Cowboys and Aliens: Cheatgrass Management in Wyoming

A case study in ecosystem management

BACKGROUND

Cheatgrass (*Bromus tectorum*) is an invasive annual grass found across rangelands in the western United States. Originally introduced from Eurasia, cheatgrass gained a foothold in range systems largely due to overgrazing of native perennial communities. It is classified as a noxious weed because of its ability to outcompete other species, especially under dry conditions. Cheatgrass thrives under disturbed conditions, and can often be found in landscapes facing heavy impacts from agriculture, intensive recreation, or construction. It is a prolific seed producer and incendiary (highly flammable), and the species increases in proliferation with frequent fires. It is a cool season (germinating in the fall) annual grass that greens up early in the spring, giving it a foothold to quickly establish dominance.

In addition to simply outcompeting native plants, cheatgrass poses a particular problem in the sagebrush systems because of its incendiary nature. Sagebrush evolved to tolerate infrequent, low-intensity fires, conditions under which sagebrush can recover from this disturbance. Cheatgrass introduces frequent, high-intensity fire, rendering the sagebrush incapable of recovering and thus perpetuating the invasion. While cheatgrass can be grazed for a very brief window in the spring as it greens up, it is largely unpalatable and therefore has a hugely degrading effect on the utility of rangelands. Replacement of sagebrush communities by cheatgrass changes habitat qualities, leads to significant reduction in diversity in the vegetative community, facilitates a frequent fire cycle, changes hydrologic ecosystem features, and creates a source of propagule pressure to generate further encroachment into new communities.

PROBLEM DESCRIPTION

You will be discussing and formulating a management proposal for a 15,000 acre parcel of federal land known as the Ram Mountain Area, located southeastern Wyoming. The Ram Mountain Area grades into forest and montane environment and is located in the Snowy Range region; it is classified as part of the Wyoming Basin shrub steppe ecoregion -- aridic and high elevation.

Approximately half of RMA was burned during a large, recent summer fire, and regional managers, residents, and scientists are concerned about a potential cheatgrass invasion. There are many adjacent populations of cheatgrass contributing to a significant amount of propagule pressure, and cheatgrass has been identified at trace levels in the area before. The fire is likely to make sagebrush recovery in the burned area a very slow process, whereas cheatgrass is likely to establish and thrive beginning early in the next spring, opening RMA up to invasion.

While the *final* management decision will be made by the federal agency that administers the area, state and local stakeholders have been asked to present management suggestions. There is a reasonably good relationship between the federal agency and stakeholders. If you can come to a consensus and present a strong, multi-dimensional justification for your proposed management action(s), it is very likely that the federal agency will incorporate your advice into their decision.

TASK

Your task will be to **create a management proposal** to address a looming cheatgrass invasion in the aftermath of a fire on public land. The class will be divided into three groups (scientists, managers and economists, and local residents) representing **ecological, economic, and sociocultural** concerns related to different possible management approaches.

You will first meet with all other students assigned to your stakeholder group to determine your management preferences among the available options, according to the background information that your group has been given. Afterwards, mixed groups of "scientists," "economists," and "residents" will meet to discuss these preferences and attempt to form a management plan. *One* management approach may not be desirable -- you may choose a combination of options. However, **the final agreed-upon plan must be justified and explained using economic, ecological, and sociocultural logic.**

REFERENCES

Cheatgrass and Wildfire. Updated Jan 18, 2014. Colorado State University Extension. http://www.ext.colostate.edu/pubs/natres/06310.html

Rocky Mountain Cheatgrass Management Project. 2013. Cheatgrass management handbook: managing an invasive annual grass in the Rocky Mountain region. University of Wyoming and Colorado State University.

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An intro to the available weed control options for the RMA

- Hands-off**:** No intervention conducted on Sheep Mountain, but monitoring is continued. A "wait and see" approach to watch how cheatgrass does or does not spread, and at what rate.

- Fire suppression: This approach would focus on reacting to, rather than preventing, fires. Extra support would be allocated to regional wildland fire crews to manage wildfires in the Ram Mountain Area for the next several seasons. This approach would be a tool to reduce the impact of fire frequency on cheatgrass dominance over native plant communities. It would primarily serve to prevent cheatgrass from establishing in new areas and protect the remaining sagebrush-grass community.

- Targeted grazing: Cheatgrass is palatable for a brief window early in the spring when it "greens up." After this point, it is not palatable. A targeted grazing strategy would bring cattle into RMA for this brief window (2-3 weeks) in order to graze on young cheatgrass. The objective would be to suppress the cheatgrass's early growth and give native plants an opportunity to grow in the burned area.

- Competitive seeding: Reintroduction of desirable species to compete with cheatgrass; use of native species is preferable, but introduced species such as crested wheatgrass tend to be most competitive and so are frequently used. Perennial grasses are commonly introduced, but other species (forbs, etc.) may also be included.

- Mechanical treatments: Disking (use of a disk/"harrow" to disturb the soil) and plowing with a moldboard plow (complete soil turnover) are the mechanical treatments under consideration for the RMA. This approach would attempt to bury cheatgrass seeds deep in the soil where germination is less likely.

- Herbicide application -- Chemical control is one of the most widely used weed control methods. Repeated applications of herbicide are sometimes necessary, because cheatgrass can germinate in the spring as well as in the fall (it is a winter annual). In the RMA, the herbicide under consideration is glyphosate, commercially known commonly as "Roundup." This would serve as a direct treatment on aboveground biomass of cheatgrass in spring.

LOCAL RESIDENTS: Sociocultural implications

Hands-off: Residents are reluctant to endorse a hands-off approach. In the first place, public land is meant to be managed, they argue, and simply "letting it be" does not seem to be a good management technique. Since so much land in the area is public, residents have few options for taking matters into their own hands, and many would rather simply see managers *acting* rather than stepping back. While residents might not be troubled by shifts in the plant community under other circumstances, word has gotten around that cheatgrass tends to form extensive monospecific stands, which has major habitat implications. Specifically, such a change could make recreating in the Ram Mountain Area and the entire region much less enjoyable, as wildlife viewing and hunting are popular activities that could be damaged by such a dramatic shift toward dominance by a generally unpalatable species. Further, cheatgrass's status as a highly flammable grass that continues bringing high-intensity fire into ecosystems is also cause for intervention.

On the other hand, a minority of residents concerned about excessive government spending argue that land management for plant invasion is not a reasonable investment. A few support the idea of cutting back on government expenditures that may or may not result in any actual change on the invaded landscape.

Fire suppression: Everyone in the region worries about fire. For example, the summer of 2012, several hundred residents of Woods Landing-Jelm, Albany, and other communities in the Snowy Range had to evacuate to Laramie in response to the Squirrel Creek Fire. The fire burned almost 11,000 acres in the Medicine Bow National Forest before it was contained, and it destroyed multiple structures (Peterson 2012). The burn occurred during a very dry summer, creating unpredictable fire behavior, and with cheatgrass populations increasing, many residents are thinking about how soon another fire may ignite in the area.

In the aftermath of the Squirrel Creek Fire, tensions are heightened among residents during forest fire season. Many residents would be very relieved to hear that federal agencies are investing more resources into prevention and early detection of forest fires for the purposes of suppression.

Targeted grazing: Most local residents have expressed a very strong opinion against grazing cattle in the Ram Mountain Area. Livestock grazing has not occurred on the parcel in recent

memory, and community members find it aesthetically and environmentally distasteful to introduce a grazing regime, even for a short amount of time. Many are worried that opening the area to any amount of grazing, even as a temporary mitigation strategy, will pave the way for future expansion of grazing in the area.

The small communities adjacent to the Ram Mountain Area derive a significant portion of their revenue from visitors who come to the region to recreate. Ram Mountain Area features miles of single-track trail popular with local mountain bikers and hikers, and hunters use the area seasonally. Residents are also concerned that the seasonal presence of cattle will make the mountain a less desirable recreational space, leading to a decline in tourism-related business at the bar and grill on the main road in town. In a town so small, that could have a significant impact. Local residents also tend to be very active and have historically recreated in the area themselves, so many are personally invested in a cattle-free, aesthetically pleasing area.

On the positive side, the local residents who run cattle (a minority, but vocal) may be glad to take advantage of the new grazing allotments.

Competitive seeding: The idea of seeding plants to compete with invaders is generally popular, although not many residents are particularly conscious of how such a plan would unfold. Two recreational gardeners in town run a local group that supports planting home gardens with native plant species, and would prefer the seeding of native species – they are opposed to seeding non-natives, which is the most common practice in competitive seeding. Due to their efforts and presence at the local Sunday farmer's market in one of the larger (population 200) and more frequently-visited towns, residents have very positive associations with the idea of "native" plants. Generally, people also perceive this management option to be less intrusive than other suggested interventions. Many laypersons have expressed enthusiasm about supporting a native population and helping to preserve genetic diversity of native plants on the landscape, but are more cautious about the use of non-native plants. However, a sizeable minority of the population knows a little about crested wheatgrass and has neutral-to-positive associations with it.

Herbicide application: Residents are divided on this particular treatment. Some individuals are enthusiastic about the possibilities of applying a herbicide in particular Roundup (glyphosate) because it has proven to be a highly effective treatment in many contexts. It is a familiar "brand name" to residents with a background in agriculture.

On the other hand, many residents are deeply uncomfortable with the idea of introducing an herbicide into a wildland system in lieu of more "natural" interventions. Many people find the idea of organic agricultural and management practices to be appealing, and are opposed to herbicide use in general, let alone on publically managed land. They are worried about the long-term environmental impacts of allowing such a powerful herbicide into the system, and are equally concerned that, in the short term, the application could generate unforeseen consequences and/or drift into areas where desirable species will be eradicated. At the very least, they argue that herbicide should be used as an absolute last resort.

Mechanical treatment: Residents have no strong ethical/moral convictions about the use of mechanical treatments, although some who own property leading up to Ram Mountain Area are grumbling about the government potentially moving large equipment on the public right-of-ways that cross their properties.

Sources

Peterson, C. July 03, 2012. "Scores flee Squirrel Creek Fire southwest of Laramie." Casper Star Tribune: http://trib.com/news/state-and-regional/scores-flee-squirrel-creek-fire-southwest-of-laramie/

RESOURCE MANAGERS AND ECONOMISTS: Economic implications

Hands-off: This is the cheapest option for intervention, and will incur no costs except for the minor costs of monitoring, which are necessary for all other intervention strategies as well. The potential benefit of this approach is that if ecosystem functionality is maintained/restored without intervention, it will have saved money. The potential cost is that the invasion occurs and the ecosystem loses functionality, leading to a loss of potential range resource, fire hazard for the surrounding area, and a less desirable recreation destination. However, since cheatgrass is very difficult to eradicate once introduced to a system, if other methods are tried and do not succeed, the same conclusion will have been reached anyway. In other words, if regime shift is inevitable, the "hands-off" approach wouldn't waste money. Further, not all economists are convinced that cheatgrass will inevitably spread and dominate the burned area, since it was only present in trace amounts prior to the burn.

Fire suppression: Fire suppression is a massively expensive operation in both the short- and long-term, and at both the federal and local scales. Since the 1990s, yearly federal expenditure on fire control has averaged almost $3 billion, more than double the budget for fire management in the 1990s (U.S. Government Accountability Office 2009; Wildland Fire Leadership Council 2004).

State and local monies are also expended in firefighting efforts. Both the state of Wyoming and the county provided financial backing for firefighting during the Squirrel Creek Fire that burned 11,000 acres of the Medicine Bow National forest in 2012, including much of Sheep Mountain. Federal agencies in the region have made an explicit policy of containing wildland fires as quickly as possible in order to limit property damage in the area (BLM Wyoming State Office 1998).

The benefit of fire suppression is that the policy attempts to limit damage to structures, especially to private property. The BLM notes that public and private sections of land intermingle, and "there are many structures and facilities associated with ranches and summer cabins in the area" (BLM Wyoming State Office 1998). However, since the number of properties protected is relatively limited, it is important to acknowledge that funds expended are not balanced by the amount of property protected -- this is still a massive cost, and certainly the most expensive approach to controlling the damaging impacts of cheatgrass.

Targeted grazing: After the "hands-off" response, this is likely to be the cheapest option. The costs associated with this approach are the costs of monitoring, enforcement, and infrastructure maintenance incurred by agency employees, which can be easily built into or accounted for in annual budgets. While public grazing fee rates are highly discounted compared to private costs, federal agencies that issue grazing permits are charging $1.35 per Animal Unit Month (AUM)[1] in 2013 (Forest Service 2013).

Competitive seeding: The BLM and Forest Service engage in a Seed Buy every year, and seed for restoration purposes is available for purchase, varying by price. Native shrubs and forbs are the most expensive seeds to purchase, with prices ranging from around $40-$80 per pound. Native grass seed tends to be less expensive, around $10-$20 per pound (Western Native Seed). Crested wheatgrass, a non-native but very competitive grass, retails for about $3 per pound (Great Basin Seed). Rates of seeding vary according to several factors, but in creating seed mixes for distribution in restoration areas, each acre being seeded will require about 15 pounds of grass seed and 8 pounds of shrub and forb seeds. Crested wheatgrass can be grazed.

Costs incurred by seeding vary by method of distribution: broadcast seeding, meaning seed spread on surface (cheap), versus drill seeding, meaning seed is placed into the earth at a given depth (expensive). Different equipment is necessary for different distribution methods and varying terrains (Revegetation Equipment Catalog 2005). In the Ram Mountain Area, the gate accesses required to reach potential restoration sites as well as the difficult (rocky, hilly) terrain could limit usage of the cheapest options. To determine exact costs, further study on this matter may be necessary, and it is possible that broadcast seeding would have to be conducted by aircraft, which would be expensive. However, it is also possible that seeding native perennial plants could have net positive economic effects, as the intervention could create a desirable and valuable stable state.

[1] Animal Unit Month (AUM) is a measure used to assess forage requirements for grazing animals, and therefore determine appropriate stocking rates. The base "animal unit" (AU) is equivalent to one 1000 lb. cow; animals that are not 1000 lb. cows are represented in terms of number of AUs -- for example, one medium-sized sheep would be measured as 0.2 AU. Animal Unit Month is the amount of land needed by one AU to feed for one month. AUM varies by region, i.e. type of forage available. For example, in a Wyoming big sagebrush-bluebunch wheatgrass system, a stocking rate of 4 acres per AUM might be the standard prescription.

Herbicide application: Glyphosate is a herbicide best known as Roundup or Rodeo, both produced by Monsanto Company. It is a highly effective broad spectrum herbicide used primarily in agriculture. To date no specific herbicide formulations have been developed to combat cheatgrass, but the broad-spectrum nature of Roundup makes it a reliable choice.

Roundup can be applied at rates of .75-1.5 ounces per acre depending on the severity of the invasion. Roundup currently retails at commercial rates for $29/gallon, or 22 cents per ounce.

Mechanical treatment: Mechanical treatment can be expensive, depending on how extensively it is done. Both disking and moldboard plowing locally cost between $12 and $25 per acre.

Sources

BLM Wyoming State Office. 1998. Fire management implementation plan. http://www.blm.gov/pgdata/etc/medialib/blm/wy/programs/fire/firedocs.Par.3291.File.dat/wyfireplan.pdf

Great Basin Seed. http://greatbasinseeds.com/wordpress/product/crested-wheatgrass/

Revegetation Equipment Catalog. 2005. http://reveg-catalog.tamu.edu/09-Seeding.htm

United States GAO. 2009. http://www.gao.gov/new.items/d09877.pdf

USDA Forest Service. 2013. http://www.fs.fed.us/news/2013/releases/01/grazing.shtml

Western Native Seed. http://www.westernnativeseed.com/

Wildland Fire Leadership Council. 2004. Large fire suppression costs: strategies for cost management. http://www.fs.fed.us/fire/ibp/cost_accounting/costmanagement_aug_04.pdf

ECOLOGISTS AND AGENCY BIOLOGISTS: Ecological implications

Hands-off: This approach is very unpopular among all scientists represented. While it may appear that cheatgrass is unlikely to establish (having previously only existed in limited trace amounts), the plant prolifically produces seeds, and there is enough of a seedbank to facilitate robust growth. Extremely significant amounts of aboveground biomass are expected in the early spring. Because cheatgrass is likely to substantially alter habitat qualities and important ecosystem characteristics, scientists strongly recommend taking management action. In particular, hydrologists have advised that loss of sagebrush will change snowpack dynamics, which could potentially decrease water availability to towns around the county. Scientists strongly advise managing cheatgrass early rather than waiting until it is too late and the fire cycle is nearly impossible to break. Experience and many studies have shown that there is no easy solution for a cheatgrass invasion once it is well-established.

Fire suppression: While this could be a useful part of the puzzle, scientists are skeptical that merely suppressing fire in the future will be enough to curb the potential invasion. Because cheatgrass presents such a flashy and continuous fine fuel load, fires spread extremely quickly, making it nearly impossible to react in time to put out a fire before it carries across a far distance and burns at a high temperature (Rocky Mountain Cheatgrass Management Project 2013). During peak fire season in the summer, flames may spread at a rate of 231 m min^{-1} (very quickly) (Diamond et al. 2009). On its own, scientists doubt that a fire suppression strategy will be particularly successful and preventing a full-blown cheatgrass invasion. Besides, the Ram Mountain Area grades into forests with an evolutionary history of fire, and these forests are currently experiencing a bark beetle outbreak killing large patches of tries and providing much tinder – fire is, in many ways, inevitable, and could easily and quickly spread through the area.

Targeted grazing: Scientists are very enthusiastic about using targeted grazing to exert pressure on cheatgrass early in the spring. Studies have shown that cheatgrass can be effectively checked with intensive early season grazing in the "boot" stage (well before seed shatter, which is when seeds drop from a plant). Targeted grazing can also effectively reduce the fire risk presented by cheatgrass – fire in grazed cheatgrass is far less likely to carry (Diamond et al. 2009).

Further, cheatgrass is actually relatively valuable forage at this point, because it is so early in the season and few other plants are green. This also means that the risk of non-target impacts (i.e. the effect that the treatment will have on species other than cheatgrass) is relatively low, since cheatgrass reaches the boot stage long before many other species of plants. However, there are some perennial cool season native grasses that could potentially be negatively affected by this strategy. Scientists warn that while grazing alone can potentially have a tremendous impact on reducing cheatgrass populations in the targeted area, it is very difficult to get the timing consistently right over several years. Further, variables such as moisture availability cannot necessarily be controlled. It is important not to view targeted grazing as a catch-all solution, but as a potentially important and strong tool (Rocky Mountain Cheatgrass Management Project 2013).

Competitive seeding: This treatment is also popular among scientists, because it does have a reasonably successful track record. A study conducted in Wyoming has shown that drill-seeded crested wheatgrass varieties can lead to a significant reduction in cheatgrass cover as crested wheatgrass establishes and competes (Whitson & Koch 1998). While there are many studies ongoing in search of competitive native species that could be seeded against cheatgrass, currently there are no clear native options that have had any particular success (Rocky Mountain Cheatgrass Management Project 2013). Any native species seeded is apt to be a risky enterprise at this point. Some scientists uncomfortable with seeding a non-native species have not fully endorsed this competitive seeding approach, or would prefer to conduct small-scale seeding trials with native plants to look for potential competitors. However, crested wheatgrass is often recognized as a potential "placeholder" species in restoration. Because it is palatable, it could be used for forage under future grazing conditions.

Herbicide application: Opinions on this treatment are mixed. On the one hand, use of chemical control for weed management is very common and has many advantages, including lack of soil disturbance and a huge amount of flexibility. However, non-target effects can be significant with a broad-spectrum (non-selective) herbicide such as glyphosate, a fact that worries many scientists. Native plants exposed to the herbicide, in other words, will be killed too. Over-treatment using herbicides is also a common problem, a concern for more cautious scientists.

Several scientists wonder about whether cheatgrass could potentially develop herbicide resistance (a growing topic of conversation in weed management). At the least, scientists are agree that herbicide may be an effective tool, but should probably not be the only tool under consideration. Coupled with other methods, it has well-established positive impacts. On the positive side, it does not have soil residual effects, so it doesn't "stick around."

If this method is chosen, scientists recommend applying early in the season while the cheatgrass is still growing.

Mechanical treatment: Scientists strongly caution against relying on mechanical treatments. Cheatgrass thrives on disturbance, and disturbing the soil will likely only cause it to spread more. When tilled (disked or moldboard plowed) repeatedly, burying cheatgrass seeds at a depth of 4-6" may be sufficient to suppress growth. Moldboard plows are most effective for this purpose but do poorly on rocky soils such as those in this area (USDA Forest Service 2012).

Sources

Diamond, JM, CA Call, and N Devoe. 2009. Effects of targeted cattle grazing on fire behavior of cheatgrass-dominated rangeland in the northern Great Basin, USA. International Journal of Wildland Fire 18:944-950.

Rocky Mountain Cheatgrass Management Project. 2013. Cheatgrass management handbook: managing an invasive annual grass in the Rocky Mountain region. University of Wyoming and Colorado State University.

USDA Forest Service. 2012. Field guide for managing cheatgrass in the southwest. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5410110.pdf

Whitson, TD and DW Koch. 1998. Control of downy brome (*Bromus tectorum*) with herbicides and perennial grass competition. Weed Technology 12:391-396.