*Human–Wildlife Interactions* 12(1):46–57, Spring 2018

# *Synthesis*

# Wild horse demography: implications for sustainable management within economic constraints

**Robert A. Garrott**, Fish and Wildlife Ecology and Management Program, Ecology Department, Montana State University, 310 Lewis Hall, Bozeman, MT 59717-3460, USA *rgarrott@montana.edu*

***Abstract:*** Management of wild horse (*Equus ferus caballus*) populations on western U.S. rangelands has been a challenge since horses were given legal protection through the passage of the Wild Free-Roaming Horses and Burros Act (WFRHBA) in 1971. Horses have no effective predators, and unmanaged populations can double in 4–5 years and triple in 6–8 years. In order to meet the multiple-use paradigm for managing public rangelands, the Bureau of Land Management (BLM) has limited horse population growth through the periodic capture and removal of animals. While the WFRHBA mandates disposal of captured horses through placement into private ownership and prompt destruction of any excess animals, administrative restrictions have prohibited the destruction of healthy horses for nearly the entire history of the management program. This has led to an ever-increasing number of unwanted horses maintained in captivity, which has required increasing Congressional appropriations. There are currently 44,000 horses in long-term captivity at an annual cost of approximately $50 million. Recently, Congress has denied requests from the BLM for further funding increases to support continued growth in the number of horses in long-term maintenance, obligating the BLM to dramatically curtail population management. Horse numbers on public rangelands are now rapidly increasing, and if left minimally managed will exceed the capacity of rangeland resources, resulting in serious degradation of these public lands for all other uses and eventually will result in large numbers of horses dying of starvation and dehydration. Horse advocates suggest this management crisis can be solved with the aggressive use of contraceptive technologies. Limitations in efficacy and the logistics of administering contraceptives indicate that contraceptives can only slow population growth rates, but alone cannot decrease numbers. The BLM and other stakeholders are pressing for authorization to destroy excess horses but are facing public and Congressional opposition, with the potential that the status quo continues. A sustainable wild horse and burro (*E. asinus*; WHB) management program could be achieved by a combination of reducing the on-range population and treating adequate numbers of horses remaining on rangelands with contraceptives to reduce subsequent population growth rates. Under this scenario, the free-roaming horse population would produce a modest annual increment of horses, which could be removed and readily placed into private ownership. It has taken nearly half a century for the wild horse problem to reach this critical point, and any transition to a sustainable program will take time and additional resources. The fundamental challenge to developing a sustainable program will be solving the problem of the fate of excess horses. The policy decisions confronting us are historic, challenging, and controversial with a real danger of not finding the resolve to chart a new course for the WHB Program. If we fail and continue with the current policies, then horses, native wildlife, all stakeholders, and our public rangelands will pay a heavy price.

***Key words:*** contraceptives, *Equus ferus caballus*, lambda, population regulation, rangeland management, Wild Horse and Burro Program

**Horses** *(Equus ferus caballus)* native to the North American continent were part of the fauna of the Pleistocene epoch. They shared the landscape with such animals as giant sloths, the American lion (*Panthera leo atrox*), short-faced bears (*Arctodus* spp.), giant tortoises (*Hesperotestudo crassicutata*), saber-toothed cats, dire wolves (*Canis dirus*), stag-moose (*Cervalces scotti*), saiga (*Saiga tatarica*), camelids, and giant beaver (*Castoroides* spp.). A number of factors including hunting by an expanding human population and major changes in the climate 10,000–14,000 years ago changed the evolutionary trajectory of the fauna of North America, resulting in the extinction of horses and many other Pleistocene megafauna. Over the ensuing millennia, horses continued to evolve in Eurasia and approximately 5,500 years

ago were domesticated by humans and became intricately incorporated into many aspects of human society, spreading throughout Asia, Europe, and northern Africa (Olsen 2016).

When Europeans began colonizing North America approximately 500 years ago, they brought with them domestic horses that were not only essential to the colonizing Europeans, but also incorporated relatively quickly into the cultures and economies of many of the indigenous peoples of the temperate plains and western regions of the continent. During this period, horses escaped human control or were purposely released, forming wild populations. After the machines spawned by the Industrial Revolution replaced horses as a primary means of transportation and agricultural production, wild horse populations of the western United States were primarily controlled by commercial "mustangers" that captured free-roaming horses and sold them for slaughter.

Until the 1970s, these animals had no legal status, and wild horses could be captured, killed, and utilized for any purpose. In the late 1950s, public concerns over the humaneness of some of the practices of the mustangers led to the passage of a series of increasingly restrictive laws and eventually led to Congress passing the Wild Free-Roaming Horses and Burros Act (WFRHBA) in 1971 (Public Law 92-195). This legislation establishes public ownership over wild horses occupying certain western public rangelands where free-roaming horses existed at the time the legislation was passed, prohibits exploitation or destruction of these horses by private citizens, and declares wild horses occupying these rangelands are to be managed by federal natural resource agencies (primarily the Bureau of Land Management [BLM] and the U.S. Forest Service [USFS]) as "an integral part of the natural ecosystem."

Soon after horses were given legal protection, management of wild horse populations became embroiled in controversy due to a host of factors, including uncertainties in their natural history and biology and disagreement among natural resource professionals and various advocacy groups who challenged the need for population control and the methods employed by managers. When public discord on an issue reaches a level of national prominence, Congress and federal agencies often solicit the aid of the National Research Council (NRC), which is an independent scientific organization chartered to conduct rigorous and objective studies to inform the public and Congress, advance knowledge, and contribute to the development of sound public policy.

**Table 1.** Projections of the current estimated wild horse (*Equus ferus caballus*) populations occupying Bureau of Land Management (BLM) Herd Management Areas into the future under assumptions of no active management and 15% and 20% annual population growth rates that the recent National Research Council (NRC) Committee to Review the BLM Wild Horse and Burro Program concluded are typical of herds on western rangelands (NRC 2013).

| Year | 20% growth x1.20 | | 15% growth x1.15 | |
|---|---|---|---|---|
| 2017 | 60,000 | | 60,000 | |
| 2018 | 72,000 | | 69,000 | |
| 2019 | 86,400 | | 79,350 | |
| 2020 | 103,680 | | 91,253 | |
| 2021 | 124,416 | double | 104,940 | |
| 2022 | 149,299 | | 120,681 | double |
| 2023 | 179,159 | triple | 138,784 | |
| 2024 | 214,991 | | 159,601 | |
| 2025 | 257,989 | | 183,541 | triple |
| 2026 | 309,587 | | 211,073 | |

Despite 4 NRC reports (NRC 1980, 1982, 1991, 2013) and decades of public and professional dialogue and debate, the establishment of a coherent and sustainable policy for the management of wild horse populations on western rangelands has remained elusive. As a consequence, wild horse numbers are at a record high with an estimated 113,000 animals on public rangelands in 10 western states and in holding facilities, and an additional 93,000 free-roaming horses estimated to reside on tribal lands (Government Accountability Office [GAO] 2017). Recent budgetary constraints for managing wild horses on federal lands has led to a dramatic curtailment of active population management, threatening significant and widespread deleterious impacts to public rangelands, wildlife, local communities, and the horses themselves. My paper describes the history and current status of the wild horse

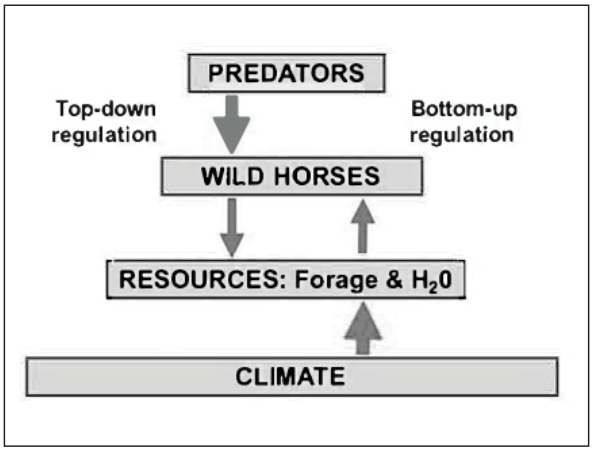


**Figure 1.** A simplistic diagram of the trophic pyramid of an ecosystem illustrating 2 processes that can naturally regulate wild horse (*Equus ferus caballus*) populations. Top-down regulation occurs when predators kill horses in substantial numbers, and bottom-up regulation occurs when there is inadequate forage and/or water ($H_2O$) to support the number of animals present on a rangeland and animals die of starvation and dehydration.

management issue, predicts consequences if management does not change, and provides suggestions for the development of a sustainable management policy.

## Wild horse population growth rates

A fundamental ecological question addressed by several of the NRC committees evaluating various aspects of wild horse ecology and management has been the demographics of free-ranging horse herds—specifically population growth rates. At the time of the passage of the WFRHBA, natural resource managers and wildlife biologists knew very little about the population ecology of wild horses. Early census data collected by the BLM and USFS suggested annual population growth rates of 15–20%. The first NRC (1980) committee questioned the validity of the agencies' counts based on their review of a number of model-based studies that incorporated a range of probable vital rates (survival and fecundity) that indicated wild horse growth rates were unlikely to exceed 10%. The committee could not resolve the conflicting evidence and concluded adequate data were not available to determine population growth rates on western rangelands and recommended additional research (NRC 1980). The second NRC (1980) report reiterated the uncertainty in the scientific evidence regarding typical annual population growth rates of horse herds occupying western rangelands.

Since these initial NRC reports were produced, a considerable number of studies of wild horse demography have been completed. The most recent NRC committee (NRC 2013) exhaustively reviewed all pertinent published research and performed a novel analysis using an extensive dataset of horses removed from public rangelands. Ecologists have used 3 approaches to explore population growth rates of wild horses: (1) counts of animals in individual populations to estimate herd-specific trends in abundance over time; (2) population models that incorporate estimates of survival and fecundity rates reported from field studies; and (3) program-level data on the age structure of horses removed from public rangelands. While the herd-specific data demonstrated population growth rates varied from 1 herd to the next, and within herds from year to year, the collective insights from all sources of data were relatively consistent and strongly corroborated the initial growth rates reported by the BLM, indicating typical annual growth rates of 15–20% (NRC 2013).

The management implications of these growth rates can be illustrated with a simple mathematical example (Table 1). In 2017, the BLM estimated there were 60,000 free-roaming horses on federal lands in the West (BLM 2017). If the average annual population growth rate is 20%, then multiplying each consecutive year's population by 1.2 provides a prediction of the subsequent year's population. This illustrates that, if unmanaged, horse numbers will double in 4 years and triple in 6 years. Assuming a more modest growth rate of 15% annually, horse numbers would double in 5 years and triple in 8 years. There are little demographic data available for horse herds occupying tribal lands, where numbers are estimated to be 150% greater than on federally-managed rangeland.

## Natural regulation of wild horse populations

No population can increase indefinitely. Wild horses exist within an ecosystem. In any ecosystem, there are ecological processes that can naturally regulate populations. These regulatory mechanisms can be broadly categorized as top-down and bottom-up processes. Figure 1 is a simplistic illustration of an ecosystem with predators at the top of the trophic pyramid,

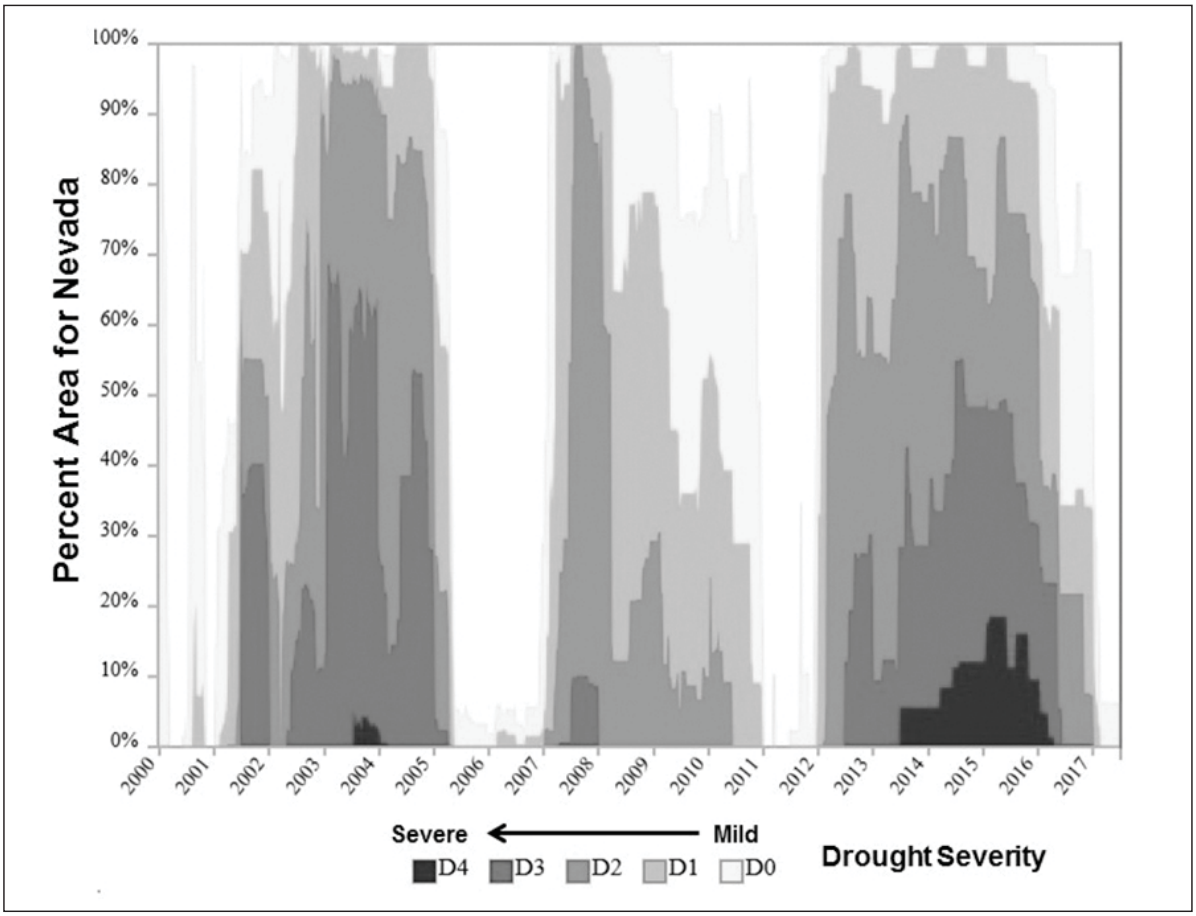


**Figure 2.** The frequency and intensity of drought in Nevada from 2000 to 2017 (Source: National Integrated Drought Information System, www.drought.gov, accessed September 26, 2017).

horses in the middle of the pyramid, then plant and water resources required to support horses, and at the bottom of the pyramid, climate, which has a fundamental impact on all ecosystem processes. Top-down regulation of horses can occur when predators, at the top of the trophic pyramid, kill wild horses in numbers sufficient to remove a substantial proportion of the population each year.

Bears (*Ursus americanus, U. arctos*), wolves (*Canis lupus*), and mountain lions (*Felis concolor*) are all capable of killing animals as large as wild horses. However, only mountain lions commonly occur on western rangelands occupied by wild horses. Field studies indicate that mountain lions are generally only effective predators on young horses, and only a few studies of small, isolated horse herds have documented mountain lion predation of sufficient magnitude to have a noticeable impact on population growth (Greger and Romney 1999, Turner and Morrison 2001, Roelle et al. 2010). Thus, the scientific evidence indicates that top-down population regulation by predators is rare and not a significant influence on wild horse populations on western rangelands.

Bottom-up population regulation is driven by a limitation of resources required by wild horses to survive and reproduce (i.e., forage and water). A large body of scientific work on large mammal population dynamics has documented that when animal densities are low, the per capita resources to support the animals are high, and populations grow at or near their biological maximum. However, as populations continue to grow and densities increase, there is a concurrent decrease in per capita resource availability. As resources become more limited, a relatively predictable sequence of changes in demographic attributes gradually reduces population growth rates and, hence, can naturally regulate large mammal populations (Eberhardt 1977, Gaillard et al. 1998).

While these density-dependent regulatory processes certainly apply to wild horses, the vast majority of wild horse populations in the western

**Figure 3.** Approximately 70 wild horses (*Equus ferus caballus*) at Palomino Buttes Horse Management Area, near Burns, Oregon, were without water for several days. The Bureau of Land Management (BLM) tried hauling water but determined an emergency gather was necessary. The reality in the arid systems routinely occupied by wild horses on western U.S. rangelands is that resource limitation due to climate variation is unpredictable and often severe. Under these conditions, horses experience a slow death due to dehydration and/or starvation, with large numbers dying periodically during droughts and associated severe range deterioration (*photo courtesy of the BLM*).

United States occupy arid rangelands where climate is highly variable and unpredictable from year to year. The recent record of drought severity in Nevada, where nearly 60% of the wild horses managed by the BLM reside, illustrates this dramatic annual variation in precipitation and temperatures, which, in turn, results in large annual variation in forage production and water availability to support wild horse populations (Figure 2). During the past 17 years, Nevada experienced years where the entire state received precipitation that supported adequate forage production and water availability for horses. These periods were followed by periods, spanning multiple years, of widespread moderate-to-severe drought.

The reality in the arid systems routinely occupied by wild horses on western rangelands is that resource limitation due to climate variation is unpredictable and often severe. Under these conditions, horses experience a slow death due to dehydration and/or starvation, with large numbers dying periodically during droughts and associated severe range deterioration (Figure 3). These conditions have occurred many times in the recent past on western rangelands and are unacceptable to both land managers and the public, which precipitates management interventions, such as emergency gathers to remove animals, and providing forage and water to horses remaining on range (NRC 2013). Thus, while bottom-up regulation due to resource limitation can potentially limit wild horse populations, we do not let it operate at the scale required for natural regulation to be effective. Therefore, in the absence of effective top-down or bottom-up natural processes for regulation, wild horse populations must be actively managed.

## Four decades of wild horse population management

Active population management was initiated soon after the passage of the WFRHBA but began in earnest after the 1978 passage of the Public Rangelands Improvement Act (Public Law 95-514). The 1978 Act amended the WFRHBA and reinforced the responsibility of the BLM to actively manage wild horse populations to maintain a "thriving natural ecological balance" within the multiple-use paradigm. As a consequence, the BLM developed and refined an administrative procedure to establish population objectives, known as Appropriate Management Levels (AML), for each Herd Management Area (HMA; NRC 2013). While the process of determining AMLs was not without flaws (NRC 2013), the population goals were established to protect the health of the horses and other native wildlife, prevent range deterioration, and balance all other authorized uses of these public lands. By 1984, AMLs had been established for all HMAs, with the maximum range-wide population goal fluctuating between approximately 20,600 and 29,000 horses. The current maximum AML is 23,622 horses (Figure 3).

The only management tool broadly used to control wild horse populations has been the capture and removal of horses from the range. After the passage of the Public Rangelands Improvement Act, Congress substantially increased BLM's Wild Horse and Burro (WHB) Program budget to facilitate more aggressive capture and removal of horses from management areas where they exceeded population objectives. Program budgets have been increased repeatedly over the ensuing years, primarily to support the continued removal of horses from western rangelands.

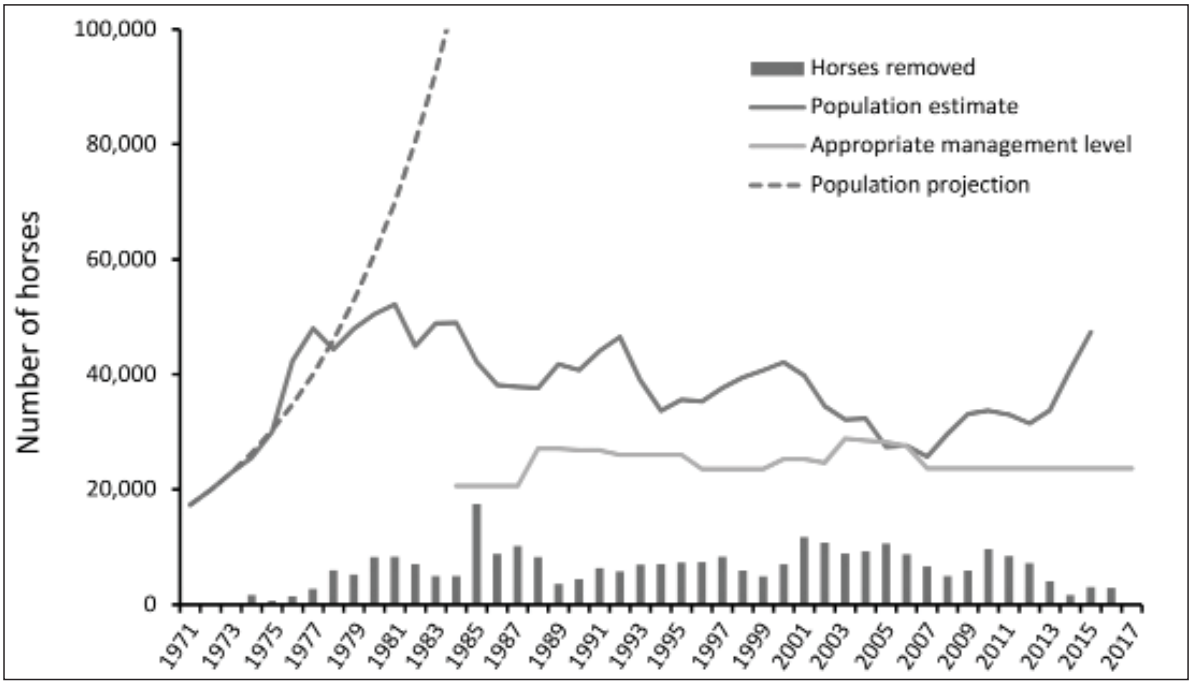


**Figure 4.** Numbers of wild horses (*Equus ferus caballus*) estimated to be living on Bureau of Land Management (BLM) administered lands in the western United States compared to the Appropriate Management Level (AML) determined by the BLM. Annual removals of wild horses as well as a projection of the range-wide horse population assuming a 15% annual growth rate in the absence of removals are also depicted.

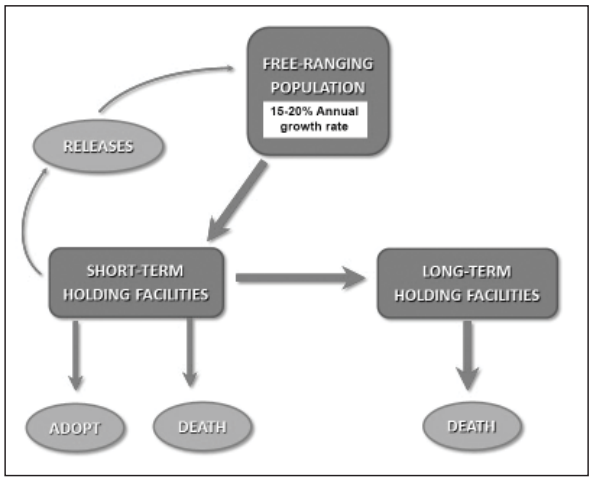


**Figure 5.** A generalized diagram of the Bureau of Land Management's (BLM) wild horse (*Equus ferus caballus*) management program.

The successful development of administrative and field expertise, as well as horse handling and holding facilities required to remove and process thousands of horses annually, has been instrumental in curbing the growth of wild horse populations. In the absence of the BLM's horse removal program, the western rangeland population would have exceeded 100,000 animals by 1984. This projection is based on a 15% annual growth rate for the estimated 17,300 horses occupying western rangelands managed by the BLM at the time of passage of the WFRHBA (Figure 3). The success of the existing horse management program, however, has been limited. Due to high population growth, as well as Congressional and policy constraints on active management options, the horse management program has been unable to reduce and maintain the on-range population to the management objective.

More than 200,000 horses have been removed from western rangelands over the past 4 decades, and the fate of these captive horses has been a core problem with the WHB Program since the start of active population management. Historically, 5,000–11,000 horses were removed annually to limit wild horse populations (Figure 4). Horses removed from rangelands are transported to short-term holding facilities where they may be held for several months to years. Some of these animals are readily placed into private ownership through the successful Adopt-A-Horse Program (Figure 5). Approximately $2,500 is invested in each animal that is adopted, but the public demand for these horses is limited to 2,000–3,000 animals per year, with the BLM spending approximately $6.8 million annually to support the program. In addition to adoptions, some

**Figure 6.** There are approximately 44,000 wild horses (*Equus ferus caballus*) being maintained in captivity. Over $49 million of the FY16 total annual appropriation of $80 million allocated for the Wild Horse and Burro Program is expended on the long-term holding facilities (*photo courtesy E. Thacker*).

deaths occur in the short-term holding facilities, and small numbers of horses are released back onto the range. While Congress mandated that "the Secretary shall cause additional excess wild free-roaming horses and burros for which an adoption demand by qualified individuals does not exist to be destroyed in the most humane and cost efficient manner possible," the destruction of excess healthy un-adopted horses has been prohibited for nearly the entire history of the BLM's WHB Program by Bureau directives or Congressional budget riders on appropriations bills for the Department of the Interior (NRC 2013). As a consequence, all un-adopted animals are eventually transferred to long-term holding facilities (Figure 4), where they are maintained like domestic animals in pastures until they physiologically deteriorate due to old age and are euthanized or die. It costs approximately $1,100 to maintain a horse in these facilities for 1 year. The average age of horses transferred from short-term to long-term holding facilities is 7 years, and the average age of animals that die in these facilities is 22 years. Thus, horses transferred to long-term holding facilities live 15 years on average, costing the WHB Program $16,500 per animal (Garrott and Oli 2013). Currently, there are approximately 44,000 horses being maintained in captivity, and it is the high cost of warehousing tens of thousands of these unwanted horses that consumes the majority of the funds appropriated by Congress. Over $49 million of the FY16 total annual appropriation of $80 million allocated for the WHB Program is expended on the long-term holding facilities (Figure 6).

Garrott and Oli (2013) used WHB Program data that the BLM provided to the recent NRC committee (NRC 2013) to develop projections of the number of unwanted horses currently needed to be placed into long-term captivity, along with the associated costs. They concluded the costs of maintaining captive wild horses would exceed $1 billion by 2030 if the management of excess horses remained unchanged. While this empirical study helped document and publicize this fundamental problem, many people associated with the WHB Program understood the program was unsustainable and rapidly approaching a critical juncture. Indeed, this was likely a major impetus for commissioning the 2013 NRC study. That critical juncture came soon after the

publication of the NRC report when Congress did not increase the WHB Program budget to support the continued growth in the number of horses in long-term captivity. As a result, the BLM had no choice but to curtail population management and reduce annual removals to the 2,000–3,000 horses that could be placed into private ownership via the Adopt-A-Horse Program.

The implication of this reduction in annual removals is readily evident by revisiting the simple population projections presented earlier in this paper. Because management actions currently in place are unlikely to substantially reduce horse population growth, we can expect substantial and relatively rapid increases in numbers that many natural resource professionals consider a worst-case scenario. If current management and program budgets remain unchanged, we can expect large numbers of free-ranging horses to become severely resource limited and die due to starvation and dehydration. Plant communities and water sources will become severely degraded, and managers will need to curtail or eliminate livestock grazing on public lands occupied by wild horse herds. Native wildlife will also be severely impacted by competition with horses and deterioration of rangeland health. As a result, the BLM will be unable to fulfill numerous Congressional mandates for effective and responsible management of public resources.

## Contraceptive technologies are not a panacea

There is a 40-year history of research to develop contraceptives that could be applied to wild horse population management, with the recent NRC committee report describing a variety of tested technologies that vary in how each affects the reproductive process, duration of efficacy, and potential strengths and limitations (NRC 2013). The development of contraceptive technologies and regulatory approval by the Environmental Protection Agency of multiple contraceptive vaccines for use in the management of wild horses has led some stakeholders to advocate for the exclusive use of contraceptives to address horse overabundance and routine population management. These groups argue the aggressive use of contraceptives could eliminate the need for periodic gathers and removals of horses from rangelands and, hence, solve the ethical and budgetary problems of a growing number of unwanted horses housed in off-range facilities. The science, however, does not support this assertion.

Some of the earliest studies exploring the application of contraceptives for population management (Garrott 1991, Hone 1992) concluded that in wild animals with high survival rates, such as horses, fertility control can reduce population growth rates, but is unlikely to affect a decline in a population that is already overabundant. These conclusions have been reiterated and reinforced by many other studies (Garrott 1992, Garrott 1995, Gross 2000, Hobbs et al. 2000, Bartholow 2007, Ransom et al. 2014). These scientists identified various practical considerations of applying contraceptives to free-ranging animals and the demographic processes that limit their impacts on population growth. Authors have evaluated the number of animals that must be treated, the difficulty of detecting and treating animals in field settings, and the efficacy of contraceptives. Additional considerations included potential compensatory increases in the survival of treated animals that do not incur the high energetic costs of pregnancy and lactation, as well as the potential for an overall general increase in the survival of animals in a treated population if animal densities are reduced and there is an increase in available per capita resources. Thus, effective population reductions cannot be attained with the sole use of the currently available contraceptive technologies.

The general consensus of scientific studies indicated that the effective integration of contraceptive technologies for the management of wild horse populations will require initial reductions in abundance through gather and removal programs. Once a population has been reduced below the maximum AML, a proportion of the remaining animals can be treated to reduce fecundity. This approach would slow the population growth rate and extend the time needed for the population to reach the AML and require another gather and removal event. While contraceptive vaccines may be effectively delivered to adequate numbers of animals in small and accessible horse populations by ground-based darting,

efficacy of remotely delivered vaccines is lower than manual delivery via syringe (NRC 2013).

Most horse populations on western rangelands number in the hundreds of animals and occupy remote landscapes, making ground-based vaccine delivery impractical. Darting from aircraft is also not a practical option, as it is difficult to keep track of which animals have been treated and the activity is inherently dangerous to those participating in the aerial operations. Thus, in most situations, the treatment of horses with contraceptive agents will still require routine gathering of horses and, for short-duration contraceptives, likely require an increase in the frequency of gathers compared to a simple gather and removal program. Thus, contraception, when used in conjunction with animal gather and removal programs, can contribute to effective population management by reducing the frequency and number of horses that need to be removed from rangelands to maintain populations near management objectives. Debates about the relative merits of each contraceptive technology, however, have inhibited any serious attempts at broad-scale management-level applications.

Throughout the history of contraceptive development for wild horse population management, advocacy groups, competing teams of scientists, and agency personnel have debated the merits of various contraceptive technologies. Besides the practical attributes of technologies such as permanent versus temporary agents, procedures for treating animals, costs, and efficacy, proponents and opponents of various contraceptives have also highlighted the potential for impacts of treatments on behavior, social systems, fitness, and genetics. While all of these factors should certainly be considered and discussed among concerned stakeholders, these debates and arguments have had the effect of delaying the broad-scale application of any contraceptive technology for wild horse management while more research is pursued to find the perceived perfect agent (i.e., the silver bullet). There is no single perfect contraceptive agent because all technologies for inhibiting fertility have a suite of strengths and limitations (NRC 2013). The diversity of herds, management goals, landscapes, local community perceptions and involvement, and a host of other considerations suggest managers will need a diverse tool box of contraceptive agents if they are ever to successfully incorporate fertility control as a complementary approach to the traditional approaches for wildlife population management that manipulate survival. All techniques we currently apply for the management of wildlife populations have multiple impacts on individual animals and populations. The potential for contraceptive technologies to contribute to wild horse management should be weighed against the current management approach of capture, removal, and warehousing of excess horses that terminates all attributes and behaviors that distinguish wild from domestic horses, completely disrupts natural social systems, eliminates all potential reproduction that would contribute to an individual's fitness, permanently removes animals from the gene pool, and is estimated to cost the taxpayer tens of thousands of dollars per un-adopted animal removed from rangelands.

## Choices confronting the BLM, Congress, and society

Wild horse population control requires horse deaths, and therefore, the fundamental policy decisions are when, where, how many, and how horses will die. Under the current policy of minimal removals, the cost of managing wild horses would remain static or perhaps be reduced, and most horses will die on range due to resource limitation. If we return to the previous policy of aggressive removals and maintaining un-adopted horses in long-term holding facilities, most horses would be euthanized or die after at least a decade of captivity when they became physiological senescent. This management strategy would require substantial increases in funding for the WHB Program to support a potential doubling of the number of horses maintained in long-term holding facilities. Recently, a third alternative of selling without restrictions or euthanizing excess horses was recommended by several WHB Advisory Boards (2016, 2017). This strategy would result in most un-adopted horses dying after a short period of captivity and would dramatically reduce the proportion of the WHB budget that is currently devoted to maintaining horses in holding facilities. Thus, the choices are death on range, with all of the

associated impacts to stakeholders, public resources, and the health and well-being of the horses; death in captivity after a long period of captivity; or death relatively quickly after removal from the range. None of these options are easy to consider because of the sheer number of animals involved.

The biological problem is relatively high population growth rates, which results in the management problem of large numbers of horses added to the free-ranging population each year. It is this continually increasing annual increment to the number of horses on range that is alarming to most natural resource managers and western public land stakeholders. The estimated population of 60,000 wild horses on BLM lands in 2017 will have added 9,000–12,000 animals to the free-roaming population by the time this special journal issue is widely distributed in 2018. These are daunting numbers given the current constraints on the ability of the BLM to manage wild horse populations.

There is a practical and reasonably plausible strategy to move the WHB program toward a more sustainable future by minimizing the annual population increment that needs to be actively managed. This problem can be addressed with existing tools if we can find the political will to design, fund, and implement a sustainable management policy (NRC 2013). Two effective strategies would need to be integrated and aggressively implemented. First, the base population of free-ranging horses would need to be reduced to the currently established AML of approximately 24,000 horses through the gather and removal program. Once AML is achieved, adequate numbers of horses remaining on range would need to be treated with contraceptives to reduce subsequent population growth rates. Current contraceptive technologies can realistically be effectively employed to halve population growth rates. An effective combination of both strategies could provide a sustainable management program for wild horses. Under this scenario, the free-ranging horse population would produce an annual increment of approximately 2,400 horses, which could be removed and readily placed into private ownership through the Adopt-A-Horse Program. The free-ranging population could then be managed for stability, and the BLM would have the flexibility to adjust population goals and growth rates as required by conditions on the ground and shifts in policy.

The window of opportunity to put the WHB Program on a path toward sustainability and responsible public resource management is closing quickly. The BLM's capacity to plan, administer, and execute horse gathers and removals from the range has a limit. Personnel responsible for the program suggest that a maximum of 20,000 animals could be removed from the range annually. With an estimated on-range population of 60,000 horses producing an annual increment of 9,000–12,000 horses, removing 15,000–20,000 animals annually could result in attainment of AML within 5–10 years. However, if Congress fails to act in the near future and the current policy of minimal horse management continues, within 5–6 years the on-range population will likely exceed 100,000 animals, and the population's annual growth would exceed the capacity of the BLM's gather and removal program. It is difficult to envision any effective management program if this scenario is realized. One only needs to look to Australia, where wild horse (brumbie) population management is minimal and sporadic, and numbers may now exceed 1 million, to get a glimpse of the potential future of western rangelands in the United States (Burdon 2016).

It is difficult to envision society and Congress supporting the increased costs of an aggressive gather and removal program to reduce the on-range horse population to at or below AML if maintaining the population near AML thereafter would require the annual killing of thousands of excess horses in perpetuity or warehousing excess animals, thereby creating an ever-increasing captive population. In the absence of reproductive intervention, an on-range horse population near AML realizing the typical 15–20% annual population growth rate would produce an annual increment of 3,600–4,800 horses that would need to be removed each year to maintain stable populations on the range. These numbers would exceed annual adoption demand and would perpetuate the problem of disposing of excess horses.

If Congress and society refuse to authorize euthanasia or slaughter for excess horses,

then these animals would need to be placed in long-term holding facilities for the rest of their lives, recreating the unsustainable management program that has brought us where we are today. Embracing the use of contraceptive technologies may be the key to convincing society and Congress to make the difficult decision to fund the reduction of the current on-range population to AML and decide the fate of excess horses. This strategy would produce a relatively economical and sustainable horse management program where the horses removed annually are readily placed into private ownership through the Adopt-a-Horse Program and the need for the destruction of horses or warehousing animals in captive facilities is minimized or eliminated.

## Conclusion

It has taken nearly half a century for the wild horse problem to reach this critical point, and any transition to a sustainable program will take time and need additional resources. Good science and adaptive resource management will be essential to successfully develop a new management paradigm. The fundamental challenge to developing a sustainable program will be solving the problem of the fate of excess horses. The most economical solution would be to remove the constraints on disposing of un-adopted horses and allow these animals to be euthanized or sold without restriction, which would most likely result in most of these animals being slaughtered. The WFRHBA (as amended) mandates this management solution to the problem of excess horses; however, it is uncertain if the public and the current Congress will support such a solution.

We slaughter >9 billion agricultural animals in the United States annually (U.S. Department of Agriculture 2017) and euthanize an estimated 15 million of our companion animals (dogs and cats; American Society for the Prevention of Cruelty to Animals 2017). The history of administrative and Congressional constraints on destroying healthy horses suggests that horses may hold a value to our society beyond any other animals under the management authority of our governments and public institutions. If this is the case, then it is very plausible that Congress will neither lift restrictions on the destruction of un-adopted horses nor increase funding to support an increase in the capacity to maintain horses in long-term holding facilities. Perhaps the prospect of developing a sustainable wild horse management program that employs contraception to eventually eliminate the need to destroy horses or place them into captivity for the rest of their lives will provide the incentive to fund and implement the difficult transition required to achieve a goal that has eluded us since the passage of the WFRHBA in 1971. The BLM's WHB Program is indeed at a critical crossroad. The policy decisions confronting us are historic, challenging, and controversial, with a real danger of not finding the resolve to chart a new course for the WHB Program. If we fail and continue with the current policy, wild, free-roaming horses, native wildlife, all stakeholders, and our public rangelands will pay a heavy price for our inaction.

## Acknowledgments

The author appreciates discussions of this manuscript and suggestions for improvement with J. Cunningham, E. Flesch, B. Lowrey, M. Oli, and P.J. White. Comments provided by J. Beck, HWI Associate Editor, and 2 anonymous reviewers also greatly improved the manuscript.

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*Associate Editor: Jeffrey Beck*

**Robert A. Garrott** is a professor of wildlife ecology and director of the Fish and Wildlife Ecology and Management Program in the Department of Ecology at Montana State University-Bozeman. He earned a B.S. degree in wildlife biology from the University of Montana, an M.S. degree in wildlife management from the Pennsylvania State University, and a Ph.D. degree in wildlife conservation from the University of Minnesota. He works closely with regional natural resource management agencies to conduct research to enhance our ecological knowledge of important wildlife species, aid in the development of more effective policies, and provide training for students pursuing careers in natural resource conservation and management. He has authored or edited 4 books, 33 book chapters, and >120 scholarly articles in peer-reviewed scientific journals.