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You Can Lead a Horse to Water: Mapping Seasonal Water Resources to Predict Wild Horse Movements on Utah Rangelands

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Abstract
Livestock producers in Utah can be adversely impacted by competition from wild horses whose seasonal distribution is strongly influenced by the availability of temporary surface water. We used a simple analysis of Landsat imagery acquired over an 18-year period to determine the distribution and duration of surface water in Utah rangelands. The resulting maps can be used to identify conflict hotspots and prioritize management activities. Improved prediction would result from future mapping of water sources not resolved at the 30-m scale of our analysis.

Introduction

Deserts are defined not only by the lack of water, but also by tremendous year-to-year variation in the timing and amount of precipitation. Water distribution strongly influences animal movements and habitat use in these systems. A major problem on western ranges in the United States is that areas managed for wild horses overlap those managed for livestock.

Seasonal movements of wild horses (*Equus caballus*) are determined by water availability (Schoenecker et al., 2022), which varies with elevation, latitude, and from year to year. In summer, herds with access to permanent springs or stock ponds may remain relatively sedentary, whereas those without these resources may become nomadic, searching for temporary water resulting from rainfall or snowmelt. Field studies in Utah and Arizona have shown that surface water availability is the strongest determinant of habitat use for horses and livestock (Miller, 1983; Schoenecker et al., 2022). Migrating horses traverse cattle grazing allotments (areas of public land managed by federal agencies like the Bureau of Land Management – BLM - and the U.S. Forest Service -USFS - where livestock grazing is permitted), croplands, and highways, resulting in conflict with other land uses.

Wild horses and burros in Utah are managed by the BLM within congressionally designated wild horse herd management areas (HMA), all of which overlap BLM grazing allotments. In dry periods or droughts, to which the region is prone, wildlife and livestock concentrate in mesic areas, which can become problematic for farmers and livestock producers.

We aimed to map the annual distribution of temporary surface water across Utah as an aid in predicting the likely impact of wild horses on livestock grazing operations.

Methods

To estimate the extent and duration of surface water (perennial and ephemeral, combined), we employed the methods described in Feng et al. (2016). This procedure involved compiling images from the Landsat archive from May through October, 2000-2018. These months were selected as they encompass the growing season when temperatures and therefore evapotranspiration are highest, and water is most limiting to animals. This is also the driest time of year as all snow cover has melted and the only ephemeral surface water available is the result of highly sporadic summer thunderstorms. Based on these criteria, we selected all available images for the study area across this interval. This amounted to approximately 2-4 images per month at 30-m pixel resolution. We then used the Normalized Difference Water Index (NDWI) to detect areas of water cover. This index uses near-infared (NIR) to distinguish water from soil or vegetation, as water strongly absorbs NIR, whereas vegetated surfaces reflect this wavelength. The NDWI is defined as [NIR-Red]/ [NIR+Red]. Index values range from -1 to 1, with negative values indicating water cover (McFeeters 1996).

To estimate the duration of surface inundation, we overlaid all images compiled between 1 May and 31 October and calculated the proportion of time each pixel displayed evidence of surface water using NDWI < 0 as our threshold. Thus, a pixel with NDWI values < 0 for the entire 6-month duration would be indicative of perennial water, and proportions less than 100% would be indicative of corresponding degrees of ephemeral water cover. Some localized water sources could not be detected at 30-m resolution, so our estimates are biased low.

To estimate the number and areal extent of public-lands grazing allotments potentially affected by wild horses, we used spatial data from the Utah Automated Geographic Reference Center (AGRC: https://gis.utah.gov/). This dataset delineates all allotments designated for grazing on USFS or BLM land. Attributes include the area (in acres) and the species of livestock that are permitted. We then overlaid HMA polygons, to determine the identity and size of all grazing allotments that fell within any HMA. Lastly, we overlaid this new data layer on the water rasters described above to calculate the amount and duration of water on each allotment.

Results

Within the state of Utah, there are approximately 9,709 grazing allotments, covering 57,566 square miles of federal and state rangelands (BLM, USFS and State Institutional Trust Lands Administration). Of these, 1,651 (17%) fall within 6 miles (9.7 km) of a HMA, representing 27% of all grazing lands by area. The number of allotments and total grazing area are inversely related to the seasonal duration of surface water (Table 1). Allotments on which water is only available for approximately 10% of the growing season account for 24% of rangelands within the 6-mile buffer while those with perennial surface water (available for $> 90\%$ of the growing season) account for only ~ 5%. Figure 1 illustrates this relationship.

Table. 1. The proportion of the growing season during which the ground is covered by water (1 May to 31 October). This does not include manmade sources, such as guzzlers, stock ponds, or leaking pipes. The number of allotments is determined by a six-mile buffer around each HMA.

Water present (days)	Proportion growing season	No. allotments	Total area of grazing allotments (mi^2)
18	10%	940	13,472
37	20%	495	9,163
55	30%	326	7,811
73	40%	240	6,479
92	50%	199	5,162
110	60%	170	4,507
128	70%	141	3,501
146	80%	122	3,115
165	90%	88	2,671

The distribution of water, grazing allotments, and vulnerability to competition with wild horses were not distributed evenly across the study area (Table 2).

Discussion

Horses in the American West typically travel > 6 miles per day in search of forage and water. Approximately 17% of public lands grazing allotments fall within this distance of a HMA, representing 27% of all grazing lands, by area. Since this figure does include some allotments potentially affected, or account for horses moving on and off tribal, military, or national park lands, it probably underestimates the number of allotments affected. Competition between wild horses and free-ranging livestock thus has the potential to affect many Utah producers, especially when consumption of forage by horses prevents ranchers from returning their livestock to grazing allotments in the spring after the traditional winter rest.

Areas in which water is reliably available are likely to experience a disproportionate amount of crop depredation and competition for water from wild horses. We found that only about 5% of the area grazed within the HMA buffers had water available for 90 % of growing season (although water can also be permanently available from other natural and anthropogenic sources). Conversely, the 24% of the grazing area that has water available for only 10% of the growing season is likely to experience a much lower level of conflict.

Our approach provided a quick assessment of the locations and times when ranchers may be impacted by wild horses. Managers can use these maps to identify conflict hotspots, provide proactive deterrents during droughts, prioritize fence constructions and maintenance, and establish range monitoring stations to evaluate grazing impacts. Future mapping of water sources that were not resolved at the 30-m scale would further refine our predictions.

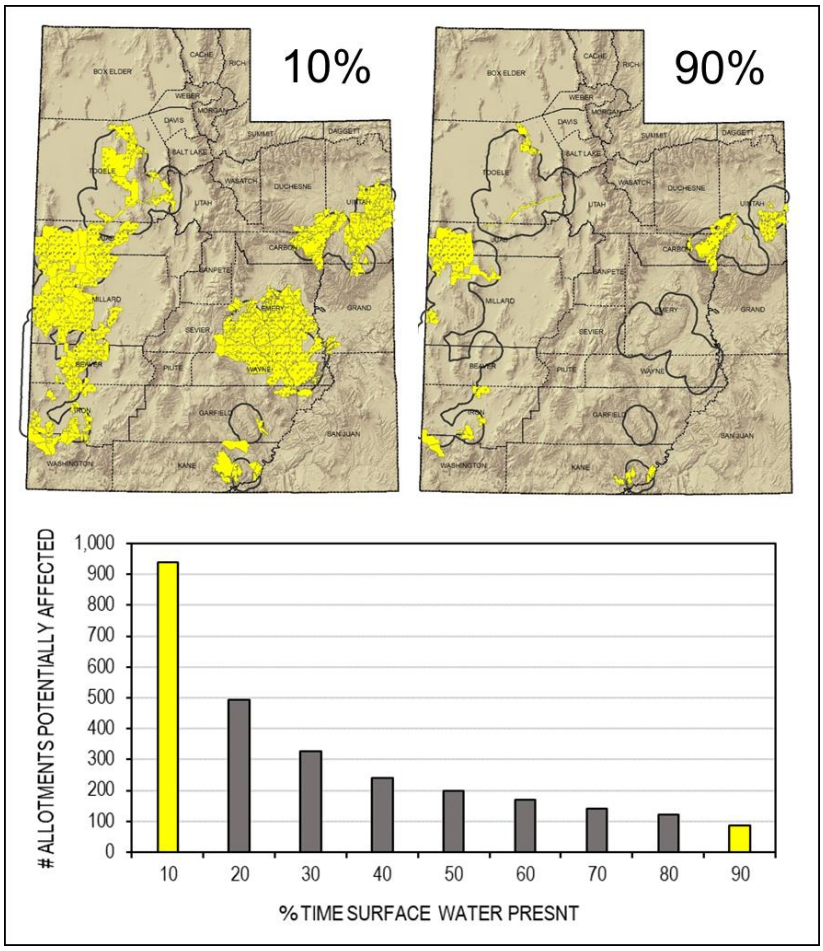

Figure 1. Relationship between the number of grazing allotments within a 6-mile buffer of HMAs and duration of surface water. Yellow bars represent the driest (10%) and wettest (90%) conditions (i.e. only ~ 100 allotments have surface water present for 90% of the growing season). Maps illustrate the distribution of grazing allotments that could be affected by wild horses for corresponding periods.

Table. 2. The number, proportion of total, and area of grazing allotments potentially affected by wild horses. All figures are for allotments within 6 miles of a HMA.

	GRAZING ALLOTMENTS		
COUNTY	NO.	PROPORTION OF TOTAL	AREA (km^2)
Beaver	221	21%	678
Carbon	10	1%	351
Emery	162	15%	2,200
Garfield	10	1%	237
Iron	126	12%	1,039
Juab	66	6%	1,708
Kane	2	0%	77
Millard	141	13%	3,177
Tooele	148	14%	2,205
Uintah	127	12%	1,363
Wayne	44	4%	1,038
TOTALS:	1057		678

References

Feng, M., Sexton, J. O., Channan, S., & Townshend, J. R. (2016). A global, high-resolution (30-m) inland water body dataset for 2000: First results of a topographic-spectral classification algorithm. *International Journal of Digital Earth, 9,* 113–133.

McFeeters, S. K. (1996). The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features. International Journal of Remote Sensing 17:7, 1425-1432.

Miller, R. (1983). Habitat use of feral horses and cattle in Wyoming's Red Desert. *Journal of Range Management, 36,* 195–199.

Schoenecker, K. A., Esmaeili, S., & King, S. R. B. (2022). Seasonal resource selection and movement ecology of free-ranging horses in the western United States. *Journal of Wildlife Management,* e22341.