APPENDIX C - Cheatgrass Invasion & Greenstripping

Cheatgrass: A Weedy Annual on Great Basin Rangelands

by Scott Tobler

Introduction

Cheatgrass is pre-evolved to fill niches created by humans through concentrations of their domesticated livestock (Young and Allen, 1997). This adaptability of cheatgrass allows it to out compete native vegetation in the semi-arid areas of the U.S. where it has been introduced. In the Great Basin, cheatgrass readily invaded overgrazed and deteriorated rangelands reaching its present distribution by the 1930's. Once established, cheatgrass changes the fire frequency by creating an easily ignited, continuous fine fuel between native shrub and bunchgrass species. The forage quality of cheatgrass is low, and as it forms a monoculture there can be irreversible damage to the native plant and animal communities. Rehabilitation of cheatgrass ranges requires intensive methods that are very expensive. A recent, more cost effective approach to rehabilitating cheatgrass infested rangelands is greenstripping. Established greenstrips will reduce the cheatgrass fire frequency and give native vegetation a chance to recover.

Cheatgrass Physiology

Cheatgrass (Bromus tectorum) is an exotic Mediterranean winter annual. The life history of this grass was preadapted to the wet, cold winters and dry, hot summers of the Great Basin (Mack, 1981). Cheatgrass typically germinates in the fall and forms numerous roots that occupy the soil surface. These roots continue to elongate during the winter while small dormant leaves are maintained. When spring moisture becomes available it "cheats"

other vegetation out of the moisture because it has already established a root system and can begin growing at lower temperatures than most other plants. Cheatgrass grows rapidly, ripens and dries out in, or even before June. If conditions in the fall do not allow cheatgrass to germinate, it will germinate in the spring and complete its lifecycle by early summer. When moisture is deficient, total height growth may be only 5 to 8 cm. In a wet year it can reach 60 cm or more. Cheatgrass is a prolific seed producer, and even in a dry year produces enough of a seed crop to provide for the next year's plants. In fact, one plant/m^2 can produce as many seeds as 10,000 plants/m^2 (Stewart and Hull, 1949, Yensen, 1981, Young and Allen, 1997). Seeds are short-lived (less than 3 years) in most situations, and most control strategies for this weed are driven by the principle of depleting the soil seed bank (Ogg, 1994).

Pre-Cheatgrass Invasion Grazing History

The cheatgrass problems now being experienced on Great Basin rangelands are a result of practices that began back in the mid-1800's. The Mormons first filled the Utah ranges with stock they drove across the plains, beginning in 1847. By about 1880, the ranges in northern and central Utah were occupied by about 160,000 head of cattle (Stewart, 1936). Strong cattle markets in the late seventies and early eighties, as a result of gold and silver discovered in the Rocky Mountains, carried grazing onto most of the accessible ranges as cattle were raised and driven annually to the mines (Mack, 1981). Spurred by strong markets, the accumulated forage of many years was mined by too early and too continuous grazing. Then harsh winters and severe droughts in the mid-to-late 80's wiped out many stockmen making the necessity of providing a dependable forage supply evident. But just when security in the ownership of cattle was becoming established there was a tremendous

and rapid increase in sheep. In Utah, sheep numbers increased from a few hundred thousand in the early eighties to nearly 2.9 million by 1901 (Stewart, 1936). These vast numbers of sheep arriving on fully used cattle ranges, further exhausted the range forage. The mindset of the time was that the only way to prevent another outfit from obtaining a given range on public lands was to strip it clean. Homesteading also rapidly increased in the early 1880's (Mack, 1981), and crop growing had the effect of decreasing the range area and added the settlers' farm stock to the shrinking ranges. Alien weeds also started appearing with the advent of agriculture (Mack, 1981). War demands created high prices, and by 1918-19, the number of animal units in the nation was the highest ever attained (Stewart, 1936). These record numbers of livestock further speeded up range depletion. In Utah, there were reported to be 344,000 cattle and 2,926,000 sheep in 1931 (Pickford, 1932), going into the drought of 1930-35, further setting back any range recovery. As perennial range grasses were depleted throughout this history of grazing and land use, they were replaced by annuals that had originally only been able to gain a hold in disturbed areas along roadways, railways, and deserted agricultural fields.

Cheatgrass Invasion and Spread

Cheatgrass glumes are covered with short strong barbs that cause the spikelets to work into wool, hair, and clothing and aids in the dispersal of seed (Stewart and Hull, 1949). Cheatgrass is thought to have arrived in Idaho from awns carried in the coats of sheep trailed from California through Nevada to Southern Idaho (Yensen, 1981, Young and Allen, 1997). Another way cheatgrass was dispersed throughout the west was probably in contaminated seed grain (Mack, 1981). Cheatgrass is also often a contaminant of alfalfa seed (Young and Allen, 1997). Billings (1994) traced the introduction of cheatgrass to eastern North America

from ships bringing settlers of the 17th and 18th centuries and from there it moved west as a seed grain contaminant. Cheatgrass was being collected repeatedly on ballast dumps at Portaland, Oregon in 1902, and was also spread in discarded straw packed with dry goods (Mack, 1981). Cheatgrass is now widely distributed in the United States, occurring in all areas except for the coastal southeast.

Cheatgrass was first collected in Pennsylvania in 1864, Washington in 1893, Utah in 1894, Colorado in 1895, and Wyoming in 1900 (Stewart and Hull, 1949, Mack, 1981). In the first few years of the 1900's, cheatgrass gained a foothold on disturbed areas like railroad right-of-ways, road shoulders, orchards, and fallow fields. The most spectacular occupations were on abandoned farms (Stewart and Hull, 1949). By 1915 to 1920, cheatgrass started to colonize overgrazed rangelands (Stewart and Hull, 1949, Young and Allen, 1997). Cheatgrass increased very rapidly, especially when fire was combined with overgrazing, which was often the case. Figure 1 characterizes the spread of cheatgrass.

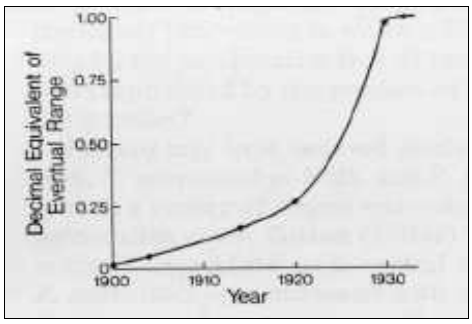

Fig. 1. Plot of area occupied by cheatgrass verses time (Mack, 1981).

Aldo Leopold (1941) portrayed the expansion of cheatgrass well when he said, "One simply woke up one fine spring to find the range dominated by a new weed . . . cheatgrass (Bromus tectorum)."

Some stockmen, in search of new forage for depleated rangelands, aided the spread of cheatgrass by enthusiastically and deliberately introducing it to new areas (Young and Allen, 1997, Yensen, 1981). As it invaded rangelands, cheatgrass started to fill the interspaces between shrubs, where perennial grasses had been before being lost through overgrazing. Pickford (1932) did a study to determine the changes that had taken place on

the Utah spring-fall range type as a result of grazing, fire, or other human induced factors and paints a pretty clear picture of the trend toward the annualization of rangelands as it was beginning in the early 1930's. The density of perennial grasses on grazed plots was only 38 percent as great as on protected plots, and sagebrush density was about 2.25 times higher on the grazed plots. Sagebrush had been practically eliminated on the burned plots and cheatgrass constituted 22 percent of the vegetation with the density of perennial grasses being 32 percent lower on the burned plots than on protected plots. On plots both burned and grazed, cheatgrass was the dominant species, and the density of perennial grasses was only 16 percent as great as that of protected plots.

Cheatgrass and Fire

Cheatgrass is extremely flammable. Cheatgrass range is 500 times more likely to burn than any other rangeland type (Yensen, 1981). Because of the lifecycle of cheatgrass, it can burn 4 to 6 weeks earlier in the summer than perennials do and remains susceptible to fall fires for 1 to 2 months later. The Forest Service estimates that five times more men and equipment are needed for standby crews on cheatgrass ranges than if these same ranges were in perennial grasses (Stewart and Hull, 1949). These characteristics of cheatgrass change the fire regime of the ranges they have invaded by creating a continuous fuel that carries wildfires to more widely spaced shrubs.

Much of the Great Basin can be characterized by three general range types: low-elevation with playas, greasewood (Sarcobatus verticulatus), or saltgrass (Distichlis stricta) habitat, mid-elevation shrub dominated upper valleys and foothills with big sagebrush (Artimesia tridentate) and bunchgrass species, and high-elevations donminated by juniper (Juniperous osteosperma) habitat (Sparks et al., 1990, Rogers, 1982). Fire was not a driving

variable in the low-elevation salt-desert shrub ecosystems (West, 1994). The natural fire frequency of mid-elevation sagebrush-grass vegetation is 32 to 70 years, and in the driest sagebrush communities the fire frequency could have been as low as 100 years (Wright and Baily, 1982). Until about the 1950's, cheatgrass had not invaded juniper woodlands to any serious extent. Since then, fires have become much more common in this woodland ecosysetem fueled by dry cheatgrass and once started by the resins of the trees themselves. This woodland is being replaced after fire by great expanses of annual grassland dominated by even more cheatgrass (Billings, 1994). Cheatgrass is fire tolerant and is perpetuated by fire, causing large areas of the salt-desert shrub, sagebrush-bunchgrass, and juniper ecosystems to burn as often as every 3 to 5 years (Whisenant, 1994). Pickford (1932) noted that on burned-over areas of the Great Salt Lake District, cheatgrass had replaced sagebrush as a dominant and often occupies these sites in dense stands. Today, millions of hectares of rangelands in the Great Basin are characterized by cheatgrass in a conversion from native vegetation that has occurred at an accelerated rate during the 20th century (Young and Allen, 1997).

Cheatgrass as Forage

Cheatgrass produces a relatively large amount of herbage and on many ranges it is the most important forage plant, especially for spring use. However, the period during which the herbage is fresh and green is several weeks shorter than for wheatgrasses. Forage quality decreases as plants mature and the protein content drops to about 3 percent (Nesse and Ball, 1994). The palatability of cheatgrass is often lower than that of associated perennial grasses and long slender awns on the seed head can limit feed intake by irritating and puncturing the soft tissues inside the mouth of grazing animals. Herbage production of

cheatgrass also fluctuates greatly year-to-year due to weather variations as compared to perennial grasses. Perennial grasses produce twice as much herbage as cheatgrass in a moist year and 12 times as much herbage in a drought year (Roberts, 1991, Stewart and Hull, 1949).

Cheatgrass and the Environment

The long-term implications of the cheatgrass invasion and its effects in relation to fires and their cumulative repetitive impacts will be a loss of biological and genetic diversity. The native plant and animal species in ecosystems that are now prone to widespread wildfires are at considerable risk of going extinct at the population level locally or even regionally. Worse, this conversion of native ecosystems to simplistic annual grasslands could alter the energy flow, water cycling, and nutrient balance, causing ecosystemic destruction that could be irreversible (Billings, 1994).

Revegetating Cheatgrass Infested Rangelands

The presence of cheatgrass makes it very difficult to reestablish perennial grasses. The efficient root system of cheatgrass simply overwhelms and starves out new seedlings by absorbing all of the moisture from the soil. As few as four cheatgrass plants per square foot can out-compete crested wheatgrass seedlings and the seedlings of native bunchgrasses are even less competitive (Young et al, 1987). However, once established, species like crested wheatgrass will out-compete cheatgrass in the following years. Weed control revegetation techniques involving furrowing during seeding have been developed that permit the establishment of desirable species in areas dominated by cheatgrass. James DeFlon (1986) describes a revegetation procedure that has been successful on the Promontory Ranch, about

40 miles west of Ogden, Utah, for replacing cheatgrass. In August or September when conditions are dry, the old stand of cheatgrass is burned. This is followed by running a brush beater over the ground to remove all remnants of brush and other vegetation. When the cheatgrass starts to sprout, usually around the first of October, the area is tilled with a chisel plow equipped with sweeps to suppress any sprouting cheatgrass and remove any surface roots left from the brush. A deep furrow drill equipped with shoes spaced 14 inches on the center followed by packer wheels is used to plant the seed of perennial grass species about one-half inch deep.

A chemical fallow technique was used by Eckert et al. (1967) to establish perennial grasses on cheatgrass infested rangelands in eastern California and in central Nevada. Six by six meter plots were treated with Atrazine in the fall and then seeded with perennial grasses the next fall. There was a significant decrease in cheatgrass density during the fallow year. Treated plots produced significantly more herbage than did the check, and seeding in furrows resulted in about twice as many, and also more vigorous seedlings than did surface seeding. The success of the Atrazine fallow technique on the study plots led Eckert et al. (1974) to apply the technique to sites in central and eastern Nevada of 20 to 65 hectares. Very high spring precipitation in the seedling year masked some of the treatment effects, but seedling height, vigor, and survival were better in the Atrazine fallow and furrowed areas. Deep furrowing tended to remove more of the Atrizine residue from the vicinity of the seeded plants as well as create a more moist and weed free microenvironment for the seeded species.

Greenstripping

The costs of rehabilitating cheatgrass infested rangelands, using an aggressive approach, can exceed the appraised value of the land. The cost of rehabilitation has influenced how much land can be treated and prohibits it on marginally productive sites. An alternative to seeding entire areas that are dominated by cheatgrass being implemented mostly in southern Idaho is greenstripping. Greenstripping is the practice of establishing or using patterns of fire resilient vegetation and/or material to reduce wildfire occurrence and size (USDI, 1987). The Idaho BLM has put strips of fire resilient vegetation up to 91 meters wide, mainly along roads and railways to reduce human-caused fire starts and create a wider fire barrier. It is hoped that these greenstrips will protect fire-susceptible vegetation types (sagebrush/grass and salt-desert shrubs) by reducing the cheatgrass induced fire frequency and give native plants a chance to reestablish (Pellent, 1990). For greenstrips a relatively small area of land is treated compared to the amount of land that will be protected, therefore, the cost of an aggressive approach for seedling establishment may be justified. Plant materials suitable for greenstrips need to be adapted to persist on semiarid sites, capable of establishing and persisting in competition with annual weeds, fire resistant throughout much of the wildfire season, fire tolerant (to survive occasional burns), and palatable to herbivores (to reduce fuel buildup) (Pellant, 1990; Pellant, 1994; Monsen, 1994). Two widely adapted and uniformly establishing possibilities that the Idaho BLM has had success with are crested wheatgrass (Agropyron desertorum) and forage kochia (Kochia prostrata). Few other species demonstrate the broad adaptability, establishment, or competitive attributes of these two species (Monsen, 1994).

Conclusion

Cheatgrass is also a problem in agricultural crops, especially winter wheat where 10 cheatgrass plants per square foot will give a 27 % reduction in wheat yield (Young et al., 1987). However, crop rotations, tillage practices, and many herbicides have been developed to combat cheatgrass in agricultural settings, but there are not the financial incentives to pursue such practices on public rangelands. Many herbicides do exist, however, that can be used on rangelands. Ogg (1994) lists the herbicides registered for cheatgrass control (Table 1) and Whitson et al. (1988) tested some of them on cheatgrass infested rangelands with the results shown in table 2. Much research is still needed to develop more efficient means of rehabilitating the cheatgrass infested rangelands of the Great Basin. Aldo Leopold (1941) summed it up well when he said, "The cheat problem reminds me, again, how difficult a task has been laid upon the coming generation of technical men."

Table 1. Herbicides registered for control of downy brome (Ogg, 1994).

Amitrole	Hexazinone	Pronamide
Atrizine	Metribuzin	Propham
Bromacil	Napropamide	Sethoxydim
Diuron	Norflurazon	Simazine
Ethofumesate	Oryzallin	Sulfometuron-methyl
Fluazifop-butyl	Paraquat	Terbacil
Glyphosate	Prometon	Trifluralin

Table 2. Herbicides applied April 1987 (Whitson et al., 1988).			
Herbicide	**lbs ai/a**	**% downy brome control**	**% perennial grass damage**
atrazine	0.25	0	0
atrazine	0.5	3	0
atrazine	1.0	17	0
atrazine	2.0	83	38
metribuzin	0.25	6	0
metribuzin	0.5	27	0
Sethoxydim + crop oil conc.	0.25 + 1%	0	3
Sethoxydim + crop oil conc.	0.5 + 1%	10	7
Fluazifop-P + crop oil conc.	0.25 + 1%	100	Suppressed seed heads
Fluazifop-P + crop oil conc.	0.5 + 1%	100	Suppressed seed heads
ethyl metribuzin	0.5	3	0
ethyl metribuzin	1.0	7	0
quizalofop	0.25	100	Suppressed seed heads
quizalofop	0.5	100	Suppressed seed heads
terbacil	0.5	17	33
terbacil	1.0	90	83
terbacil	2.0	98	95
check	--------	0	0

Literature Cited

Billings, W.D. 1994. Ecological impacts of cheatgrass and resultant fire on ecosystems in the western Great basin. In; Monsen, S.B., Kitchen, S.G.; comps. 1994. Proceedings – symposium on ecology and management of annual rangelands; 1992 May 18-22; Boise, ID: Gen. Tech. Rep. INT-GTR- Ogden, UT: U.S.D.A. Forest Service, Intermountain Research Station: 22-30.

DeFlon, James G. 1986. The case for cheat grass. Rangelands. 8(1):14-17.

Eckert, Richard E. Asher, Jerry E. Christensen, M. Dale. Evans, Raymond A. 1974. Evaluation of the Atrazine-fallow technique for weed control and seedling establishment. Journal of Range Management. 27:288-292.

Eckert, Richard E. and Evans, Raymond A. 1967. A chemical-fallow technique for control of downy brome and establishment of perennial grasses on rangeland. Journal of Range Management. 20:35-41.

Leopold, Aldo. 1941. Cheat takes over. The Land. 1(4):1-4.

Mack, Richard N. 1981. Invasion of Bromus tectorum L. into western north America: an ecological chronical. Agro-Ecosystems. 7:145-165.

Monsen, Stephen B. 1994. Selection of plants for fire suppression on semiarid sites. In; Monsen, S.B., Kitchen, S.G.; comps. 1994. Proceedings – symposium on ecology and management of annualrangelands; 1992 May 18-22; Boise, ID: Gen. Tech. Rep. INT-GTR-313. Ogden, UT: U.S.D.A. Forest Service, Intermountain Research Station: 363-373.

Monsen, Stephen B. 1994. The competitive influences of cheatgrass (Bromus tectorum) on site restoration. . In; Monsen, S.B., Kitchen, S.G.; comps. 1994. Proceedings – symposium on ecology and management of annual rangelands; 1992 May 18-22; Boise, ID: Gen. Tech. Rep. INT-GTR-313. Ogden, UT: U.S.D.A. Forest Service, Intermountain Research Station: 43-50.

Ogg, Alex G. 1994. A review of the chemical control of downy brome. In; Monsen, S.B., Kitchen, S.G.; comps. 1994. Proceedings – symposium on ecology and management of annual rangelands; 1992 May 18-22; Boise, ID: Gen. Tech. Rep. INT-GTR-313. Ogden, UT: U.S.D.A. Forest Service, Intermountain Research Station: 194-196.

Nesse, P.E. and Ball, D.A. 1994. Downy brome. Pacific Northwest Extension Publication. Oregon. Idaho. Washington. PNW-474.

Pellant, Mike. 1994. History and applications of the intermountain greenstripping program. . In; Monsen, S.B., Kitchen, S.G.; comps. 1994. Proceedings – symposium on ecology and management of annual rangelands; 1992 May 18-22; Boise, ID: Gen. Tech. Rep. INT-GTR-313. Ogden, UT: U.S.D.A. Forest Service, Intermountain Research Station: 63-68.

Pellant, Mike. 1990. The cheatgrass-wildfire cycle – are there any solutions? In; McArthur, E.K.; Romney, E.M.; Smith, S.D.; Tueller, P.T., comps. 1990. Proceedings-symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management; 1989 April 5-7; Las Vegas, NV. Gen. Tech. Rep. INT-276. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 11-18.

Pickford, G.D. 1932. The influence of continued heavy grazing and of promiscuous burning on spring-fall ranges in Utah. Ecology. 13:159-171.

Roberts, Thomas C. 1991. Cheatgrass: management implications in the 90's. Rangelands. 12(2):70-72.

Rogers, G. 1982. Then and now: a photographic history of vegetation change in the central Great Basin Desert. Salt Lake City, UT: University of Utah Press. 152p.

Sparks, S.R.; West, N.E.; Allen, E.B. 1990. Changes in vegetation and land use at two townships in Skull Valley, Western Utah. In: McArthur, E. Durant; Romney, Evan; Smith, Stanley D.; Tueller, Paul T. comps. Proceedings-symposium on cheatgrass invasion, shrub die-off, and other aspects of Shrub biology and management; 1989 April 5-7; Las Vegas, NV. Gen. Tech. Rep. INT-276. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 26-36.

Stewart, G. 1936. A history of range use. Pages 119-134 in USDA Forest Service. 74th Congress, 2nd session. Senate Document #199.

Stewart, George and Hull, A.C. 1949. Cheatgrass (Bromus tectorum)-an ecologic intruder in southern Idaho. Ecology. 30(1):58-74.

U.S. Department of the Interior, Bureau of Land management. 1987. Greenstripping handbook. Boise, ID: U.S. Department of the Interior, Bureau of Land Management, Idaho State Office. 80 p.

West, Neil E. 1994. Effects of fire on salt-desert shrub rangelands. 1994. Proceedings – symposium on ecology and management of annual rangelands; 1992 May 18-22; Boise, ID: Gen. Tech. Rep. INT-GTR-313. Ogden, UT: U.S.D.A. Forest Service, Intermountain Research Station: 71-74.

Whitson, T.D., Reynolds, D.A., Lauer, Arthur. 1988. Downy brome (Bromus tectorum (L.)) control in rangeland with various herbicides. Res. Prog. Rep. West Soc. Weed Sci.

Wisenant, Steven G. 1990. Changing fire frequencies on Idaho's Snake river Plains: ecological and management implications. In: McArthur, E. Durant; Romney, Evan; Smith, Stanley D.; Tueller, Paul T. comps. Proceedings-symposium on cheatgrass invasion, shrub die-off, and other aspects of Shrub biology and management; 1989 April 5-7; Las Vegas, NV. Gen. Tech. Rep. INT-276. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station: 4-10.

Wright, Henry A. and Bailey, Arthur W. 1982. Fire ecology: United States and southern Canada. John Wiley & Sons, Inc. New York.

Yensen, Dana L. 1981. The 1900 invasion of alien plants into southern Idaho. The Great Basin Naturalist. 41:176-183.

Young, James A. and Allen, Fay L. 1997. Cheatgrass and range science: 1930-1950. Journal of Range Management. 50:530-535.

Young, James A., Evans, Raymond A., Eckert, Richard E., Kay, Burgess L. 1987. Cheatgrass. Rangelands. 9(6):266-270.