Cheatgrass

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Editor's Note: The authorship of the paper represents 120 years of collective research on cheatgrass. The readers may also wish to read "The Case for Cheatgrass" by James G. DeFlon *Rangelands* 8(1):14-17 1986, and "Piemeisel Exclosures" by M. Hironoka *Rangelands* 8(5):221-223 1986.

This article is dedicated to Raymond Evans and Richard Eckert, Jr.

Range managers might well ask, "Will the real cheatgrass stand up and be recognized?" Cheatgrass is a major forage species in the Intermountain area. This introduced annual grass is also a major range weed and its herbage provides the fuel that triggers many of the disastrous wildfires that occur on sagebrush rangelands. Competition from cheatgrass for moisture is the major factor limiting the establishment of perennial forage species, forbs, grasses, or shrubs on most big sagebrush rangelands. Cheatgrass is the classic example of a plant species that is difficult to live with, but would cause disruptions in forage bases if the range livestock industry was forced to live without it. Cheatgrass has become a center of discussion in ecological theory and a growing political issue.

Origin and Distribution of Cheatgrass

The origins of cheatgrass are obscure. Apparently, the species evolved in southwestern Asia in the same area where sheep, goats, and cattle were first domesticated. Cheatgrass has followed in the shadow of man and his flocks to some of the world's more remote rangelands.

Cheatgrass is widely distributed in the United States occurring in all areas except for the coastal southeast. In the Pacific northwest, cheatgrass is a serious weed in fields of grass grown for seed production. In the Palouse wheat country of eastern Washington and northern Idaho, cheatgrass is a pest in fields of winter wheat. A population density of 10 cheatgrass plants per square feet will give an average 27% reduction in wheat yield. Cheatgrass continues to be a problem in winter wheat areas through Montana down the western Great Plains to Oklahoma. On semiarid rangelands, cheatgrass reaches its greatest development on degraded big sagebrush/bunchgrass ranges in the Intermountain area between the Sierra-Cascade and Rocky Mountains. Despite the abundance of alien grasses on the annual ranges, cheatgrass is relatively rare on the California ranges with Mediterranean climates.

With its wide distribution, cheatgrass has been labeled with a variety of common names. In local areas ranchers may refer to the annual as bronco grass or six-weeks grass. The Weed Science Society of America adopted the common name of downy brome for *Bromus tectorum* to distinguish it from cheat *(Bromus secalinus)*.

Cheatgrass was probably introduced into the United States independently several times. It was first reported in the far western United States near the end of the 19th century. The trained botanists David Griffith and P.B. Kennedy failed to report cheatgrass in northern Nevada during the course of extensive field surveys at the turn of the century. The first report of the annual grass in Elko County, Nev., occurred in 1906. Once introduced to the sagebrush rangelands, cheatgrass spread in the biological vacuum created by excessive grazing and reduction of the native herbaceous vegetation after 1870.

Cheatgrass spread rapidly through the sagebrush ranges. Following World War I, the country had fallen into an agricultural depression, and numerous dryland homesteads along the Snake River plains of Idaho were abandoned. Often the sandy-loam textured surface soils were subjected to wind erosion before being colonized by the alien weed, Russian thistle. Gradually the Russian thistle gave way to tumble mustard or tansy mustard, and finally the fields were covered with cheatgrass. Disturbance by spring grazing or even rodent activity was sufficient to perpetuate this successional continuum with cheatgrass always coming out on top. R.L. Piemeisel was assigned to do something about the problem of abandoned cropland, not as a range manager, but as an entomologist interested in eliminating the broadleaf species in these successional communities because they were alternate hosts for leafhoppers. In a series of papers, Piemeisel enumerated the stages in succession that led to cheatgrass dominance and suggested that plant succession on millions of acres of sagebrush rangelands was irrevocably changed. Piemeisel speculated that wholesale accelerated erosion would have occurred over vast areas if the alien weeds had not been available to colonize abandoned farm lands during the 1930's.

Adaptation of Cheatgrass

Cheatgrass is an adaptable species. In areas like the Palouse of the Pacific Northwest, seeds (caryopses) of cheatgrass germinate in the fall with the first effective rain. Grant Harris of Washington State University had shown how roots from fall-germinated plants of cheatgrass continued to elongate during the winter while the aerial portion of the plant remained a prostrate rosette. The developed root system provided a competitive advantage to cheatgrass seedlings in the spring when temperatures are adequate for shoot growth. In the more arid portions of the Great Basin, cheatgrass germinates in the fall about once every five years. Usually by the time effective moisture is received, it is too cold for germination. In this more arid environment germination occurs in the early spring and cheatgrass must complete its life cycle before soil moisture is exhausted.

During the 1940's Joseph Robertson in Nevada formulated the concept that cheatgrass-dominated communities in the sagebrush/grasslands were closed to the establishment of seedlings of perennial grass because of competition from this annual grass. Detailed laboratory and field studies by R.A. Evans and R.E. Eckert, Jr., in Nevada and Grant Harris and associates in the Pacific Northwest confirmed that available soil moisture was the limiting seedling establishment factor in these cheatgrass-dominated sites. As few as four cheatgrass plants per square foot could out compete crested

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wheatgrass seedlings. The seedlings of native bunchgrasses were even less competitive. Seedlings of bluebunch wheatgrass could only hope to establish in competition with cheatgrass during seasons with exceptional summer precipitation.

Piemeisel offered the explanation for succession in cheatgrass dominated communities that the first plant species to mature won the competitive battle. Cheatgrass matured before tumble mustard and tumble mustard before Russian thistle. Studies of the microenvironmental parameters that control germination have shown that the microtopography and litter coverage on the seedbed coupled with the inherent potential of the seeds to germinate under specific temperature and moisture regimes determine the direction and speed of secondary succession. Most of the cheatgrass seeds fall to the surface near the parent plant, but a significant number of seeds are assured some long distance dispersal by the awns sticking in the coats of animals or in range managers' socks. Cheatgrass seeds cannot absorb moisture fast enough from the seedbed surface to initiate germination, especially under semiarid conditions. The seeds must work their way into cracks or litter to find suitable safesites for germination. Often the seed mass provides the necessary litter for a portion of the crop to germinate.

In the Intermountain area, the seeds of most populations of cheatgrass are highly viable and ready to germinate at maturity. On the Great Plains where summer rains can occur, cheatgrass seeds have an afterripening requirement that protects against germination until fall. It has been found that seeds initially ready to germinate, but not dispersed in favorable locations for germination, can acquire a dormancy. This environmentally acquired dormancy gives cheatgrass seeds the best of two worlds with respect to potential establishment. The seeds are poised to occupy all available sites that will support germination. Seeds that acquire dormancy provide a reserve to renew the population in case of environmental disasters. The dormancy normally breaks down slowly over a 2 to 3 year period. The germination of dormant seeds can be stimulated by increased concentrations of nitrate. In a long wet spring with abundant nitrification, many cheatgrass seeds lose dormancy and germinate.

Replacement of Cheatgrass

Over a million acres of the 29 million acres of degraded big sagebrush communities in Nevada have been converted to crested wheatgrass. The conversion of cheatgrass-dominated areas is much more difficult.

High technological methods have been developed to take advantage of weaknesses in the biology of cheatgrass, i.e., failure to germinate on the surface of seedbeds, while accentuating physical aspect of seedbeds to favor the perennial seedlings. Weed control with herbicides incorporated with revegetation techniques involving furrowing during seeding have been developed that permit the establishment of desirable forbs, grasses, or shrubs in areas dominated by cheatgrass.

Grazing of Cheatgrass

Charles E. Fleming realized during the 1930's that ranchers in Nevada were becoming increasingly dependent on cheatgrass as a source of range forage. Fleming showed them sagebrush rangeland cheatgrass has a short green feed period in the late spring. This short green feed period occurs when AUMs of forage from perennial grasses are most abundant and least valuable. Green forage is at a premium earlier in the year in March and April. During this time cheatgrass consists of seedlings or prostrate rosettes of virtually no harvestable forage production. In contrast, perennial grasses, both native and introduced, have greened up and grown enough to provide some early spring forage. Unfortunately, this is the time of year when native perennial grasses are most susceptible to damage from repeated grazing, which depletes the carbohydrate reserves needed for flowering.

The climate of the Intermountain area is highly variable with wide differences in precipitation among years, making the production of forage or browse from native or introduced species highly variable. Burgess Kay showed that on good years, cheatgrass produces forage far surpassing the requirement of the typical cow and calf operation. Of more importance to the livestock producer is the lack of cheatgrass production in dry years. Cheatgrass herbage production can very easily approach zero with less than one seed produced per plant established. Production of herbage by native or introduced wheatgrasses during these very dry seasons is much lower than normal, but the perennial grasses always produce some herbage.

Despite the major contribution that cheatgrass makes to the forage base of many Intermountain livestock operations, we do not have an abundance of hard data on how forage of this kind meets the nutritional needs of livestock. This is especially true for winter grazing of dry herbage of cheatgrass. Ranchers have observed that cattle on desert ranges will move rapidly through cheatgrass stands located several miles from watering points and only graze the seed heads or lick seeds of cheatgrass from the ground.

Grazing of dry cheatgrass herbage may greatly increase the incidence of lumpy-jaw infections in cattle and cause severe eye injuries from the sharp seeds. Heavy production of cheatgrass herbage also leads to the occurrence of smut in the seed florets. Hereford cows grazing smutty cheatgrass have black faces. Grazing of smutty cheatgrass may also be dangerous to the grazing animals.

Fire and Cheatgrass

The ecology of cheatgrass cannot be separated from the occurrence of wildfires in sagebrush communities. Cheatgrass provides a fine-textured fuel that dries by mid July and provides an easily ignitable fuel that allows fire to spread from shrub to shrub. Virtually every year some wildfires occur in sagebrush infested with cheatgrass. On years with above-average spring rainfall and subsequent high production of cheatgrass followed by dry summers, the stage is set for huge uncontrollable fires. Widespread dry lightning storms can set off fire storms such as occurred the first week in August 1964 in Elko County, Nev., which required an army of 3,000 fire fighters for suppression. During the summer of 1985 over 1 million acres of rangeland burned in Nevada with 500,000 acres burning in the Winnemucca District of the Bureau of Land Mangement, USDI.

Wildfires in degraded sagebrush-cheatgrass communities create ideal conditions for artificial revegetation when fires burn hot. Brush is burned to the soil surface, most cheatgrass seeds are destroyed, and virtually weed-free seedbeds are created. Seeding of perennial grasses and other forage and browse species after these fires have a high probability

Typical early spring scene on big sagebrush rangeland. Cows and calves are on area in foreground that has previously burned in wildfire and is dominated by cheatgrass. Production of cheatgrass herbage is very limited at this season.

for successful establishment. Established perennial species reduce fire and soil erosion hazards and create a dependable source of forage for livestock and wildlife.

Burned areas in degraded big sagebrush stands that are not revegetated are destined for long periods of dominance by cheatgrass. The time scale for natural return of perennial grasses on some of the burned, degraded sites in the Great Basin may well exceed a century even with the exclusion of the grazing of domestic livestock. The input of cheatgrass seeds into these ecosystems fuels the dynamics of small mammal populations whose activities create enough disturbance to perpetuate cheatgrass. During the time that cheatgrass dominates, the stand is preconditioned to reburn, further retarding succession. This process has been described as a downward spiral of concentric cycles of degradation leading to the dominance of annuals.

Public land management agencies have definite policies to follow in establishing rehabilitation programs for areas of big sagebrush burned in wildfires. For large fires, an interdisciplinary team is formed to evaluate the burned resource area. The team of managers has to accept environmental and economic trade-offs that occur in various shades of gray rather than absolute black and white.

For example, a basic decision facing range managers evaluating burned areas is the density of perennial grasses that remain in the stand. If there are enough perennial grasses, they will profit from the environmental parameters released by the burning of the brush, especially water and nitrate-nitrogen. The managers must estimate how many of the bunches of perennial grass will sprout after being burned. This is a judgment based on the species of perennial grass present, and the seasonal timing and intensity of the wildfire that destroyed the community.

In the Winnemucca District of the Bureau of Land Management, U.S. Department of Interior, a total of 127 wildfires burned an estimated 515,912 acres in 1985. The resource evaluation team had to decide on a course of action that would most readily restore the devastated range resource on this large area. The team recommended that 355,380 acres of this burned area not be seeded because there were sufficient perennial grasses to respond after the fire to provide an adequate forage base. It was determined that 68,550 acres did not have sufficient perennial grasses to respond after the fire or represented on active erosion hazard. These critical areas were planned to be seeded with exotic species of herbaceous forage species.

The burned area of 423,930 acres that was rested will be closed to grazing for 2 years to allow for either the natural recovery of the remnant perennial grasses or the establishment of the seeded plants in order to reestablish the perennial forage base that was destroyed by the wildfires. This was not a simple nor an easy decision. During the 2-year rest period, this scale of closure will severely impact the local ranching economy and, especially in the second year, cheatgrass will increase and pose a fire hazard.

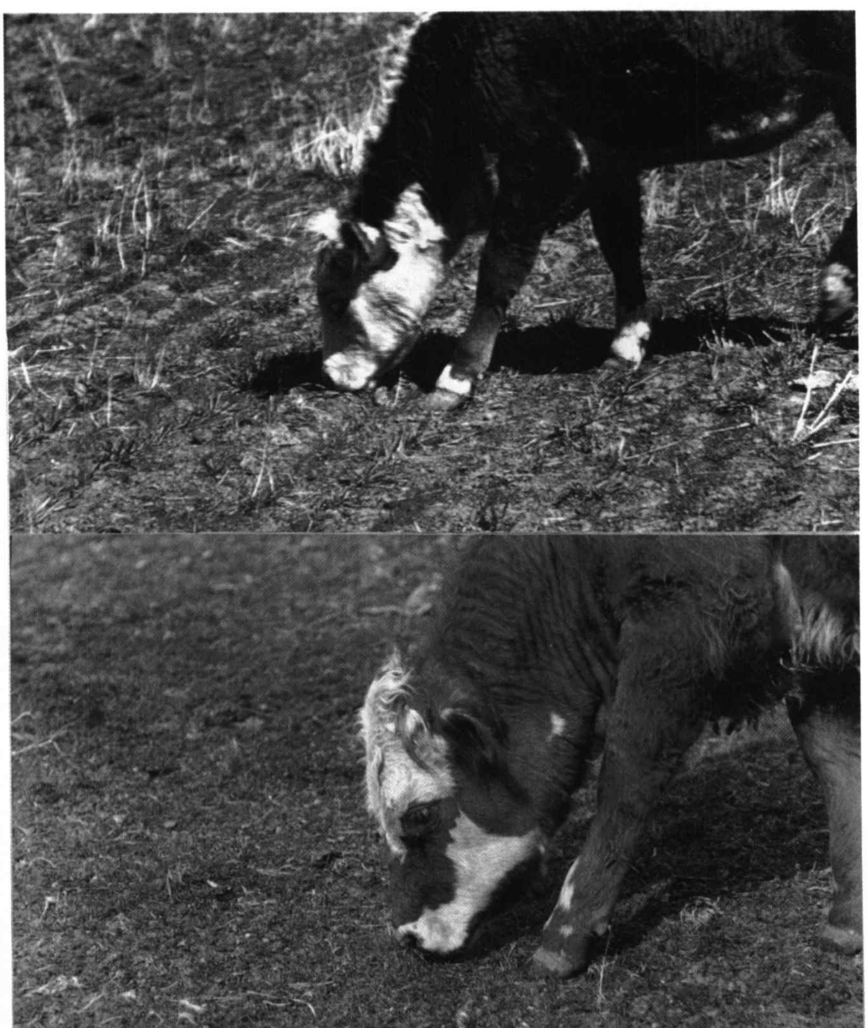
The decision to rest from grazing will enhance the vigor and hopefully the density of native perennial grasses. Through this rest and seeding, the entire range can be brought back to perennial grass domination. Portions of the burned area (91,980 acres) were left open to grazing. These areas were dominated by annuals before the fire, are deemed unsuitable for seeding, or are too small to manage as separate units.

Reproduction of Cheatgrass

In an exhaustive review of the literature, Klemmedson and Smith commented on the continued search by eco-physiologists for *the* characteristic that allows cheatgrass to be such a competitor. We have proposed that it is not a single characteristic, but rather it is a genetic and breeding system that is responsive to environmental change that contributes to the colonizing and persistence of cheatgrass. Cheatgrass has tremendous phenotypic plasticity. Densely packed stands of 1,000 plants per square foot are common with each plant producing 25 seeds. A single open grown plant with abundant tillers can easily produce 5,000 seeds.

The breeding system of cheatgrass is vividly illustrated by following a population through a wildfire. The preburn population averages 1,000 plants per square foot. After the burn most of the cheatgrass seeds beneath the canopy of sagebrush plants are consumed by the heat associated with the burning of the shrub. A portion of the cheatgrass seeds located in the interspace among shrubs are also consumed. The next season the remaining seeds germinate and a population averaging 1 plant per square foot establishes. This sparse stand utilizes the environmental potential, water and nutrients, released from competition by the destruction of most of the vegetation by burning. The cheatgrass plants in this sparse population exhibit phenotypic plasticity with abundant production of tillers, each supporting many flowers. The anthers of these flowers remain exerted from the florets for prolonged periods because of the vigor of the plants. This heightens the opportunity for cross pollination of the usually self-pollinated plants. A high portion of the seeds set the year after the burn are hybrids. Essentially, each cheatgrass plant in the preburn population is a self-pollinated inbred line. The hybrid seeds that germinate the second year after the burn express hybrid vigor just as hybrid cultivars of corn or crossbred cattle. The hybrid cheatgrass populations seem to explode to fully occupy the burned site at the expense of seedlings of most native perennials. Segregations and recombination occur in subsequent generations, but each new successful combination lapses back to the stable, self-pollinated means of reproduction. This means there is the opportunity for natural selection for cheatgrass plants adapted for growth and reproduction on the north, east, west, and south sides of a rock in a given habitat.

Fertilizer experiment on the Likely Table in northeastern California where the combination of above average rainfall and nitrogen fertilization produced 6,000 pounds per acre of dry cheatgrass herbage. During some years cheatgrass production may be near zero on the same site.



Contrast in forage availability for cheatgrass and crested wheatgrass in the early spring. From April 1 to 15, cheatgrass is a small seedling or flat rosette on the soil surface with limited forage production or utilized forage.

Recent Changes in Cheatgrass Distribution

Considering what we know about the dynamic breeding system of this species and its capacity for near instant evolution in response to changing environmental conditioning, it is not realistic to assume that the distribution of cheatgrass will remain static over time. It is now apparent that cheatgrass has extended its range down from the typical big sagebrush communities into the more arid margins of the salt deserts of the Great Basin. The invaded areas support sparse native communities of shadescale and Bailey greasewood. Dwight Billings, in a classic study of the Carson Desert, noted that the lower edge of the distribution of big sagebrush in the western Great Basin often reflects atmospheric drought rather than changes in soluble salt accumulations. The apparent spread of cheatgrass and wildfires onto the margins of salt deserts and into ranges of sand dunes may be a product of grazing management. Within the last decade, many year-long grazing permits have been changed to 9 or 10 month grazing under some form of deferred management system. Ranchers have suggested that cheatgrass has increased under this form of grazing management and the periods of deferred grazing result in hazardous fuel accumulations.

Emigrant Pass near Elko, Nevada in 1964. Exceptional spring precipitation produced 4,000 pounds per acre of cheatgrass forage. This area burned that season in the 400,000 acre firestorm that swept Elko County.

The expanded distribution of cheatgrass, no matter what the cause or the state of permanence has had immediate results. Normally there is insufficient fine textured fuel in shadscale—Bailey greasewood communities to carry fire from shrub to shrub. Abundant cheatgrass herbage changes this, not only for the season of production, but for several seasons afterward. In the aridity of the shadscale zone cheatgrass herbage cures and does not rot and disappear after a single winter. The standing second or third year's growth is dry and ready to burn by late spring. A large portion of the half million acres of the area burned in the Winnemucca, Nev., and Susanville, Calif., Districts of the Bureau of Land Management in 1985 occurred in shadscale or sand dune plant communities rather than big sagebrush. Shrubs provided a major source of forage on these ranges, especially digestible protein. These shrubs may have stand renewal processes requiring decades. The technology for revegetating these burned communities does not exist. This has great practical significance in range management. Ecologically, the burning of these desert ranges introduced a radically new and catastrophic form of stand renewal to this group of plant communities.

The spread of cheatgrass from typical big sagebrush ranges into the margins of the salt deserts is not the only expansion of the range of this annual in the Great Basin. Over the last decade, knowledgeable observers believe there has been an increasing frequency of cheatgrass in higher elevation aspen parklands and pine woodlands. The consequences of cheatgrass in these areas of higher environmental potential for the growth of perennial grasses is not totally understood.

Cheatgrass and Range Management

Charles E. Poulton inspired several generations of range science students with lectures on the scientific basis for range management. He considered one of the basic tenets of American range science to be the use of departure from climax to judge range condition. This extension of the ecological philosophies of Clements, Dyksterhuis, and Daubenmire has gained wide acceptance in range management. The role of alien weeds such as cheatgrass in such a system of range condition assessment has always created problems. As interpreted by the regulations of most public land management agencies, cheatgrass has been given varying value in establishing the existing forage base on a given grazing allotment. Most public land management agencies give the highest credit for utilization of cheatgrass during the spring or fall when it is green (i.e., 60% in the Winnemucca BLM District). Proper grazing use factors decrease dramatically for other seasons when preference for the dry herbage of this species diminishes (i.e., 20 and 30%, respectively, in the summer and winter seasons of use).

We are not passing judgement on the validity of such assumptions as long-term goals and standards for the quality of public lands. We do point out, however, the step from management for perennial grass to grazing management of cheatgrass is a major one that range science in America seems reluctant to take.

The growth of the new wave of ecologists, termed landscape ecologists, may offer a means of accomplishing this step. Landscape ecology suggests that man and his disturbances are the center of all ecosystems and the concept of stable plant communities in equilibrium with their pristine environmental potential has outgrown its usefulness. If landscape ecology can accommodate the reality of cheatgrass in big sagebrush communities without unduly compromising the current standards of range condition, it will truly be the new wave of range ecology.

One of the most difficult decisions for a public land manager to make is the reclassification of big sagebrush/bunchgrass rangeland to annual grasslan[illegible]sed on dominance by cheatgrass. Based on the historic concept of the management of sagebrush/bunchgrass ranges, it amounts to saying, "We have failed". That is a collective "we" which includes researchers, ranchers, and land managers. The decision to manage for cheatgrass instead of native perennial grasses is most often considered for the most degraded of big sagebrush rangelands where environmental potential is limiting. These sites have limited potential because they receive scant rainfall, are easily eroded, and are outside the potential for current revegetation practices. Such harsh sites seem the last place to give a new standard of environmental quality that involves accepting less as adequate. One disturbing factor about managing for cheatgrass is that our knowledge base for such management may be less developed than for managing the grazing of perennial grasses on the same site.

In the meantime, ranchers should be aware that reports of cheatgrass as wonderful winter forage are just a spark away from no forage and, in the case of public rangelands, no forage for 2 or more years.