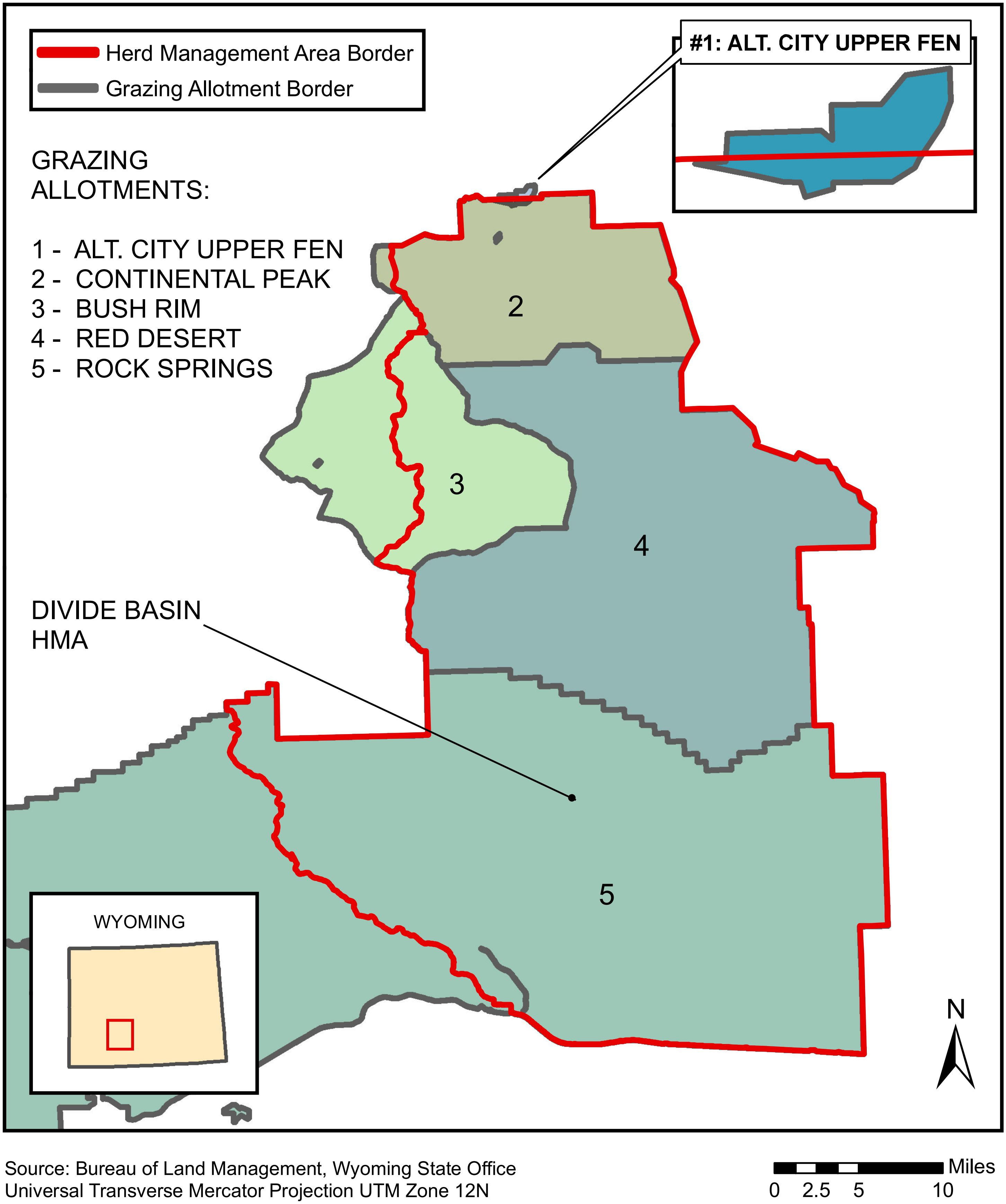
Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N

Antelope Hills, Lost Creek, Stewart Creek, Crooks Mountain and Green Mountain Herd Management Areas and Associated Grazing Allotments of Wyoming



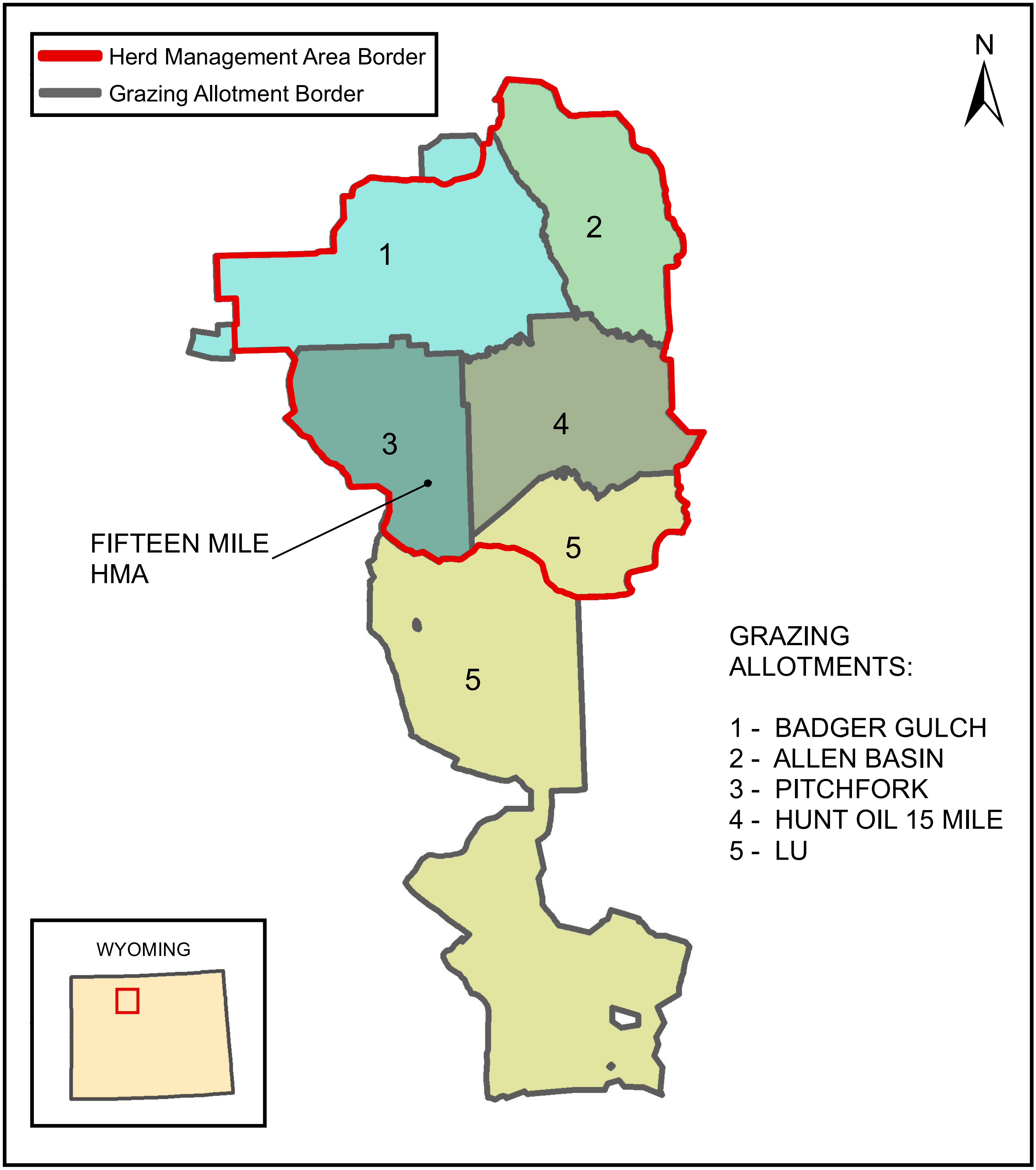
Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N

Divide Basin Herd Management Area and Associated Grazing Allotments of Wyoming



Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N

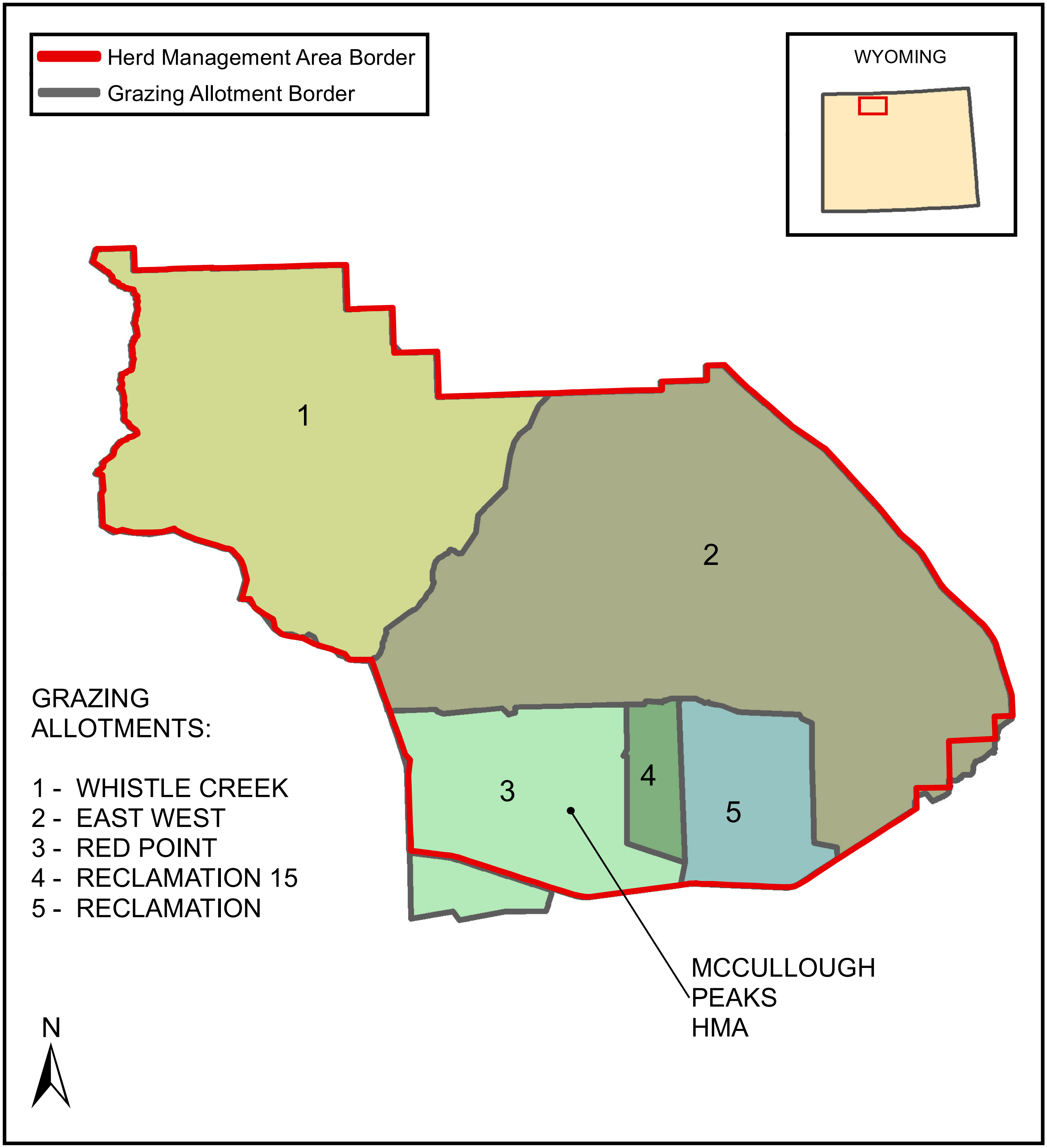
Fifteen Mile Herd Management Area
and Associated Grazing Allotments of Wyoming



Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N

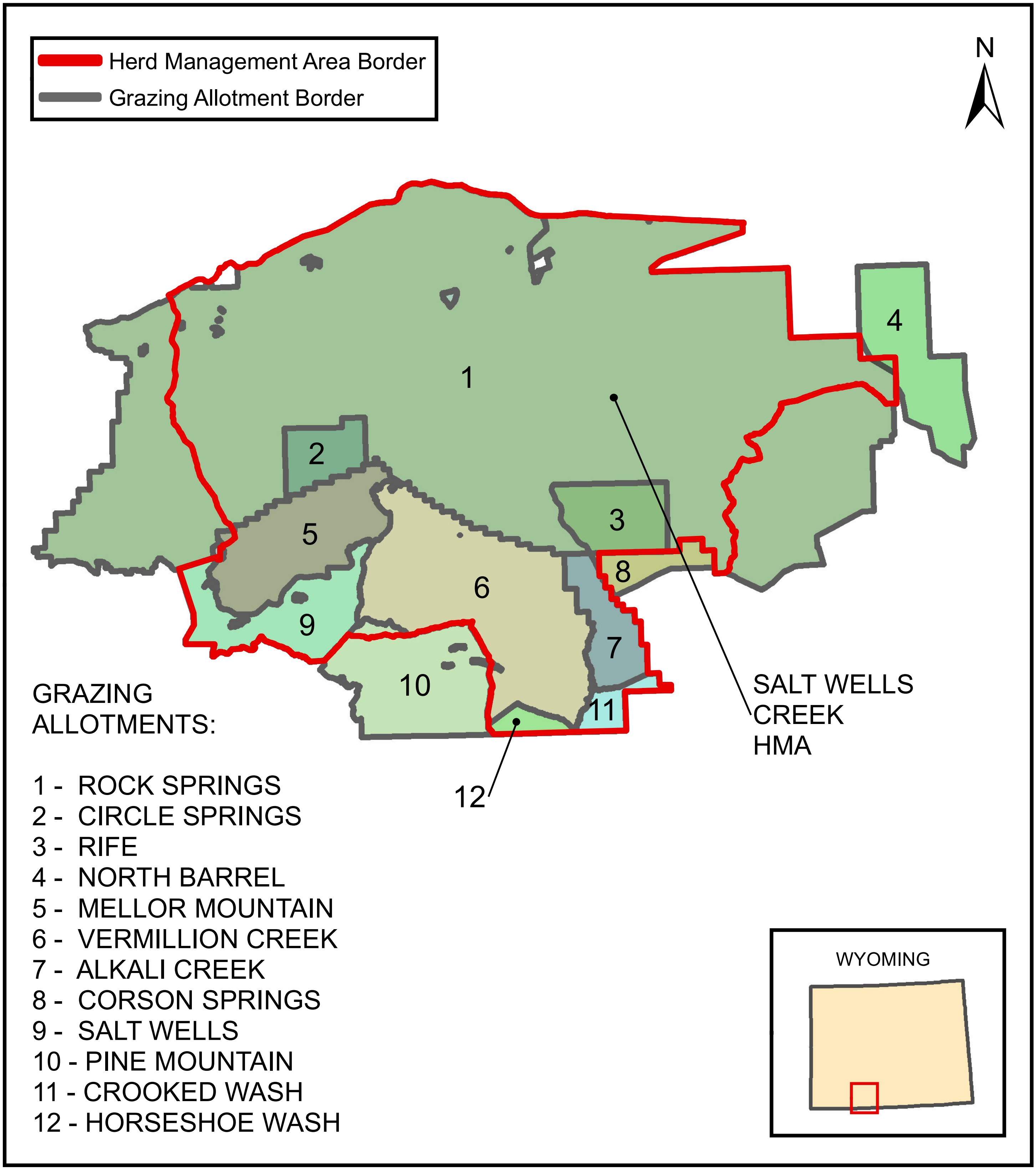
Miles
0 1 2 4

McCullough Peaks Herd Management Area and Associated Grazing Allotments of Wyoming



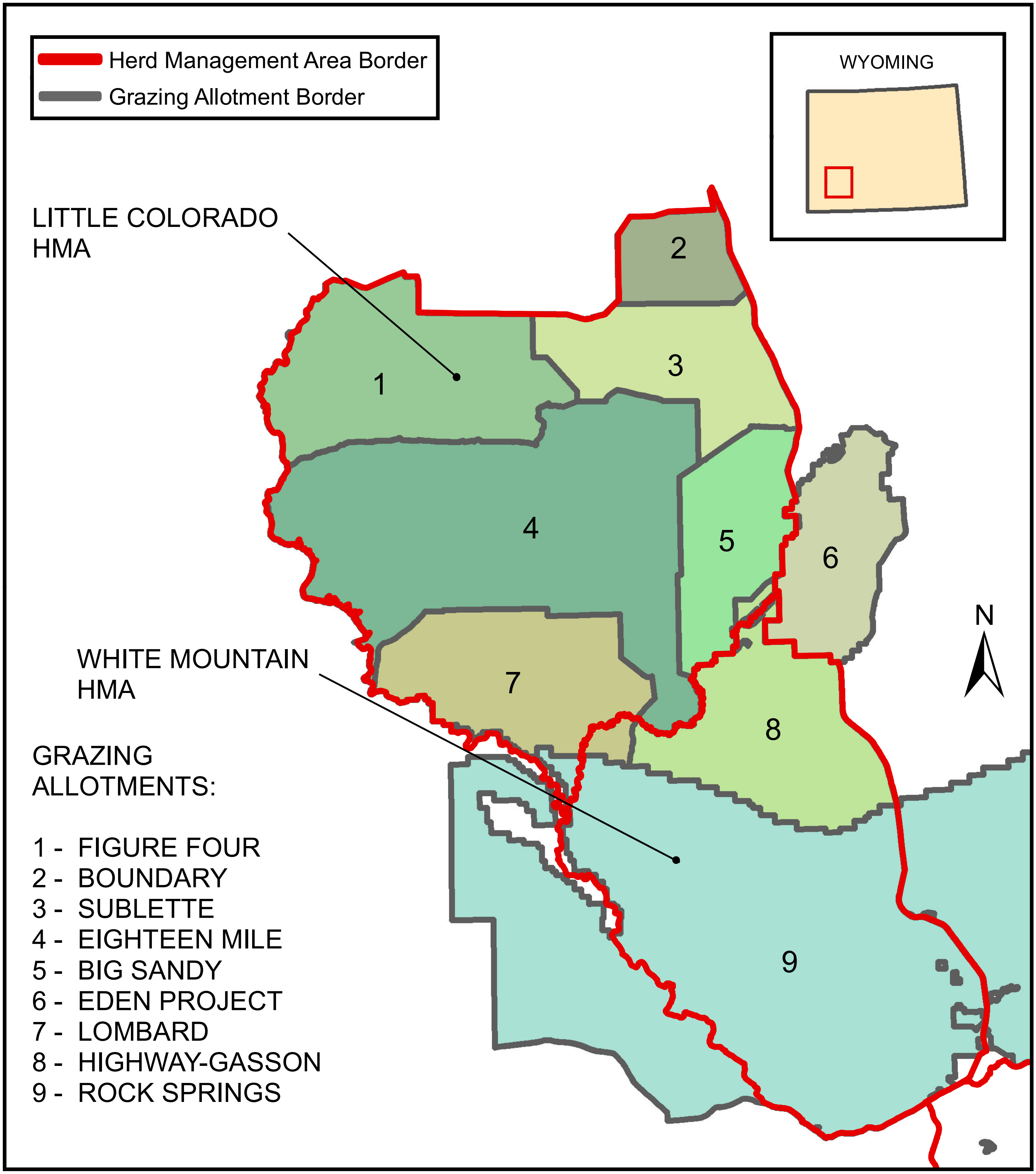
Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N

Salt Wells Creek Herd Management Area and Associated Grazing Allotments of Wyoming



Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N

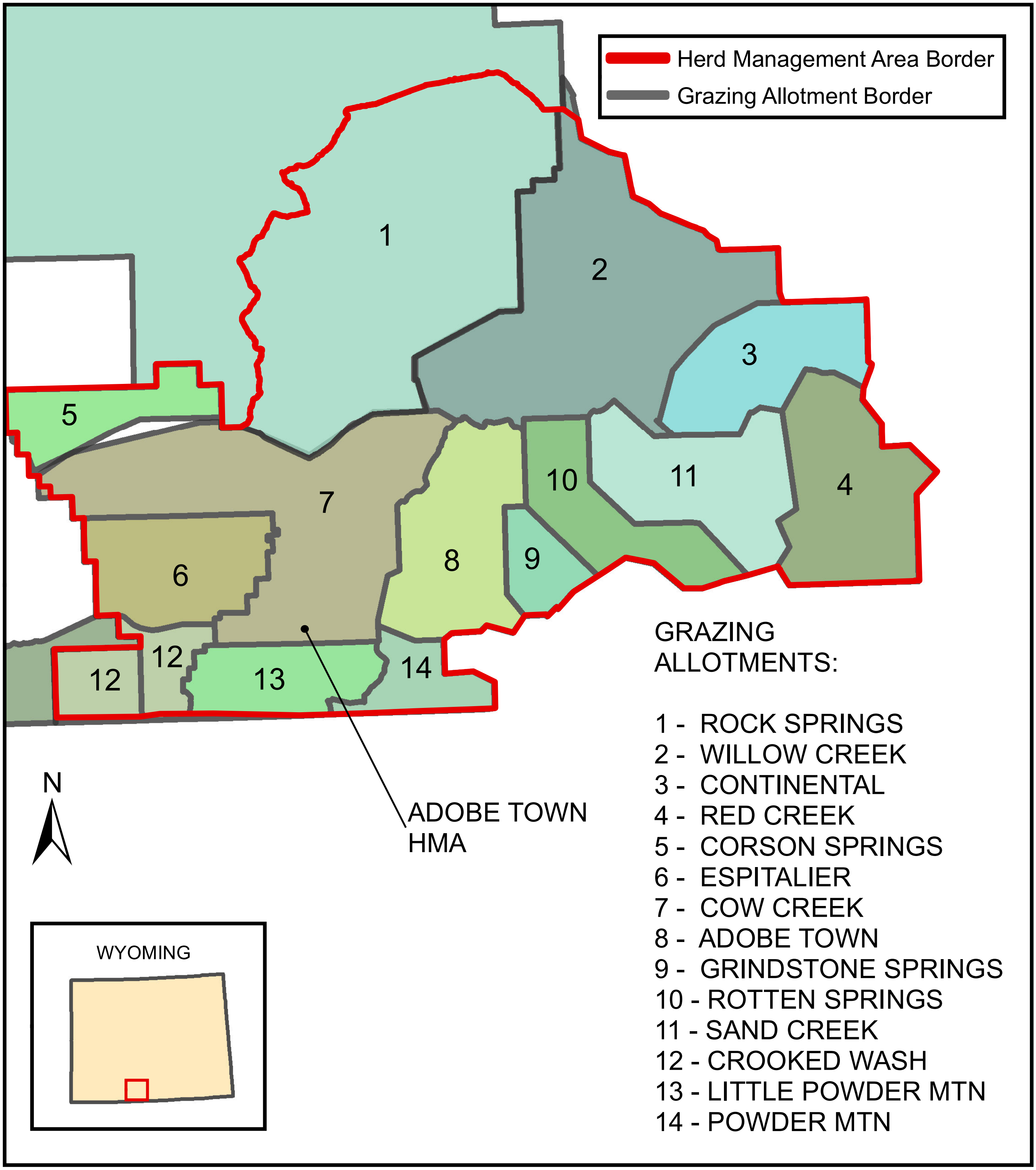
White Mountain and Little Colorado Herd Management Area and Associated Grazing Allotments of Wyoming



Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N

Miles
0 2.5 5 10

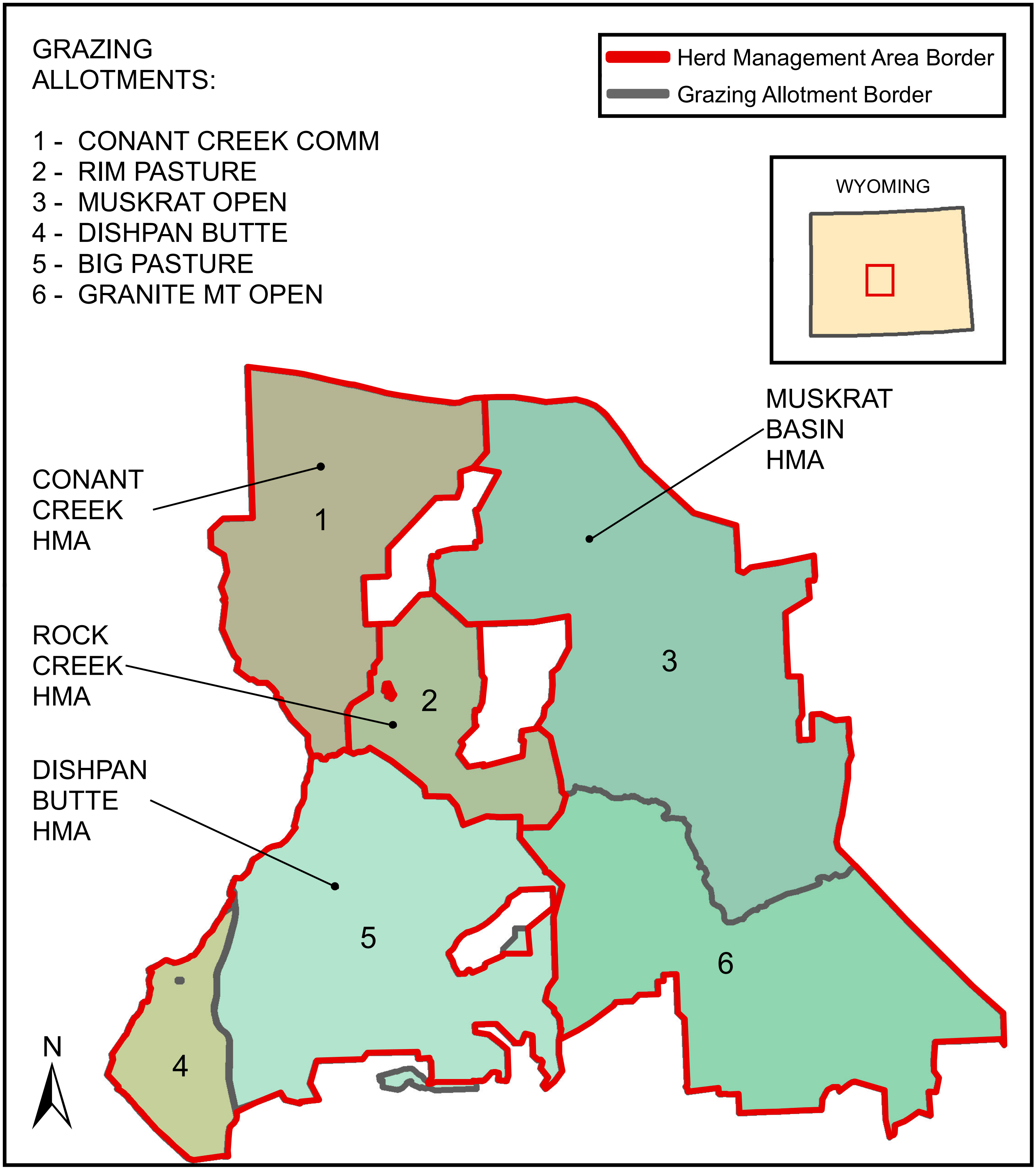
Adobe Town Herd Management Area and Associated Grazing Allotments of Wyoming



Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N

Miles
0 2.5 5 10

Conant Creek, Dishpan Butte, Muskrat Basin and Rock Creek Herd Management Areas and Associated Grazing Allotments of Wyoming



Source: Bureau of Land Management, Wyoming State Office
Universal Transverse Mercator Projection UTM Zone 12N