Cheatgrass and Red Brome: History and Biology of Two Invaders

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Abstract—In recent history, there has not been a more ecologically important event than the introduction of cheatgrass (*Bromus tectorum*) and red brome (*Bromus rubens*) into the Intermountain West. These grasses are very similar in ecology and history and are separated mostly by function of elevation. Both species are from the Mediterranean region, and both arrived in the Western United States about the same time (1880). Cheatgrass and red brome have greatly affected fire frequency and intensity, which has been detrimental to native shrubs and other perennials in these systems. Red brome may have had an even greater impact, in that it has readily invaded non-disturbed areas, has had great impact on fire sensitive shrub species, and, to this point, we have not identified adapted species native or non-native for rehabilitating burned areas. Introduction of cheatgrass and red brome in the West has wreaked ecological havoc on the areas they have invaded and will continue to affect structure, function, and management of these areas well into the future. This paper will detail the history and ecology of these two highly invasive species.

Introduction

In recent history, there has not been a more ecologically important event than the introduction of cheatgrass (*Bromus tectorum*) and red brome (*Bromus rubens*) into the Intermountain West. This paper details the history and biology of these two highly invasive species.

The reality of these annual grasses is well summed up by Peters and Bunting (1994) with the suggestion that the introduction of exotic annual grasses, including cheatgrass, into the Snake River Plain may have been the most important event in the natural history of that region since the last glacial period. Catastrophic ecosystem change for the western Great Basin has been suggested as a function of cheatgrass by Billings (1994).

In: Kitchen, Stanley G.; Pendleton, Rosemary L.; Monaco, Thomas A.; Vernon, Jason, comps. 2008. Proceedings—Shrublands under fire: disturbance and recovery in a changing world; 2006 June 6–8; Cedar City, UT. Proc. RMRS-P-52. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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These grasses are very similar in biology, ecology, and history and are separated mostly by function of elevation; we will review cheatgrass first and then follow with red brome.

Cheatgrass

Cheatgrass—also called June grass, bronco grass, downy chess, and downy brome—is a winter annual that was introduced from the Mediterranean region in packing material and first found near Denver, Colorado, (Whitson and others 1991) or perhaps in the eastern coastal states prior to its entry into the West (Monsen 1994).

Colonization of the West by Cheatgrass

Railways, roads, and contaminated grain seed are indicated as the principal means of initial spread of cheatgrass after which it was advantageous with heavy grazing and other disturbance (Billings 1994). One of the earliest reported collections of cheatgrass in the West was made in Washington by Sandberg and Lieberg in 1883, and a year later it was collected near Provo, Utah, by M. E. Jones (Billings 1994). In the course of extensive field surveys of about 1900, it was not reported for northern Nevada, and the first report for Elko County was in 1906 (Young and others 1987).

By 1946 it occupied at least 10 million acres in eastern Oregon (Monsen 1994). By the 1980s, Kunzler and others (1981) found it among the most abundant species in Gamble oak communities of central and northern Utah, and by the 1990s it was common to dominant over hundreds of thousands of acres in the Great Basin of Utah and Nevada. Roberts (1991) reported 900,000 acres (about 30%) of the Salt Lake District of the Bureau of Land Management was producing cheatgrass. It is present in all counties of Utah, where it is an integral part of the flora (Arnow 1987).

Cheatgrass is now widespread in North and South America in many plant communities of plains, deserts, foothills, and lower montane areas and especially where snow depth and temperatures allow for fall germination and some winter development or at least persistence of seedlings through winter.

It is most abundant in areas of between 6–16 inches of annual precipitation (Monsen 1994). It does not do well on saline soils, but its ability for rapid growth might allow it to make considerable growth from shallow, less saline moisture early in the season (Rasmuson and Anderson 2002).

Cheatgrass is an explosive invader in the Great Basin, Snake River Plain, Columbia Plateau, and other areas of the

West where it proliferates with fire and other disturbance including roads and associated traffic, off road vehicle use, construction of recreation facilities, and livestock grazing.

It is highly flammable when dry, and with relatively little moisture it produces enough biomass to create continuous fine fuel that leads to high frequency and increasing size of subsequent fire, which perpetuates this plant and excludes many others including sagebrush.

Although some native and introduced grasses compete well with cheatgrass when the grasses are mature, the seedlings of few species can compete with cheatgrass. Francis and Pyke (1996) found that cheatgrass seedlings were superior competitors compared with seedlings of two cultivars of crested wheatgrass. However, they found that increasing densities of Hycrest cultivar of crested wheatgrass reduced cheatgrass biomass and tiller production.

Near complete control of cheatgrass might be necessary before seedlings of some perennial grasses, including desert needlegrass (*Achnatherum speciosum*), can be established (Rafferty and Young 2002).

In number of seeds produced per plant per unit of area, cheatgrass has the capacity to overwhelm native perennials at the seedling level even if the starting density of cheatgrass seeds is low (Young and Allen 1997).

Management Implications

With dynamic expansion of cheatgrass with disturbance, it is desirable to promptly rehabilitate burned sagebrush and pinyon-juniper communities before cheatgrass has a chance to establish dominance of the site (Evans and Young 1978). In some cases, cheatgrass has been found to make an initial rapid increase and then greatly decline (Barney and Frischknecht 1974; Erdman 1970; Davis and Harper 1990).

A fire return interval of 3–6 years fueled by cheatgrass tends to wear down perennials. Regardless of some perennial plants being able to compete with cheatgrass at one point in time, the ability of cheatgrass to drive ecosystem dynamics over time is a function of high fire frequency as well as its aggressive growth features.

To beat cheatgrass in communities where sprouting perennial species have been depleted often requires prompt seeding of adapted perennials that are able to establish uniform stands with a single seeding. Few species are known to be able to establish stands with a single seeding in areas of less than 10–12 inches annual precipitation. Most of these, such as crested wheatgrass, have been introduced from Eurasia.

In recent years, great emphasis has been placed on seeding only natives after fire or other disturbance to maintain native plant communities. However, unless seedings are successful in keeping cheatgrass from dominating, the goal for natives is not achieved, and cheatgrass drives a departure from native ecosystems that exceeds the departure induced by crested wheatgrass.

Until native plant materials with the capability of competing with cheatgrass in low precipitation areas are available in large quantities, "pick your alien" (annual or perennial) will remain a dilemma for the native only concept. The option to not seed exotic perennials has and will likely continue to favor cheatgrass. Indeed, the concept of pure native communities has become not only problematic, but it is presented with catastrophic challenges by cheatgrass.

A growing body of evidence strongly suggests that cheatgrass presents a potential to turn the pure native concept into romantic fantasy. That body of evidence includes the presence, the abundance, and even dominance of cheatgrass in areas where native plant communities have been protected from disturbance.

Kindschy (1994) reported the presence and increase of cheatgrass in southeastern Oregon's Jordan Crater Research Natural Area that has been protected from human activities including livestock grazing.

On Anaho Island in Nevada, Tausch and others (1994) found cheatgrass has displaced native perennials despite a general absence of human-caused disturbance and fire. They attributed the increase to the competitive ability of cheatgrass.

In Red Canyon of the Green River, cheatgrass has been found as the most frequent species where livestock use and other post European related disturbance have been minimal (Goodrich and Gale 1999).

Young and Clements (1999) reported invasion of cheatgrass into ecologically high condition shadscale/greasewood communities in Nevada despite apparent lack of livestock grazing.

Young and Tipton (1990) cited two works from southeastern Washington that documented observations of cheatgrass successfully inserting itself into climax perennial grass/shrub communities that had been protected from fire and grazing for as long as 50 years. They proposed that the idea of cheatgrass spreading in a biological vacuum created by excessive grazing may be somewhat misleading or overstated.

Young and Allen (1997) have emphasized that site degradation is not necessary for cheatgrass invasion.

In western Utah, Harper and others (1996) found cheatgrass able to establish in ungrazed areas in desert shrub communities where, although native perennials were able to greatly suppress the size of cheatgrass plants, cheatgrass was able to maintain a presence by which it could expand upon disturbance including gopher mounds.

Austin and others (1986) found cheatgrass present in Red Butte Canyon of the Wasatch Mountains where livestock grazing was discontinued in 1905, which was essentially prior to cheatgrass reaching that area. Austin and others (1986) also found cheatgrass in Emigration Canyon of the Wasatch Mountains where livestock grazing was discontinued in 1957. They reported higher cover values for cheatgrass in 1983 than for 1935 in Red Butte Canyon and higher values in Red Butte Canyon than for Emigration Canyon in 1983. These values for cheatgrass are contrary to the concept of cheatgrass only increasing as a function of livestock grazing.

Knight (1994) reported that the cheatgrass problem is not restricted to land grazed by livestock, and he gave an example of an increase of cheatgrass following fire in Little Bighorn Battlefield National Monument in southern Montana. He suggested that managing vegetation of a National Monument so that it reflects presettlement conditions is a goal that may be impossible once certain introduced species become established.

Although some of these examples deal with areas that have been relatively little affected by human activities, nowhere is the climatic zone of cheatgrass in North America wholly isolated from the modern world. The rapidity, volume, and distance of transport of people and goods across the globe by air, water, and ground strongly suggest additional introductions of cheatgrass and other aggressive species from around the world will not only continue but will increase.

That livestock grazing has been a factor in the spread and abundance of cheatgrass is not disputed here. However, the suggestion by Young and Tipton (1990) that this factor has been overstated seems appropriate in that other factors of spread have perhaps received less attention. Disturbance of roadsides and water runoff from roads creates favorable habitat for several weedy species. Highway and off-road vehicles are highly efficient seed catching and dispersing agents. These features would have resulted in the spread of cheatgrass even in the absence of livestock grazing.

The reality of modern life and the aggressive nature of cheatgrass present challenges for managing wildland resources that will not be well addressed by clinging to concepts based on conditions that no longer exist. The world is not what it was prior to European settlement of the Americas. Air traffic, super highways, railways, and roads of high density were not part of the environment prior to 1492. Reality of today includes not only vehicles that travel hundreds of miles in a day with the potential to carry seeds not only across major drainages, but also across oceans.

A highly mechanized and highly mobile human population contributes to a high fire frequency that favors cheatgrass. The competitive nature of cheatgrass will not be reduced by the concept that native communities that are well managed or even untouched will keep it out. In some environments, it has demonstrated that it is a better competitor than native species. Within the ecological range of cheatgrass, basing potential natural plant communities of today on the environment prior to 1492 makes little sense.

Dealing with this force might require seeding some of the most aggressive and less fire prone perennials the world has to offer, regardless of origin. Although this concept is laced with the problem of the cure being worse than the malady where native communities are desired, such a desire is laced with a serious problem or dilemma of its own. The replacement of native ecosystems and their function by cheatgrass driven systems indicates a departure from "native" that exceeds that associated with seeding selected perennials.

Each fire on the Snake River Plain, valleys and foothills of the Great Basin, and other cheatgrass prone areas of the West tightens the grip cheatgrass has on these ecosystems. Opposition to seeding highly competitive perennials in cheatgrass prone areas is indicated to be a demonstration of values that are no longer a potential. Billings (1994) indicated that the potential has changed with the catastrophic ecosystem change induced by cheatgrass as indicated by Billings (1994).

The retort that cheatgrass is a function of past mismanagement of livestock on rangelands will do nothing to improve the condition, and it conveniently ignores the high likelihood that cheatgrass spread and dominance was inevitable with European settlement with or without livestock. Although the early advance of cheatgrass in the West was facilitated by livestock grazing, the ultimate spread of this species is a function of a number of factors, some of which could have advanced cheatgrass in the absence of livestock grazing. The dense network of roads, off-road vehicle use, and frequent use of these by an expanding population would have been the means of spread throughout the potential range of cheatgrass. Fire would have done the rest. It is quite likely that livestock simply set forward or accelerated the inevitable by a few decades.

The long-term trend in numerous crested seedings indicates that these seedings could be managed for the return and maintenance of at least native sagebrush (Huber and Goodrich 1999). In contrast, cheatgrass and its shortened fire cycles excludes sagebrush. Although crested wheatgrass is introduced, it presents an opportunity for greater diversity than does cheatgrass. Where stands of crested wheatgrass are managed for return of sagebrush, it can facilitate development of much greater structural diversity than does cheatgrass.

The use of natives at the present appears problematic; Britton and others (1999) evaluated performance of 24 taxa at a sagebrush site and 20 taxa at a greasewood site. The top performing 9 taxa at the sagebrush site and 10 taxa at the greasewood site were introduced.

Hull (1974) evaluated the performance of 90 plant taxa including many natives in rangelands of southern Idaho. Where annual precipitation was less than 25 cm (10 in), only 17 of the 90 taxa rated over 1 on a relative scale of 1–10. Of these 17 only 6 were natives and none of these natives rated over 2.1. Phases of crested wheatgrass rated from 7.7 to 9.5. Pubescent wheatgrass rated at 6.2 and intermediate wheatgrass rated at 5.1. No other taxon rated over 5.

In general, it seems that the expansion and dominance of cheatgrass has been more dramatic in the inherently grass-poor regions of the sagebrush ecosystem than in the inherently grass-rich regions. As indicated by Tausch and others (1994), the boundary between Wyoming big sagebrush and mountain big sagebrush in western Nevada represents a boundary below which moisture and other conditions favor annual grasses and above which perennial grasses are favored.

However, the Wyoming big sagebrush region of Wyoming compared to that of the Great Basin seems to be relatively rich in native grasses. In this grass-rich region, the invasion of cheatgrass has been comparatively mild. This contrast demonstrates that features other than livestock grazing are important in abundance of cheatgrass. Intensity of livestock grazing on sagebrush areas of Wyoming has probably been equal to, if not greater than, that in the Great Basin.

Forage Value

Cheatgrass is nutritious when young and palatable to a wide range of ungulates and is highly preferred by mule deer during spring and fall (Austin and others 1994). Bighorn sheep have been observed using cheatgrass on the steep, southerly facing slopes of Red Canyon of the Uinta Mountains in winter when this winter annual is one of the few green herbaceous plants. It is of great economic importance to the domestic livestock industry in some places. Emmerich and others (1993) and DeFlon (1986) reported on range operations where cheatgrass is a major part of the winter and spring forage base. Kufeld (1973) rated it as valuable to elk in winter. This value is likely—at least in part—a function of the southerly exposures or other warm places that are often open in winter where this plant grows best.

On the Mojave Desert, Phillips and others (1996) found that domestic sheep showed high preference for this plant in spring. Cheatgrass seeds and new growth are valuable forage for chuckars (*Alectoris graeca*), Gamble quail (*Lophortyx gambelii*), and mourning doves (*Zenaidura macroura*) (Plummer and others 1968).

Disadvantages of cheatgrass include (1) high fire frequency, which greatly alters forage supplies and maintains rangelands in an annual condition frequently exposed to wind and water erosion; (2) a short green-feed period; (3) great variability of herbage production between moist and dry years; and (4) mechanical damage to mouth parts of grazing animals after drying and hardening of sharp seed-parts (Young and Allen 1997). Also cheatgrass has been associated with reduced nutritive quality of other species (Haferkamp and others 2001). DeFlon (1986) reported winter use of cheatgrass ranges was more favorable to achieving a stable forage base than was spring use. He explained that spring use lead to an increase in halogeton in his study area.

It appears that the consequences of cheatgrass remain little understood. Preservation of native plant communities based on hands-off management, seeding only locally collected native seed to avoid genetic contamination, and rangeland evaluation criteria that ignore cheatgrass in site potential are ideals difficult to implement where cheatgrass is well adapted. However, these and other preservation based ideals often prevail in planning, management, and legal maneuvering dealing with cheatgrass prone rangelands. Yet there seems to be little in the literature dealing with cheatgrass to support ideals of preservation on lands where cheatgrass is highly competitive.

The departure from native ecosystems inflicted by cheatgrass exceeds that of seeding selected, exotic perennial plants and other cultural practices that foster perennial plants that tend to reduce influence of cheatgrass. Ironically, advocates of preservation often support actions that favor cheatgrass over establishment of adapted perennial plants.

Red Brome

As stated earlier, red brome is very similar to cheatgrass, thus most, if not all of the proceeding discussion on management and ecological implication also applies to red brome. The following is specific to the history and biology of red brome.

Introduction and History

Red brome, often called an ecological equivalent of cheatgrass, is another Mediterranean winter annual that has invaded disturbed and undisturbed areas of western Northern America, especially the desert southwest. Red brome was brought to North America from the Mediterranean before 1880 (Watson 1880). Three possible scenarios have been proposed for introduction into this area: (1) California Gold Rush and Central Valley Wheat, (2) Southern California Shipping, and (3) Northern California Sheep.

The period of most rapid spread was from 1930 to 1942. The greatest spread into new regions during the past 50 years coincides with "warm" Pacific Decadal Oscillations regimes (El Nino) (Salo 2005). El Nino southern oscillations that result in consecutive years of above-average winter precipitation provides red brome 1st year germination and 2nd year high biomass. Increased CO_2 and N deposition also may be contributing to red brome's success.

The early history of California includes the Mexican Period (1822–1846). It appears unlikely that red brome was introduced from Mexico because red brome was first reported in Mexico in 1931–1932 (Howell 1942), 50 years after its first collection in the United States.

In contrast to accidental introductions, red brome was seeded near the University of Arizona at Tucson from 1906 to 1908 for evaluation as a forage plant; this grass soon escaped and became established along the Santa Cruz River (Thornber 1909)

Red brome was also reported in northern Arizona in 1911 and collected near St. George, Utah, in 1926, where it increased in collections from this area for the next 35 years. In addition, it was also becoming common in waste places and cultivated areas around Las Vegas, Nevada, during this time (Maguire 1935).

Red brome was found throughout northeastern Nevada by the 1940s and continued to spread in designated natural areas of Arizona during this time. By the 1960s, red brome dominated even relatively undisturbed areas of Nevada, Utah, and Arizona and was also reported in New Mexico. Collections of red brome in south-central Utah increased dramatically after the construction of Glen Canyon Dam in 1963.

Red brome now occurs from British Columbia to northwestern Mexico and coastal California to western Texas; continued introductions may have provided new genotypes.

Biology

The available literature suggests that red brome does not maintain a soil seed bank but exhibits early and uniform germination. In contrast, native annuals depend on soil seed banks, hedging in time; however, at least one researcher disputes this (J.A.Young, personal communication). Red brome has nearly uniform germination under cool, moist conditions typical of this region and can germinate with 0.5 inch of precipitation, Mojave native annuals appear to require twice that amount (Beatley 1966). One author contends this characteristic can lead to population crashes during drought, and winter droughts dramatically reducing red brome densities (Salo 2004). However, Beatley (1974) states that although its numbers vary from season to season where established, red brome has never been observed to miss a growing season.

Fire Ecology

Red brome may be even more problematic than cheatgrass from a fire standpoint. Low humidity in its range leads to slower decomposition than cheatgrass, increasing fuel loading for a longer period of time. Red brome has been particularly troubling in this aspect because most of the systems it occurs in are not fire adapted, nor have we identified suitable native or non-native species for reseeding into these areas. These characteristics along with its ability to occupy non-disturbed blackbrush (*Coleogyne ramosissima*) sites, the shrub type most susceptible to fire in the region (Beatley 1966), is of great concern.

Conclusion

The introduction of cheatgrass and red brome in the West has degraded invaded ecosystems and will continue to affect structure, function, and management of these areas well into the future. New land management paradigms will be required to manage these ecosystems.

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