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Viewpoint: An Alternative Management Paradigm for Plant Communities Affected by Invasive Annual Grass in the Intermountain West

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On the Ground

- Over 400,000 km² of the Intermountain West is colonized by cheatgrass and other annual grasses.
- Planning and management actions designed to foster perennial grass health throughout the region have never addressed how annual grasses would respond.
- For decades, the most significant landscape-level management approach toward invasive annual grasses has been to complain.
- We now know how to begin the process of taking the Intermountain West back from the domination of invasive annual grasses: through the management of standing dead litter.
- Sustaining perennial bunchgrasses at landscape scales will require an integrated ecological approach to fuels management.

Keywords: Bromus tectorum, Intermountain West, Great Basin, fuels management, invasive annuals, remnant perennial grasses.

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Nineteenth-century explorers Jedediah Smith,[1] Peter Skene Ogden,[2] and James H. Simpson[3] travelled across the Great Basin between 1820 and 1860. They encountered and described a number of geographic, fluvial, riparian, human, wildlife, and vegetation features present throughout the region. They did not record/report any annual grasses that ecologists currently consider invasive, nonindigenous species in what is now Nevada and Utah. Nonindigenous annual grasses may have certainly been present in California by that time, but their impactful migration eastward was still decades away. Moreover, phytogeographers generally agree that the native floristic composition of the Intermountain Region is essentially the same today as at the beginning of the Pleistocene[4–6] (with the notable exception of single-leaf pinyon pine [*Pinus monophylla* Torr. & Frém]).[7] However, internal migration and changes in abundance of species have occurred, with respect to elevation, latitude and longitude, in response to climatic changes during glacial–interglacial periods.[8–10] The current suite of native species is the same suite of species that Smith, Ogden, and Simpson saw on their expeditions, although changes in abundance are probable.

Fire intervals during and just prior to European expeditions into the area were a product of vegetation characteristics influenced by Little Ice Age weather patterns,[11] uncontrolled grazing from native herbivores (including many species of small mammals and insects), and wildfire from both human and nonhuman ignitions.[12] In addition to grazing species such as jackrabbits and pronghorn antelope, bison were widespread in the Great Basin (probably as sink populations) until just before Europeans entered the region,[13] and abundant in eastern Idaho and eastern Oregon from the beginning of the Pleistocene until historic times.[14–16]

Fire intervals in the sagebrush steppe portions of the Great Basin have been estimated, where tree-ring data were in proximity to mountain big sagebrush (*Artemisia tridentata* ssp. vaseyana [Rydb.] Beetle) communities, to be between 6 to 60 years, and these plant communities were neither fuel or ignition limited.[12] Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young) and low sagebrush (*Artemisia arbuscula* Nutt.) communities had less frequent disturbance events and slower recovery rates than mountain big sagebrush communities,[17] with fire return intervals in Wyoming big sagebrush communities reported to be from 100 to 240 years.[18] Ignition by indigenous peoples as

well as lightning both played a significant role in shaping the species composition (and their relative abundance) of some Great Basin ecological sites. However, the processes that sorted out native species compositions occurred prior to the advent of the annual grass invasion that began around 120 years ago.

Perryman et al. coined the phrase *pristine-management--paradigm* to describe the widely held concept that ecological systems are static entities that can be held in a static condition if they are literally protected from burning, grazing, and other disturbances.[19] The authors argued it was impossible to achieve societal objectives today based on landscape conditions that were present in 1800 A.D. Others have also stated that returning ecosystems to historical or pre-Euro-American settlement conditions by reintroducing historical disturbance may be detrimental or impractical.[20] Processes that created the landscape conditions of 1800 A.D. or any other previous time period have changed or been altered making their replication impossible. For example: Little Ice Age weather conditions have ended; uncontrolled grazing by wild ungulates presumably influenced by codependent predators is no longer possible or desirable; widespread burning by Native Americans is no longer practiced; and annual grasses have colonized many sagebrush and salt desert shrub communities, permanently altering plant community compositions. We believe that objectives for ecosystem management should instead focus upon specific measurable goals that society has determined are valuable under current ecological conditions (e.g., soil stability, biodiversity, wildlife habitat, forage production, etc.). Today's landscapes are not those described by Smith, Ogden, and Simpson. With over 400,000 km^2 colonized by cheatgrass (*Bromus tectorum* L.) and other annual grasses,[21] we believe it is time to declare: The *pristine-management-paradigm* has failed. Continued, wholesale application of this concept is misguided.

Management Practices of the Past

Although a healthy, resilient perennial grass understory is likely the single most important long-term assurance against invasive annual grass dominance, rangeland ecologists and managers have long applied science-based management practices that exclude consideration of the biology, ecology, and probable management effects these grazing systems would have on the non-native annual grass component of modern landscapes. For instance, the two major grazing systems employed in the Great Basin are deferred-rotation and rest-rotation. Both focus on meeting the physiological needs of grazed perennial grasses,[22,23] but their implementation throughout the region failed to address how annual grasses would respond. Authorized grazing of animal unit months (AUM) on public lands in the Great Basin focuses on allotment carrying capacities provided by only native perennial species (CFR 4110.2–2 Specifying grazing preference). Non-native annual grasses generally are not recognized, authorized, allocated, or normally considered in the development of district wide or allotment management plans. In fact, almost all management planning efforts and implementations are designed to manage perennial grass or palatable shrub species. The allocation of forage derived from annual grasses requires a separate Record of Decision based on an Environmental Assessment (CFR 4130.6–2 Nonrenewable grazing permits and leases) and is seldom granted.

Fuel breaks have received considerable attention for several decades, for reducing fire risks in and around annual grass-dominated plant communities. At best, this management tool, especially when applied as a stand-alone action, is only a stopgap measure to postpone the fire effects of annual grasses near areas still dominated by desired native species. All the while, annual grasses have become the ecologically dominant life form on upwards of 20,000 km^2 in the Great Basin.[24]

Over the past decade or so, a related movement toward an ecologically based weed management approach has spawned the development of potential new tools for the management of invasive annual grasses. Scientists are currently developing delivery methods for newly identified biological control agents. Undoubtedly, these tools will find useful and appropriate applications for yet undetermined situations and scales. The precise combination of chemical fallow and seeding with both native and non-native, deep-rooted perennial grasses and half-shrubs like forage kochia (*Bassia prostrata* L.) has provided success on many ecological sites and topographic settings, but only for a relatively small percentage of the entire affected area.[25] Likewise, grazing cheatgrass in the fall and early winter months, when perennial grasses are dormant, has demonstrated that managed livestock grazing can reduce carryover fuels going into the next year's fire season, while simultaneously reducing the ability of cheatgrass to dominate areas with a remnant perennial grass component (Figs. 1 and 2).[26,27] Managing cheatgrass with dormant season grazing has been successful on demonstration projects at a scale of thousands of acres in southeastern Oregon, on winter dominated precipitation sites (W. Dragt, B. Wilber, and S. Davies, personal communication, August, 2017).

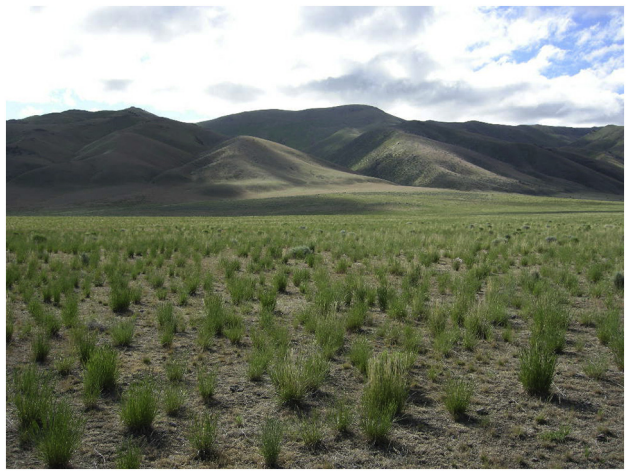

Figure 1. A mixed annual-perennial grass seeding during spring of 2009 that was fall grazed for 3 consecutive years (2006–2008), Gund Ranch, Nevada.

Figure 2. A mixed annual-perennial grass seeding during spring of 2009 with no fall grazing for 3 consecutive years (2006–2008), Gund Ranch, Nevada.

Cheatgrass and medusahead (*Taeniatherum caput-medusae* [L.] Nevski) require standing dead litter or thatch to maintain their ability to establish and dominate perennial grasses.[28,29] The specific epithet, *tectorum*, is a form of *tectum,* the Latin word for roof. Specifically, *Bromus tectorum* means *brome of the roof*. In Europe, where cheatgrass was first identified and named, its major recognized habitat was in the decaying straw of thatched roofs.[30] Removal of the standing dead litter in the fall before cheatgrass begins to germinate establish reduces "safe sites"[31] conducive for growth and establishment (Fig. 3). This knowledge is not new, being first identified by Evans and Young almost 50 years ago.[28,32] Yet, the value of reducing dead litter as a tool to manage annual grasses has been unrecognized or ignored for decades.

A New Paradigm

Given the advances and successes in the management tools available, the rangeland ecology and management community needs to recognize that annual invasive grasses must be managed as a permanent component of the Great Basin and Intermountain West. For the past 50 years, perhaps longer, most of our collective management objectives, goals, and practices have focused on only the perennial grass component, or toward palatable shrubs in the case of salt desert shrub communities. Rest-rotation and deferred rotation grazing systems (and their various combinations) focus management on the perennial grass component of the plant community while ignoring the annual grasses. Both grazing systems actually favor the proliferation and dominance of annual invasive grasses, especially on warmer and drier sites,[33] by essentially maximizing the standing dead biomass left at the end of the traditional grazing season.[26,27] The antigrazing sentiment[34] that led to a general reduction of annual and temporary grazing authorizations over the past several decades has also played a significant role in annual grass proliferation by providing an increase in safe sites for annual grass establishment, as well as creating larger, more contiguous fuel loads. Through our management activities that foster standing dead litter, we have inadvertently exacerbated invasive annual grass expansion in the Great Basin and Intermountain West. Most standing litter eventually becomes surface litter, creating the "safe site" for the germination of seed from annual grasses. Research-based science has been applied toward the management of perennial grasses on many landscapes,[35] but not toward the ecologically dominant annual grasses that often occur with remnant populations of native perennial species.

The first step for dealing with this issue is recognition of the almost ubiquitous presence of invasive annual grasses across the Intermountain West, particularly at lower and drier elevations. Cheatgrass, medusahead, and North Africa grass (*Ventenata dubia* [Leers] Coss.; a relative newcomer) are here to stay. Not only are annual grasses present, they have become one of, if not the primary driver of the ecological changes occurring in many lower elevation big sagebrush and salt desert shrub communities. It is time that scientists, managers, and policy makers begin to develop and implement research,

Figure 3. Cheatgrass seedlings extracted from standing litter safe sites in fall 2017, Imlay, Nevada.

planning objectives, policies, and management actions that allow and provide for the active landscape-scale management of annual grasses, instead of continuously lamenting of being their victim. We must admit that many of the shrub dominated communities in the Great Basin and Intermountain West now have diminished perennial grass understories, and have become mixed communities of annual and perennial grasses. They should be recognized and managed first and foremost as annual grasslands, just as the California annual grasslands have been recognized for decades, despite many having some perennial grasses in the plant community. Manage the ecologically dominant annual grasses (the target species) first, while also developing strategies that minimize or eliminate harm to the nontarget remnant perennial species.

Reassessing Fire Disturbance

Fire is not a new disturbance process in sagebrush ecosystems.[12,36] However, fire characteristics have gradually changed over the past five decades. Rangeland fires today re-burn areas more frequently, are larger, and have greater intensity than in the recent past.[36] A gradual warming since the close of the Little Ice Age, combined with uninformed legacy grazing practices conducted nearly a century or more ago (and quickly discontinued in many areas), and the introduction and proliferation of invasive annual grasses have resulted in a net loss of sagebrush and salt desert shrub habitats, as well as perennial bunchgrasses. The loss of perennial bunchgrasses increases the likelihood of annual grass invasion and eventual dominance.[37–39]

The dominance of invasive annual grasses in sagebrush rangelands can also be attributed in part to increased mortality of bunchgrasses due to alterations in fire characteristics.[40,41] Perennial bunchgrasses evolved with fire,[17] but the presence of invasive annual grasses has changed fuel characteristics and increased fire frequency on many sagebrush and salt desert rangelands.[36] Perennial bunchgrasses are more susceptible to fire mortality when left ungrazed because litter accumulates near growing points, which facilitates greater temperatures and longer heat residence times that weaken or kill perennating buds and root crowns.[20] Greater perennial bunchgrass mortality with each fire, which occurs ever more frequently, decreases both the resistance of perennial plant communities to invasion by annual grasses and their resilience after disturbance. Fire frequencies shorter than the pre-Euro-American pattern, combined with abundant annual grasses, creates a positive feedback cycle detrimental to perennial bunchgrasses and nonsprouting shrubs.[42]

The Logical Alternative: A Fuels Management Approach

Maintaining and eventually increasing perennial bunchgrasses in fire-dominated annual-grass landscapes will require breaking (lengthening) the fire cycle. To sustain perennial bunchgrasses at landscape scales will require an integrated ecological approach to fuels management. Among the tools used will be direct chemical control, chemical fallow, large scale reseeding, the creation of greenstrips and other mechanical fuel breaks, surfactant seed coating technology, microbiological controls like the fungi *Pyrenophora semeniperda* ([Brittlebank and Adam] Shoem.), and the tool with the most upside potential, targeted or objective-based livestock grazing, particularly during the late summer to early winter dormant period. Fall or dormant-season grazing has high potential for numerous reasons. The infrastructure at a landscape scale is largely in place in many (but not all) locations and is relatively stable from year to year. Dormant season grazing does not depend on the vagaries of public funding and can cover very large acreages in a variety of different configurations. Given flexibility of application by federal agencies, fall/winter grazing not only reduces annual grass carryover fuel loads, but may also initiate positive changes in the annual-perennial grass dominance ratio (Figs. 1 and 2).[26] Intense dormant-season grazing, compared with spring (growing season) grazing, provides more reasonable logistics, and also has much less potential to adversely affect desired perennial species, while increasing the removal of standing and surface fuels. Grazing practices in general affect fuel characteristics, which changes the nature of wildfires: reducing flame height, flame depth, rate of spread, and the size of area burned, while increasing fuel moisture content.[40,41] These fuel characteristics are the primary factors driving not only ignition potential, but also fire timing, severity, continuity, and size. Common sense dictates that fires generally burn hotter, longer, and leave fewer unburned islands when fuel moisture is lower and fuel loads and continuities are greater. These hazardous conditions occur when livestock grazing is reduced or excluded from most or all of the landscapes ecologically dominated by annual grasses.

Changing the current management paradigm on landscapes where annual grasses are the ecologically dominant lifeform requires acknowledging that past approaches have completely failed in some situations and at best maintained the status quo in others. Managing these landscapes requires a new direction, an alternative approach with new purposes and objectives. Fire is an almost universally accepted threat, and is recognized by many as the greatest threat to the more arid sagebrush and salt desert shrub ecosystems. It seems logical to offer a fuels management approach as an alternative to the failed paradigm.

The ecological goal of the new fuels management paradigm is essentially the same: achieving and sustaining plant communities ecologically dominated by perennial species, especially the bunchgrasses that may competitively exclude invasive annual species. Achievement of this goal will require different strategies and associated objectives that focus equally across time (but not necessarily in the same year or decade) on both the annual and perennial components of the landscape. Managing fuels as the priority instead of incidentally will require authorizing AUMs for annual grasses, not just the perennial components in grazing allotments. We propose that a logical starting point is the consideration of fuels and potential fire proximity to priority wildlife habitats and wildland-urban interface areas. This approach will require

cooperation among professionals with backgrounds in rangeland ecology and management, wildlife, archeology, fire planning, and probably other disciplines for specific situations, to identify, quantify, and prioritize areas where fuels management practices can be implemented with the greatest probability for success. Current management paradigm practices were often implemented for rational reasons (improve the perennial herbaceous plant community) but failed to fully understand and/or include the ecology of the invasive annual component. The result is an unacceptable large-scale ecological situation for almost all users of sagebrush and salt desert rangelands. For landscapes where annual grasses are the ecologically dominant lifeform, a step in the right direction would be to address both the annual and perennial grass components (i.e., regularly hurt the annuals and benefit the perennials) simultaneously, with all situationally available tools.[43] This approach requires the recognition and management of mixed annual-perennial grass understories for what they are, but also for what we want them to be in the future. This approach only makes ecological sense.

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