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REVIEW DRAFT

Introduced Forage Grasses in the Interior Columbia Basin: Science Assessment

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"INTRODUCED FORAGE GRASSES" - HARRISON, CHATTERTON, PAGE, ASAY, JENSEN AND CURTO

"CRESTED WHEATGRASS IN THE ECOSYSTEM" - ROBERT R. KINDSCHY

SUMMARY BY THOMAS G. MILES and M.G. (SHERM) KARL

Summary

Environmental and site conditions including geomorphology, slope aspect, soil types, salinity, human impacts or management, seed sources and existing vegetation determine how successful a plant species will be on a site. All plants are most competitive in those environments where they are best adapted. Competitiveness of a given species declines as the environment in which it is best adapted becomes less favorable. When taken to the extreme the most aggressive of plants do not even occur in areas outside their tolerance limits.

The impact of introduced grasses in the Columbia Basin drainage is not only site specific but also dependant upon the management conditions imposed. If vegetation is removed prior to seeding by fire, grazing or cultural practices, the likelihood is greatly increased that a monoculture will follow. It is difficult to establish a monoculture without removal of existing vegetation. In general, bulbous bluegrass, crested wheatgrass and intermediate/pubescent wheatgrass complexes, Kentucky bluegrass, hard fescue, orchard grass, reed canarygrass and tall wheatgrass establish as monocultures only if all the competition is removed prior to their seeding and if no other well adapted species are present. It is rare to find instances where the introduced species contained in this review have moved significantly into undisturbed areas or otherwise replaced existing vegetation.

In those instances where equally well adapted native and introduced species occur, both contribute to biodiversity. Thus, biodiversity includes the variety of species or ecotypes present in an ecosystem that exhibits a variety of characteristics regardless of the origin of that genetic variation.

The need for improved forage production for livestock and wildlife use, soil stabilization and the absence of native species adapted to man-altered environments were important factors in management decisions. Native and non-native grass species play important roles in providing a broad range of genetic diversity. They significantly contribute to biodiversity and provide options for ever changing land and management goals.

More important than the presence or occurrence of a randomly selected plant species (native or introduced) is the maintenance of soils and ecosystem processes. In light of the many worthy multiple use goals, it is our challenge as caretakers of the land to assure maximum contributions from existing species while protecting and maintaining both the biotic and abiotic resources.

Competition

Competition for resources generally determines the presence, absence or abundance of species within a plant community and their spatial arrangement (Pyke and Archer 1991). Fowler (1986) indicated there is sufficient evidence that competition regulates growth of plants in arid and semiarid communities. Competition among plants for resources often result in reductions in individual biomass with increases in the density of competitors (Harper 1977).

Reichenberger and Pyke 1991 concluded that "even though the response of a single fitness component may vary among seedling species, interspecific and intraspecific competition play major roles in determining the abundance of individuals in populations within semiarid ecosystems.

Biodiversity

Fundamentally biodiversity is the complete compositional and functional process present in any ecological (abiotic-biotic) system. Issues surrounding biodiversity are intricately intertwined with cultural, religious, and individual values and beliefs about the role of humans in global ecology.

Most articles especially those in the popular media, that advocate concern over diminishing biodiversity tend to emphasize an anthropocentric, commodity based view, detailing the many foods (eg., Prescott-Allen and Prescott-Allen 1990 and drugs (Ehrlich and Wilson 1991) humans obtain from natural sources, rather than the less comprehensible, yet more critical global ecosystem processes that sustain life. Varying degrees of biodiversity have been observed in ecosystems consisting of native and introduced species. Seeding of introduced species for site stabilization may ultimately promote establishment of native species.

Exotic Plant Invasion

Westoby et al. (1989) noted that plant associations do not operate as "organismal entities" through time and space, but rather as individual species populations with differing physiological tolerances and life histories. Consequently local, regional, and global environmental dynamics all operate to shape the more accidental than the determinant vegetation patterns observed at any one point along a time continuum.

Perhaps the most important concept to consider is that no specific spatial vegetation association or landscape (eg., North America just prior to human occupation) holds any greater fixed value over any other temporal view of that same landscape. Through examination of the fossil record, we see that vegetation associations are plastic and quite dynamic. Arid regions of western North America experienced significant climatic changes with major vegetation expansions and contractions during the Holocene period and even greater fluctuations during the inclusive Quaternary Period (Taush et al. 1993). Brandt and Richard (1994) found that within the Columbia Basin on the "protected" Hanford site, unintentionally introduced plants (cheatgrass and Russian thistle have persisted and have invaded areas undisturbed by humans or livestock since 1944. Tyser and Worley (1992) reported a similar scenario within Glacier National Park.

Walker (1992) and West (1993) placed greater importance on the preservation of ecosystem processes than on the maintenance of any temporal species association or of "ecologically redundant" species. Some authors eg. Orr 1990, have argued that humans will never have the capability to fully understand the complexity of our global ecology and therefore the concept of ecological "management" is ludicrous. While perhaps extreme this contention highlights the need for caution when evaluating the "ecological importance" of any one organism.

Biodiversity issues concerned with the introduction of forage grasses can be grouped into two primary categories: 1) aspects about each individual grass species or species complex and 2) results from vegetation type conversion. Although some authors e.g., Temple 1990 have simplistically treated introduced plants as inherently "evil organisms," others have viewed introduced plants as relatively benign additions (e.g.,Lugo 1990, 1992). Still others (e.g. Johnson and Mayeux 1992) see introduced plants as having "increased species richness and probably diversity." As noted by Lodge (1993), the "truth" depends on the specific situation as each successful invasion results from the chance coincidence of numerous ecological factors - no one invasion model will hold universally. Accordingly, predictions about the "invasion potential" of any one species remain difficult, as conditions for successful introduction will vary significantly from site to site. Without doubt, the introduction of individual species can result in dramatic changes to local habitat, as with the introduction of Andropogon virginicus C, von Linne', Paspalum conjugatum Bergius, and Pennisetum setaceum (Forskal) Chiovenda into Hawaii (Vitousek et al, 1987). Such examples have prompted some authors (e.g., Coblentz 1991) to advocate as a condition of the introduction process that the introducer must demonstrate that a given plant will never affect local biodiversity. No matter how appealing this theory may be, this proposal is impractical because one would need a parallel world in which to introduce any new species. No model or experimental plot could ever accommodate all possible ecological factors at any one site through time. Assessments regarding the invasive potential, and possible adverse effects on biodiversity of any given species can only be an "educated guess." Speculations for a given environment must draw from previous knowledge about competitive ability for space and resources, together with any known capability to pollute local gene-pools with deleterious alleles. Forage grasses are often viewed as "preadapted" invaders owing to a suite of traits selected for by plant scientists or agronomists, including high germination, strong seedling vigor, overall robustness, wide or specific ecological tolerance (e.g. salt, drought), and abundant seed production; however, "pre-adaption" does not automatically impart invasion. Only with adequate scientific monitoring can knowledge beyond casual observations be acquired to estimate negative or positive influences that introduced species have had on local, regional or global ecological complexity.

Perhaps an appropriate way to view the introduction of non-indigenous forages in relation to biodiversity is in the context of vegetation type conversion. When attention is focused on introduced forage grasses in the landscape, a much greater portion of the debate centers around the removal of existing vegetating or reseeding areas where existing vegetation has been depleted with the concurrent seeding of introduced species rather than the invasion of introduced plants into relatively intact indigenous vegetation. When viewed realistically, type-conversion is a single-purpose strategy for the promotion of specific objectives that initially results in local ecological simplification through the promotion of monocultures often of significantly altered structure. Such structure changes may markedly alter the food sources, the numbers and species of animals or fauna requiring the food sources or thermal and visual cover, resulting from a habitat of more uniform height and spacing. Also, results of analysis conducted during eleven years by Tilman and Downing (1994) suggests that the more species diverse Minnesota grasslands examined were more resilient after significant drought than grasslands with four or fewer total species. The maintenance of many species with varying tolerances to drought, frost, fire, herbivory and fungal pathogens is more likely to ensure the persistence of some of the existing species on a given site than does a single genetically uniform cultivar.

Rangeland degradation, expanding desertification, and ecosystem fragmentation are interrelated issues of paramount concern among ecologists (eg. Allen and Jackson 1992; Lord and Norton 1990; Milton et al 1994; Saunders et al 1991; West 1993). In arid regions, once vegetative cover is removed isolation increases, hydrology is altered, soils erode, and functional processes are impaired. The resulting fragmented landscape is often vulnerable to an accelerated spiral toward perhaps irreversible desertification with potentially devastating ecological, social and political effects. Accordingly, land managers within arid regions, including North America, must examine each new type-conversion for the total ecological consequences and then work to restore fragmented landscapes (Hobbs and Saunders 1993). However, in many situations planting of introduced grasses to preserve eroding soils and ecosystem processes is imperative.

BULBOUS BLUEGRASS

Used for pasture and soil control

Competitive ability and invasiveness

Bulbous bluegrass was first introduced in the eastern US from Russia in 1906. In 1915 it was accidentally introduced in alfalfa seed and spread rapidly throughout the western US. It is aggressive and invades disturbed areas and established stands of some other species. It produces an abundance of seed even in dry years and is well adapted to the granitic foothills of the Boise River drainage, Snake River plains, and northern Nevada and Utah. It grows aggressively in areas that receive favorable spring and fall precipitation at elevations from 2,000 to 6,000 feet. It does well on dry gravely soil that is low in organic matter (Hull 1940).

Carlson, 1994; Gibbs, 1994; Harris, 1994; and Harrison, 1994 have found that bulbous bluegrass invades disturbed sites but soon gives way to longer-lived native perennials in eastern Oregon and Washington. They reported that it coexisted with other natives but did not dominate them. The found that it gives way to squirreltail, Sandberg's bluegrass and bluebunch wheatgrass. However, Winward (1994) noted at Baker, Oregon that bulbous bluegrass persists under grazing pressure.

Winward (1994) found that bulbous bluegrass is extremely aggressive and invaded the valleys and foothills of the

Curlew National Grasslands in south central Idaho. It is competitive in areas where soil dries in July or August and receives 10 to 18 inches of annual precipitation.

Bulbous bluegrass has become a widespread grass in the Columbia River drainage. It volunteers and is well adapted in the winter-rainfall zone. However, stands fluctuate from year to year. It often persists in mixtures with long-lived bunchgrasses from which it may invade nearby areas and is sometimes troublesome on croplands. It has many of the weedy characteristics of Cheatgrass (SCS and PPMC files, Pullman, WA, researched in 1994).

Wildlife use

Mule deer have been observed to graze bulbous bluegrass during early spring and late fall in northern Utah and southern Idaho (McArthur 1994; Harrison 1994; Winward 1994).

Summary

Bulbous bluegrass is persistent, highly competitive, aggressive, easily regenerates itself and may become dominant on disturbed areas where adapted. Nevertheless, on many sites it either gives way to other species or coexists in mixed communities. Thus, on some sites it adds to instead of distracting form biodiversity.

CRESTED WHEATGRASS COMPLEX

It is used for pasture, hay, soil conservation practices, turf, wildlife.

Competitive Ability and Invasiveness

Crested wheatgrass is one of the most successful of all grasses introduced into the sagebrush-grass ecosystem of the Columbia Basin. According to Hull and Klomp (1966), crested wheatgrass was the first successful species seeded in sagebrush-grass sites in southern Idaho and continues to be one of the best adapted species. It has wide adaption, long life, drought and cold resistance, relative freedom from disease, good productivity and palatability, persistence under abuse, good competitive ability, high seed production, ease of establishment and excellent seedling vigor (Hull and Klomp 1966).

Dwyer (1986) and Asay (1994) stated that crested wheatgrass may be the single most economically and biologically important range plant in North America. This grass was introduced from Siberia where it evolved under and survived intensive grazing. It has been used to replace bluebunch wheatgrass which is susceptible to defoliation. Crested wheatgrass produces from 3 to 20 times the grazing capacity of the so-called native plants it has replaced. It sustains heavy and long or even continual grazing, much to the surprise of most early range ecologist who predicted it would easily succumb to the pressures of grazing or to its new environment or a combination of both. Not only has it not succumbed, but it has survived three of the centuries worsts droughts (Dyer, 1986).

Crested wheatgrass is a hardy perennial bunchgrass, that has evolved under heavy grazing for centuries. It is highly adaptable to semi-arid sites and competes well with undesirable exotics plants such as halogeton and cheatgrass. It sustains productivity surprisingly well under heavy and long grazing and provides valuable forage for livestock and big game. It is these characteristics that have led to crested wheatgrass being the grass of choice for rangeland seedings in the arid 8 to 12 inch rainfall areas (Kindchy 1995).

Uncontrolled livestock grazing had depleted and permanently altered vegetative composition of rangelands as early as the turn of the century (Griffiths 1902). A prolonged severe drought during the 30s undoubtedly caused widespread mortality of weakened native perennial grasses (Pechanec et al. 1937, Lanf 1945, Blaisdell 1958, Wernstedt 1960). Exotic species such as Cheatgrass filled the void (Young and Evans 1978).

Eventually a number of concerns became apparent. First, there was not sufficient forage to meet licensed livestock use. Second, invasion of weedy plants was creating problems including increasingly large areas burned repeatedly by wild fires (Conrad and Poulton 1966, Uresk et al. 1976, Bunting 1991). Other complications were also developing. Big game suffered a lack of both summer and winter forage (Gruell 1986). Watershed conditions were such that erosion was often rampant (Rauzi and Hanson 1966, Laycock and Conrad 1967, Buckhouse et al. 1981). Crested wheatgrass became the seed of choice for these areas because: crested wheatgrass seed was commercially available, and as a well adapted and easily established perennial, crested soon out-competes annuals. . . such as cheatgrass, Russian thistle and Halogeton. Thus crested has been used extensively in reclamation of disturbed sites (Rogler and Lorenz 1983). Also a strong history of establishment success was well known (Long 1958, Heady and Bartolome 1977, Evans and Young 1978).

Criticisms of Crested wheatgrass are it is an exotic and it establishes monocultures. Although exotic, it is well established within western North America. There can be little doubt that it now qualifies for residency (Dwyer 1986). There is little doubt that early seedings resulted in a monoculture initially. Fortunately nature through natural succession is mitigating this monoculture problem with natural reestablishment of sagebrush and other native plants in most older seedings. In fairness, it should be mentioned that mixed seedings of forbs and shrubs including adapted species of alfalfa were also seeded in many rangeland projects (Kindschy 1991).

Monocultures are limited in both plant and animal diversity. Seedings of crested wheatgrass initially produced a monculture. The same could be said for any grass or herbaceous species. Degraded rangeland dominated by a shrub species such as big sagebrush also became monocultures. Neither were well suited for wildlife (Kindschy 1978, Oakleaf et all. 1983, Holechek et al. 1982, Ellis et al 1989). Overtime, sagebrush often becomes naturally reestablished in seedings of crested wheatgrass because it is a part of the potential natural plant community within much of the Columbia Basin (Passey and Hugie 1962, Vale 1975). Degraded sites are less diverse due to lack of variety in plant species. Sites with a long history of degradation may pass the point of successional recovery due to an absence of native grasses, forbs and shrubs. Such sites have been aptly termed "locked in" because they are for practical extents of time not subject to change (Tausch et al 1993). Cheatgrass ranges would be a good example of a "locked in" site. Cheatgrass ranges burn frequently, within 5 years normally, and have limited availability of native plants so that natural reseeding of the site cannot occur. Without intervention by humans (seeding), there is not much hope for improvement through natural succession within time frames acceptable to most humans.

Observations of ecological processes within an SE Oregon livestock exclosure built by the CCC and Grazing Service in 1939, show seeded crested wheatgrass living in evident balance with native grasses, especially bluebunch wheatgrass, thurbers needlegrass and squirreltail. Such observations would suggest that crested wheatgrass is not an overly aggressive competitor with native grass species. There is no doubt that it is highly competitive with annuals, however.

Kindschy (1988) observed that crested wheatgrass rarely spread from the actually seeded site. In those few instances, crested filled the void created when other introduced grasses died. Without doubt, vehicle undercarriages gather ripe seed while traversing crested seedings then brush wipe the seed off along the truck trail. Crested wheatgrass seems to be confined to the center where introduced (Kindschy unpbl.)

Once established which requires 3 to 4 growing seasons following seeding, crested seedings become difficult sites for other plant species to colonize. In this sense, crested wheatgrass is quite competitive. It establishes a closed community where inter-spaces between plants are fully occupied by their root mass.

Stress from repeated grazing or drought reduces vigor and competitiveness of crested wheatgrass. During such times drought hardy species, especially sagebrush, may become established in interspaces (Miller et al. 1991). I have also observed annual grasses and forbs for example cheatgrass and halogeton fill interspaces among drought dormant crested wheatgrass. Once more normal moisture returns however, annuals fail to compete with revitalized crested wheatgrass and nearly all disappear from the site. Similar phenomena occur between native bunchgrasses and annuals (Kindschy 1992)

Kindschy (1991) reported on the great amount of success with seeding nomad dryland alfalfa, concurrently with crested wheatgrass. Success has also been attained with four-winged saltbush and bitterbrush.

Stands of Nomad variety alfalfa have coexisted with crested wheatgrass for over 25 years in the Vale Project rehabilitation area of SE Oregon (Kindschy 1991).

Johnson (1986) did a detailed analysis of competition with cheatgrass. A summary of this analysis indicates that characteristics which make cheatgrass a strong competitor with seedlings of crested wheatgrass include: 1) high seed production, resulting in extremely large resident seed banks, 2) highly viable seed that exhibits rapid germination and aggressive emergence capabilities and 3) rapid and extensive root penetration into the soil and extensive root system development. Although these characteristics a specifically relate to cheatgrass, various combinations of these factors undoubtedly contribute to the success of other species competing with seedlings of crested wheatgrass. "Early seeding root development and seedling ability to tolerate widely fluctuating moisture and temperature conditions undoubtedly contribute to the ease of establishment of crested wheatgrass (Johnson 1986).

Hyder and Sneva (1963) attributed the high grazing tolerance of crested wheatgrass to early root-growth activity, early accumulation of leaf tissue, and early accumulation of carbohydrate reserves in underground parts.

Roots of crested wheatgrass move down in the soil faster that bluebunch wheatgrass and nearly as rapid as cheatgrass and remain in favorable moisture while bluebunch wheatgrass does not. These differences result in lower leaf water potential and poorer survival of bluebunch than crested wheatgrass (Harris and Wilson 1970).

Crested wheatgrass seedings in Vale, Oregon and elsewhere (Asay, 1994; Hull and Klomp 1966; Blaisdale et al. 1982; Johnson 1986; USDA-ARS 1992; Harrison 1994) suggest that some seedings persist for a long time (30-45 years). Big sagebrush repopulated the crested wheatgrass area reaching about 15% relative cover during a 20 year period in plowed and seeded areas (Heady 1988).

Rumple (1994) noted over a 30-year period at the Vale project that crested wheatgrass plants were able to invade bluebunch wheatgrass stands in areas where bluebunch wheatgrass vigor was low (livestock concentration areas, areas recovering from drought, etc.). Big sagebrush and rabbitbrush were the only native species observed that would invade stands of crested wheatgrass. The severity of invasion is somewhat related to the vigor of the crested wheatgrass stand.

Cook and Lewis (1963) found that big sagebrush with its 5 to 11 foot taproot and wide lateral branched roots (Weaver and Clements, 1938), strongly competed with crested wheatgrass. Hyder (1954) reported that reinvasion of sagebrush in the CRB following its control is to be expected. Sneva (1971) found that after 17 years "even when managed for minimal ecological impact that sagebrush will return "to crested wheatgrass seedings following chemical brush control in SE Oregon.

Frischknecht and Bleak (1957) reported in their study in NE Nevada that the reestablishment of sagebrush, following its control and seeding of grass, occurs immediately after the brush is removed. They also found that seeded bluebunch wheatgrass was more likely to permit big sagebrush recruitment than created wheatgrass stands in similar condition. Reichenberger and Pyke (1990) indicated that bluebunch wheatgrass was a stronger competitor than crested wheatgrass on a mountain big sagebrush site.

Eissenstat and Caldwell (1988b) reported that standard crested wheatgrass has greater competitive ability than bluebunch wheatgrass when they used Wyoming sagebrush transplants as indicator plants. They concluded that the "rapid water extraction by crested wheatgrass is probably a major factor when comparing its ability with bluebunch wheatgrass to compete with big sagebrush."

Many crested wheatgrass seedings evaluated by Evans et al. (1986) became "infested with sagebrush and rabbitbrush within 5 to 10 years following establishment. Brush infestation, which may be as heavy as 20 to 25% crown cover, drastically reduces forage productivity of associated grasses.

Crested wheatgrass reseeds itself well on western rangelands Weintraub (1953). Several plant material scientists have documented sites where crested wheatgrass has not spread. They note 40 year old crested wheatgrass plants with "no evidence of progeny established around the original plants in the Great Basin." On the Yakima Training Center in Washington, Nissen (1994), Pudney (1994) and Harrison (1994) noted that crested wheatgrass did not appear to spread or compete with native species.

Rummel (1946) reported that species such as crested wheatgrass, which germinate early in the season and make rapid growth following emergence, can resist cheatgrass competition more successfully than that developed more slowly such as western wheatgrass. Harris (1965) found similar results with bluebunch wheatgrass, but reported that cheatgrass out competes bluebunch wheatgrass seedlings by extending its roots more rapidly during the winter, thus gaining control of the site before bluebunch seedlings become established. Cheatgrass matured four to six weeks earlier and utilized the limited moisture supply prior to use by bluebunch.

Asay and Johnson (1983) and Horton (1994) reported that planting various wheatgrasses, particularly crested is effective in controlling annual weeds like cheatgrass. However, Monsen and Shaw (1983) and Walker, et al. (1993) questioned whether introduced perennials are compatible with most native species and suggested they may hinder native plant recovery. Crested Wheatgrass roots have the ability to grow at colder temperatures than bluebunch wheatgrass roots (Harris and Wilson 1970; Eissenstat 1986; Eissenstat and Caldwell 1988a).

Frank (1983) reported that western wheatgrass has the ability to maintain a higher leaf potential than crested wheatgrass and through its reduced growth rate during drought, it remains green longer than crested wheatgrass. In comparing invasive root growth into disturbed soil by crested wheatgrass and bluebunch wheatgrass, Eissenstat and Caldwell (1989; 1988a) found that crested wheatgrass invaded "more rapidly into the newly available soil...." and in early spring when soils are cold.

Pike (1990) reported that seed production was much greater for crested wheatgrass than bluebunch wheatgrass. Crested wheatgrass not only produced more seed than bluebunch wheatgrass but produced nearly the same amount in dry years while bluebunch wheatgrass produced none at the study area in NW Utah. Pyke (1990) further noted that bluebunch wheatgrass seeds were dispersed when they matured, while crested "retained some seeds and dispersed them slowly throughout the year," which allowed seeds of crested to escape peak periods of seed predation. He noted that seeds were carried over beyond one year for crested but not for bluebunch. Pyke (1990) suggested that "Demographic factors associated with seeds of crested wheatgrass seemed to favor maintenance and spread into native stands formerly dominated by bluebunch wheatgrass." Roche' (1994) and Pudney (1994) found that crested wheatgrass out competed bluebunch wheatgrass in established stands in eastern Washington.

Caldwell et al. (1981) found that crested wheatgrass has better recovery from defoliation than bluebunch wheatgrass and this difference appeared to be related to rapid growth of new tillers in crested wheatgrass. Keller (1979) concluded that squirreltail may provide vigorous competition for crested wheatgrass. He found that it also invades both cheatgrass and medusahead stands.

Roche' et al. (1994) found that apparently a stand of adapted introduced perennial grasses such as intermediate wheatgrass in eastern Washington, can limit yellow starthistle if the grasses can be managed to provide shade to the soil surface from fall through spring and deplete soil water in late spring through summer. Pyke and Archer (1991) suggested that both stress tolerance and competitive ability should be considered when evaluating competition factors in an environment.

Does crested wheatgrass add or detract from biodiversity? The answer is affected by the conditions that existed prior to seeding and the success in the establishment of native or native like species. If the conditions that existed prior to the seeding was that of a sagebrush or cheatgrass monoculture with little to no additional species present a proper seeding mixture of crested and natives along with other valuable plants such as dryland alfalfa, sagebrush and four-winged saltbush would add to the biodiversity of these "locked in" ranges as well as other degraded ranges with little chance for natural rehabilitation. If we take existing rangeland that is not in a degraded condition and eliminate the native species of grasses, forbs and shrubs to replace them with a monoculture of crested wheatgrass, then we have detracted from biodiversity.

Wildlife Usage

Sagebrush covers about 270 million acres of western rangeland with Wyoming big sagebrush covering more than half of this area. Animals inhabiting this area are more often than not shrub obligates. Complete removal of this dominant shrub will cause immediate displacement of individuals to areas where habitat requirements of reproduction and foraging can be met (Kindschy 1978). Horned larks and meadowlarks are normally the most common birds in crested seedings devoid of sagebrush cover (Kindschy, unpubl.). McAdoo et al. (1986, 1989) presented an excellent summary of on-game bird responses to type conversion of sagebrush communities. Trade-offs occur when sagebrush dominated habitats are converted to monoculture crested seedings. Although shrub nesting bird species are displaced, grass-nesting species respond favorably to the openness and increased herbaceous cover resulting from brush removal and seeding. As succession proceeds sagebrush and associated bird species return while the grass-nesting species remain. If pristine sagebrush steppe shrub communities actually did have more grass cover than their present counterparts, then the vegetation structure and bird communities of seedings where sagebrush has become reestablished may more closely resemble presettlement conditions than do those of present degraded sagebrush habitats with sparse herbaceous understory. Boula and Sharp (1985) studied species composition and abundance of small mammals within native rangeland vegetation and a crested seeding of SE Oregon. They found post-recruitment populations were highest and most diverse in native upland shrub habitat. Crested seedings yielded fewer species and a lower total capture biomass.

Protection from predation may be an important habitat feature for small mammals that is limited in drilled crested seedings. Feldhamer (1977) reported a positive correlation between small mammals species density and canopy cover in shrub habitats. Several big game mammals, pronghorn antelope, mule deer, bighorn sheep and elk use crested seedings to varying amounts depending on seeding location and season of year. Response of pronghorn to rangeland development, including crested seedings and their water developments have been dramatic (Heady and Bartolome 1977) In SE Oregon's Malheur county, the principal area of the Vale Rangeland rehabilitation project, pronghorn census has increase from an average of 900 head to >3000. Fecal analysis from deer wintering within these seedings was performed by Colorado State University on randomly selected deer pellets gathered by the writer. Crested wheatgrass averaged between 84 and 92 percent of the volume of excreted material. Urness (1986) cited Lekenby (1969) in the Silver Lake, Oregon, mule deer winter range where crested seedings accounted for 34% of deer use observations Holechek (1981) treated a number of attributes of crested wheatgrass. He stated that "deer and elk seek early spring foliage of crested following snow melt, and they also use fall growth." Austin and Urness (1983) recommended that managers should curtail fall livestock grazing on critical deer wintering areas to assure maximum regrowth availability for deer. They concluded that green crested wheatgrass regrowth is an important over-winter forage for mule deer and where available should be considered in management plans.

Austin et al. (1994) noted that mule deer preferred Fairway crested wheatgrass in the spring and fall over several other plants including natives. Willms and McLean (1978) found in British Columbia that green crested wheatgrass was second in importance to Sandbergs bluegrass in mule deer diets during March 6 to May 5 and the most important in their diet from May 6 to 31. Crested wheat grass seedlings often provide high-quality forage for wildlife grazers that aids in rapid recovery of body condition lost during the stressful winter period. Seeding of introduced grass species on spring-fall range resulted in reduced browse use by livestock and reduced competition with wildlife (Lamb 1966, Vale 1974) (Appendix II).

Green growth from crested wheatgrass is important from fall to mid-spring in supplementing browse diets. Such seedings have helped to reduce use conflicts between deer and livestock on foothill ranges. Antelope receive less direct value from crested wheatgrass seedings because of their dependance on forbs. When available, crested wheatgrass seedings are heavily used by elk and bighorn sheep (Urness, 1986).

Heady (1988) reported in his evaluation of the Vale Rangeland Rehabilitation Program" that "the program did not help or harm wildlife and perhaps resulted in improved overall wildlife habitat. He noted that "deer and antelope numbers seem to have increase in response to the reduction of tall brush and the increase of winter forage made available by fall growth of crested wheatgrass." The reduction of sagebrush may have adversely affected black-tailed jackrabbits. Kindschy (1986) found that sage grouse declined in the Vale program area because of the reduction of sagebrush.

Shrub dependent nongame bird species were displaced when crested wheatgrass seedings were established in sagebrush communities (McAdoo et al. 1986). However, ground-nesting species increased in response to improved herbaceous cover. The ground nesting birds are adapted to this grass species life form or structure. "Total bird abundance in the seeding may be similar to that of unconverted sagebrush habitat, but in total number of species is lower and relative abundance of species is much different in the monoculture seeding."

Live small mammal trapping studies conducted in 1978-79 at the Idaho National Engineering Laboratory in SE Idaho revealed that small mammal densities on Surface Disposal Areas seeded with crested wheatgrass equaled or exceeded those in the adjoining sagebrush.

Summary

Crested wheatgrass is well adapted to much of the western US. The crested wheatgrass taxa are generally long lived on adapted sites in the Columbia River drainage. Some plantings in the Great Basin have been reported to be more than 50 years old, while other well established stands of crested wheatgrass seedlings have died out after 5 to 15 years. These areas are generally low or high in precipitation.

In areas where full stands were established and proper management was applied to maintain a monoculture, crested wheatgrass is competitive and withstands native grass and forb encroachment. However, big sagebrush and rabbitbrush often invade crested wheatgrass seedings, especially in those instances where seed sources are nearby. Some researchers have noted that brush species do not invade large crested wheatgrass seedings when seed sources are nonexistent.

Researchers differ in their opinion regarding the invasiveness and spread of crested wheatgrass. Some have not found it to spread in specific areas while others have recorded its spread. However, most agree that in areas where it has spread or invaded native sites, it moved very slowly.

Many small birds and rodents eat crested wheatgrass seeds; mule deer and elk eat green crested wheatgrass forage in early spring and early fall.

Eurasian species such as cheatgrass and Russian thistle have been a part of the Columbia River Basin flora for more than a century. Most originated in the semiarid regions of Eurasia, where they had been subjected to millennia of various intensities of anthropogenic disturbance. Many of the taxa in the crested wheatgrass complex also originated in Eurasia and therefore have capabilities to compete well with unintentionally introduced taxa like cheatgrass and Russian thistle.

Hard and Sheep Fescue

Soil erosion control, pasture, turf, watershed protection, roadside beautification, airports, dams sites, terraces, diversions, ditchbanks, mine spoils, soil builder, ski slopes.

Competitive ability and invasiveness

Aiken and Darbyshire (1990) agreed with researchers in Europe that these fescues successfully invaded habitats disturbed by humans in central Europe. "vigorous establishment in early successional habitats was undoubtedly a character recognized as valuable in its early selection as a turf and pasture plant. Through commercial seeding and naturalization, the distribution of these plants now extends into most of Europe and North America."

Durar Hard Fescue has extensive root production. It has been used for soil stabilization and watershed protection and is well adapted in the 38-60 cm precipitation zone (Ensign 1985). Durar Hard Fescue increased from 2% in 1940 to over 90% in four years and by six years it had completely suppressed crested wheatgrass (Schwendiman et al. 1964). It out competes cheatgrass and other annuals. Roche' (1994) found after 20 years Durar seeded plots were invaded and completely taken over by pinegrass and elk sedge on Grand and Doug fir sites.

"Covar sheep fescue suppresses brush invasion following burns in chaparral communities" (Ensign 1985).

Both Durar hard fescue and Covar sheep fescue are very competitive after they are established and generally become a monoculture. Covar which is adapted to the 10 to 18 inch rainfall areas in the Columbia Basin, is more drought tolerant than Durar. Covar and Durar are the most aggressive plants used in Northern Idaho to compete with spotted knapweed. However, Covar is not a strong invader and spreads very slowly by seed and has not been noted to take out native stands

(Carlson 1994, Gibbs 1994, Krueger 1994, and Ogle 1994).

Wildlife Usage

Small seeded sheep fescue was removed more frequently than larger-seeded perennials such as intermediate and pubescent wheatgrass. Birds may inhibit improvement of range sites by heavy utilization of the seed. Although Durar and Covar fescues are not highly preferred by herbivores, both mule deer and elk graze Covar sheep fescue in the early spring (Gibbs, 1994).

Summary

Durar hard fescue and Covar sheep fescue when established in their adapted habitat have developed monocultures and persisted up to 50 years. They both have a dense spreading root system and have the ability to exclude most invading plants. Nevertheless, rhizomatous plants have encroached onto their stands. The spread or non-spread of hard and sheep fescues into adjacent areas appears to be site specific. Rodents use Durar as a habitat. Elk and mule deer graze sheep fescue in the early spring, and wild birds use sheep fescue seed.

Intermediate/Pubescent Wheatgrass Complex

Pasture, hay, soil erosion, turf, wildlife, forage and habitat.

Competitive ability and Invasiveness

Hull and Klomp (1966) found that plots seeded in 1946 to intermediate and pubescent wheatgrass at the US Sheep Experiment Station Dubois, Id had spread 155 and 210% respectively from their initial plantings. At the Arrowrock site 20 miles SE of Boise, they found that intermediate and pubescent wheatgrass seeded in 1941 had spread considerably by 1963.

Asay and Knowles (1985) indicated that intermediate wheatgrass is known for its productivity during early years of the stand. Even though newer varieties of intermediate wheatgrass are better (Asay, 1994), "it has been criticized for its lack of longevity when mismanaged or subjected to environmental stress." They further noted that it was successfully used in mixtures with alfalfa.

Whitmar bluebunch wheatgrass was seeded in individual plots with 10 other species, including pubescent wheatgrass, in 1962 at the Yakima Training Center in Washington. By 1994 whitmar bluebunch wheatgrass has encroached into several other plots and become the dominant species in the adjoining plot of pubescent wheatgrass (Nissen 1994).

Yellow Star thistle would not be excluded by seedlings of pubescent wheatgrass. When densities of the two species were equal it was concluded that yellow star thistle would not be excluded by seedlings of pubescent wheatgrass. Pubescent wheatgrass has greater longevity and, after becoming well established, may be able to deny resource to yellow star thistle seedings, ensuring it is not excluded from the site.

Monsen and Anderson (1993) designed a study "to investigate the longevity of a number of introduced and native grasses (132 accessions) and to evaluate variability in plant longevity among ecotypes." After 52 years the following introduced grass plant accessions were rated the most successful: intermediate wheatgrass, sulcata sheep fescue and fairway crested wheatgrass. "Most ecotypes of intermediate wheatgrass, including pubescent wheatgrass survived for 52 years, but some were less abundant than others. Fairway crested wheatgrass was much more abundant and persistent than standard.

Bartels (1992) showed "that during the dry years 1987 to 1990 western wheatgrass was competitively superior to intermediate under short-duration grazing or when protected from grazing. Removal of western wheatgrass from the interface led to an improvement in the performance of intermediate wheatgrass over a wide range of environmental conditions... . During the three years of this study and underprotection from grazing, western wheatgrass eliminated intermediate wheatgrass from the interface." It appears that the native western wheatgrass is more competitive and in fact will crowd out introduced intermediate wheatgrass.

Wildlife Usage

Kangaroo rats and black-tailed jackrabbits show a preference to greenar intermediate and Luna and Topar pubescent wheatgrass compared to other grasses at the 1965 Coffee Point Sage Grouse Habitat Improvement Field Evaluation Planting near Aberdeen, Idaho (Hoag, 1994). Goebel and Berry (1976) conducted seed preference trials for 25 different birds. Intermediate was the most highly preferred wheatgrass used in these trials. They concluded that birds may inhibit seedling establishment by consuming planted seeds.

Summary

Intermediate is a long-lived grass (50+ YEARS) that may outlive associated natives and other introduce species. The competitive ability and invasiveness of the intermediate complex is highly dependent upon environmental conditions and use. However, Sherman big bluegrass and western wheatgrass have a competitive superiority over some of the introduced species in this complex. Other studies have shown that these introduced species successfully outcompete yellow starthistle when intermediate wheatgrass densities are high enough. Competition from big sagebrush effectively reduced both grass height and leaf length. Some studies showed that intermediate may spread into adjoining vegetative communities while other studies have shown no plant expansion. In many instances, it coexists with native taxa and thus adds to the degree of biodiversity.

Kentucky Bluegrass

Controversy still exists as to whether all populations of Kentucky bluegrass are foreign to North America or whether some native populations existed along the Cascade-Sierra Nevada Cordillera, the Rocky Mountain Cordillera and northern Canada, prior to either intentional or accidental spread of European cultivars by Euro-American farmers and ranchers during the past three centuries (see Duell (1985). Whatever the origin of Kentucky bluegrass may be on the North American continent, this species seems assuredly foreign to the indigenous Columbia Basin flora.

Turf, pasture, hay, wildlife, soil erosion control.

Competitive Ability and Evasiveness

Kentucky bluegrass is often considered a perennial rhizomatous species introduced from Europe by early settlers (Vinall and Hein 1937). It is a common increaser on disturbed sites in the steppe region (Bates 1935; Burden and Randerson 1972. The winter root growth gives it an edge over such natives as bluebunch wheatgrass, which grows very little in the winter (Harris 1965). McArthur et al. (1994) found that Kentucky bluegrass, timothy and smooth brome dominated the meadow area and the severely disturbed sagebrush-grass site. Bookman (1980) found that Kentucky bluegrass competed well with cheatgrass in SW Oregon, by preventing cheatgrass lateral root spread.

Observations and research findings by Winward (1994) noted that Kentucky bluegrass did not compete with Douglas fir once the tree roots were below those of Kentucky bluegrass. He found that Kentucky bluegrass competed very little with pine grass and elk sedge. In contrast it competed with Idaho fescue and bluebunch wheatgrass. Kentucky bluegrass did not eliminate either fescue or bluebunch wheatgrass but was compatible with them (Winward 1994).

Krueger (1994) and Winward (1994) noted that Kentucky bluegrass cannot tolerate a high water table, but is very aggressive and strongly competes on dry meadow sites in area receiving 18 to 25 inches of precipitation. they noted as have others (Carlson 1994, Gibbs 1994, Harris 1994 and Harrison 1994) that it withstands grazing pressure from livestock and wildlife. It often dominates and readily competes with native species on disturbed sites. Krueger and Winward (1974) reported that within a livestock exclosure Doug fir-ninebark, elk sedge, pinegrass, blue wildrye and western needlegrass withstood competition from Kentucky bluegrass. Gomm (1974) reported that Kentucky bluegrass is very competitive in western Montana.

Wildlife Usage

Kentucky bluegrass is heavily grazed by mule deer, elk, antelope and moose (Carlson 1994, Gibbs 1994, Harris 1994, Harrison 1994, Krueger 1994, Winward 1994). Frequency of Kentucky bluegrass in ungrazed and big-game-only grazed pastures remained 100% indicating no significant loss of stand due to big game use.

Summary

Although some have stated that Kentucky bluegrass is indigenous to the intermountain region of the western US early literature states that it was introduced to the native Columbia Basin Flora. Researchers have found, on moist and dry meadows with more than 18 inches of annual precipitation, it to be an aggressive spreader and very competitive on adapted sites. Apparent root growth during the winter gives bluegrass a decided advantage over natives that lack such growth. When present as a sward it restricts the entry of native herbs and shrubs. In some instances it competes well with cheatgrass. However, it does not compete with douglas fir once the roots are below those of bluegrass. Although it may grow compatible with bluebunch wheatgrass and fescue it is unable to compete with elk sedge, pine grass, velvet grass, red top, trailing blackberry and mountain ash (in western Washington. In other instances Kentucky bluegrass may dominate native species such as Deschampia spp. or it may grow as an equal with elk sedge, pine grass, blue wildrye and western needlegrass on other sites. Thus, the competitive nature of Kentucky bluegrass is highly dependent upon environmental conditions. It withstands grazing under heavy livestock or big game grazing pressure and may dominate by becoming a monoculture under such management conditions. It is highly desired by livestock and a variety of wildlife herbivores.

Orchardgrass

Pasture, hay, green chop, silage, orchard ground cover.

Orchardgrass is a long-lived, shade tolerant bunchgrass with good seedling vigor. It readily establishes itself when there is little competition from other plants. Some orchardgrass cultivars are more competitive than others in different Columbia Basin ecosystems. Elliot and White (1987) noted that orchardgrass competed with Ponderosa pine seedlings for moisture and nitrogen in their study near Flagstaff, Arizona. Powell et al. (1994) found that orchardgrass competed with lodgepole pine seedlings in southern British Columbia. If perennial grasses are to survive with annuals in these areas, they must initiate growth early, continue through the winter, and mature before soil moisture is depleted.

Zamora (1994) found orchardgrass non-competitive with native species at the Centralia Mining Company in western Washington in a doug and grand fir site. Gomm (1974,1994) found orchardgrass non-competitive with native plants in western Montana and Wyoming. Other scientists (Carlson 1994, Gibbs 1994, Harris 1994, Krueger 1994, Winward 1994, Olge 1994, and Harrison 1994) have found orchardgrass to be non-competitive in various ares of the Columbia Basin.

Wildlife Usage

Orchardgrass is highly palatable to mule deer and elk in the early phenological stages. In fact, elk have eliminated orchardgrass seedlings by heavy use (Gibbs 1994, Harrison 1994, Pudney 1994). Upland game birds use orchardgrass for cover and nesting and small birds eat its seed (Gibbs 1994, Harrison 1994).

Summary

Orchardgrass in the Columbia River drainage is somewhat shade tolerant, has good seedling vigor and spreads by seed in open and shaded areas. This bunchgrass is generally considered noninvasive, compatible with native species and does not out compete natives in most ecosystems. Although orchardgrass may have little or no adverse effects on weedy species, it reduces the growth of pine seedlings. Nevertheless, after several years, stand survival was not different in lodgepole pine stands established with and without orchardgrass. Orchardgrass does not spread under the right conditions, but it frequently coexists with natives and thus increases biodiversity except in those instances when it is purposely established as a pure stand. It is highly palatable to livestock and wildlife.

Reed Canarygrass

Pasture, hay, stream and channel ditch bank stabilization and other soil conservation practices, water pollution control from sewage effluent.

Competitive Ability and Invasiveness

Zamora (1994) noted that reed canarygrass is a very aggressive rhizomatous grass that persists between the aquatic and upland zones in Washington. Comes (1971) also reported that reed canarygrass is extremely competitive. It occurs on several thousand miles of ditch bank in the Columbia Basin and grows vigorously along the waterline of ditches and to a lesser extent on the drier portion of the bank. Rootlets develop at each node as they contact water or moist soil banks. It will completely eliminate legumes from a community in two or three years (Bronin and Tomlin 1968; Heath and Hughes 1953). Reed Canarygrass has a broad adaption with large acres in Oregon and Washington.

Although the natural habitat of reed canarygrass is poorly drained wet areas, it grows quite well on upland sites. Reed canarygrass is tolerant to shade and gives way to willow dogwood and chokecherry. Sedges and rushes have replaced reed canarygrass in some areas (Zamora 1994).

Wildlife Usage

Reed canarygrass is used as a habitat for pheasants and ducks in upland and wetlands, respectively. Small birds eat the seed. Small mammals use it as a habitat in upland areas (Chatterton, 1994; Harrison 1994).

Summary

Reed canarygrass is generally a highly aggressive, competitive, persistent and vigorous perennial grass that grows in poorly drained wet areas on streams and canal banks in the drainage of the Columbia River. It usually, dominates and grows as a monoculture in the area where best adapted. Where it is best adapted, even quackgrass and redtop have difficulty competing with it. However, reed canarygrass is intolerant of shade and has been replaced in some instances by sedges, rushes willow, dogwood and chokecherry.

Tall Wheatgrass

Pasture, hay, alkaline or saline soil reclamation, wildlife habitat.

Competitive Ability and Invasiveness

Tall wheatgrass is a bunchgrass that spread by seed. Gomm (1994) noted that tall wheatgrass has not spread or competed with native plants after 45 years in Star Valley, Wyoming or in a planting made in Bozeman, Montana. Gibbs (1994) and others (Carlson 1994, Harris 1994, Harrison 1994) found that tall wheatgrass persists for long periods once established on adapted sites in Washington, Oregon and Idaho. It establishes itself as a strong dominant and when conditions are right, develops into a monoculture. Borman et al (1990) found that tall wheatgrass has a high production potential in years of above average precipitation but does not persist many years in SW Oregon or compete well with Idaho fescue and annuals. Roundy (1983) found, as did Young and Evans (1981) that although tall wheatgrass is more salt tolerant than basin wildrye or slender wheatgrass it is less drought tolerant.

Wildlife Usage

Tall wheatgrass seeds are eaten by birds and rodents. Its abundant foliage furnishes habitats for nesting and cover of nesting game birds. Mule deer use it for cover (Gibbs 1994; Harrison 1994).

Summary

Tall wheatgrass is a long-lived perennial bunchgrass that may persist for a long time on adapted sites. On less-well adapted sites, including those exhibiting both salinity and low moisture conditions, it is short-lived unless there is a water table below the dry surface. Generally it does not spread. In the Columbia River drainage it competes well with natives such as Basin wildrye on saline soils, but does not withstand drought as well as Basin wildrye and many other natives. In seedings in Utah, tall wheatgrass has done very well under very droughty conditions. The limiting factor is usually its inability to establish as a seedling under dry conditions. Once established it has a very well developed root system that seeks out deeper water sources than most dryland species on arid sites. It also had a great ability to produce large amounts of foliage on areas that have dryer surfaces and heavy soils (Lower Basin salty areas), but sub-surface water. If conditions are right, it establishes as a dominant and may exist as a monoculture.

Management Implications of Introduced Forage Grasses

General

Introduced forage grasses can be a mixed bag depending on the way each species is used on the rangelands. In general, if competition from other plant species is eliminated when seeding exotic grasses, such as in a plow and seed treatment then monocultures of the seeded species is highly likely. Conversely, it is very difficult to establish a monoculture with these exotic species without removal of existing vegetation. These species rarely invade undisturbed areas and generally, do not replace existing vegetation. Therefore, when considering these traits the federal land manager must determine the objectives for the area to be seeded and decide whether a diverse seeding is the goal or a seeding dominated by one or more species.

The big question that exists today regarding exotic grasses and the seeding of them is whether or not they add or detract from biodiversity and are they compatible with ecosystem function or do they hinder ecosystem function. The more emotional question is the idea of seeding exotic species where once there were native perennial species.

It you look at biodiversity being tied to the diversity or variety of species and not whether the species is native or exotic, then exotic grasses can detract or add to biodiversity. If seeded in conditions that lead to a monoculture then exotic species may detract from biodiversity. If they are seeded into existing vegetation or seeded along with numerous other species then they could add to biodiversity. The key is the condition or state the area that is being seeded is in. If the project area to be seeded is a monoculture of cheatgrass, noxious weeds or a closed canopy of sagebrush with no understory, then a diverse seeding which includes exotic grasses would add to biodiversity. If the project area is a diverse, native rangeland that had recently burned, but does not have an appreciable amount of exotics (cheatgrass) then seeding such an area may detract from biodiversity. The reason for this, is that the area probably would have recovered on its own with a few years of rest from livestock grazing and seeding exotic species may hinder the restablisment of a variety of native species.

Management Implications of Crested Wheatgrass

Crested wheatgrass has replaced a predecessor in many locations that suffers great stress under even relatively light defoliation. Yet that predecessor, bluebunch wheatgrass is generally held in much higher ecological esteem (Dwyer 1986). Crested Wheatgrass produces from 3 to 20 times the forage of so called native plants it has been called on to replace. It sustains productivity surprisingly well under heavy and long or even continual grazing much to the surprise of most early range ecologists (Dwyer 1986). Because it evolved in an environment where heavy grazing has occurred for centuries it is well adapted to early and close defoliation. This is not true of most native cool season grasses of the West.

Improvement of native range occurs because crested wheatgrass seedings often reduce grazing pressure on native range areas, or provide for management programs that are more suitable for improvement of native ranges (Sharp 1986, Heady 1988). Historically livestock were turned out onto rangelands in March or April, depending on snowmelt. Grazing followed spring plant growth into the upper elevation ranges until the onset of autumn storms forced stock downward to the areas of initial turnout. This pattern of livestock use deprived perennial plants of leaf tissue necessary for food manufacture through photosynthesis. Crested Wheatgrass furnished a solution to this physiological problem because high quality early season production of seedings provided an alternative to pasturing native vegetation.

Rittenhouse and Sneva (1976) reported a 4% decline in crested wheatgrass production for every 1% increase in cover of sagebrush. McKell (1986) found a 5 to 10% shrub canopy best for growth of understory grasses and forbs. Heady (1988) found sagebrush encroachment to be curtailed by competition from crested wheatgrass with sagebrush seldom covering more than 10% of land area. It is difficult to establish other plants within an existing wheatgrass stand. Competition from existing mature crested wheatgrass need be removed prior to successful establishment of introduced vegetation.

Crested wheatgrass has a remarkably wide range of site adaptability and is fairly easily established. Crested wheatgrass had some management problems too. The most forage productive strains tend to become rather rank or "wolfy" unless grazed. It might be termed overproduction and underutilization. Both are correct. Crested wheatgrass is now available in various varieties such as Hycrest that are more palatable than others and are thus less apt to become rank of wolfy.

Unfortunately, those crested wheatgrass plants that are grazed receive all the grazing pressure in following years, and in fact, may become overgrazed. Wolf plants are avoided by grazing stock and wildlife. Hence, it is possible to have a portion of a seeding of crested in a overgrazed status while the remainder is not utilized at all. A loss of forage production from the wolfy seeding transfers this grazing use to native forage species with subsequent loss in grazing flexibility and possible deterioration of that resource. As the seeding forage decreases more use of the natives occur. Eventually a manager is back to the point he was prior to the seeding being established. To correct this situation the manager must use corrective measures to remove the old plant material in the seedings. This can be economically done by grazing and prescribed fire.

Grazing a wolf plant problem can be accomplished by fencing off small paddocks of the seeding with electric fencing (solar powered) and grazing the area in the late fall-late winter when moisture has softened the crested wheatgrass. A prescribed fire needs to be in very dry and hot conditions in order for the seeding to burn. The release of nitrogen and other elements stimulate the rehabilitation of the crested wheatgrass.

A mixture including 6%-10% ground cover of sagebrush has proven to be adequate for many obligatory wildlife and does not greatly restrict productivity of crested wheatgrass for grazing use. The wolf plant problem developed because of low intensity-long duration grazing. The solution requires the opposite condition, namely large numbers of stock for short periods of time. This requires small pastures to concentrate livestock use. It must be noted that high intensity grazing on some areas increases soil compaction and adversely affects microbiotic crusts. The manager must way the benefits of different methods of wolf plant control so that other values are not overlooked.

For big game close utilization of crested wheatgrass during spring and early summer by cattle and then complete rest during .late summer and fall is recommended. Autumn "green-up" is then available during snow-free periods of winter. This kind of grazing "conditions" the crested wheatgrass for improved palatability and availability for big game animals.

Design of new seedings of crested should now incorporate additional species of forbs and shrubs. Avoidance of large blocks of land through contour or patch seeding to maximize edge effect is also desirable. Adapted dryland varieties of alfalfa remain one of the best forbs for concurrent seeding with crested wheatgrass. Allow 2 growing seasons rest from livestock use to enable establishment. Small burnet, sweetclover and sainfoil hold promise in future mixtures. Fourwing saltbush, winterfat, antelope bitterbrush and sagebrush represent good brush species to seed with crested wheatgrass. Time has established crested wheatgrass as one of the most important grasses in the Columbia River Basin. Time has also corrected in the case of older seedings the monoculture problem of crested seedings. Attention should be paid to design of future seeding to insure plant species diversity and maximization of edge. Many new cultivars of grasses, forbs and shrubs are now available for inclusion in seeding mixtures.

Preserving Ecosystem Function

Preserving ecosystem function is a goal of the ICEMP. Preserving the role of vegetation on the landscape for soil protection, nutrient recycling, cover and forage for wildlife, etc., is a basic management objective at the broad and fine scale. The problem of preserving ecosystem function becomes complex when dealing with the arid rangelands of the CRB. Generally, rangeland vegetation is more resilient as precipitation increases. The capability of rangelands to withstand disturbances, such as fire, without converting into exotic ranges such as cheatgrass, is greater in those areas receiving 12 inches and greater rainfall. In those areas, rest following fire or heavy grazing will normally allow recovery of the area. Management options in these areas are numerous ranging from resting to non impairment grazing to seeding natives or exotic species. In the those areas that receive 10 inches of rainfall and less, management options are limited.

It is in these areas that cheatgrass, medusahead, halogeton, russian thistle, etc. seem to be the most competitive. Once disturbance occurs in these areas and cheatgrass is present in the area, there is a strong tendency for the cheatgrass to take over the once native rangeland. Once cheatgrass becomes a dominant vegetation in the landscape then fire cycles increase and cheatgrass abundance increases untill the rangeland is essentially a cheatgrass range which some federal land managers call "locked in" range. The name "locked in" refers to the never ending cycle of fire and more cheatgrass filling in the interspaces until perennial plants such as Wyoming sagebrush and bluebunch wheatgrass become replaced. Once this occurs the area is "locked in" this cycle with no hope for recovery in the foreseeable future. Ecosystem function in "locked in" areas is compromised as cheatgrass reduces diversity, nutrient cycling and allows accelerated erosion when compared to the native plant community prior to disturbance.

Federal land managers run into a problem when faced with "locked in" cheatgrass areas. How does a manager return this locked in area to functionality and also be able to meet management objectives? Emphasis now is on the seeding of native species and the idea of seeding exotic species such as crested wheatgrass is considered "politically incorrect" because it is an exotic and basically the public wants to see native species on the landscape. The problem with seeding natives in the 10" and below precipitation areas that are "locked in" is that in many cases the manager is not able to get the native seeding established. This is because, native seed that is acclimated to such areas almost have to be locally collected which is a very expensive proposition. Native seed from traditional sources in most cases will not become established in the harsh, lower precipitation areas. Compounding this problem is the intense competition that cheatgrass has with the seedlings of natives grasses. Generally, due to its growing characteristics and root structure, cheatgrass out competes native grass seedlings for important water and nutrients which in most cases leads to failure of the native seeding. In those areas where seeding natives run a high risk of failure, the land manager has little choice but to use exotics such as crested wheatgrass along with other species such as sagebrush, to bring back a perennial bunchgrass/sagebrush community to these areas. Although, the seeding contains exotics, the functionality of a bunchgrass/sagebrush range is restored which is a vast improvement over the one dimensional cheatgrass range. Where in native seedings cheatgrass will dominate the interspaces between seeded plants, the growth and root characteristics of crested wheatgrass allows crested wheatgrass to generally out competed cheatgrass for water and nutrients in the interspaces so that cheatgrass is reduced. If a native seeding does become establish there may be high risk that another disturbance along with the cheatgrass in the interspaces might lead to another locked in area, eliminating the native seeding investment.

When federal land managers must look at the prospect of restoring or rehabilitating rangeland areas that will not rehabilitate by theirselves, they must have all the tools necessary to bring them back to functionality that was there prior to the degradating disturbance. Since, cheatgrass and other exotic invaders are now a growing part of the CRB, and they are not going away, we must be able to control their undesirable affects on the functionality of the landscape. Although, it is desirable to place emphasis on the reestablishment of native species in degraded areas, we must not eliminate the option of using exotic species where no other reasonable option exist.

Management Recommendations

Managers need to have all the tools available to achieve management objectives and to implement ecosystem management. The ecosystem in the CRB has been altered by exotics which in some cases cannot be controlled by the use of native species. Exotic grass species, most of which have competed successfully for years with cheatgrass, medussahead and other exotic "noxious" weeds in their home environment in Eurasia, have the best chance in some areas of outcompeting "noxious plants".

Depending on objectives, native seedings should be emphasized in most areas, where seedings have to take place, with exotic seedings being used in the low precipitation, locked in areas.

In general, natural rehabilitation from rest or native seedings should be the emphasis on 12" and above areas and natives or exotics (depending on the area) may be used in areas receiving 10 inches and less precipitation.

Seedings should not be monocultures. Care should be taken to use diverse seed mixtures or to interseed in areas with existing diversity. Plow and seed, spray and seed and burn and seed efforts run a high risk of establishing monocultures unless seed mixture is diverse.

Management emphasis on degraded or "locked in" areas needs to focus on the elimination of accelerated erosion and the return of the ecosystem processes that existed when the area was a sagebrush/bunchgrass community.

History is a great lesson for those who wish to seed natives in marginal (<10" precipitation). Check out previous projects where attempts to seed have been made. Determine what seed mixtures were used and find out if they worked or if it failed. Sometimes we tend to forget that in some areas there were numerous attempts to try and seed natives in the past. There is no sense wasting funds on efforts that do not work.

In marginal areas, or areas where there is some concern on success, try out a seeding in a small area as a test to see if the proposal will work.

Generally speaking, if the area had a good undertory of perennial bunchgrasses there is normally little reason to seed this are following wildfire. The area should come back by itself with rest from disturbance such as grazing. If the area has a high amount of cheatgrass in the understory, then following fire it is highly likely that the area will become a cheatgrass range, and should be seeded.

Native cultivars such as those for bluebunch wheatgrass (Goldar, secar, etc.) may be the best compromise between exotics and native seedings. Cultivars resemble native species in appearance and have been adapted for a variety of conditions. It must be noted that they may not be any more competitive than natives when competing against cheatgrass or medusahead.

Sites that reflect potentially successful seedings are those with sagebrush greater than 3 feet which indicates deep soils. Marginal soils are represented by rocky and low growing sagebrush areas.

MOISTURE ADAPTIONS PRECIPITATION INCHES				
Species	States			
	Idaho[1]	Oregon[2]	Utah[3], W. Wyoming, E. Nevada	Washington[4]
Bulbous Bluegrass[5]	10+	10+	10+	10+
Crested Wheatgrass Complex[f]	10-16	8-12	8-30	9-18
Hard Fescue	14-18	14-18+	14-30	15-25+
Sheep Fescue		8-25	12-14	9-18
Intermediate Wheatgrass Complex[g]	12-18	10-18+	14+	12-24
Kentucky Bluegrass[h]	18+	18+	18+	18+
Orchardgrass[i]	17+	14+	14+	18+
Reed Canarygrass[j]	18+	18+	18+	18+
Tall Wheatgrass	15+	10-25	12+	15+

[1]Numbers refer to Literature Citations in Appendix I

[2]See footnote number 1

[3]See Footnote number 1

[4]See footnote number 1

[5]See Footnote number 1

[f]Siberian is generally more drought tolerant than other cultivars.

[g]Pubescent is generally more drought tolerant than other cultivars.

[h]Based on Idaho's seeding guide

[i]Piute is generally more drought tolerant than other cultivars and may tolerate as low as 14 inches while others require 16 inches or more.

[j]Based on Washington seeding guide

Soil Adaptions						
Species	Soil Characteristics 1,2 *					
	Deep to moderately deep loamy	Clay	Shallow, Sandy and/or very Gravel	Water Wet Surface Shallow	Table Dry Surface Deep	Relative Salt Tolerance Rating
Bulbous Bluegrass	X	X	X			poor
Crested Wheatgrass Complex[k]	X	X	X			fair
Hard and Sheep Fescue	X	X				poor
Intermediate Wheatgrass Complex	X	X	X			poor to fair
Kentucky Bluegrass`	X	X	X[l]		X	Poor
Orchardgrass	X	X				poor
Reed Canarygrass	X	X	X	X	X	poor
Tall Wheatgrass	X	X	X		X	good

* numbers refer to literature citations in Appendix I

[k]Crested wheatgrass best adapted on deep to moderately deep well-drained loamy soils, but will grow on a wide range of soils.

[l]In higher moisture areas

FIRE TOLERANCE 6,7 *					
Species	Favored	No Effect	Negative Effects Slight	Moderate	Severe
Bulbous Bluegrass[m]	X	X	X		
Crested Wheatgrass Complex[n]	X FALL	X	X SPRING		
Hard Fescue 8		X	X SPRING		
Sheep Fescue 8		X FALL		X SPRING	
Intermediate Wheatgrass Complex	X				
Kentucky Bluegrass[o]	X				
Orchardgrass	X	X			
Reed Canarygrass[p]		X	X		
Tall Wheatgrass		X			

* Numbers refer to literature citations in Appendix I

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[m]Based on burning studies of Sandberg's bluegrass. Different studies show it to be favored, no effect, slight negative effect

[n]Negative effect by burning in spring and may reduce growth for two years; however, studies show growth favored by late summer fires

[o]Fire appears to favor Kentucky bluegrass in the Columbia Basin.

[p]Negative effect by burning every two to three years during dry period.

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TOTAL ACRES OF SEEDED RANGELANDS ON BLM LANDS

The following information regarding seeded acres on BLM was compiled from the BLM's Range Improvement Project System (RIPS) in 1995. This system keeps track of all project work, that is authorized, on BLM lands . The assessment boundary of the ICBEMP causes problems in coming up with an accurate acreage for seeded range. This is because the assessment boundary cuts through BLM districts without regard to administrative boundaries of the district or resource areas. Therefore, the following acreage figures are not exact for Nevada and possibly Idaho. In addition, it is assumed that most of the acreage seeded was seeded with crested wheatgrass.

STATE	**ACRES SEEDED**	**COMMENTS**
Idaho	1,414,657 acres	Malad RA not included in assessment boundary or in this figure
Nevada	612,505 acres	includes 014, 015, 024
Oregon/Washington	838,058 acres	all BLM east of Cascades
Montana	none	
Utah	none	
Total for the BLM in CRB	2,865,220 acres	