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Impacts of Wild Horses, Cattle, and Wildlife on Riparian Areas in Idaho

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On the Ground

- Our study confirms that grazing by cattle and horses can negatively impact riparian ecosystems if not properly managed.
- Population levels and grazing patterns of wild free-roaming horses limit management options, potentially leading to rangeland and riparian degradation.
- Grazing by wild free-roaming horses and cattle in riparian areas caused streambank disturbance and reductions in stubble height and herbaceous biomass.
- Both wild free-roaming horses and cattle affected riparian attributes while wildlife had little effect.
- Horses had a greater negative impact than did cattle when examined on an individual animal basis.
- Managers and ranchers in areas with wild free-roaming horses will need to consider potential impacts of unmanaged wild free-roaming horses in combination with livestock to mitigate the cumulative effects of multiple species of grazers on riparian condition.

Keywords: streambank alteration, stubble height, game camera, species interaction, grazing.

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Excessive and poorly timed grazing can negatively affect riparian ecosystems. Increasing populations and grazing habits of wild free-roaming horses make it difficult to manage their impacts on riparian areas. We empirically quantified effects of wild horses, cattle, and wildlife on riparian habitat characteristics using game cameras to monitor riparian use. We also examined riparian vegetation and streambank disturbance each month to compare with animal occurrences. We observed overall negative impacts of wild free-roaming horses and cattle on riparian attributes, but wildlife had little effect. In areas with wild horses, land managers should consider the combined use of unmanaged wild horses with livestock to address their cumulative effects in riparian areas.

Wild Horses, Cattle, and Riparian Areas

Wild free-roaming horses (*Equus caballus*) and burros (*E. asinus*) are surrounded by controversy in the western United States. As cultural icons of the West, they hold great emotional significance, often eliciting heated debates over how they should be managed. The horses and burros that are free-roaming across the western United States are biologically feral, but are hereafter termed "wild." Wild horses and burros roam public lands in 10 western states, with large and potentially unsustainable populations in several regions. Having few natural predators, wild horse and burro herds can increase by 15% to 20% each year and double every 4 years.[1,2] Estimates of wild horse and burro populations have risen from 30,000 individuals in 2005 to about 49,000 individuals in 2014,[3,4] although there is concern this number is underestimated due to limited detection of secretive individuals.[2] This prolific growth can result in populations exceeding appropriate management levels within their federally delineated herd management areas (HMAs; Table 1). Large populations of wild horses and burros in many areas can contribute to ecological damage and increase risk of rangeland degradation.[2]

The effects of wild horses on riparian areas are a concern for many land managers. Riparian areas are ecologically important zones around rivers, streams, and lakes. Although riparian areas comprise only about 2% of western lands, they are some of the most ecologically important habitats in rangelands[5] by providing important resources for many species of wild and domestic animals such as abundant forage, cover, and water.[2] Riparian areas are also important for trapping sediment, slowing runoff, and supporting ecologically functioning watersheds. Excessive animal grazing and trampling in riparian areas can decrease sediment capture, limit infiltration, and increase the energy of water flow.[6] These hydrogeomorphic impacts can magnify erosion and down-cutting which can lead to separation of the streambed from the flood plain and decrease riparian area size.[6]

Riparian areas attract wild and dometic grazing animals because of available water, cooler micro-climates, and more nutritious and abundant forage generally staying green longer into the summer than the surrounding upland vegetation.[7,8] The negative impacts of livestock grazing in riparian zones have been well documented for nearly half a century.[6] In

Table 1. Population estimates of wild horses and burros (total estimated number of individuals) in 10 western US states in 2014 as compared with the recommended high appropriate management level (AML) set by the Bureau of Land Management to maintain healthy rangeland and resources[4]

State	Total	High AML
Arizona	4,744	1,676
California	6,008	2,184
Colorado	1,205	812
Idaho	668	617
Montana	160	120
Nevada	25,035	12,796
New Mexico	146	83
Oregon	3,180	2,715
Utah	4,292	1,956
Wyoming	3,771	3,725
TOTAL	49,209	26,684

recent decades, research has also shown that wild horses can have detrimental impacts on riparian areas.[9,10,11,12]

Wild horses and domestic cattle (*Bos taurus*) are both implicated in degrading riparian areas (Fig. 1). However, horses may have a greater impact on riparian areas than cattle because horses often have year-round access to these areas, while cattle are generally removed for part of the year (Fig. 2).[9,13,14] Though free-roaming horses are generally smaller than modern rangeland cattle, they may have a greater than expected influence on riparian vegetation because horses have a digestive system that enables greater intake per unit of body weight than cattle.[13,15] In addition, because many breeds of wild horses can go longer without water than can cattle, they often spend less time per day within riparian zones than individual cows do.[1] Therefore, to truly understand the effects of horses compared with cattle, intensity of use should be assessed to account for both the number of animals and the time spent in the area rather than strictly the number of animals using the area.

Habitats used by wild horses are also used by wildlife and livestock species, making it difficult to determine which species has the greatest influence on riparian health.[9,16] Land managers often struggle to balance rangeland health and forage allocations for wild horses, livestock, and wildlife. These difficulties are compounded by the lack of empirical information about the compounding effects of grazing by different species of herbivores. In turn, maintaining wild horse populations while sustaining healthy plant communities requires a better understanding of their role in the rangeland ecosystems they inhabit.

Figure 1. Game camera picture of wild horses (foreground) and cattle (background) using a riparian area in southwestern Idaho.

Figure 2. Game camera picture of wild horses using a riparian area in central Idaho. Note grazing exclosure on left portion of photo.

We used a modeling approach to assess the effects of varying intensity of use by different herbivores on riparian condition. Our objective was to evaluate the relative effects of wild horses, cattle, and wildlife on riparian condition. Specifically, we aimed to 1) experimentally determine individual and combined impacts of observed animal groups each month on the change in measurements of riparian condition (streambank alterations, stubble height, and herbaceous biomass); and 2) assess how the presence of one animal species might affect the presence of other species.

Study Area

We monitored eight sites in Idaho (four in Owyhee County and four in Custer County; Fig. 3) for animal intensity of use and riparian habitat characteristics during 2015. Site selection was based on recommendations from local Bureau of Land Management (BLM) professionals and ranchers, accessibility for researchers, and known animal use. We controlled for potential effects of grazing at each site by establishing exclosures as experimental controls (described below). Riparian vegetation included overstories of willows

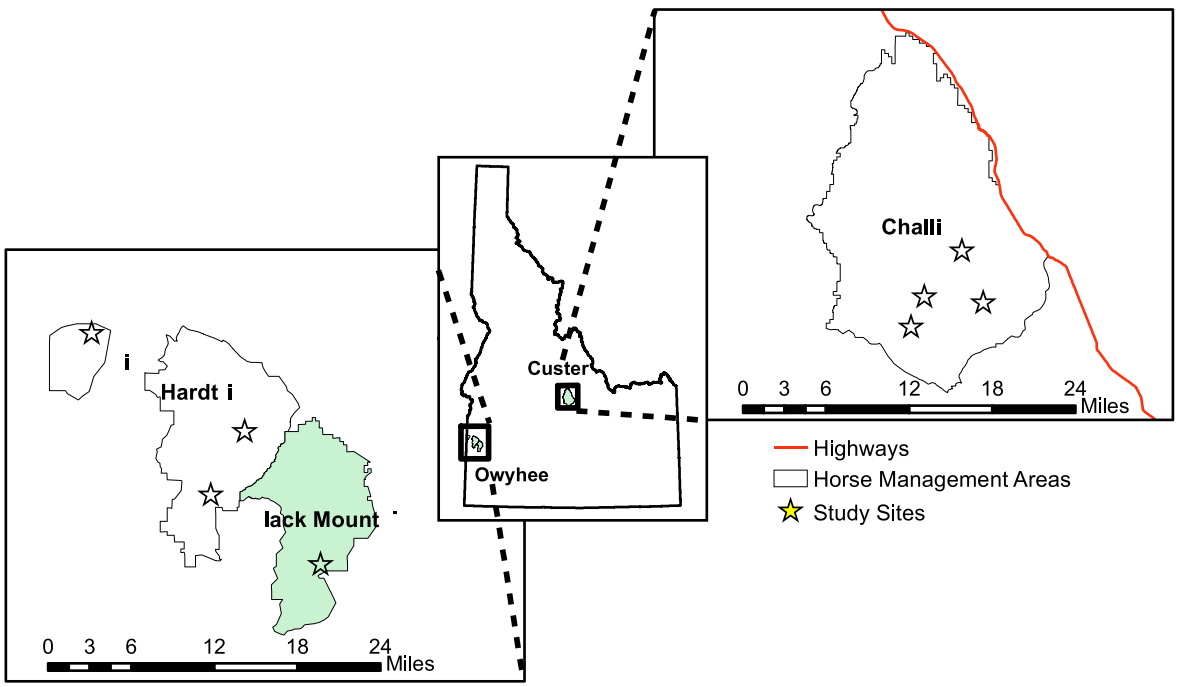

Figure 3. Study areas to assess effects of grazing ungulates on riparian areas in Idaho. Streams examined occurred in three herd management areas (HMA) in Owyhee County (i.e., Sand Basin, Hardtrigger, and Black Mountain) and the Challis HMA in Custer County.

(*Salix* spp.) and black cottonwood (*Populus balsamifera*), and understories of herbaceous plants including Nebraska sedge (*Carex nebrascensis*), beaked sedge (*C. utriculata*), Baltic rush (*Juncus balticus*), inland saltgrass (*Distichlis spicata*), and meadow barley (*Hordeum brachyantherum*).

The four study sites in Owyhee County were contained within three Herd Management Areas: Sands Basin, Hard-trigger, and Black Mountain, covering 130,500 acres with an estimated 276 horses. The streams we examined in the Owyhee area ranged from 2,100 to 6,600-feet above sea level. Precipitation at the Owyhee research sites during 2015 was 10.0 inches, occurring primarily during the winter and early spring. Only two of the four sites studied in the Owyhee area were grazed by cattle. These sites were grazed between April and July in 2015.

The four study sites in Custer County were within the Challis HMA, which covers 154,150 acres and had an estimated 218 horses. Elevations of stream reaches we studied ranged from 6,200 to 7,600 feet above sea level. The precipitation in Challis research sites in 2015 was 7.2 inches, occurring mostly between April and September. In 2015, cattle grazed on all study sites in the Challis HMA between June and September.

Animal Observations and Vegetation Monitoring

We monitored animal intensity of use and riparian habitat characteristics between April and October at each of the eight study sites. Exact monitoring times at each site varied due to weather and a wildfire that limited accessibility. Each of the eight study sites was located on BLM land and consisted of a 328-feet long stream reach, which was divided into five, 65-feet segments. Two segments along each stream reach were randomly selected for in-depth monitoring, yielding a total of 16 stream segments (two segments per study site).

We installed motion activated game cameras (Bushnell Trophy Cam HD 8MP Hybrid Night Vision Trail Cameras) to assess animal intensity of use at the study sites. We indexed intensity of use each month by counting the number of animal occurrences in each photo and categorizing the animals as wild horse, cattle, or wildlife. Wildlife species included ungulates such as elk (C*ervus elaphus*), pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), and moose (*Alces americanus*). We did not identify individual animals, but rather the total number of occurrences of each group resulting in an index of intensity of use rather than a population estimate.

We measured three characteristics of riparian habitat at each study site: streambank disturbance, vegetation/stubble height, and live herbaceous biomass. Streambank disturbance, or trampling, was estimated in 20 plots (7.8 × 19.6 inches) along each stream segment. Each plot contained five, 7.8-inch lines spaced evenly every 3.9 inches. We recorded the number of times one of the five lines intercepted a hoof print. Each line could only be counted once even if one line intercepted more than one hoof print. This methodology followed the protocol for streambank alterations in the Multiple Indicators Monitoring handbook.[17] To assess grazing effects on grasses, grass-like plants, and forbs, we selected nine plots (15.7 × 19.6 inches) in the floodplain of each stream reach. We then randomly selected three of the nine plots to be ungrazed control plots and constructed welded wire exclosures (20 × 24 inches) over these plots. The exclosures were slightly larger than the plot size and the welded wire panels were 5.5 feet tall, which we believe was enough to limit edge effects from animals reaching over the top or through the sides to graze the plot. The average vegetation height (including seed and flower stalks) was measured by gathering a 3-inch diameter area of grasses, grass-likes, and forbs, standing the leaves upright and determining the average height to the nearest centimeter.[17] Live herbaceous biomass was also visually estimated. For quality assurance, we conducted biomass calibrations at each stream reach and throughout the day for every sampling period. We achieved a 70% accuracy rate before ocular biomass estimates were recorded. Both riparian habitat characteristics, live herbaceous biomass and average vegetation height, were sampled in each plot to compare grazed and ungrazed vegetation.

To assess whether the presence of one species of animal (horses, cattle, or wildlife) was associated with riparian use by other animal species, we used Spearman's rank correlation to determine the strength, direction, and significance of the correlation between weekly observations of each species at each of the eight study sites.[18] We used mixed-effects linear regression to examine how different the intensity of use of each animal species each month affected stream bank disturbance and differences in biomass and stubble height between grazed and ungrazed plots. We modeled correlation structures of county, site, and repeated measures as random effects. We selected the model that best explained riparian changes, calculated the relative importance of each animal species, and estimated the change in riparian attributes for an increase of one individual occurrence of each animal species (i.e., the slope).

Animal Observations and Relationships

The game cameras captured 17,891 photos of animals from the end of April through October at our eight study sites, until access to the sites was prohibited by weather conditions, cameras were lost to theft, or a wildfire that occurred in Owyhee County in August 2015. Within those 17,891 photos, 44,408 animal occurrences were recorded. Of the 8,134 photos taken in the Challis area, 15,715 animal occurrences were documented, of which 15% were wild horses, 80% were cattle, and 5% were wildlife. In the Owyhee area, 9,757 photos recorded 28,693 animal occurrences, of which 35% were wild horses, 64% were cattle, and 1% was wildlife.

Due to grazing management practices, cattle were observed between April and July in the Owyhee study sites and had the most occurrences between the end of April and the beginning of May (Fig. 4). In Challis, cattle were observed between June and September, and had the most occurrences in mid-June

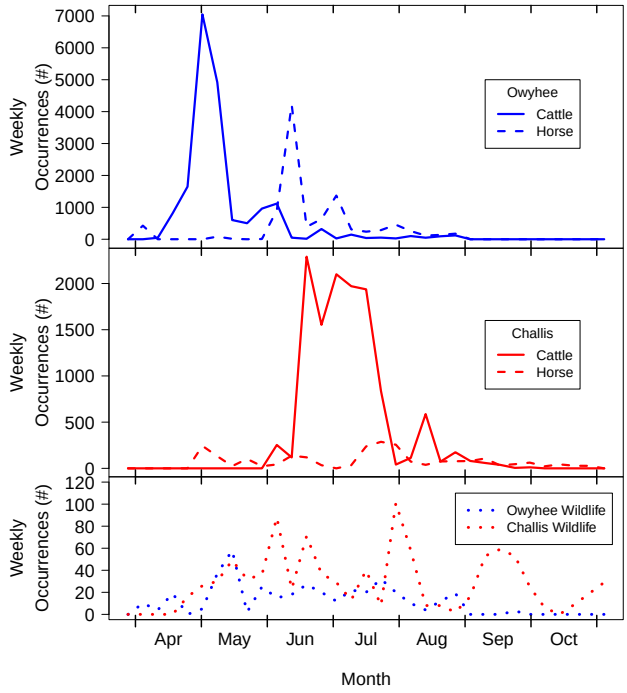

Figure 4. Animals observed on eight riparian areas managed by the Bureau of Land Management (BLM) in Owyhee and Custer Counties of Idaho. Weekly number of occurrences reflects the number animals counted in photos taken by two game cameras at each site. Cattle abundance was regulated by BLM grazing permits while horse and wildlife were not manipulated. Wildlife were observed in relatively low abundance, and were therefore split into a separate plot.

through the end of July (Fig. 4). Horses and wildlife had their highest use between mid-May and mid-September (Fig. 4). (See Fig. 5).

Our analysis did not show any evidence that use of riparian areas by one species of animal caused other species to avoid the area. In fact, there was a slightly positive relationship between horses and wildlife ($\rho = 0.24$, $P < 0.01$) and between horses and cattle ($\rho = 0.25$, $P < 0.01$), indicating that these species of animals were using riparian areas during similar times. This most likely reflects a pattern that animals were attracted to riparian areas for similar habitat features such as available water and green vegetation and that the presence of another species using the area during the month was inconsequential. We did not observe any relationship between cattle and wildlife use at our study sites ($\rho = -0.05$, $P = 0.60$).

Horse, Cattle, and Wildlife Impacts on Riparian Attributes

Overall Grazing Effects

The effects of cattle and wild horse grazing were evident in comparisons of grazed and ungrazed plots on the study sites (Fig. 5). Plant height in grazed plots was 55% lower than the paired ungrazed plots ($P < 0.001$, df = 389). Live herbaceous

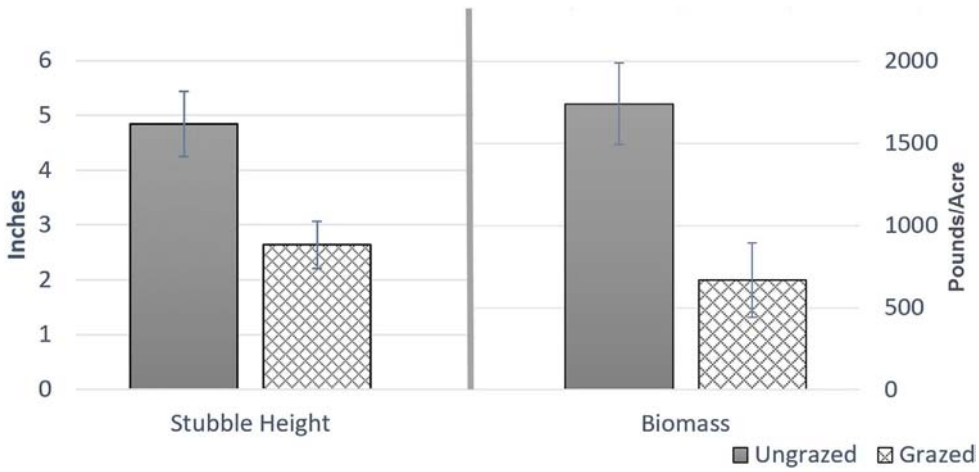

Figure 5. Comparison of vegetation stubble height and biomass in grazed and ungrazed paired plots along riparian areas in eight studies areas in Owyhee and Custer Counties of Idaho. Error bars represent 95% confidence intervals.

biomass was 2.13 oz/plot (2,693 lb/ac) lower in the grazed (1.32 oz/plot; 1,673 lb/ac) compared with ungrazed plots (3.45 oz/plot; 4,366 lb/ac), representing 62% utilization in the grazed riparian areas ($P < 0.001$, df = 389).

Streambank Disturbance

A combined effect of horses and cattle was selected as the best model affecting streambank disturbance (77% probability; Table 2). Horses were more influential than cattle, and both were much more important than wildlife relative to streambank disturbance, largely because of the greater abundance of horses and cattle compared with wildlife (Table 3). The effect of each additional individual animal occurrence, interpreted from model slopes, indicated that horses and cattle both increased streambank disturbance, but an individual horse occurrence (Slope ± 95% confidence interval [CI]; 0.016 ± 0.007) had about 4 times greater effect on streambank disturbance compared with an individual cow occurrence (Slope ± 95% CI; 0.004 ± 0.002), and an increase in 1,000 horse occurrences in 1 month could be expected to increase disturbance by 16.7%.

Table 2. Comparison of models with different sets of animal groups impacting three measures of riparian condition

Model	Probability
A) Streambank alterations ($n = 80$)	
Horse + cattle	0.773
Horse + cattle + wildlife	0.209
Horse	0.014
Horse + wildlife	0.004
Cattle	0.000
Cattle + wildlife	0.000
None	0.000
Wildlife	0.000
B) Vegetation height ($n = 228$)	
Horse + cattle	0.545
Cattle	0.203
Horse + cattle + wildlife	0.183
Cattle + wildlife	0.069
Horse	0.000
None	0.000
Horse + wildlife	0.000
Wildlife	0.000
C) Vegetation biomass ($n = 228$)	
Horse + cattle	0.507
Horse + cattle + wildlife	0.491
Horse + wildlife	0.001
Horse	0.001
Cattle	0.000
Cattle + wildlife	0.000
Wildlife	0.000
None	0.000

Note. Model probability is the relative probability of the model being the best in the set and is derived from AICc (corrected Akaikes Information Criterion) which is an index of support for a model. Models with horses and cattle consistently had the most support.

Table 3. Relative magnitude of wild horses, cattle, or wildlife on observed changes in riparian condition

	Variable Importance		
	Horse	Cattle	Wildlife
Streambank alterations	1.00	0.98	0.21
Vegetation height	0.73	1.00	0.25
Vegetation biomass	1.00	1.00	0.49

Note. Higher values mean more important effects with a maximum value of 1.00.

Vegetation Height

The combined effects of horses and cattle were also the best models describing changes in vegetation height (55% probability; Table 2). Cattle were more strongly related to stubble height reductions than were horses, and wildlife were relatively unimportant to explaining changes in stubble height (Table 3). Again, this is primarily because cattle occurred in greater numbers than horses and wildlife when there were observations of sharp reductions in stubble height. When considering the effect of an individual occurrence, horses and cattle both decreased vegetation height, but a horse occurrence (Slope ± 95% CI; -0.0009 ± 0.0008) had 1.4 times greater effect compared with a cow occurrence (Slope ± 95% CI; -0.0006 ± 0.0003), and an increase in 1,000 horse occurrences would be expected to decrease average vegetation height by 0.9 inches.

Herbaceous Plant Biomass

The combined effect of horses and cattle was also the best model to describe the effect of animal abundance on herbaceous biomass (51% probability; Table 2). Horses and cattle were the most important while wildlife were only moderately important (Table 3). Though cattle were observed at greater abundance, an individual horse occurrence (Slope ± 95% CI; -0.033 ± 0.013) had about 3 times greater impact on biomass than a cow occurrence (Slope ± 95% CI; -0.010 ±

0.005). An increase of 1,000 horse occurrences in an area over a month was estimated to decrease biomass by 32.7%.

Conclusions of Impacts to Riparian Areas

In our study, horses and cattle both affected riparian conditions, including streambank disturbance, stubble height, and herbaceous biomass. Our results complement a recent study of wild horse effects on riparian vegetation by Boyd and colleagues.[12] While they assessed grazed versus ungrazed, we were able to assess effects of intensity of use. We found that horses had a greater effect on these riparian attributes than did cattle on an individual basis. The larger effect of horses may have been caused by their greater individual forage consumption,[13,15] which has a subsequently greater impact on the vegetation. Increased forage consumption may also increase the amount of movement in riparian areas, thereby increasing disturbance from trampling.

Several studies have documented increased soil compaction and decreased water infiltration in response to use by wild horses,[16,19] which supports our observation of increased disturbance and trampling.

Our conclusions that wild horses are having the greatest effect per animal occurrence on change in herbaceous stubble height agrees with previous studies which showed that the presence of horses significantly reduced standing biomass, species richness, and plant cover.[9,11,14] Drastic responses have been observed at the Sheldon National Wildlife Refuge in Nevada, where stubble height of ungrazed plants was nearly 10 times greater than grazed plants after wild horses were removed and grazing pressures reduced.[14] Likewise, Beever and Bussard[9] compared plant heights in upland meadows grazed by only horses, by horses and cattle, or not grazed by either. Plant heights in areas grazed by horses only were 2.8 times lower than plant heights in areas with no grazing, while plant heights in areas grazed by both horses and cattle were 4.5 times lower than those in areas with no grazing.[9] A few studies have looked at the impacts made by wild horses separately from other ungulates and have found that when present, they negatively impacted plants and plant communities through biomass removal, reducing plant species richness and cover of grasses and forbs.[9,11,12,20] Although not selected as important in our models, when included, wildlife had a positive relationship with herbaceous biomass and height, possibly indicating that wildlife are attracted to high quality riparian areas and may potentially avoid degraded habitat, leading us to believe there may be indirect effects of wild horses on wildlife. While there is probably little dietary overlap, horses may affect habitat through trampling and other disturbance. More research assessing interactions between horses, wildlife, and their habitat is needed.

Management Implications

Large grazing ungulates, such as horses and cattle, can have significant detrimental effects on riparian areas at high population levels and stocking rates. It is well known that effective management of riparian areas can be accomplished by controlling season of grazing and levels of use. Riparian management is difficult in areas with wild horses because these animals generally have year-long access to riparian areas, and levels of use or population levels are difficult to restrict. The tough management reality is that in areas with both wild horses and cattle grazing, land managers and ranchers need to account for potential additive effects. To maintain riparian productivity and ecological integrity in riparian areas grazed by both species, cattle grazing and use by wild horses will need to be carefully managed. An alternative may involve fencing to limit access to riparian areas; this could improve riparian integrity, but would limit riparian benefits to cattle, horses, and some wildlife. Balancing the needs of livestock, wild horses, and wildlife is important but challenging, and maintaining ecologically important habitats such as riparian areas may be key to ensuring sustained multiple use of rangelands.

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References

1. Beever, E.A. 2003. Management implications of the ecology of free-roaming horses in semiarid ecosystems of the western United States. *Wildlife Society Bulletin* 31:887-895.
2. National Research Council, 2013. Using science to improve the BLM Wild Horse and Burro Program: a way forward. Washington, DC, USA: The National Academies Press.
3. BLM, 2005. Public Land Statistics 2005. BLM/BC/ST-06/001+1165. Washington, DC, USA: US Department of the Interior, Bureau of Land Management.
4. BLM, 2015. Public Land Statistics 2014. BLM/OC/ST-15/005+1165. Washington, DC, USA: US Department of the Interior Bureau of Land Management.
5. Svejcar, T. 1997. Riparian zones: 1) what are they and how do they work? *Rangelands* 19:4-7.
6. Poff, B., A.K. Koestner, D.G. Neary, and V. Henderson. 2011. Threats to riparian ecosystems in western North America: an analysis of existing literature. *Journal of the American Water Resources Association* 47:1241-1254.
7. Crane, K.K., M.A. Smith, and D. Reynolds. 1997. Habitat selection patterns of feral horses in southcentral Wyoming. *Journal of Range Management* 50:374-380.
8. Swanson, S.R., S. Wyman, and C. Evans. 2015. Practical grazing management to meet riparian objectives. *Journal of Rangeland Applications* 2:1-28.
9. Beever, E.A., and P.F. Brussard. 2000. Examining ecological consequences of feral horse grazing using exclosures. *Western North American Naturalist* 60:236-254.
10. Davies, K.W., G. Collins, and C.S. Boyd. 2014. Effects of feral free-roaming horses on semiarid rangeland ecosystems: an example from the sagebrush steppe. *Ecosphere* 5:1-14.

11. Levin, P.S., J. Ellis, R. Petrik, and M.E. Hay. 2002. Indirect effects of feral horses on estuarine communities. *Conservation Biology* 16:1364-1371.
12. 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 & Management* 70:411-417.
13. Menard, C., P. Duncan, G. Fleurance, J.Y. Georges, and M. Lila. 2002. Comparative foraging and nutrition of horses and cattle in European wetlands. *Journal of Applied Ecology* 39:120-133.
14. US Fish and Wildlife Service, 2014. Sheldon National Wildlife Refuge – Wild Horse Management. Available at: http://www.fws.gov/sheldonhartmtn/sheldon/horseburro.htm.
15. Duncan, P., T.J. Foose, I.J. Gordon, C.G. Gakahu, and M. Lloyd. 1990. Comparative nutrient extraction from forages by grazing bovids and equids: a test of the nutritional model of equid/bovid competition and coexistence. *Oecologia* 84:411-418.
16. Beever, E.A., and C.L. Aldridge. 2011. Influences of free-roaming equids on sagebrush ecosystems, with focus on greater sage-grouse. *Studies in Avian Biology* 38:273-290.
17. Burton, T.A., S.J. Smith, and E.R. Cowley. 2011. Riparian Area Management: Multiple Indicator Monitoring (MIM) of Stream Channels and Streamside Vegetation. Technical Reference 1737-23. BLM/OC/ST- 10/003+1737+REV. Denver, CO, USA: US Department of the Interior, Bureau of Land Management, National Operations Center.
18. Zou, K.H., K. Tuncali, and S.G. Silverman. 2003. Correlation and simple linear regression. *Radiology* 227:617-628.
19. Beever, E.A., and J.E. Herrick. 2006. Effects of feral horses in Great Basin landscapes on soils and ants: direct and indirect mechanisms. *Journal of Arid Environments* 66:96-112.
20. Porter, K.M., C.S. DePerno, A. Krings, M. Krachey, and R. Braham. 2014. Vegetative impact of feral horses, feral pigs, and white-tailed deer on the Currituck National Wildlife Refuge, North Carolina. *Castanea* 79:8-17.

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