

Commentary

Healthy Western Lands: a proposal for healthy rangelands, wildlife, and free-roaming horses and burros

JAMES S. SEDINGER, Department of Natural Resources and Environmental Science, University of Nevada Reno, 1664 N. Virginia St, Reno, NV 89557, USA jsedinger@unr.edu

REBEKAH STETSON, Coalition for Healthy Nevada Lands, Wildlife and Free-roaming Horses, Reno, NV 89570, USA

Abstract: The Coalition for Healthy Nevada Lands, Wildlife and Free-roaming Horses (CHNL) is dedicated to proper management of free-roaming horses (*Equus caballus*) and burros (*E. asinus*) so rangelands are healthy, which benefits wildlife and the horses and burros themselves. The CHNL proposes the rapid reduction of horses and burros on designated public lands to achieve appropriate management levels (AML). After these reductions, the use of fertility control, supplemented with some gathers and adoption of gathered horses, should allow the Bureau of Land Management to economically maintain horse and burro populations at AML. The CHNL believes this approach will be the most expeditious to restoring rangeland to health and cost-effective as it reduces handling of horses and burros. Herein, we describe CHNL's rationale for this approach and our effort to have the Nevada Legislature pass a resolution supporting the proposal.

Key words: appropriate management level, burros, *Centrocercus urophasianus*, *Equus asinus*, *E. caballus*, fertility control, greater sage-grouse, horses, Nevada legislature, wildlife

As of 2020, free-roaming horse (*Equus caballus*) and burro (*E. asinus*) populations were nearly 4 times the Bureau of Land Management's (BLM) established appropriate management levels (AML) on designated federal lands (BLM 2020c). More than half of all horses and burros that inhabit designated federal lands in the western United States are in Nevada (BLM 2020b). These populations increased at 17% per year between 2007 and 2017 even though the BLM gathered thousands of horses annually (Norris 2018). This suggests that the demographic potential for annual increase exceeded 17%.

At high densities, horses and burros can deplete food and water for themselves and native wildlife (Beever and Brussard 2000, Beever et al. 2008, Davies et al. 2014, Boyd et al. 2017, Street 2020). These impacts can be exacerbated under the extreme drought experienced by western states (Bradley and Mustard 2008, National Integrated Drought Information System 2021). Because of insufficient food and water, the BLM emergency gathered horses in Nevada in 2020 to reduce horse mortalities (BLM 2020a).

Free-roaming horses have well-established negative impacts on ecosystems in arid environments (Beever 2003, Beever and Brussard 2004). Horses exclude native ungulates, small mammals, and even birds from access to riparian areas (Osterman-Kelm et al. 2008, Perry et al. 2015, Hall et al. 2016, Gooch et al. 2017).

Lamb-to-ewe ratios were about half that expected in the population of bighorn sheep (*Ovis canadensis*) in the Virginia Mountain Range near Reno, Nevada, where horses were present in large numbers but livestock were absent (M. Cox, Nevada Department of Wildlife, personal communication). Horses were being fed in this area (Chadwell 2020, Wild Horse Connection 2021), and there was clear deterioration of habitats around springs upon which both horses and bighorn sheep depended (M. Cox, Nevada Department of Wildlife, personal communication). There is potential for these effects to be widespread as BLM herd management areas (HMAs) and U.S. Forest Service Wild Horse and Burro Territories overlap significant proportions (16–60%) of the distributions of native

ungulates in Nevada (Stoner et al. 2021).

Grazing by free-roaming horses degrades greater sage-grouse (*Centrocercus urophasianus*; sage-grouse) habitat (Davies et al. 2014, Burdick et al. 2021, Coates et al. 2021, Hennig et al. 2021). Street (2020) reported that free-roaming horses in a Nevada study area depleted key sage-grouse food plants and reduced survival of sage-grouse chicks. Coates et al. (2021) reported sage-grouse populations decline when free-roaming horse populations are above AML but are stable or increasing when horses are below AML. Collectively, these studies suggest that impacts of non-native grazers, including horses, may be greatest in areas where precipitation and primary productivity are lowest.

In the spring of 2019, stakeholders concerned about the impact of free-ranging horses and burros on Nevada's rangelands and native wildlife organized the Coalition for Healthy Nevada Lands, Wildlife and Free-roaming Horses (CHNL). The CHNL's goal is to foster effective management of free-ranging horses and burros to conserve Nevada's rangelands, native wildlife, and the horses and burros. The CHNL seeks to engage and inform the public and state and federal legislators to encourage adoption of appropriate management plans as well as appropriation of the fiscal resources needed to implement plans to bring horse numbers down to sustainable management levels. The CHNL is highly collaborative, and we look forward to continued work with like-minded organizations to accomplish these goals.

In 2018, CHNL members coordinated fundraising for the production of the informational film "Horse Rich and Dirt Poor" (<https://wildlife.org/horse-rich-dirt-poor/>): 21 professional and conservation organizations contributed to production costs. This film was produced to inform the public and legislators. The film premiered in Nevada to a standing-room-only audience at the Nevada Museum of Art in Reno on October 23, 2019. The response to the film indicated substantial interest in the issue of overabundant horses, but the audience was comprised disproportionately of people with an interest in the outdoors. Members of groups opposed to the film and the current BLM management were also present, and some picketed the event.

The next step in CHNL's efforts to bring attention to the issue was development of a

resolution to be considered by Nevada's state legislature calling for rapid reduction of horse numbers to AML and the funding for federal agencies to achieve this goal. The CHNL crafted language for the resolution while simultaneously organizing a coalition of groups and individuals who shared our concerns. The draft resolution was presented to the Interim Public Lands Committee of the Nevada Legislature in September 2020.

Nevada's legislature only meets in alternate years, and in the intervening year, interim committees composed of members of both the state senate and assembly meet to address the state's business that cannot wait for the next legislative session. The CHNL's resolution with slightly amended language was unanimously approved for consideration during the next legislative session. In addition, the Interim Public Lands Committee sent a letter to Nevada's Congressional Delegation urging that the actions called for in our draft resolution be supported by Congressional action.

The resolution was introduced in the Senate Natural Resources Committee during the 2021 legislative session as Senate Joint Resolution 3 (SJR 3; Nevada State Legislature 2021) and called for bringing numbers of free-roaming horses and burros down to AML within 6 years. The resolution also called for delay in reliance on fertility control as a key component of population control until populations were at AML, at which time we encourage the use of fertility control as an important component of long-term maintenance of populations at AML. The resolution was supported by a broad range of groups with a strong interest in healthy lands, including Friends of Nevada Wilderness, Toiyabe Chapter of the Sierra Club, Trout Unlimited, Nevada Wildlife Federation, Backcountry Hunters and Anglers, Nevada Bighorns Unlimited, Coalition for Nevada's Wildlife, Nevada Chapter of the Wildlife Society, Rocky Mountain Elk Foundation, Nevada Farm Bureau, Nevada Cattlemen's Association, Nevada Association of Counties, Nevada Wildlife Commission, and the Nevada Sagebrush Ecosystem Council.

The CHNL members testified during the committee meeting when SJR 3 was introduced, and the resolution was generally positively received. A few days later, 30 minutes before a work session with the Natural Resources Com-

1 WHEREAS, This thriving natural ecological balance needs to be
 2 restored as quickly as possible; now, therefore, be it
 3 RESOLVED BY THE SENATE AND ASSEMBLY OF THE STATE OF
 4 NEVADA, JOINTLY, That the members of the 81st Session of the
 5 Nevada Legislature support the **humane and science-based management of Nevada's wild free-**
~~6 **roaming horse and burro populations** Bureau of Land Management's 2020~~
~~7 **Report to Congress urging sufficient short-term funding for**~~
~~8 **immediate effectiveness and longer-term funding for sustained**~~
~~9 **efficacy and overall success, apportioned according to free-roaming**~~
~~10 **horses and burros numbers in each state; and be it further**~~
 11 RESOLVED, That given the impacts of excess free-roaming
 12 horses and burros on our fragile Great Basin and Mojave
 13 ecosystems, the members of the 81st Session of the Nevada
 14 Legislature support reducing excess free-roaming horses and burros
~~15 **to achieve the appropriate management level, using non-lethal**~~
~~16 **means including, without limitation, humane fertility control, as recommended by the National**~~
~~17 **Academy of Sciences within 6 years** to protect and restore the health and viability~~
 of our public lands and habitats for wildlife, free-roaming horses
 and burros and other uses into the future; and be it further

Figure 1. Amended language in Nevada Senate Joint Resolution 3. Amendments offered by the American Wild Horse Campaign (AWHC). Note that language calling for adequate funding for the Bureau of Land Management, bringing horse (*Equus caballus*) numbers down to appropriate management levels and doing so within 6 years, were all struck from the original resolution. Language initially offered by AWHC also called for fertility control to be the primary method of population management, but the Coalition for Healthy Nevada Lands, Wildlife, and Free-roaming Horses was able to get this language modified.

mittee, we were informed that the American Wild Horse Campaign (AWHC) had requested that SJR 3 be amended. Specifically, the amendments eliminated language calling for adequate funding for the BLM, managing horses at AML, and bringing numbers down to AML as rapidly as possible (Figure 1). The original amended language also called for fertility control to be the primary method of population management. We do not agree that fertility control can be the primary method of population management at this point and were successful in maintaining that messaging in SJR 3. Other amended language removed recommendations for actions that, in our view, are required to bring horse and burro numbers down to AML within a reasonable time and had the effect of rendering SJR 3 ineffective.

The AWHC also opposed the resolution on their website and sought support from other advocacy groups to oppose it. Surprisingly, SJR 3 was also opposed by Western Watersheds. As a consequence of the amended language, CHNL requested that the amended resolution not be introduced to the full Legislature; the committee chair agreed, and SJR 3 died.

Although, the AWHC generated substantial opposition to SJR 3 through its website, conservation groups were also able to generate substantial support for SJR 3. The resolution

became one of the most popular pieces of legislation in the 2021 legislative session. We found that increasing numbers of people supported managing free-roaming horses at AML when they were provided with the facts.

The fact that free-roaming horse and burro populations are at nearly 4 times the AML reflects systematic underfunding of the BLM, litigation challenging specific management action, and Congressional appropriation riders (Norris 2018). Inadequate funding reflects pressure by advocates to maintain high numbers of horses on rangelands (e.g., The Could Foundation 2021) combined with lack of knowledge of the impacts of these horses and burros by much of the general public and their congressional representatives (S. N. Frey, Utah State University, unpublished data).

We argue that activist group insistence on maintaining large numbers of horses on designated public lands essentially represents making free-roaming horses the highest priority for use of public lands. The maintenance of high horse population levels will impact native wildlife, livestock grazing, and other multiple-uses.

Livestock producers have reduced their stocking rates or time of use on allotments they rely on in areas where horses are overabundant (Masters 2017). In some years and in some areas, ranchers are unable to graze live-

stock because excess horses and burros have already exceeded allowable use levels on forage. We are not advocating livestock grazing as the principal use of public lands, and in fact are concerned about improper management of livestock grazing in many areas. That said, it is important for the public to understand that an implication of overabundant horses is reduced livestock grazing. We have also observed that advocates for free-roaming horses frequently point to poor livestock management as a reason for not properly managing horses. We argue that horses should be properly managed irrespective of whether livestock are so managed.

There is a substantial constituency for the use of fertility control measures as the principal tool for management of free-roaming horses (e.g., AWHC 2020). Experimental application of fertility control agents has demonstrated that these drugs can substantially reduce pregnancy rates in breeding-age horses (Turner et al. 2007, Rutberg et al. 2017, Baker et al. 2018). Fertility control by itself is unlikely, however, to provide a solution to the overabundance of free-roaming horses on public lands. First, foaling rates for mares receiving contraceptive treatments, while substantially reduced, are in the range to fully replace adult mortalities (Rutberg et al. 2017, Carey et al. 2019), given the high rate of annual survival of horses (Garrott and Taylor 1990).

For horses occupying remote landscapes, the need for a booster treatment about every third year presents clear logistical constraints on the use of fertility control to manage free-roaming horse populations. Hobbs and Hinds (2018) estimated that >50% of breeding-age females in Australia would need to be treated annually to achieve long-term reduction in federally managed horse populations; in the western United States, this effort would require treating tens of thousands of mares annually. We are unaware of a single example where the use of fertility control by itself has resulted in a reduction in numbers of free-roaming horses on western rangelands.

The Path Forward and Healthy Western Lands

The Path Forward represents an agreement among disparate interests including the Humane Society of the United States, American Society for the Prevention of Cruelty to Ani-

mals (ASPCA), Society for Range Management, American Farm Bureau Federation, Public Lands Council, National Cattlemen's Beef Association, Return to Freedom Wild Horse Conservation, American Mustang Foundation, and several other groups. The Path Forward relies on a 4-tiered approach to reduce the growth rate of free-roaming horse populations and to eventually reduce their numbers.

The principal components of The Path Forward, intended to be implemented simultaneously, are: (1) conduct targeted gathers and removals at densely populated HMAs to reduce herd size and make progress toward AML; (2) treat gathered horses and burros with largely reversible fertility control prior to being returned to the range; (3) relocate horses and burros in holding facilities and those taken off the range to large, cost-effective, humane pasture facilities funded through public-private partnerships; and (4) promote adoptions to help reduce captive populations and costs (ASPCA et al. 2019). The Path Forward in part reflects a compromise that recognized potential fiscal (and other) limitations on federal ability to capture, handle, and hold horses and burros and the need to reflect the missions and philosophies of a very disparate group of collaborators (ASPCA et al. 2019). The Path Forward's recognition and promotion of the importance of fertility control as an important management tool represents a critical contribution by this group to the long-term efficacy of management of free-roaming horses and burros.

Despite the broad base of support, The Path Forward is nevertheless opposed by some horse activist groups, including the AWHC. The Path Forward, in our view, is a remarkable and important compromise that fostered communication among formerly adversarial groups (e.g., the Humane Society of the United States and the National Cattlemen's Beef Association), allowing these groups to agree to a solution to the problem of overabundant horses. As importantly, The Path Forward facilitated political support for improved management of free-roaming horses by the federal government and appropriations necessary to support such management.

The Path Forward recognizes the need to gather and remove horses as part of the solution, especially in HMAs that are above AML; this element is the basis for much of the opposition by

advocates. The Path Forward also calls for heavy reliance on fertility control to solve the problem of overabundant horses, including maintaining populations near AML once that target has been achieved. This latter element breaks the chain of a continuous need to gather large numbers of horses because fertility control can substantially reduce production of new offspring.

The CHNL proposed a modification and acceleration of The Path Forward in the original version of SJR 3, presented to the Nevada Senate Public Lands Committee in 2021. The approach we favor, which we call Healthy Western Lands, relies on gathers until horse and burro numbers are brought down to AML, at which time fertility control facilitated by limited gathers should become the principal approach to maintaining horses at AML. The CHNL advocates for accelerated research on fertility control methods to increase their efficacy. Some gathers will still be necessary even when horses and burros are at AML for administration of fertility control and because even with fertility control some population growth may occur.

Once AML is achieved, numbers gathered, however, can be substantially lower than under current management because there are many fewer horses on the range and fertility control reduces the birth rate of horses remaining on the range. Furthermore, once AML is achieved, we suggest the age composition of gathered horses and the small numbers gathered will mean that most can be adopted out.

It is important to recognize that while fertility control can slow or even halt population increase, it is unlikely to reduce populations. As an example, gonadotropin-releasing hormone vaccine (GonaCon-Equine) reduces birth rates by about 92% following administration of a booster (Baker et al. 2018), which is very promising. Even this level of effectiveness, however, will not reduce population growth rates below replacement when adult survival rates and birth rates are high. To understand this point, consider the following example. The annual rate of population increase (λ), which is the ratio of current population size to that in the previous year, equals the sum of annual survival (ϕ) and annual per capita recruitment when there is no immigration into the population (Nichols et al. 2000).

If recruitment into the breeding population

equals adult mortality, a population will be approximately stable. Per capita recruitment can be approximated as the product of the annual foaling rate (multiplied by 0.5 to restrict the estimate to female foals) and survival of foals to breeding age. Assume adult annual survival equals 0.96 (Garrott and Taylor 1990). Berger (1986) reported mean annual foaling rates of 0.74 (0.37 female foals per adult female) and survival of 89% of foals to breeding at age 2. Assume a 92% reduction in foaling rate results in a recruitment rate of 0.03 and $\lambda = 0.99$, a 1% annual population decrease, indistinguishable from a stable population. The intent of this exercise is not to predict population dynamics; λ will vary under different demographic rates.

First-time breeders produce fewer than the average number of foals (Berger 1986). On the other hand, some populations experience higher adult annual survival (Garrott and Taylor 1990) than the value we used in the calculation above. Additionally, there is a 1-year delay in the effects of fertility control because females are already pregnant when treated and fertility treatment does not terminate the pregnancy but eliminates ovulation in the following year (Baker et al. 2018). This delay reduces the ability of fertility treatments to slow population growth. Our point here is that even if all females are treated with highly effective fertility control, the result will be a population that is approximately stable, with the potential for slight increases or declines, depending on demographic rates specific to each population. Additionally, our calculation above assumes all females can be treated as needed and effectiveness of fertility control is constant. If either of these assumptions is untrue, populations will increase faster than predicted by our calculation. This exercise indicates that while fertility control will likely be an important tool for maintaining populations at AML, fertility control, by itself, will not be effective for reducing populations.

If the goal is to achieve AML and manage populations at this level, we suggest that The Path Forward will result in a greater number of horses being gathered than our Healthy Western Lands proposal for 3 reasons. First, resources used to gather and treat females (that will be returned to the range) with fertility control drugs reduce resources available to gather and remove horses, which will slow the approach

to AML and increase the number of horses that ultimately must be gathered. Second, returning treated mares to the range and having to repeatedly regather them for treatment, by itself, increases the number of horses gathered, relative to gathering horses once and sending them to long-term holding. Third, even with the application of fertility control, foals will continue to be produced, and to the extent this production exceeds adult mortality in populations above AML these animals will eventually need to be gathered and removed. For all of these reasons, the longer horses remain on the range in populations above AML, the larger the number that will eventually have to be gathered.

Continued production by some mares left on the range also increases the number of horses that must be held in long-term holding for the reasons identified immediately above. Horses sent to long-term holding do not produce foals that must also be held or adopted, but because >90% of horses survive each year, horses sent to long-term holding must be supported for 20–30 years, at a cost of ~\$1,000 per horse per year (BLM, unpublished report).

The Healthy Western Lands approach, because it reduces the time required to achieve AML, reduces long-term costs, reduces the time interval before rangelands can begin to recover, and more quickly places the BLM horse and burro program on a sustainable basis. We acknowledge that gathering more rapidly increases short-term costs because of the costs of the gathers themselves and the increased numbers of horses in long-term holding early in the program. These effects will necessitate increases in both short- and long-term holding facilities, contractors for gathers, and BLM staff, all of which cost money. We recognize that the BLM currently has insufficient short-term and long-term holding facilities, adequate funds for necessary gathers and fertility treatment, and the personnel to accomplish the Healthy Western Lands initiative. We believe, however, that the best strategy is to promote the plan we believe best addresses the problem of overabundant horses and burros and to ask Congress to appropriate sufficient funds to support that program.

We contend that more rapid recovery of rangelands returns some of the early costs immediately and the Healthy Western Lands approach is less costly than other alternatives

(except the exceedingly dangerous no management option) over a timeline of 2–3 decades, consistent with modeling of an approach similar to that of Healthy Western Lands (Schoenecker et al. 2022).

Once AML is achieved and fertility control is applied to free-roaming mares, we envision relatively small numbers of horses would need to be gathered annually throughout the West. This number should be fully adoptable, and the BLM's horse and burro program should be sustainable over the long term. But we must achieve AML before this will be possible.

Acknowledgments

K. Boeger, S. Swanson, T. Nappe, W. Mollini, and 2 anonymous reviewers all provided especially helpful comments on the manuscript, which are much appreciated.

Literature cited

- American Society for the Prevention of Cruelty to Animals (ASPCA), American Farm Bureau Federation, Society for Range Management, Humane Society Legislative Fund, Public Lands Council, Return to Freedom Wild Horse Conservation, National Horse and Burro Rangeland Management Coalition, Eureka County NV County Commission Office, Humane Society of the United States, National Cattlemen's Beef Association, Beaver County Utah County Commission Office, American Mustang Foundation, and Utah Governor Office. 2019. The Path Forward for management of BLM'S wild horses and burros. Unpublished document.
- American Wild Horse Campaign (AWHC). 2020. Fertility control. American Wild Horse Campaign, Davis, California, USA, <<https://americanwildhorsecampaign.org/fertility-control#:~:text=Porcine%20Zona%20Pellucida%2C%20or%20PZP,federally%20protected%20wild%20horse%20herds>>. Accessed July 2, 2023.
- Baker, D. L., J. G. Powers, J. I. Ransom, B. E. McCann, M. W. Oehler, J. E. Bruemmer, N. L. Galloway, D. C. Eckery, and T. M. Nett. 2018. Reimmunization increases contraceptive effectiveness of gonadotropin-releasing hormone vaccine (GonaCon-Equine) in free-ranging horses (*Equus caballus*): limitations and side effects. PLOS ONE 13(7): e0201570.
- Beever, E. A. 2003. Management implications of

- the ecology of free-roaming horses in semi-arid ecosystems of the western United States. *Wildlife Society Bulletin* 31:887–895.
- Beever, E. A., and P. F. Brussard. 2000. Examining ecological consequences of feral horse grazing using exclosures. *Western North American Naturalist* 60:236–254.
- Beever, E. A., and P. F. Brussard. 2004. Community- and landscape-level responses of reptiles and small mammals to feral-horse grazing in the Great Basin. *Journal of Arid Environments* 59:271–297.
- Beever, E. A., R. J. Tausch, and W. E. Thogmartin. 2008. Multi-scale responses of vegetation to removal of horse grazing from Great Basin (USA) mountain ranges. *Plant Ecology* 196:163–184.
- Berger, J. 1986. *Wild horses of the Great Basin: social competition and population size*. University of Chicago Press, Chicago, Illinois, USA.
- Boyd, C. S., K. W. Davies, and G. H. Collins. 2017. Impacts of feral horse use on herbaceous riparian vegetation within a sagebrush steppe ecosystem. *Rangeland Ecology and Management* 70:411–417.
- Bradley, B. A., and J. F. Mustard. 2008. Comparison of phenology trends by land cover class: a case study in the Great Basin, USA. *Global Change Biology* 14:334–346.
- Burdick, J., S. Swanson, S. Tsochanos, and S. McCue. 2021. Lentic meadow habitat and riparian functions impaired after season-long horse and cattle grazing. *Journal of Wildlife Management* 85:1121–1131.
- Bureau of Land Management. 2020a. BLM Nevada gathers and removals. Bureau of Land Management, Washington, D.C., USA, <<https://www.blm.gov/programs/wild-horse-and-burro/herd-management/gathers-and-removals/nevada>>. Accessed July 2, 2023.
- Bureau of Land Management 2020b. Herd area and herd management area statistics. Bureau of Land Management, Washington, D.C., USA, <https://www.blm.gov/sites/blm.gov/files/wildhorse_2020_HAHMA_Stats_508.pdf>. Accessed June 24, 2021.
- Bureau of Land Management 2020c. Wild horse and burro program data. Bureau of Land Management, Washington, D.C., USA, <<https://www.blm.gov/programs/wild-horse-and-burro/about-the-program/program-data>>. Accessed June 24, 2021.
- Carey, K. A., A. Ortiz, K. Grams, D. Elkins, J. W. Turner, Jr., and A. T. Rutberg. 2019. Efficacy of dart-delivered PZP-22 immun contraceptive vaccine in wild horses (*Equus caballus*) in baited traps in New Mexico, USA. *Wildlife Research* 46:713–718.
- Chadwell, J. 2020. Local organization seeks volunteers to help feed Virginia Range wild horses. This Is Reno. September 9, 2020, Reno, Nevada, USA, <<https://thisisreno.com/2020/09/local-organization-seeks-volunteers-to-help-feed-virginia-range-wild-horses/>>. Accessed July 2, 2023.
- Coates, P. S., S. T. O’Neil, D. A. Muñoz, I. A. Dwight, and J. C. Tull. 2021. Sage-grouse population dynamics are adversely affected by overabundant feral horses. *Journal of Wildlife Management* 85:1132–1149.
- Davies, K. W., G. Collins, and C. S. Boyd. 2014. Effects of feral free-roaming horses on semi-arid rangeland ecosystems: an example from the sagebrush steppe. *Ecosphere* 5(10):127.
- Frey, S. N., J. D. Scasta, J. L. Beck, L. Singleton, and L. K. Snell. 2022. Public knowledge of free-roaming horses in the United States. *Proceedings of the Vertebrate Pest Conference* 30(17):1–11.
- Garrott, R. A., and L. Taylor. 1990. Dynamics of a feral horse population in Montana. *Journal of Wildlife Management* 54:603–612.
- Gooch, A. M. J., S. L. Petersen, G. H. Collins, T. S. Smith, B. R. McMillan, and D. L. Eggett. 2017. The impact of feral horses on pronghorn behavior at water sources. *Journal of Arid Environments* 138:38–43.
- Hall, L. K., R. T. Larsen, M. D. Westover, C. C. Day, R. N. Knight, and B. R. McMillan. 2016. Influence of exotic horses on the use of water by communities of native wildlife in a semi-arid environment. *Journal of Arid Environments* 127:100–105.
- Hennig, J. D., J. L. Beck, C. J. Duchardt, and J. D. Scasta. 2021. Variation in sage-grouse habitat quality metrics across a gradient of feral horse use. *Journal of Arid Environments* 192:104550.
- Hobbs, R. J., and L. A. Hinds. 2018. Could current fertility control methods be effective for landscape-scale management of populations of wild horses (*Equus caballus*) in Australia? *Wildlife Research* 45:195–207.
- Masters, B. 2017. *Wild horses: the consequences of doing nothing*. National Geographic Society, Washington, D.C., USA, <

- algeographic.com/adventure/article/wild-horses-part-two>. Accessed June 21, 2021.
- National Integrated Drought Information System. 2021. Great Basin region watershed drought information. National Integrated Drought Information System, Boulder, Colorado, USA, <<https://www.drought.gov/watersheds/great-basin>>. Accessed July 2, 2023.
- Nevada State Legislature. 2021. Senate Joint Resolution (SJR) no. 3: Committee on Natural Resources. February 25, 2021. Nevada State Legislature, Carson City, Nevada, USA, <<https://www.leg.state.nv.us/App/NELIS/REL/81st2021/Bill/7539/Text>>. Accessed July 2, 2023.
- Nichols, J. D., J. E. Hines, J.-D. Lebreton, and R. Pradel. 2000. Estimation of contributions to population growth: a reverse-time capture–recapture approach. *Ecology* 81:3362–3376.
- Norris, K. A. 2018. A review of contemporary U.S. wild horse and burro management policies relative to desired management outcomes. *Human–Wildlife Interactions* 12:18–30.
- Osterman-Kelm, S., E. R. Atwill, E. S. Rubin, M. C. Jorgenson, and W. M. Boyce. 2008. Interactions between feral horses and desert bighorn sheep at water. *Journal of Mammalogy* 89:459–466.
- Perry, N. D., P. Morey, and G. San Miguel. 2015. Dominance of a natural water source by feral horses. *Southwestern Naturalist* 60:390–393.
- Rutberg, A., K. Grams, J. W. Turner, Jr., and H. Hopkins. 2017. Contraceptive efficiency of priming and boosting doses of controlled-release PZP in wild horses. *Wildlife Research* 44:174–181.
- Schoenecker, K., S. Ekernas, C. Carlisle, K. Krasaka, and S. B. Griffin. 2022. Modeling for wild horse management. Free Roaming Equids and Ecosystem Sustainability Network (FREES) Summit, Utah State University, Logan, Utah, USA, <<https://extension.usu.edu/freesnetwork/summit-2020>>. Accessed November 8, 2021.
- Stoner, D. C., M. T. Anderson, C. A. Schroeder, C. A. Bleke, and E. T. Thacker. 2021. Distribution of competition potential between native ungulates and free-roaming equids on western rangelands. *Journal of Wildlife Management* 85:1062–1073.
- Street, P. A. 2020. Greater sage-grouse habitat and demographic response to grazing by non-native ungulates. Dissertation, University of Nevada Reno, Reno, Nevada, USA.
- The Cloud Foundation. 2021. Urge DOI Secretary Haaland: humane management, note round-ups! The Cloud Foundation, Colorado Springs, Colorado, USA, <<https://www.thecloudfoundation.org/action-alerts-tcf/2021/6/2/urge-doi-secretary-haaland-humane-management-not-roundups>>. Accessed July 2, 2023.
- Turner, J. W., Jr., I. K. M. Liu, D. R., Flanagan, A. T. Rutberg, and J. F. Kirkpatrick. 2007. Immunoneutralization in wild horses: one inoculation provides two years of infertility. *Journal of Wildlife Management* 71:662–667.
- Wild Horse Connection. 2021. Wild Horse Connection range management. Wild Horse Connection, Reno, Nevada, USA, <<https://wildhorseconnection.org/>>. Accessed July 2, 2023.

Associate Editor: Terry A. Messmer

JAMES S. SEDINGER is a Foundation Professor Emeritus in wildlife ecology from the Department of Natural Resources and Environmental Science, University of Nevada Reno. He has 46 years' experience studying waterfowl and sage-grouse in remote areas of Alaska and Nevada. He was a professor of wildlife ecology for 34 years at the University of Alaska Fairbanks (16 years) and the University of Nevada Reno (18 years). He is a Fellow of the Wildlife Society and recipient of the Robert L. Patterson Award for his contributions to sage-grouse research. He and his students recently completed a 7-year study of the effects of livestock and free-roaming horses on sage-grouse in northwest Nevada.



REBEKAH STETSON is a native Nevadan whose passion for wildlife started young and curious with lizard and horny toad hunting in the fields surrounding her family home in Reno. Her curiosity and drive have led her into action at a local, regional, and national level in a variety of areas including organic farming, public health, environmental protection, and wildlife habitat. She is passionate about the delicate ecosystems that intertwine leading to the health of habitats.

