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**Western
Watersheds
Project**

Working to protect and restore Western Watersheds and Wildlife

March 14, 2022

Sent via email and ePlanning this date

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**RE: DOI-BLM-AZ-A010-2022-0005-EA
Sullivan Canyon Allotment (#AZ04810) Water Development EA**

“My experience forces me to the assertion that the diminution of the flow of springs and streams in Arizona is due more to the destruction of brush, grass or herbage, than the destruction of forests proper. I would not be understood as opposing the pasturing of public lands as a principle, but it cannot be denied that the free ranging of stock on public domain is measurably responsible for the unfavorable conditions which we find on the watershed today.”
(American Forestry Association. 1902)

The following comments are submitted on behalf of Western Watersheds Project, Grand Canyon Trust, Sierra Club – Grand Canyon Chapter, and Wilderness Watch.

The staff and members of Western Watersheds Project (WWP) are concerned with the management of our public lands. WWP is a nonprofit organization dedicated to protecting and restoring western watersheds and wildlife through education, public policy initiatives, and legal advocacy. With members and supporters throughout the United States, including Arizona, WWP actively works to protect and improve upland and riparian areas, water quality, fisheries, wildlife, and other natural resources and ecological values. We work throughout the West, advocating for watersheds, wildlife, and ecological integrity. WWP’s staff and members are concerned with the management of public lands throughout Arizona, including those lands located in the Arizona Strip Field Office of the Bureau of Land Management (Bureau) and specifically on the Sullivan Canyon Allotment.

Wilderness Watch is a national wilderness conservation organization focused on the protection of all units of the National Wilderness Preservation System, including the Paiute Wilderness. Our work is guided by the visionary 1964 Wilderness Act (16 U.S.C. 1131- 1136).

The Grand Canyon Trust’s mission is to safeguard the wonders of the Grand Canyon and the Colorado Plateau, while supporting the rights of its Native peoples.

The Sierra Club’s mission is “to explore, enjoy, and protect the wild places of the earth; to practice and promote the responsible use of the earth’s ecosystems and resources; and to educate and enlist humanity to protect and restore the quality of the natural and human environments.” Inspired by nature, the Sierra Club’s more than 3.5 million members and supporters work together to protect our communities and the planet. Our members have a significant interest in this proposed action as we care deeply about the protection of wilderness values.

Wilderness Impacts

The Wilderness Act of 1964 defines Wildernesses as areas where “in contrast with those areas where man and his own works dominate the landscape... the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain.” 16 U.S.C. § 1131(c). It further provides:

An area of wilderness is further defined to mean in this chapter an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Id. Agencies charged with managing Wilderness are charged with preserving “wilderness character” under the Act. *Id.* § 1133(b).

The Wilderness Act generally prohibits nonconforming uses that degrade wilderness character. The Act provides that “[e]xcept as specifically provided...and subject to existing private rights, there shall be no commercial enterprise and no permanent road¹ within any wilderness area.” *Id.* § 1133(c). It further provides that “except as necessary to meet minimum requirements for the administration of the area for the purpose of this chapter...there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.” *Id.* (emphasis added).

¹ The use of the word road in the PA for the Paiute Trail and the path from Pocum Cove to the proposed Sullivan Spring Tank suggests an existing violation of the Wilderness Act. We address this more below.

While some limited nonconforming uses are allowed, which do detract from Wilderness, the agencies are to administer such uses in ways that these uses have the least impact on Wilderness. Thus, nonconforming uses like grazing must be “subject to such reasonable regulations as are deemed necessary” by the agency in order to minimize impacts to Wilderness and wilderness character. *Id.* § 1133(d)(4).

This project would add over a mile of buried pipeline to the already existing Sullivan Spring pipeline to move water 800 feet uphill to a 4,500 gallon storage tank that is 8 feet wide and 12 feet high. The pumping of water uphill requires the installation of eight 3.5 feet x 5.5 feet solar arrays each of which will be installed on 4 metal poles. The 4,500-gallon storage tank may or may not be partially buried. All of this will be installed in designated wilderness.

According to BLM Manual 6340 on Management of Designated Wilderness Areas, there are ten “Prohibited Uses” in Wilderness Areas. These include temporary roads, motor vehicles, motorized equipment, and installations, all of which are proposed as part of this project. We are not aware of any exceptions to the Prohibited Uses for this project in existing legislation. Please let us know if we are mistaken on this point. Prohibited Uses may be allowed where valid existing rights exist. BLM Manual 6340 1.6.B.3.b (at page 1-16) states:

In general, valid existing rights must have been:

- i. in existence on the date of the wilderness designation or on a date provided for in the act that designated the area as wilderness; and have been either:
 - a. created by legally binding conveyance, lease, deed, contract, or other document;
 - or
 - b. otherwise provided for by Federal law.

Regarding grazing in particular, BLM Manual 6340 states that the continuation of grazing applies to “the use and maintenance of livestock management development and facilities that were associated with the grazing activity at the time of designation and have been authorized by the BLM.” (p. 1-28) Regarding grazing facilities, Manual 6340 states: “*Structures and installations used for livestock management existing at the time of designation* may be maintained. Maintenance may be done by the occasional use of motorized equipment where:

- A. practical non-motorized alternatives do not exist; and
- B. the motorized use is expressly authorized in the grazing permit and advanced written permission for each maintenance activity is granted by the BLM; and
- C. the motorized use was allowed prior to wilderness designation.” (p. 1-28)

The Bureau states that the existing corral, tank, and troughs were authorized in 1938 and pre-date the designation of the Paiute Wilderness in 1984. However, the Bureau fails to mention that many components of the proposed project did not exist in 1938 and were not installed in the Paiute Wilderness at the time of its designation in 1984. Proposed new infrastructure in the Wilderness includes at least 5,405 feet of pipeline, a 4,500-gallon water storage tank, solar pump, 550-gallon reservoir pump tank, and 8 solar panels.

The proposed action includes burying the pipeline “along an existing road/trail that leads to an existing trough approximately 500 feet south of Sullivan Spring, which is where the pipeline currently terminates” (p. 2). This seems to imply that the current pipeline from the spring to the trough is not buried. We request that the Bureau clarify whether this is correct. If it is, burying the pipeline would constitute new disturbance, and would not merely be maintenance of existing infrastructure. Thus it appears that this would not be permitted under wilderness management legislation, regulation, and policy.

The proposed action states: “The pipeline extension would follow the road south to an existing corral” (p. 2). This pipeline extension would constitute new infrastructure not in place at the time of Wilderness designation, and thus appears to not be permitted under wilderness management legislation, regulation, and policy.

Indeed, Bureau policy permits new structures “only for the purpose of enhancing the protection of wilderness character.” BLM Manual 6340 1.6.C.8.d.iii, page 1-29. There is no indication in the PA that this project is for a wilderness purpose. Any future determination of need would appear to be a *post hoc* rationalization rather than a real wilderness need.

The proposed action states that a solar pump, 550-gallon reservoir tank, and eight 3.5' x 5.5' solar panels would be installed at the spring location to pump water up an 800-foot rise to reach the proposed 4,500-gallon storage tank at the existing corral (p. 2). The solar pump, 550-gallon reservoir tank, eight 3.5' x 5.5' solar panels, and 4,500-gallon storage tank would all constitute new infrastructure not in place at the time of Wilderness designation, and thus appear to not be permitted under wilderness management legislation, regulation, and policy.

Regarding the solar pump, in addition to the considerations in the above paragraph, the pump constitutes motorized equipment. BLM Manual 6340 defines motorized equipment as: “Any machine that applies force by transferring energy from a motor, engine, or other non-living power source”, and explicitly identifies solar as a prohibited power source (p. 1-13). Thus, to allow such a Prohibited Use, the Bureau must demonstrate that such use was in existence on the date of the Wilderness designation **and** that such rights were created by a legally binding document, or otherwise provided for by Federal law. We doubt that this is the case for the solar pump.

In the context of both the pipeline from the spring to the existing trough, and the pipeline extension to the existing corral, the proposed action refers to a road, when there is no authorized motorized route in the location. It appears that this refers to the Paiute Trail, which is a non-motorized trail in the Paiute Wilderness. The proposed action states: “The proposed water development would require administrative access for construction and maintenance via the BLM Paiute Trail 1551. The proposed action would also include future maintenance activities for the project” (p. 2). Thus it appears that the Bureau is proposing to authorize motorized use, both now and into the future, on a non-motorized trail in the Paiute Wilderness. As cited above, the use of temporary roads, motor vehicles, and motorized equipment are all Prohibited Uses in Wilderness. The Bureau has not demonstrated that a valid existing right exists for any of these uses. In order to do so, Bureau must demonstrate that motorized use of the proposed route was in existence on the date of the Wilderness designation **and** that such rights were created by a legally binding document, or otherwise provided for by Federal law. In order to authorize motorized use just for maintenance purposes (which the proposed action goes far beyond), practical

non-motorized alternatives must not exist, the motorized use must expressly be authorized in the grazing permit, **and** such use must have been allowed prior to Wilderness designation.

For these reasons, we believe that the proposed new infrastructure, disturbance, and motorized use within the Paiute Wilderness is not permitted under wilderness management legislation, regulation, and policy, including the Wilderness Act of 1964, Arizona Wilderness Act of 1984 (PL 98-406), and BLM Manual 6340 on Management of Designated Wilderness Areas. Thus the Proposed Action should not be undertaken, and instead no action should be taken.

Spring Impacts

We are concerned about the potential effects that pumping would have on the spring. The Bureau does not have a comprehensive understanding of the hydrology of the watersheds in the Paiute Wilderness. The goal of spring management should be to maintain ecological structure and function of the spring habitat in part by stabilizing discharge. Springs should not be subjected to impacts that change functional characteristics. In the southwest, these features are under threat in part due to water diversions like the proposed action, which can partially or completely dewater springs. Pursuant to NEPA, the EA must include an analysis of the indirect and cumulative impacts to the natural resources from dewatering the natural riparian area, and to the area where the trough will be. The Bureau must comply with NEPA's hard look requirement by analyzing the existing hydrological conditions at the spring, including a clear delineation of how much water flows from the spring, how much water will be used annually as a result of the project, how much water will be returned back to the spring, and how the water removal will affect the riparian area supported by the spring. These factors constitute the most critical analysis in determining the direct environmental impacts of the proposed project. A hydrologist should be contracted to prepare a hydrologic assessment estimating how much water the spring system contains. Without this empirical analysis, the Bureau and the public have no way of determining whether the project will result in adverse environmental impacts, what the result of those impacts might be and whether those impacts are acceptable in light of the requirements set out in NEPA, the Federal Land Policy and Management Act (FLPMA), and the Wilderness Act.

Tribal Consultation

As the Bureau is aware, it must consult with all Indigenous tribes with cultural connections to this landscape before proceeding. Due to the potential of this project to eliminate traditional springs, which are often of significant cultural importance, the Bureau should offer a field trip to tribal representatives. This would allow tribal members to identify the cultural importance of the springs and the forms of life they contain. The loss of such culturally significant sites is a potentially significant impact, and the Bureau cannot determine that the project would have no significant impacts without first ascertaining whether these springs have cultural importance to interested tribes. We recommend that the Bureau allow extra time for this process, especially in light of the COVID-19 pandemic, its impact on Tribal communities, and possible travel restrictions from Tribal governments.

We recommend that the Bureau follow best practices for Tribal consultation.² Federal agencies should proactively consult and coordinate early with Tribes when considering the planning of Federal projects and require free, prior, and informed consent of the Tribe (as stated in the UNDRIP) before proceeding with any project.” This goes beyond sending a letter to a “Tribal Leader” and means building sustained, reciprocal, relationships that go beyond the bounds of project-specific consultation.

Cheatgrass and Impacts Around Water Developments

Cheatgrass (*Bromus tectorum*) and other weedy species such as Russian thistle (*Salsola* spp.) are of particular concern with regard to this project. A recent fieldtrip to the nearby³ Sullivan Tank and Mud and Cane allotments showed that hundreds of acres that have been disturbed by fire and grazing and are now dominated by these exotic species (see below). There is a real danger of the expansion of these species onto nearby areas that are disturbed by construction activity, especially near the spring.

Damage around water source, Mud and Cane allotment 11/2/2021



Russian thistle and cheatgrass flat in Sullivan Tank allotment, 11/3/2021



In addition, introducing greater livestock concentration around the new water development will increase impacts to soils, vegetation, surface hydrology, and any cultural sites in the area. Cattle can do extensive damage to resources directly around the water source, and these impacts continue in lessening degrees for some distance from that point. There are a variety of studies on the effects of water sources on surrounding vegetation and soils. Holechek et al. (2001)⁴ indicated that, depending on topography, areas of severe degradation, or “sacrifice areas” occur around water sources, including water developments, which can extend from one mile to several miles from water sources. Holechek et

² <https://www.achp.gov/sites/default/files/reports/2018-06/ImprovingTribalConsultationandTribalInvolvementinFederalInfrastructureDecisionsJanuary2017.pdf>

³ We are well aware that these allotments are not within the project area, but they are nearby and represent the likely conditions on the project area.

⁴ Holechek, Jerry L., Rex D. Pieper and Carlton H. Herbel. 2001. Range Management: Principles and Practices, Fourth Edition. Prentice-Hall, New Jersey. 587p

al. (2004)⁵ noted the effects of water developments on forage production and native bunchgrasses, including that nearly 100 percent of forage is used around water developments and this decreases with increasing distance from water. In studies from New Mexico, under moderate grazing intensities, forage production was most severely reduced in the zone 0.5 miles from water. Researchers noted that “perhaps the greatest problem with additional water developments is degradation of rangeland in high ecological condition.” They noted further that they “...observed the degradation of many publicly owned, high condition rangelands when permanent water developments were installed.”

Rinehart and Zimmerman (2001)⁶ analyzed the effects of water developments for livestock on total species, native bunchgrasses, decreasers, increasers, perennials, native species, vegetation structure, and grass production. They found that vegetation and soils within a one mile radius of water developments are adversely affected.

Similarly, Wild Utah Project conducted measurements of habitat structure for sage grouse on transects radiating out from new water troughs in the Duck Creek allotment in Rich County, Utah, three years after installation. Canopy cover of shrubs, forbs and grasses and ground cover of forbs, grasses and bare soil were measured. Compared to ungrazed sites, vegetation canopy cover was lower and bare soil was higher in the areas around troughs.⁷ Their results validate the results of Holechek et al. (2004) indicating that damage from trough influence indeed covers large areas and as, Holechek et al (2001) said, up to a mile from the water source. This constitutes a significant area of disturbance per water development in which plant community structure attributes that are important to wildlife. Therefore, the Bureau cannot assume, without empirical evidence, that this action would achieve and maintain healthy rangelands. The effects of water sources from existing and proposed water developments must be fully evaluated in the forthcoming EA.

Additional Questions and Concerns

The EA should include an analysis of the cumulative impact of potential destruction of biocrusts by analyzing the following:

- the current status of biological soil crusts within a ¼ mile radius of the proposed troughs, where livestock are most likely to congregate;
- the potential destruction to existing biocrust;
- the loss of carbon storage and its contributions to climate change.

Please disclose whether the permittees for this allotment hold the requisite base property or water.

Please disclose whether the permittees are in good standing: have bills been paid and paid in a timely manner? Is all range infrastructure maintained in good condition? Has there been unauthorized livestock use by the permittees, whether officially documented or handled “informally”?

⁵ Holechek, J.L., R.D. Pieper and C. Herbel. 2004. Range Management Principles and Practices – Fifth Edition. PearsonPrentice-Hall, New Jersey. 607p

⁶ Rinehart, S.M. and A.F. Zimmerman. 2001. The Bullseye Study: A Quantitative and Qualitative Assessment of Vegetation Community Characteristics Observed as a Function of Distance from Water on the Little Missouri National Grassland, Western North Dakota. 34p. U.S. Forest Service Region I, Missoula, Montana.

⁷ http://www.thewildlifeneeds.com/wp-content/uploads/2013/05/DCreekReport_Final_03_04_13.pdf

Please disclose the cumulative impacts of all range infrastructure projects in this watershed.

Please disclose how many range infrastructure projects have been authorized in the past 48 months in the area managed by the Arizona Strip Field Office.

We cannot find a recent Land Health Evaluation (LHE) for this allotment and it appears the last LHE was in 2010. At that time the allotment was progressing towards, but not meeting, Land Health Standards and the causes were not determined. Please provide any LHE that post-dates the 2010 LHE we are aware of and disclose whether the causes for not meeting Land Health Standards have been determined and if so, what are those causes and when was this determination last made.

This allotment was last reauthorized in 2015 via FLPMA 402(c)2's provision which authorizes the renewal of the permit as long as there are no changes to the permit. This permit will expire in 2025, just three years from now. It seems to be pre-decisional at this point to authorize the installation of this significant amount of grazing infrastructure for a permit on an allotment that may not be renewed in short order.

What wildlife will benefit from this project other than huntable wildlife? How will the livestock grazing supported by the water development harm the wildlife this water development is supposedly going to benefit?

The scoping notice makes clear that current water distribution is not adequate for current livestock use. In light of this admission that the allotment is not suitable for livestock, the Bureau must disclose how current livestock use without adequate water distribution has harmed the natural resources on the allotment.

Is seems these lands are unsuitable for livestock grazing given how arid they are. Why is the public being asked to bear the ecological costs of this private business operation?

Please disclose the anticipated costs for this infrastructure project.

How much money has the permittee received for livestock infrastructure in the past 10 years for this or any other allotments managed by the Bureau This information is relevant because the public has a right to know how much it actually costs to support livestock grazing on federally managed public lands. WWP would like to have a better understanding of exactly how much federal money this particular permittee has received for this particular allotment for livestock and we would also like an explanation as to.

What are the impacts of this project on wildlife and native plants? For example, wildlife are directly negatively impacted by water developments from crushing and displacement during construction, and drowning after the tanks are filled when the tanks are not properly maintained. Wildlife are indirectly impacted when people leave trash at the water developments or use tanks a target shooting backdrops. Please disclose any and all anticipated impacts.

How will this project impact visual resources on the allotment?

What is the current categorization of this allotment? (Maintain, Improve, At Risk?)

How often will the pipeline require repair or replacement?

What is the cost of repairing or replacing the pipeline?

Please disclose the anticipated cost of burying the pipelines.

Will native plants have time to regenerate (anticipated at 3-5 years) between replacement or repair of the pipeline?

Are there areas of this allotment that are currently not used by livestock? How would this project change that use?

What is the date of the Allotment Management Plan for this allotment?

What is the forage availability?

What are the forage species?

How will this project increase the spread of non-native invasive species of plants?

What are the impacts of the proposed project on native plants, especially rare plants?

What are the impacts of the proposed project on soils?

How often is this allotment monitored? When was the last time the allotment was monitored?

Have the permittees made full use of their permitted AUMs for the past 10 years?

As for alternatives, we recommend the Bureau consider an alternative that does not authorize this massive water development project and instead reduces livestock grazing on the allotment to match the capacity of the land and water to support livestock.

At the earliest opportunity the Bureau should engage in a NEPA process that would allow for the voluntary and permanent retirement of this grazing allotment. If it is possible to include a voluntary retirement provision in this NEPA process, the Bureau should include it.

Please explain how the impacts of this proposed project are not undue or unnecessary.

We are concerned that authorization of livestock on this allotment may be in violation of the Resource Management Plan (RMP) for the Arizona Strip Field Office. The RMP indicates that the Management Status of this allotment was "I" (Improve) and that current management was "Deferred." AZ Strip Field Office RMP Appendix C at C-3. MA-WS-06 (at page 2-8 of the RMP) states that the Arizona Standards for Rangeland Health will be followed to maintain or improve soil conditions. Since at least 2008, livestock grazing has been negatively impacting the lands managed on this allotment, but the

Bureau has failed to adequately protect these lands from those impacts. Drought has increased since 2008, yet instead of reducing the number of cows on the allotment, or even reducing the number of AUMs, the Bureau instead intends to ensure livestock grazing will occur throughout more of the drought-stricken lands by installing artificial waters to “better distribute” livestock and the impacts of that expanded grazing. MA-TE-28 (at page 2-42 of the RMP) requires the Bureau to relocate livestock developments to avoid harm to special status plants. Here, the Bureau is planning to *install* a livestock development which may be within close proximity to special status plants.

What is the Visual Resources Management Class for the project area? It should be VRM I, which requires the Bureau to preserve the existing character of the landscape, allow only natural ecological changes, allow *very limited* management activity, allow a *very low* level of change, and any management actions *must not attract attention*.

How will the installation of the solar panels and tank impact visual resources? Is there an alternative that would impact visual resources less than the proposed project? We recommend an alternative that does not include the solar panels or large storage tank. The Bureau indicates in the scoping letter that trees may be used to screen the panels and/or tank. Will the trees impact the effectiveness of the solar panels? Will the trees screen the panels and the tank from one side or multiple sides? How will this impact visual resources from all sides? Is the plan to screen the visual impact from the road? If so, how will this be effective in the designated wilderness area? Will recreational users continue to be impacted if they approach the area from someplace other than the road? If so, what are those impacts? How will someone who has exerted great effort to recreate in a wilderness area be impacted by finding mechanized and motorized equipment in a wilderness area?

What is the Recreation Management Zone for the project area?

There does not appear to be a provision in the RMP that allows for new infrastructure projects related to livestock grazing within designated wilderness areas. This project will exceed the “low” threshold for changes to the characteristic of the landscape. The Desired Future Conditions for this area is stated as, “[t]he first and dominant goal will be to provide for the long-term protection and preservation of the areas’ wilderness character under a principal of non-degradation. The areas’ natural condition, opportunities for solitude, opportunities for primitive and unconfined types of recreation, and any ecological, geological, or other features of scientific, educational, scenic, or historical value present will be managed so that they remain unimpaired...The wilderness resource will be a dominant factor in all management decisions where a choice must be made between preservation of wilderness character and visitor use...The fourth goal will be to manage non-conforming but accepted uses permitted by the Wilderness Act and subsequent laws in a manner that will prevent unnecessary and undue degradation of the areas’ wilderness character. Nonconforming uses are the exception rather than the rule; therefore, emphasis will be placed on maintaining wilderness character.” AZ Strip Field Office RMP, Chapt. 2, Table 2.15, page 2-115, DFC-WM-01, 02, 03, and 04. The Objectives from the RMP include protection and enhancement of the wilderness character. *Id.* DFC-WM-05.

Additional References for Consideration and Inclusion in the EA

We ask the Bureau to also please consider the following articles as this project moves forward. Below we provide the title of the article cited and the abstract or an excerpt from that article is included below the title.

- Abella, S.R., Guida, R.J., Roberts, C.L., Normal C.M., Holland, J.S., 2019. *Persistence and turnover in desert plant communities during a 37-year period of land use and climate change*. Ecological Monographs 00(00):e01390. Ecological Society of America.

Abstract/excerpt:

The current climate with fewer freezes, together with reduced grazing, could be among the most optimal for desert perennials in the past century, although potential response lags to continuing warming and drying are uncertain. This study of long-term elevational shifts in communities during global change is among few in deserts, and the average upward elevational shift of 6 m/ decade for species in our study is within the range reported for temperate biomes. However, the 41% of species moving downslope is unusually high. We propose that dynamics within desert perennial communities follow a core-transient species model where a site's species are either highly persistent or transient in approximately equal proportions.

Multiple global change drivers interact concurrently in some landscapes (McCarty 2001). Drivers such as land use (e.g., livestock grazing), fire regimes, and biological invasions often produce complex, interactive effects with climate (Groffman et al. 2012).

In addition to fire, grazing by livestock, the most extensive human land use covering 25% of terrestrial Earth, has influenced vegetation structure and can interact with climate change (Asner et al. 2004).

Most native plant abundance measures, such as cover and species density, increased over time, and none decreased. Seemingly paradoxically, these increases coincided with a warming and drying climate. Possible causes for the native plant increases include recovery from livestock and feral animal grazing (which was reduced and eliminated after 1994 in the study area), shifts in precipitation timing, fewer freezes, and interactions among these factors. Native grasses are among the most favored perennial species by livestock including feral burros in southwestern drylands and have increased under protection from grazing (Blydenstein et al. 1957, Abella 2008).

Responses of other plant groups could also be consistent with recovery from grazing. For example, two forbs showing among the largest temporal increases, *Mirabilis laevis* and *Lotus rigidus*, are favored forage species (Jennings and Berry 2015). Shrubs generally are less preferred forage than forbs and perennial grasses, but among shrubs, *Krameria grayi* and *Ambrosia dumosa* can be utilized by large herbivores (Blydenstein et al. 1957, Webb and Stielstra 1979, Bowers 1997, Abella 2008). Both of these species increased in cover after 1979 in our study. However, other shrubs, typified by *Larrea tridentata*, also increased and are not preferred forage (Webb and Stielstra 1979). Changes could be mediated through “nurse plant”

effects, where perennial plants provide favorable environments below their canopies for the recruitment of other plants. McAuliffe (1988), for instance, found that 67–90% of juvenile *Larrea* occurred below existing perennials even though most of the landscape was open ground. Given the importance of nurse plants to the recruitment of *Larrea* and other species, increased total cover of perennials and the resulting increase in potential nurse plants could increase favored and non-favored forage species alike.

The increase in species diversity that we observed after livestock grazing stopped would be consistent with recovery under some models of grazing effects in global ecosystems. For example, one model holds that species diversity increases with reduced grazing pressure in lowresource environments with a short-history of grazing (Cingolani et al. 2005). Under this scenario, removal of grazing would increase diversity rather than decrease it, opposite the prediction for more productive biomes with a long history of grazing.

The overall increase in native plant abundance has coincided with a period generally characterized by protection from livestock grazing, rising atmospheric CO₂ concentration, warming temperatures, and multi-year extremes of precipitation. While the potential importance of these factors or their interaction in changing desert communities remains poorly understood, it seems clear that the overall set of growing conditions during the last several decades in many protected areas of hot deserts has been favorable for many perennial species [in the absence of livestock grazing].

- Allington, G.R.H. and T. J. Valone. 2011. Long-term livestock exclusion in an arid grassland alters vegetation and soil. *Rangeland Ecology Management* 64(4):424-428.

Abstract/excerpt:

Changes in soil and vegetation due to livestock grazing are occurring in arid lands throughout the world. The most extreme cases result in desertification, which is seen as largely irreversible, because of altered soil properties. To understand better how long-term livestock removal affects soil properties and vegetation, we compared water-infiltration rates, soil bulk density, and perennial grass cover inside and outside a long-term livestock enclosure in an arid grassland site in southeastern Arizona, United States. The site had not been desertified at the time of this study. Exclusion of livestock for 40 yr was associated with lower bulk density and higher water infiltration in both the dry and wet seasons. Perennial grass cover was higher and two native grasses, *Eragrostis intermedia* and *Bouteloua hirsuta* were significantly more common ($P < 0.05$) in the ungrazed area. These findings parallel our results from a desertified site and suggest that changes in soil physical properties associated with long-term livestock removal are not an artifact of desertification and can take place in a system that has remained in a grassland state. Our data suggest that, although significant changes in species composition have occurred, this grassland is relatively resilient to substantial changes in soil physical properties.

- Brice, E. M., B. A. Miller, H. Zhang, K. Goldstein, S. N. Zimmer, G. J. Groszklos, P. Belmont, C. G. Flint, J. E. Givens, P. B. Adler, M. W. Brunson and J. W. Smith. 2020. *Impacts of climate*

Abstract/excerpt:

Although natural resource managers are concerned about climate change, many are unable to adequately incorporate climate change science into their adaptation strategies or management plans, and are not always aware of or do not always employ the most current scientific knowledge. One of the most prominent natural resource management agencies in the United States is the Bureau of Land Management (BLM), which is tasked with managing over 248 million acres (>1 million km²) of public lands for multiple, often conflicting, uses. Climate change will affect the sustainability of many of these land uses and could further increase conflicts between them. As such, the purpose of our study was to determine the extent to which climate change will affect public land uses, and whether the BLM is managing for such predicted effects. To do so, we first conducted a systematic review of peer-reviewed literature that discussed potential impacts of climate change on the multiple land uses the BLM manages in the Intermountain West, USA, and then expanded these results with a synthesis of projected vegetation changes. Finally, we conducted a content analysis of BLM Resource Management Plans in order to determine how climate change is explicitly addressed by BLM managers, and whether such plans reflect changes predicted by the scientific literature. We found that active resource use generally threatens intrinsic values such as conservation and ecosystem services on BLM land, and climate change is expected to exacerbate these threats in numerous ways. Additionally, our synthesis of vegetation modeling suggests substantial changes in vegetation due to climate change. However, BLM plans rarely referred to climate change explicitly and did not reflect the results of the literature review or vegetation model synthesis. Our results suggest there is a disconnect between management of BLM lands and the best available science on climate change. We recommend that the BLM actively integrates such research into on-the-ground management plans and activities, and that researchers studying the effects of climate change make a more robust effort to understand the practices and policies of public land management in order to effectively communicate the management significance of their findings.

- Bahre, C.J. and M.L. Shelton. 1993. Historic vegetation change, mesquite increases, and climate in southeastern Arizona. *Journal of Biogeography* 20: 489-504; Brown, J.H., T.J. Valone, and C.G. Curtin. 2007. Reorganization of an arid ecosystem in response to recent climate change. *PNAS* 94: 9729-9733.

Abstract/excerpt:

Except possibly for increases in woody xerophytes such as mesquite, all of the identified long-term vegetation changes appear to be of anthropogenic origin. Mesquite increases, however, are irregular, show no clear relation to precipitation variations, and are most likely the result of livestock grazing and/or fire exclusion.

- Bock, C.E., J.H. Bock, W.R. Kenney, V.M. Hawthorne. 1984. Responses of Birds, Rodents, and Vegetation to Livestock Exclosure in a Semidesert Grassland Site. *J. Range Management* 37:239-242.

Abstract/excerpt:

In 1981-82, a protected upland site supported 45% more grass cover, a comparatively mixed group of grass species, and 4 times as many shrubs as an adjacent grazed site. The grazed area supported a significantly higher number of birds in summer, while numbers did not differ in winter. Rodents were significantly more abundant inside the protected area.

- Bock, C.E., J.H.Bock. 1993. *Cover of Perennial Grasses in Southeastern Arizona in Relation to Livestock Grazing*. Conservation Biology 7: 371-377.

Abstract/excerpt:

Total grass canopy cover was greater on ungrazed grasslands. Eight bunchgrass species also grew taller on ungrazed areas -- the three tallest species (*Bouteloua curtipendula*, *Bothriochloa barbinodis*, and *Eragrostis intermedia*) showed the greatest increase on ungrazed areas. Two short stoloniferous species (*Hilaria belangeri* and *Bouteloua eriopoda*) were the only taxa substantially more abundant on grazed areas. *Bouteloua gracilis*, the most abundant grass in the region, showed an intermediate response to release from grazing. Livestock grazing appeared to be an exotic ecological force in these southwestern grasslands, and one destructive of certain components of the native flora and fauna.

- Bock, C.E., J.H. Bock. 1993. *Effects of Long Term Livestock Exclusion in a Semiarid Grassland*. Pp.123-133 in Proceedings of the First Biennial Conference on Research in Colorado Plateau National Parks. National Park Service, Center for Colorado Plateau Studies, Northern AZ U., Flagstaff. P. G. Rowlands, C. Riper III, and M. K. Sogge, editors.

Abstract/excerpt:

Canopy cover of upland perennial grasses was 61% on the Appleton-Whittell Research Ranch (AWRR) and 41% on adjacent cattle ranches. Peak fall densities of grasshoppers were three times higher on grazed lands. The bunch grass lizard was the most abundant reptile on AWRR and virtually absent on adjacent ranches. Cottonrats, harvest mice, and hispid pocket mice were the most common rodents in ungrazed habitat, whereas deer mice and kangaroo rat predominated in grazed areas. Montezuma quail, Cassin's sparrows, Botteri's sparrows, and grasshopper sparrows were common breeding birds on AWRR, whereas scaled quail, horned larks, and lark sparrows were the most abundant nesting birds on grazed lands.

- Bock, Carl E. and Jane H. Bock. 2000. *Response of Winter Birds to Drought and Short- duration Grazing in Southeastern Arizona*. P. 5 in Audubon Research Ranch 2000. National Audubon Society Appleton-Whittell Research Ranch. Elgin AZ. 84 pgs. Linda Kennedy and Stephanie Seltzer, editors.

Abstract/excerpt:

Abstract reports high-density short-duration rotational grazing, coupled with a drought, left the land in a substantially denuded condition through two winters, and this in turn negatively

impacted a variety of resident and migratory birds dependent on ground cover and seed production for over-winter survival.

- Bock, Carl E. and Jane H. Bock. 2000. *Vegetative Changes in a Grass/Shrubland after Fifteen Years Without Disturbance*. P. 8 in Audubon Research Ranch 2000. National Audubon Society Appleton-Whittell Research Ranch. Elgin AZ. 84 pgs. Linda Kennedy and Stephanie Seltzer, editors.

Abstract/excerpt:

Preliminary results show that from 1985-2000 total shrub densities have decreased on Bald Hill on the Appleton-Whittell Research Ranch and that exotic lovegrasses are spreading significantly but slowly, despite the absence of fire, grazing, or other disturbance.

- Bock, Jane H., Carl E. Bock. 2002. *Wildflowers, Weeds, Precipitation, and Livestock Grazing in an Arizona Grassland*. Ecological Society of America 87th Annual Meeting/Society for Ecological Restoration 14th Annual International Conference. August 4-9, Tucson, AZ. Pg.79.

Abstract/excerpt:

In summer of 2001 when winter precipitation had exceeded 25 cm., wildflower cover equaled that of native grasses and was significantly lower on livestock-grazed areas than on ungrazed native grassland, and much lower still in plantations of exotic African lovegrasses. Results suggest the important positive influence of winter rain on many of the wildflower species, and the negative effects of grazing and exotics.

- Bock, C., J. Bock, L. Kennedy, and Z. Jones. 2007a. *Spread of non-native grasses into grazed versus ungrazed desert grasslands*. Journal of Arid Environments 71:229–235.

Abstract/excerpt:

Indications are that (1) protection from grazing reduced the rate of exotic invasions into native grasslands; (2) areas deliberately planted with the exotics developed into near monocultures even under livestock exclusion; (3) livestock grazing is an exogenous disturbance to which exotics are better adapted than most native grasses.

- Brady, W.W, M.R. Stromberg, E.F. Aldon, C.D. Bonham, S.H. Henry. 1989. *Response of a Semidesert Grassland to 16 Years of Rest from Grazing*. J. Range Management 42:284-288.

Abstract/excerpt:

Long-term response to release from grazing included both increases in types of grasses and significant increases in canopy cover for midgrass, shortgrass, shrub, and forb plant groups. Total vegetation cover was not significantly different on the grazed and ungrazed areas, but cover of midgrasses was significantly different (this difference due to increased cover of plains

lovegrass on ungrazed pasture. Data do not support the hypothesis that continued animal impact is necessary to prevent ecosystem deterioration.

- Filazzola, A., Brown, C., Dettlaff, M.A., Batbaatar, A., Granke, J., Bao, T., Heida, I.P., Cahill, J.F. Jr., 2020. *The effects of livestock grazing on biodiversity are multi-trophic: a meta-analysis*. Ecology Letters (2020).

Abstract/excerpt:

Anthropogenic disturbance has generated a significant loss of biodiversity worldwide and grazing by domestic herbivores is a contributing disturbance. Although the effects of grazing on plants are commonly explored, here we address the potential multi-trophic effects on animal biodiversity (e.g. herbivores, pollinators and predators). We conducted a meta-analysis on 109 independent studies that tested the response of animals or plants to livestock grazing relative to livestock excluded. Across all animals, livestock exclusion increased abundance and diversity, but these effects were greatest for trophic levels directly dependent on plants, such as herbivores and pollinators. Detritivores were the only trophic level whose abundance decreased with livestock exclusion. We also found that the number of years since livestock was excluded influenced the community and that the effects of grazer exclusion on animal diversity were strongest in temper- ate climates. These findings synthesize the effects of livestock grazing beyond plants and demonstrate the indirect impacts of livestock grazing on multiple trophic levels in the animal community. We identified the potentially long-term impacts that livestock grazing can have on lower trophic levels and consequences for biological conservation. We also highlight the potentially inevitable cost to global biodiversity from livestock grazing that must be balanced against socio-economic benefits.

The effect of grazing on biodiversity patterns can depend on climate. In areas sensitive to disturbance, even minimal grazing can significantly alter the abundance or diversity of taxa within the community. For instance, ecosystems that have high abiotic stress with extremes in precipitation or temperature (e.g. the alpine or deserts) can be particularly impacted by grazing which damages soil characteristics (e.g. increase erosion, decrease water infiltration), reduces already limited plant biomass, and decreases animal diversity (Jones 2000; Sankaran & Augustine 2004; Evju et al. 2006). (p.2).

- Gillihan, S. W. 2006. *Sharing the land with pinyon-juniper birds*. Partners in Flight Western Working Group. Salt Lake City, Utah.

Abstract/excerpt:

Pinyon-juniper woodland is a widespread ecosystem in the North American West, estimated at 55.6 million acres. It is widely regarded that the extent of pinyon-juniper is increasing as some grasslands and shrublands are transformed by PJ encroachment, facilitated by a combination of climatic changes, fire suppression, and overgrazing which removes the grassy understory that ordinarily carries fire.

General guidelines for management of activities in PJ woodlands. Managing for a diversity of stand conditions across the landscape is recommended. Land managers should embrace natural processes that shape landscapes. Retaining large mature stands is important. Retaining beetle-killed pinyons rather than cutting them offers important habitat for birds and resources for habitat regeneration, the fire danger is only elevated while the reddish brown needles are still on the trees.

Livestock grazing in and near PJ woodlands during the nesting season increases the potential for brood parasitism of PJ birds, especially when cattle are concentrated for prolonged periods and cowbirds have more time to find nearby nests. In grazed PJ woodlands, cowbirds may parasitize more than 75% of the nests of some species. (pg. 11).

- Gregg R.M., and Kershner J. 2019. *Extremes to Ex-Streams: Ecological Drought Adaptation in a Changing Climate*. EcoAdapt, Bainbridge Island, WA.

Abstract/excerpt:

Climate change is one of the most pressing challenges on natural and cultural resource management and conservation practice. Resource managers and conservation planners are addressing these challenges by revising current plans and practices with increased attention on potential climate impacts to natural resources, communities, and socioeconomic values to better meet long-term goals. However, decision-making is complicated by uncertainty in terms of which adaptation actions are best suited for different implementation conditions and supported by scientific evidence (Sutherland et al. 2004; Cook et al. 2009; Eriksen et al. 2011; Bayliss et al. 2012; Cross et al. 2012). The purpose of this and other EcoAdapt adaptation science assessments is to evaluate the body of scientific knowledge supporting specific climate adaptation actions to determine the conditions under which particular actions may be most effective for achieving management goals...

Knowing which adaptation actions can be best implemented at different scales and in various ecosystems will help resource managers to identify and leverage funding opportunities, create new or enhance existing partnerships, and communicate and coordinate with other agencies and organizations to prioritize on-the-ground ecological drought responses. This project directly supports the expressed goal of the Northwest Climate Adaptation Science Center to provide scientific research and synthesis to support natural resource management in a changing climate.

- Jones, A., and Carter, J. 2016. *Implications of Longer Term Rest from Grazing in the Sagebrush Steppe: an Alternative Perspective*. Journal of Rangeland Applications, Vol. 3, pp. 1-8.

Abstract/excerpt:

In the inaugural volume of this journal, Davies et al. (2014) attempt to make a general case that livestock grazing is benign in sagebrush steppe, and long-term rest is not beneficial because modern “properly managed” grazing produces few significant differences compared to ungrazed areas. In this brief review, we point out the problems with this broad theory, not the least of which is a lack of supporting evidence that this “modern” grazing is afforded in the

studies cited. Additionally, areas with invasive species such as cheatgrass are conflated with areas lacking these species, while threat of fire is used to drive management decisions to include livestock grazing as a tool for fire control regardless of the state of the land or the presence/absence of invasives. Davies et al. shed light on an important problem we face in the range science literature. They correctly note that the effect of light to moderate grazing, and other grazing management scenarios, have received relatively little study compared to long-term rest on sagebrush community recovery. One reason for this may be the scarcity of established large, grazing-free reserves or control areas in the western U.S. that include sagebrush steppe habitat. Establishing large, ungrazed areas throughout the sagebrush steppe may be one of the key steps we need to take to better understand the impacts of livestock grazing on our western rangelands as our climate changes.

Davies et al. use the terms “well-managed grazing,” “current managed grazing,” “properly managed grazing,” “managed grazing,” and “modern grazing” interchangeably, but definitions are not offered for any of them and the articles cited offered little illumination on the subject. We look forward to working with the range science community, livestock operators, and land managers to help better define “well-managed” grazing, perhaps with more care towards truly sustainable utilization rates in the sagebrush steppe, and hope that one day this can be the predominant form of management in the sagebrush steppe, rather than the exception to the rule.

- Jones, A. 2000. *Effects of cattle grazing on North American arid ecosystems: A quantitative review*. Western North American Naturalist 60:155-164.

Abstract/excerpt:

A quantitative review was conducted of the effects of cattle grazing in arid systems on 16 response variables ranging from soil bulk density to total vegetative cover to rodent species diversity. Various studies from North American arid environments that used similar measures for assessing grazing effects on the same response variables were used for the review; each study was assigned to serve as a single data point in paired comparisons of grazed versus ungrazed sites. All analyses tested the 1-tailed null hypothesis that grazing has no effect on the measured variable. Eleven of 16 analyses (69%) revealed significant detrimental effects of cattle grazing, suggesting that cattle can have a negative impact on North American xeric ecosystems. Soil-related variables were most negatively impacted by grazing (3 of 4 categories tested were significantly impacted), followed by litter cover and biomass (2 of 2 categories tested), and rodent diversity and richness (2 of 2 categories tested). Vegetative variables showed more variability in terms of quantifiable grazing effects, with 4 of 8 categories testing significantly. Overall, these findings could shed light on which suites of variables may be effectively used by land managers to measure ecosystem integrity and rangeland health in grazed systems.

- Kaltenecker, J. H., and M. C. Wicklow-Howard. 1999. *Biological soil crusts: Natural barriers to Bromus tectorum L. establishment in the northern Great Basin, USA*. VIth International Rangeland Congress — Proceedings, Townsville 109-111.

Abstract/excerpt:

In arid and semi-arid lands throughout the world, vegetation cover is often sparse or absent. Nevertheless, in open spaces between the higher plants, the soil surface is generally not bare of autotrophic life, but covered by a community of highly specialized organisms (Fig. 1.1). These communities are referred to as biological soil crusts, or cryptogamic, cryptobiotic, microbiotic, or microphytic soil crusts (Harper and Marble 1988; West 1990). Biological soil crusts are a complex mosaic of cyanobacteria, green algae, lichens, mosses, microfungi, and other bacteria. Cyanobacterial and microfungi filaments weave through the top few millimeters of soil, gluing loose particles together and forming a matrix that stabilizes and protects soil surfaces from erosive forces (Cameron 1966; Friedmann and Galun 1974; Friedmann and Ocampo-Paus 1976; Belnap and Gardner 1993). These crusts occur in all hot, cool, and cold arid and semi-arid regions. They may constitute up to 70% of the living cover in some plant communities (Belnap 1994). However, biological soil crusts have only recently been recognized as having a major influence on terrestrial ecosystems.

- McInturff, A., Xu, W., Wilkinson, C.E., Dejid, N., and Brashares, J.S. 2020. *Fence Ecology: Frameworks for Understanding the Ecological Effects of Fences*. BioScience XX: 1-15. Oxford University Press, American Institute of Biological Sciences. doi:10.1093/biosci/biaa103. (in press)

Abstract/excerpt:

Investigations of the links between human infrastructure and ecological change have provided eye-opening insights into humanity's environmental impacts and contributed to global environmental policies. Fences are globally ubiquitous, yet they are often omitted from discussions of anthropogenic impacts. In the present article, we address this gap through a systematic literature review on the ecological effects of fences. Our overview provides five major takeaways: 1) an operational definition of fencing to structure future research, 2) an estimate of fence densities in the western United States to emphasize the challenges of accounting for fences in human-footprint mapping, 3) a framework exhibiting the ecological winners and losers that fences produce, 4) a typology of fence effects across ecological scales to guide research, and 5) a summary of research trends and biases that suggest that fence effects have been underestimated. Through highlighting past research and offering frameworks for the future, we aim with this work to formalize the nascent field of fence ecology.

- Root, H.T., Miller, J. E.D., Rosentreter, R., 2020. *Grazing disturbance promotes exotic annual grasses by degrading soil biocrust communities*. Ecological Applications 30(1):e02016. 10.1002/eap.2016. Ecological Society of America. heatherroot@weber.edu

Abstract/excerpt:

Exotic invasive plants threaten ecosystem integrity, and their success depends on a combination of abiotic factors, disturbances, and interactions with existing communities. In dryland ecosystems, soil biocrusts (communities of lichens, bryophytes, and microorganisms) can limit favorable microsites needed for invasive species establishment, but the relative importance of biocrusts for landscape-scale invasion patterns remains poorly understood. We examine effects of livestock grazing in habitats at high risk for invasion to test the hypothesis that disturbance indirectly favors exotic annual grasses by reducing biocrust cover. We present some of the first evidence that biocrusts increase site resistance to invasion at a landscape scale and mediate the effects of disturbance. Biocrust species richness, which is reduced by livestock grazing, also appears to promote native perennial grasses. Short mosses, as a functional group, appear to be particularly valuable for preventing invasion by exotic annual grasses. Our study suggests that maintaining biocrust communities with high cover, species richness, and cover of short mosses can increase resistance to invasion. These results highlight the potential of soil surface communities to mediate invasion dynamics and suggest promising avenues for restoration in dryland ecosystems.

- Sisk, Thomas, Timothy Crews and Lauren Golten. 2000. *Effects of Livestock Management on Ecosystem Productivity and Biological Diversity in Southwestern Grasslands*. Audubon Research Ranch 2000. National Audubon Society Appleton-Whittell Research Ranch. Elgin AZ. 84 pgs. Linda Kennedy and Stephanie Seltzer, editors. At page 31.

Abstract/excerpt:

Results from a pilot study done after two consecutive drought years showed that aboveground, net primary productivity was significantly higher at the ungrazed site (the Appleton-Whittell Research Ranch) compared to the traditional and HRM managed ranches whereas plant species diversity did not vary significantly as a function of livestock management. The aim of a proposed study is to bridge the existing gulf between research science, ranchers, other land managers, and the public.

- U.S. General Accounting Office. 1991b. *Rangeland management: Bureau of Land Management's Hot Desert Program merits reconsideration*. U.S. General Accounting Office.

Abstract/excerpt:

The U.S. General Accounting Office found that the Bureau of Land Management's grazing program in the Southwest was running at an annual loss of \$1.3 million and predicted that putting an end to the program would not significantly disrupt local economies. The report instead found that the economic value of the lands could well be greater if they were managed for recreational and aesthetic benefits.

- Wenjing Xu, Nandintsetseg Dejid, Valentine Herrmann, Hall Sawyer, Arthur D. Middleton. *Barrier Behaviour Analysis (BaBA) reveals extensive effects of fencing on wide-ranging ungulates*. Journal of Applied Ecology, 2021; DOI: 10.1111/1365-2664.13806

Abstract/excerpt:

As human activities expand globally, there is a growing need to identify and mitigate barriers to animal movements. Fencing is a pervasive human modification of the landscape that can impede the movements of wide-ranging animals. Previous research has largely focused on whether fences block movements altogether, but a more nuanced understanding of animals' behavioural responses to fences may be critical for examining the ecological consequences and prioritizing conservation interventions.

We developed a spatial- and temporal-explicit approach, Barrier Behaviour Analysis (BaBA, available as an R package), to examine individual-level behaviours in response to linear barriers. BaBA classifies animal-barrier encounters into six behaviour categories: quick cross, average movement, bounce, back-and-forth, trace and trapped. We applied BaBA to wide-ranging female pronghorn *Antilocapra americana* and mule deer *Odocoileus hemionus* in an area of western Wyoming, USA, with >6,000 km of fencing.

We found both species were extensively affected by fences, with nearly 40% of fence encounters altering their normal movements, though pronghorn were more strongly affected than mule deer. On average, an individual pronghorn encountered fences 250 times a year—twice the encounter rate of mule deer. Pronghorn were more likely to bounce away from fences, whereas deer engaged in more back-and-forth, trace and average movement near fences.

We aggregated these behavioural responses to demonstrate how BaBA can be used to examine species-specific fencing permeability and to identify problematic fence segments in order to guide fence modification or removal.

Synthesis and applications. Our work provides empirical evidence on how fences affect wildlife movement. Importantly, Barrier Behaviour Analysis (BaBA) can be applied to evaluate other linear features (such as roads, railways and pipelines) and habitat edges, enhancing our ability to understand and mitigate widespread barrier effects to animal movement.

- Williamson, M.A., Fleishman, E., Mac Nally, R.C., Chambers, J.C., Bradley, B.A., Dobkin, D.S., Fogarty, F.A., Horning, N., Leu, M., and Zillig, M.W., 2020. *Fire, livestock grazing, topography, and precipitation affect occurrence and prevalence of cheatgrass (*Bromus tectorum*) in the central Great Basin, USA*. Biol Invasions 22, 663–680 (2020). <https://doi.org/10.1007/s10530-019-02120-8>

Abstract/excerpt:

Cheatgrass (*Bromus tectorum*) has increased the extent and frequency of fire and negatively affected native plant and animal species across the Intermountain West (USA). However, the

strengths of association between cheatgrass occurrence or abundance and fire, livestock grazing, and precipitation are not well understood. We used 14 years of data from 417 sites across 10,000 km² in the central Great Basin to assess the effects of the foregoing predictors on cheatgrass occurrence and prevalence (i.e., given occurrence, the proportion of measurements in which the species was detected). We implemented hierarchical Bayesian models and considered covariates for which > 0.90 or < 0.10 of the posterior predictive mass for the regression coefficient ≥ 0 as strongly associated with the response variable. Similar to previous research, our models indicated that fire is a strong, positive predictor of cheatgrass occurrence and prevalence. Models fitted to all sample points and to only unburned points indicated that grazing and the proportion of years grazed were strong positive predictors of occurrence and prevalence. In contrast, in models restricted to burned points, prevalence was high, but decreased slightly as the proportion of years grazed increased (relative to other burned points). Prevalence of cheatgrass also decreased as the prevalence of perennial grasses increased. Cheatgrass occurrence decreased as elevation increased, but prevalence within the elevational range of cheatgrass increased as median winter precipitation, elevation, and solar exposure increased. Our novel time-series data and results indicate that grazing corresponds with increased cheatgrass occurrence and prevalence regardless of variation in climate, topography, or community composition, and provide no support for the notion that contemporary grazing regimes or grazing in conjunction with fire can suppress cheatgrass.

- Yang, X., Xu, M., Zhao, Y., Bao, T., Ren, W., Shi, Y., 2020. *Trampling Disturbance of Biocrust Enhances Soil Carbon Emission*. Rangeland Ecology & Management (in press). Available at <https://doi.org/10.1016/j.rama.2020.02.005>

Abstract/excerpt:

Biocrusts play an important role in the carbon cycle in arid and semiarid ecosystems. Activities such as livestock grazing can disturb ecosystem functions of biocrusts. However, it is unclear whether disturbance intensity impacts carbon emission from these biocrusts. Few studies have investigated the transformation of carbon within biocrusts after disturbance. Here, we conducted a field experiment on the Loess Plateau, China, in which we artificially simulated different intensities of trampling to examine the response of biocrust carbon emissions to disturbance. Our results demonstrate that disturbance significantly reduced biocrust coverage. The largest decreases were observed in the second through fourth intensity, which declined significantly by 12.6–17.1%. Disturbance decreased soil organic carbon content in the biocrust layer by 2.6 g kg⁻¹–3.7 g kg⁻¹ depending on the disturbance intensity. Disturbance significantly increased the soil easily oxidizable carbon (SEOC) content in the biocrust layer. The soil microbial biomass carbon (SMBC) content of the fifth intensity increased significantly by 70.3%. The soil mineralizable carbon (SMC) content of the fourth intensity increased significantly by 78.8%. Soil carbon emissions increased significantly with increasing disturbance intensity, were higher at night than during the day, and were higher in the summer than in the fall. Together, these findings indicate that the increase of carbon emission was mainly due to increases in SEOC and SMC. Trampling disturbance increases carbon emissions from biocrust soils. These losses of CO₂ from biocrust soils after disturbance may substantially reduce the biocrust contribution to the soil carbon budget.

- Zobell, R.A., Cameron, A., Goodrich, S., Huber, A., Grandy, D., 2020. *Ground Cover -What are the Critical Criteria and Why Does it Matter?* Rangeland Ecology & Management, 2020 (in press), available at <https://doi.org/10.1016/j.rama.2020.02.002>

Abstract/excerpt:

This publication is the result of concerns expressed regarding the definition and subsequent use of ground cover in rangeland monitoring. We reviewed 20 monitoring publications. All publications reviewed contained a definition of ground cover and/or direction on how to monitor ground cover. The majority of these publications also defined bare ground. In all cases, bare ground was defined as the opposite of ground cover.

We identified critical criteria of ground cover based on the role it plays in soil conservation as it relates to water and wind erosion. Critical criteria identified included standing and nonstanding live vegetation, standing and nonstanding dead vegetation including litter, and rock. We compared these critical criteria to the 20 monitoring publications reviewed. We found 19 of these publications included the criteria standing live vegetation or similar words and standing dead vegetation or similar words in their definition and/or use of ground cover. The one source where standing live or dead vegetation or similar words were not included was “Indicators of Rangeland Health and Functionality in the Intermountain West.” This publication was produced by the US Department of Agriculture, Forest Service, Rocky Mountain Research Station. Ground cover was limited to basal vegetation, litter, moss/lichen, or rock. We also found inconsistencies in the definition and subsequent use of ground cover in *Forest Service Handbook 2209.21–Rangeland Ecosystem Analysis and Monitoring Handbook, Intermountain Region*.

We contend a large volume of literature supports the inclusion of critical criteria as identified in this report as ground cover. These criteria are essential components contributing to resistance of water and wind erosion important to soil conservation. This review demonstrates the importance of accurately defining and subsequently including critical criteria in rangeland attributes including ground cover. This paper addresses standardizing terms and calculations used in determining ground cover.

Please see also:

Beschta, R.L., D.L. Donahue, D.A. DellaSala, J.J. Rhodes, J.R. Karr, M.H. O’Brien, T.L. Fleischner, C.D. Williams. Adapting to climate change on western public lands: Addressing the ecological effects of domestic, wild, and feral ungulates. *Environmental Management*.

Bock, C. E., J. H. Bock, W. R. Kennedy, and V. M. Hawthorne. 1984. Responses of birds, rodents and vegetation to livestock exclosures in a semi-desert grassland site. *Journal of Range Management* 37:239–242.

Bock, C. E., and J. H. Bock. 1993. Cover of perennial grasses in southeastern Arizona in relation to livestock grazing. *Conservation Biology* 7:371–377.

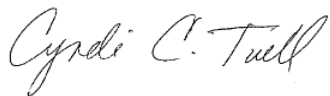
Donahue, D. L. 1999. The Western Range Revisited: Removing livestock from public lands to conserve native biodiversity. University of Oklahoma Press, Norman OK.

Fleischner, T. L. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology 8:629-644.

Conclusion

Finally, we request that all information used as part of the decision-making process for this project be posted online in a publicly available manner, preferably on a website that allows open access for all members of the public during all comment and objection periods for this project. We appreciate the opportunity to submit these scoping comments and we request that the Bureau ensure that our comments are incorporated into the project record and that we are included on the project contact list.

Thank you,



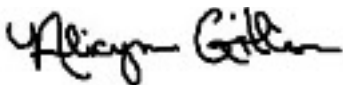
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