

HISTORY AND USE OF SEMIARID PLANT COMMUNITIES—CHANGES IN VEGETATION

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ABSTRACT

The sudden introduction of concentrations of large herbivores to the sagebrush (Artemisia)/bunchgrass ranges of the Intermountain area dramatically changed the balance between herbaceous understory and woody overstory species. The near biological vacuum created by overutilization of understory species was rapidly filled by the introduction of a host of alien annual species. Cheatgrass (Bromus tectorum) dominates many of these alien communities and truncates succession. Seedling establishment of perennials, especially herbaceous perennials, is limited by cheatgrass competition for soil moisture.

INTRODUCTION

The last symposium held in the Intermountain area to discuss the ecology, management, and restoration of annual-dominated rangelands was the Cheatgrass Symposium held 27 years ago. During the introduction to my presentation at this symposium I asked how many of the audience had attended the previous meeting, and only one person responded.

This dramatically illustrates the importance of communicating historic perspectives concerning even the recent past to those currently interested in the management and restoration of rangelands. Toward establishing historical perspective for the ecology and management of Intermountain ranges this symposium provides both first-person contact in the person of Dr. Dwight W. Billings who established research plots in the Great Basin in the 1930's (see Billings, these proceedings) and a glimpse at the future in the presentation of Dr. Ross Wight on the development of expert systems for transfer of knowledge across generations (see Wight, these proceedings).

HISTORIC CHANGES

The vegetation of the pristine sagebrush/grasslands was rather simple and extraordinarily susceptible to disturbance. The potential of the environment to support plant and animal life was limited by lack of moisture and often by accumulation of salt in the soil. The native vegetation lacked the resilience, depth, and plasticity to cope

with concentrations of large herbivores. The plant communities did not bend to adapt; they shattered. This tends to make the review of grazing in the sagebrush/grasslands a horror story, resplendent in examples of what should not have been done. In perspective, the development of ranching in the sagebrush/grasslands was a grand experiment initiated by men willing to venture beyond the limits of accepted environmental potential to settle the Great Sandy Desert between the Rocky, Sierra Nevada, and Cascade Mountains (Young and Sparks 1985).

There is a large amount of literature available with more or less direct bearing on the paragraph quoted above. The salient points in this historic perspective are: (1) the current vegetation of the Intermountain area originated during the wild climatic fluctuations of the Pleistocene as the western mountain barrier of the Sierra-Cascades arose and cast a rain shadow across the area; (2) in most of the area, native large herbivores withdrew their natural distribution from the bulk of the landscapes, except for periodic pulses of the American bison (*Bison*) across the Snake River Plains to eastern Oregon and the Columbia Basin; and (3) under post-Pleistocene conditions the concentration of large herbivores was sparse, especially in the Great Basin, and the dominant vertebrate herbivores were jackrabbits (*Lepus* spp.) (McAdoo and Young 1980).

Dr. Wayne Burkhardt of the University of Nevada strongly disagrees with most of the commonly accepted ideas concerning the evolution of the rangelands of the Intermountain area (Burkhardt 1992). He considers large herbivores to have been abundant in the Intermountain area at contact time. The classic study of the American bison by Hornaday (1887) strongly disputes this point as do the journals of such contact time travelers as Peter Skeen Ogden (Cline 1963). Burkhardt also suggests that the vegetation of the Great Basin has been stable since well into the Tertiary.

The classic study of the evolution of mid-latitude deserts conducted by Axelrod (1950) amply illustrates the relatively recent evolution of temperate desert vegetation. Perhaps the most interesting supportive evidence for Burkhardt's argument is the lack of preference domestic large herbivores exhibit for the herbage of most species of sagebrush. It well may be possible that the progenitors, North American members of the section *Tridentata* of *Artemisia*, did evolve under extreme browsing pressure. The evolution of secondary compounds by sagebrush species also may have been in response to nonvertebrate herbivores, by browsing pressure from jackrabbits, or they

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may be biochemical accidents that happened to influence preference and the rumen microflora of domestic livestock.

Of direct application to this symposium, Burkhardt uses his hypothesis of evolution of the native vegetation under intensive grazing in the Intermountain area to justify managing for cheatgrass rather than managing for the restoration of native herbaceous perennials. Apparently I am missing the point of this self-defeating reasoning (see Tipton, these proceedings, for managing with cheatgrass, but not for cheatgrass).

CLIMATIC CHANGE

One of the most significant advances in understanding the ecology of rangelands has been the widespread acceptance or realization that climatic change is a continuous process. The basis for measuring range condition and trend has been departure from the potential vegetation that often has been equated with the pristine vegetation. We now recognize that the dynamic equilibriums that existed in natural plant communities at contact times were transitory scenes on a time scale that has ecological significance to modern management.

The most significant aspect of climatic change is that anthropocentric influences, through the mechanism of changing concentrations of atmospheric gasses, may be inducing change (see Mayeux, these proceedings). Some scientists (for example, Burkhardt 1992) have used the climatic change issue as additional evidence that Intermountain rangelands should be managed for cheatgrass rather than attempting restoration of native plant communities. Essentially, the pristine plant communities of the sagebrush/grasslands were relics of former climates that were predetermined to change even if they were not grazed by domestic livestock (see Tausch, these proceedings). The relative importance of the grass genera *Agropyron* versus *Stipa* or *Oryzopsis* in the structure of the pristine vegetation is an interesting aspect of this argument.

RESTORING PLANT COMMUNITIES

The area of the greatest polarization of opinion concerning the management of Intermountain rangelands is centered on the use of exotic or native perennial grasses for the biological suppression of cheatgrass and the revegetation of rangelands. It has been generally accepted that restoration of rangeland plant communities using the native grasses—bluebunch wheatgrass (*Agropyron spicatum*), Thurber's needlegrass (*Stipa thurberiana*), needle-and-thread (*S. comata*), or Indian ricegrass (*Oryzopsis hymenoides*) is quite difficult. During the panel discussion held at this symposium the question was raised if this was based on historic fact or was a perceived idea.

The need to seed Intermountain rangelands to restore productivity was perceived by portions of the general public as early as the 1880's (Young and Sparks 1985). P. B. Kennedy strongly advocated the use of **native** species to restore depleted ranges at the beginning of the 20th century (Kennedy and Doten 1901). As far as is known Kennedy never tried to seed native perennial herbaceous species.

The earliest publications dealing with seeding depleted ranges (for example, Cotton 1908 or Griffiths 1907) dealt with exotic species for which there was a ready supply of seed. These were essentially the introduced forage species that had proven so successful in the humid East. The classic studies of A. W. Sampson (1913) also used, as the title of a bulletin reporting his research indicated, cultivated forage species. The early trials were extensive, consisting of some 500 experiments located on 86 National Forests in 11 Western States. Sampson considered most of these experiments, with notable exceptions, to be failures.

Forsling (1931) summarized the results of 2 decades of seeding trials on the rangeland of National Forests in 1931. It is important to note that the basic idea governing these seeding trials was that the greatest good could be accomplished by working with the most productive environments. This meant that seeding trials were concentrated on meadows, especially the margins of depleted meadows and depleted subalpine grasslands that formed critical watersheds.

Forsling reported establishment data for several species of native grasses, including slender (*A. trachycaulum*) and violet (*Agropyron* [?]) wheatgrass and mountain brome (*Bromus marginatus*). He admitted that the potential of native plant material for range seeding had hardly been touched. Forsling (1931) placed emphasis on the use of exotics: "Introduction of plants from foreign countries and the development of superior varieties by selective breeding both offer hope for the future."

In interpreting all of these early reports you must consider that they pertained to high-elevation meadows and conifer/aspens (*Populus tremuloides*) parklands. If artificial seedings were attempted in depleted big sagebrush (*Artemisia tridentata*)/ bunchgrass rangelands they were not reported. Interviews with scientists such as J. H. Robertson, whose career started as a scientist late in the 1930's, indicate that it was initially not considered possible to artificially seed in sagebrush environments with the plant material available.

RURAL RESETTLEMENT ADMINISTRATION

Seeding of sagebrush ranges in the Intermountain area was initiated in a rather unique manner. The agricultural economic conditions associated with the Great Depression coupled with a prolonged drought made it abundantly clear that many areas in Western North America were not suited for dryland farming. As part of the New Deal era, the Rural Resettlement Administration was established to purchase blocks of homesteads and return the property to public domain. In the Intermountain area, sites where this was carried out included the Crooked River area of eastern Oregon and Curlew and Black Pine Valleys in Oneida County, ID (Young and McKenzie 1982). Attempts were made to prevent accelerated wind erosion on these abandoned farms by seeding perennial grasses. The exfarmers and their largely horse-drawn equipment were hired to seed the former wheat fields.

These seedings were highly successful because of the recently introduced crested wheatgrass (*Agropyron desertorum*).

CRESTED WHEATGRASS

Crested wheatgrass was introduced to the northern Great Plains and was widely used to seed abandoned cropland (see Lorenz 1986 for history of introduction). It had been tried by the Forest Service, U.S. Department of Agriculture, for high-elevation seedings and was not considered a success (Forsling 1931). It had been tried in native hay meadows in the Great Basin and not considered successful because of lack of grazing animal preference when the herbage was mature.

During World War II as part of the war production effort, scientists with the Intermountain Station of the Forest Service established about 20,000 acres of experimental seedings designed to increase red meat and wool production from rangelands. This resulted in a series of publications under the general title, "How To Seed ____ Rangelands." There was one of these for southern Idaho (Hull and Pearse 1943), Nevada (Robertson and Pearse 1943), and Utah (Plummer 1943).

The "how to seed" bulletins contained nearly the same text. In comparing the native bluebunch wheatgrass and crested wheatgrass it was stated that: "Planting this species [bluebunch wheatgrass] alone is generally not recommended because of the risk involved in securing a stand. On adapted sites it is a good species to plant in combination with crested wheatgrass" (Robertson and Pearse 1943). For crested wheatgrass the bulletins state: "This hardy, long-lived, deep rooted bunchgrass is the most generally successful species for seeding the low valleys, foothills, and lower mountain slopes...."

One of the first publications that extensively dealt with native species for use in revegetation was Hoover (1939). One of the objections to the use of bluebunch wheatgrass was the awned seeds were difficult to meter from drill boxes and pass through seed tubes. This led to the popularity of the awnless form of bluebunch wheatgrass then known as beardless wheatgrass (*Agropyron inerme*). There are few reports of experimentation with native grasses from the *Stipa* group. Schwendiman (1940) developed methods for removing awns from caryopses of native grasses including needle-and-thread. The inherent dormancy of many *Stipa* species may have limited experimentation with these species (for example, Rogler 1960 for *S. viridula*). The seeds of some of the *Stipa* species will germinate (Young and others 1990), but the dormancy of landscape-characterizing species such as Thurber's needlegrass has never been overcome.

I believe that a fair summary of the published and anecdotal information available concerning attempts to artificially seed big sagebrush potential ranges with native grasses through 1945 is that such attempts were generally unsuccessful. This is based on largely negative information rather than positive, published data. The introduction of crested wheatgrass made large-scale seeding of sagebrush ranges possible. Relative seedling vigor of crested wheatgrass coupled with an abundant, inexpensive supply of seed that was highly germinable may have

been the major factors governing the success of crested wheatgrass. Subsequent forage production and resistance to grazing may also have been important considerations.

CHEATGRASS AND THE CLOSED COMMUNITY

During the period from 1945 until 1965, several million acres of sagebrush potential rangeland were seeded to crested wheatgrass in the Intermountain area. Much of this seeding was done to biologically suppress halogeton (*Halogeton glomeratus*). It is very important to recognize that a large percentage of these seedings could not be repeated today because of subsequent increases in the distribution and density of cheatgrass. The original crested wheatgrass seedings were established in seedbeds with limited cheatgrass. Cheatgrass was limited in the late 1940's and 1950's by the extreme grazing pressure that existed on many ranges (for example, Emmerich and others 1992). The dramatic increase in the forage base for Intermountain area sagebrush ranges that came about through establishment of crested wheatgrass partially permitted the establishment of universal grazing management systems that were designed to favor the establishment of native perennial grasses. The net result of these well-meaning applications of range science appears to have contributed to a gross increase in cheatgrass and new habitat for cheatgrass through associated wildfires. The biology of this process is quite simple. As predicted on the basis of research, deferment of grazing until after seed ripe or rest from grazing on a rotational basis favors the production of seeds by herbaceous perennials and the ultimate recruitment of new seedlings, **provided** (1) there are sufficient herbaceous perennials left to produce seeds, (2) woody plant competition permits herbaceous seedling recruitment, and (3) cheatgrass does not preempt the environmental potential. On millions of acres where rotational grazing management was applied, all of the above points were stacked against the native perennial grasses.

J. H. Robertson published the classic paper on cheatgrass competition with perennial seedlings in 1945 (Robertson and Pearse 1945). Since 1945, many scientists have established the competition mechanism of why cheatgrass communities are closed to perennial seedlings. If it was very risky to try to seed bluebunch wheatgrass in 1943 before cheatgrass became so dominant on Intermountain ranges, what are the chances for widespread range **restoration** using native species today?

The sad part of this whole scenario is that weed control revegetation systems employing herbicides that could control cheatgrass and allow range restoration have been eliminated by withdrawal of registration. Future registration of herbicides for use on rangelands to control cheatgrass competition in seedings is highly problematic (see Ogg, these proceedings).

The inherent variability in bluebunch wheatgrass and related native species is a vital part of the cheatgrass-range restoration picture. If the genotypes cannot be found in bluebunch wheatgrass populations, which can

compete with cheatgrass, then range restoration is dependent on: (1) reestablishment of high-technology weed control systems, (2) hybridization of bluebunch wheatgrass with relatives such as quackgrass (*A. repens*) that are not native, followed by selection for competitive ecotypes, or (3) accept exotic hybrids that are competitive.

GENETICS OF CHEATGRASS

Perhaps the most important papers at this symposium are those dealing with the population genetics and evolution of cheatgrass (for example, see Novak, these proceedings). We need to remember that while we are trying to arrive at a policy and implementing procedures to biologically suppress cheatgrass so that ranges can be restored, cheatgrass is apparently evolving into a more competitive species.

REFERENCES

- Axelrod, A. I. 1950. Evolution of desert vegetation in western North America. Publ. 590. Washington, DC: Carnegie Institute. 323 p.
- Burkhardt, J. W. 1992. Presented at 1992 Meeting, Nevada Section, Society for Range Management, Susanville, CA.
- Cline, G. G. 1963. Exploring the Great Basin. Norman, OK: University of Oklahoma Press. 254 p.
- Cotton, J. S. 1908. The improvement of mountain meadows. Bull. 127. Washington, DC: Bureau of Plant Industry, U.S. Department of Agriculture. 25 p.
- Emmerich, F. L.; Young, J. A.; Burkhardt, J. W. 1992. A Nevada ranch family: their success through four generations. Rangelands. 14: 66-69.
- Forsling, C. L. 1931. Artificial reseeding on western rangelands. Circ. 178. Washington, DC: U.S. Department of Agriculture. 68 p.
- Griffiths, D. 1907. The reseeding of depleted ranges and native pastures. Bull. 117. Washington, DC: Bureau of Plant Industry, U.S. Department of Agriculture. 52 p.
- Hoover, M. M. 1939. Native and adapted grasses for conservation of soil and moisture in the Great Plains and western states. Farmers Bull. 1812. Washington, DC: U.S. Department of Agriculture. 43 p.
- Hornaday, W. T. 1887. The extermination of the American Bison. Rep. 1887. Washington, DC: U.S. Natural History Museum. 320 p.
- Hull, A. C., Jr.; Pearse, C. K. 1943. How to reseed southern Idaho range lands. Res. Pap. No. 2. Ogden, UT: Intermountain Forest and Range Experiment Station. 22 p.
- Kennedy, P. B.; Doten, S. B. 1901. A preliminary report on the summer ranges of western Nevada sheep. Bull. 51. Reno, NV: Nevada Agricultural Experiment Station. 54 p.
- Lorenz, R. J. 1986. Introduction and early use of crested wheatgrass in the northern Great Plains. In: Johnson, K. L., ed. Symposium: crested wheatgrass: its values, problems and myths. Logan, UT: Utah State University: 9-20.
- McAdoo, J. K.; Young, J. A. 1980. Jackrabbits. Rangelands. 2: 135-138.
- Plummer, A. P. 1943. How to seed Utah range lands. Res. Pap. 1. Ogden, UT: Intermountain Forest and Range Experiment Station. 22 p.
- Robertson, J. H.; Pearse, C. K. 1943. How to reseed Nevada range lands. Res. Pap. No. 3. Ogden, UT: Intermountain Forest and Range Experiment Station. 21 p.
- Robertson, J. H.; Pearse, C. K. 1945. Artificial reseeding and the closed community. Northwest Science. 19: 58-66.
- Rogler, G. A. 1960. Relation of seed dormancy of green needle (*Stipa viridula*) to age and treatment. Agronomy Journal. 52: 467-469.
- Sampson, A. W. 1913. The reseeding of depleted grazing lands to cultivated forage plants. Bulletin. Washington, DC: U.S. Department of Agriculture. 36 p.
- Schwendiman, J. L. 1940. Processing seed of grasses to remove awns and other appendages. Circ. 58. Washington, DC: U.S. Department of Agriculture. 15 p.
- Young, J. A.; Sparks, B. A. 1985. Cattle in the cold desert. Logan, UT: Utah State University Press. 253 p.
- Young, J. A.; Emmerich, F. L.; Patten, B. 1990. Germination of seeds of Columbia needlegrass. Journal of Seed Technology. 14(2): 1-11.
- Young, J. A.; McKenzie, Dan. 1982. Rangeland drill. Rangelands. 4: 108-113.