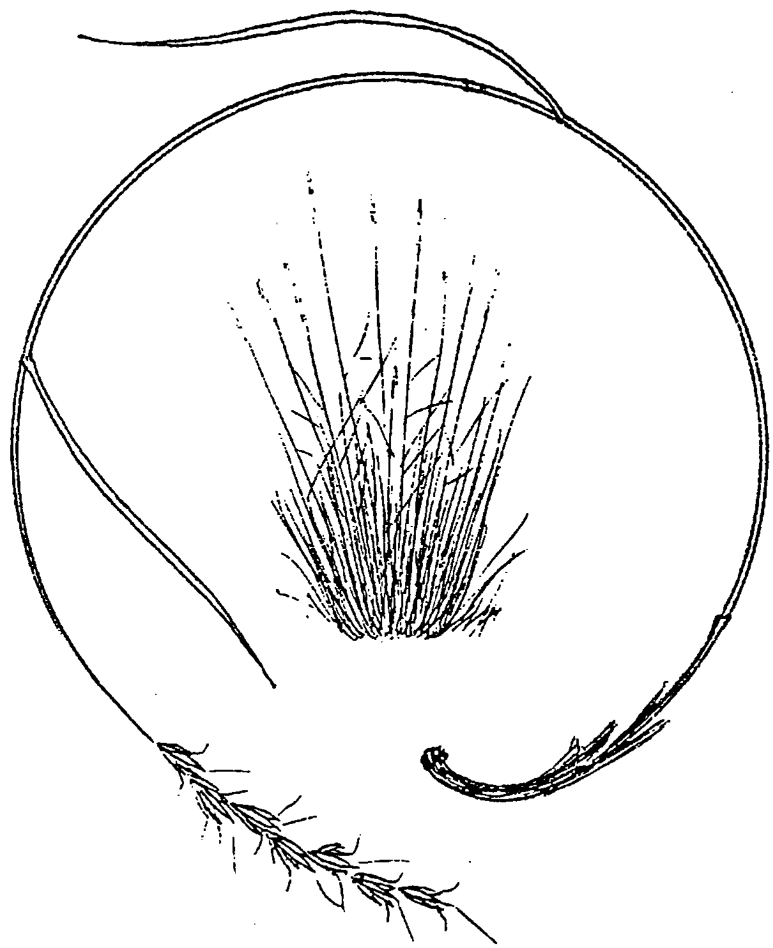
BLUEBUNCH WHEATGRASS
DEFOLIATION
EFFECTS & RECOVERY



— A Review —

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REVIEW

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I. INTRODUCTION

A. General notes

Information contained in this brief literature review may be useful in discussions on range readiness, grazing systems and management of one of the west's most important grass species, bluebunch wheatgrass. This review is primarily oriented toward defoliation impacts and subsequent recovery therefrom. Of particular interest is the species' response to grazing during the growing season. This review reflects a remarkable consistency of growing season defoliation impacts regardless of precipitation or geographic location. The long-term implications of seemingly minor levels of defoliation during the growing season are also impressive.

Abstract and Management Implications sections of reports tend to be sterile and frequently misleading. The reader is encouraged to carefully read and consider the literature review. There is a risk in doing so, however. As this epistle developed, the author was forced to reconsider and even reject some long held assumptions and beliefs regarding such items as range readiness, timing and amount of utilization, time required for plant recovery, seed trampling, grazing system value, etc. Being a card carrying skeptic, it was not easy!

Most entries in the Literature Review were lifted verbatim from reports and personal communications. The Introduction, Abstract and Management Considerations sections are this author's attempt to offer some background information helpful in interpreting the review, summarize the review and to coalesce the information fragments into a management framework.

Good sources of additional information include: Response of Bluebunch Wheatgrass to Drought and Climatic Fluctuations: a Review (Ganskopp and Bedell 1979); The Ecology and Management of Bluebunch Wheatgrass (*Agropyron spicatum*): a Review (Miller et al. 1986) and the Fire Effects Information System (F.E.I.S.). The F.E.I.S. (a DG data base located at the Boise Interagency Fire Center) contains a wealth of information on taxonomy, distribution, successional status, phenology etc. in addition to the latest on fire effects.

B. Additional considerations

1. Terminology: From the onset it was apparent that terminology confounds understanding. Terms such as "heavy", "moderate" and "light" are commonly used to describe utilization levels. In the absence of further definition, however, they have little definitive meaning other than to the individual using them - they certainly cannot be accurately understood or considered by others. Even when fully defined, perceptions are extremely varied. For example, the level of utilization Mueggler (1972) defined as "extreme" would rate no more than "moderate" to some. The category Ganskopp and Bedell (1981) defined as "moderate" was so broad as to include what many would consider "light" through "extreme". Phenology descriptions

were also somewhat of a problem for this reviewer - no less than 24 different terms were encountered describing various phases within boot, flowering and seed development.

2. Clipping studies: Many of the defoliation studies included in this review were based on clipping in which all of the plant canopy above a specified level was removed. One certainly has reason to question how valid a comparison they provide with grazing. Miller (pers. comm. 1991) noted limitations of clipping studies in that indirect effects of grazing such as trampling, nutrient cycling, and energy flow cannot be addressed. Clipping should, however, be a good reflection of plant response to leaf removal and the mechanisms involved therein. Crider (1955) reported that when a portion of a plant was clipped, only the root growth below that clipping was affected. A rancher commented to this author that a cow commonly wraps its tounge around most - if not all - of the canopy at a given height and draws that material into its mouth. It was his opinion that clipping studies should give a pretty good picture of the effects of grazing defoliation on a particular plant. Strong similarity of effects between clipping and grazing studies are evident throughout this review. It is also worth noting that these clipping studies were conducted on plants the authors believed to be of excellent vigor. Effects of even one-time clipping events are striking.

3. Weather and local conditions: Studies in this review involve seven western states and British Columbia. Precipitation levels varied from McLean and Wikeem's (1985) 9.4" to Pitt's (1986) coastal 40". In spite of a wide range of latitude, longitude, precipitation and presumably soils, defoliation effects follow a remarkably uniform pattern. The consistency of response documented among many studies strongly suggests the response pattern is independent. Above or below normal precipitation appears to either dampen or exacerbate the defoliation effects but not change the pattern. With respect to drought, Holecheck et al. (1989) noted that healthy vigorous perennial grass plants with a good root system can maintain production longer into a drought and recover more quickly. Craddock and Forsling (1938) and Stoddart et al. (1975) reported that the adverse impact of drought on grass plants was proportional to grazing intensity during the growing season. A brief study conducted in the Salmon, Idaho SCS District found that, following 5 years of drought, a bluebunch wheatgrass pasture grazed only in the fall was producing 260#/acre (USDA-SCS, Salmon District 1990). An adjacent BLM spring grazed pasture of the same soils, vegetation and precipitation produced only 110# prior to the drought. Precipitation and temperature do have a large influence on phenology. For example, Pechanec et al. (1937) reported bluebunch wheatgrass phenology was advanced approximately one month during the 1934 drought in Idaho. Sauer and Uresk (1976) found bluebunch wheatgrass to flower later and longer as a result of increased precipitation. Heady (1950) noted in a Montana study that bluebunch wheatgrass growth at low elevations was favored by cooler wetter than normal conditions while at high elevations, the opposite was true.

4. Competition: Few would argue that competitive relationships play a large role in dictating floristic composition of an area, productivity of individual plants or subsequent response to, and recovery from, defoliation. Miller (pers. comm. 1991) noted that, in many studies, it is difficult to tell whether bluebunch wheatgrass response is due to a loss of leaf tissue or to changes in competitive interactions with associated plants. For whatever reason, the mind tends to default to competition being represented by some "less desireable" species. It is important to note that competition is generalized as to species and bluebunch wheatgrass can, and frequently does, compete with itself. Risser (1969) noted that yield per plant decreases with increased plant density and that widely spaced plants produce the most seed. His comments sound familiar to anyone who has done any gardening. It does help to point out, however, that there is some threshold between production for the individual plant and maximum production for the stand. In the course of this literature review, the only definitive study found specifically regarding competition and bluebunch wheatgrass was by Mueggler (1972). His findings (see review), though of significant interest, would appear nearly impossible to replicate with grazing. Replication would require grazers to differentially select all other plants within a 35" (90-cm) radius around a particular bluebunch wheatgrass plant such that they were reduced to ground level while the bluebunch plant was only reduced 50% by weight.

Heavy grazing use under various grazing systems (eg. rest-rotation) is commonly espoused in attempt to decrease selectivity and equalize competitive relationships. Heady (1984), referring to the heavy use theory, stated that he could find no data to support the concept that desirable species will recover faster than undesirable ones. Grazing schemes which encourage heavy growing season use have resulted in the destructive use of primary forages, reduced forage production and negated the benefits from otherwise valid grazing systems (Findley pers. comm. 1990, Holecheck et al. 1989, Cook and Child 1971, Trlica et al. 1977, Van Poolen and Lacey 1979, Eckert and Spencer 1987).

II. ABSTRACT

Bluebunch wheatgrass is one of the most productive, palatable and widely distributed grasses of the west. Within Idaho's Salmon BLM District, it is dominant on 15 of 32 range sites, common on 8 and exists in trace amounts on 5 others. Active growth begins with a soil temperature near 42 degrees F. with an optimum temperature range of 58-77 degrees F. Seed production is reported as being highly variable and inconsistent between years. Seed germination rates of from 53% to 85% have been obtained in the laboratory. One study reported 16% germination under field conditions. Seedling survival is frequently very poor. Two separate review authors stated they could find no literature supporting the contention that seed trampling by cattle enhances seedling establishment. The canopy of mature bluebunch wheatgrass has been found important in "funnelling" rain to the plant thereby allowing deeper water penetration beneath the plant. Plant material below about 2" (5-cm) is not considered readily accessable to cattle grazing unless the plant is pedestalled or the plant is continually regrazed.

Bluebunce wheatgrass is considered quite sensitive to grazing during the growing season because of its upright stature, slender shoots, early elevation of apical meristems to grazable height (2" (5-cm), a high ratio of reproductive to vegetative shoots and its slow regrowth potential of new leaves. Effects of growing season defoliation injury are well documented: basal area, stem numbers and both root and forage yields are reduced and mortality can be high. A consensus of authorities indicates that bluebunch wheatgrass is most vulnerable to grazing damage during the boot/early flowering stage. Less, but still significant, damage is possible during the remainder of the growing season. Defoliation to very short stubble heights during the boot stage has been reported to essentially eliminate plants within as few as three years. There was agreement that some grazing could occur prior to boot if livestock were removed before apical meristems were vulnerable. Grazing of apical meristems removes most of the actively growing tissue and greatly retards any further growth. The value of retaining a good complement of green leafy material on grazed plants was stressed by many authorities. Vigor recovery timeframes will be compressed or expanded under the influence of wet/dry climatic cycles. Vigor recovery has been found to require most of a decade, even with complete protection from grazing. Competition, both intra- and interspecific, can exert a strong influence on seedling survival and vigor recovery.

III. LITERATURE REVIEW

A. Distribution and value

Bluebunch wheatgrass, considered one of the most important native bunchgrasses of the Palouse Prairie and Intermountain Sagebrush Province, has dominated millions of acres of pristine semiarid grass and sagebrush sites, and produced more herbage than all other associated species combined (Miller et al. 1986).

Bluebunch wheatgrass occurs in 7 Bureau of Land Management pysiographic regions, 9 ecosystems and 22 Kuchler plant associations. It is characteristic of many climax or late successional communities (F.E.I.S. 1990). Bluebunch wheatgrass dominates 15 of 32 range sites in the Salmon, Idaho BLM District, is common on 8 others and shows as a trace on an additional 5.

B. Soil temperature and growth

Bluebunch wheatgrass begins active growth as soon as soils warm to 5-6 degrees C. (41-43 deg. F.) at 10-cm (4") depths with growth accelerating until the optimum of 20-25 deg. C. (58-77 deg. F.) (DePuit and Caldwell 1975) is reached, providing other environmental factors (e.g. soil moisture) remain favorable (Quinton et al. 1982).

C. Reproduction and seedling establishment

Daubenmire (1960) noted that rhizomatous individuals may prosper in "less arid" grasslands. He indicated that in eastern Washington and northern Idaho, rhizomatous bluebunch wheatgrass may colonize areas not subject to "intense aridity" during the later stages of succession. On an areal basis, the phytomass of sterile tillers far exceeds that of flowering tillers in rhizomatous populations (Daubenmire 1978). Vegetative reproduction by bluebunch wheatgrass is rarely mentioned in the literature, and thus, it is assumed to have little management implication except perhaps on a localized basis.

Seed production was found to be very poor, especially at upper elevation grassland sites, and to be extremely variable among plants and years with no apparent relationship to tiller numbers or basal areas. No individual plant consistently produced reproductive shoots. Since studies were conducted on protected sites in excellent condition, vigor of the plants should have been good [av. precip. 12"] (Quinton et al. 1982). Daubenmire (1978) studied variability in flowering of bluebunch wheatgrass in Washington and reported similar erratic results. Total number of inflorescences produced by 18 individual plants varied from a high of 784 in 1965, a low of 0 in 1968, 589 in 1969 and 173 in 1974. He indicated observations were made in essentially a climax stand which was completely protected from livestock, starting "long before" his study began.

In a one-year study, Harris (1967) found germination rates of 53% and 16% for bluebunch wheatgrass seeds under laboratory and field conditions respectively [precip. 12"-20"]. Evans and Tisdale (1972) reported 85% germination under laboratory conditions. Hanson and Stoddart (1940) obtained 76% germination using moistened blotting paper as a planting medium in petri dishes.

Young et al. (1981) noted that bluebunch wheatgrass seed is highly germinable at a wide range of temperatures, but limited moisture and excessive competition appear to be the most limiting factors hindering successful seedling establishment.

Viable bluebunch wheatgrass seeds per square meter of ground were 50 times greater (630 seeds versus 12) on a range grazed only in autumn than on an area reflecting heavy grazing. The heavily grazed range was described as being depleted in both numbers and size of climax bunchgrasses (Hanson and Stoddart 1940). These authors did not specify the season of use on the heavily grazed area. Since they specifically noted autumn use on one range and, considering the general durability of bluebunch wheatgrass grazed during quiesence, it is assumed that the heavy use occurred sometime during the growing season.

Late-season grazing following earlier deferment has been recommended for at least 75 years because seed trampling by livestock is thought to enhance production of new seedlings and thus improve the range. However, the literature does not support this (Dwyer et al. 1984). Without taking issue with the emperical observations that seedling establishment can be enhanced by livestock trampling, it must be said that quantitative studies on the subject are not available (Heady 1984).

Miller (pers. comm. 1991)and Mueggler (pers. comm. 1990) also indicated they knew of no definitive studies showing that trampling of seed by livestock promoted increased seedling establishment.

Blaisdell (1958) reported that, on an area containing as many as 200 seedlings one year, fewer than 5% survived the following growing season.

Interspecific competition in the seedling stage has been shown to retard root growth and eventually eliminate bluebunch wheatgrass seedlings (Harris and Goebel 1976).

D. Water interception

The bunchgrass structure of bluebunch allows deeper penetration of water beneath individuals due to a "funnelling" effect of the aerial parts, as the plant canopy directs light summer rain into the rooting zone of an individual plant. The ability of the aerial parts of the wheatgrass to intercept and redistribute the incident moisture may have a bearing on the capability of the species to withstand grazing and interspecies competition. It is possible that the rapid decline of bluebunch wheatgrass under heavy grazing is related to soil moisture redistribution caused by the removal of its aerial parts (Ndawula-senyimba et al. 1971).

E. Treatments (fire, spraying, brush-beating etc.)

A minimum of 20 percent cover of A. spicatum or one plant per 10 square feet is recommended for successful release of this species from competition (Plummer et al. 1965). Young and Evans (1978) suggested a rule-of-thumb that one should be able to step from one bunchgrass plant to another in order to have a reasonable expectation of positive results from fire. The primary source of A. spicatum production for several years after treatment comes from plants occupying the site before treatment (Blaisdell and Mueggler 1956, Miller et al. 1980).

F. Grazing susceptibility and regrowth

Hyder and Sneva (1963) considered plant material above 2" (5-cm) to be accessable to grazing. Stoddart (1946) felt that a 2" (5-cm) stubble height attained by clipping is probably more severe than normal grazing. Although 2" appears to be a grazable theshold height beyond which any further grazing by cattle rapidly becomes increasingly difficult, pedestalled plants are somewhat more vulnerable to being grazed to a lower height as are plants subjected to frequent and heavy regrazing. This is demonstrated by data collected within the Salmon, Idaho BLM district. Thirteen of 34 plants were grazed to a 2" (5-cm) or less stubble height on a bluebunch wheatgrass site receiving 66% utilization. Average stubble height on the site was 2.7" (6.9-cm). A site subjected to 81% utilization in the same general area averaged a stubble height of 1.7" (4.6-cm), with 32 of 40 plants having been grazed 2" (5-cm) or less. Two pedestalled plants had been reduced to 0.5" (1.3-cm).

Species such as *Poa ampla* and *Bouteloua gracilis* possess primarily culmless vegetative shoots in which the apical meristems (site of actively growing tissue) are not elevated to within reach of the grazing animal. Thus, the potential for rapid regrowth is preserved. On the other hand, species such as *Agropyron spicatum* exhibit culmed growth in the latter part of the growing season in which apical meristems are elevated as internode elongation proceeds. Thus, these critical meristems are very susceptible to removal by grazing. Any further growth must then originate from axillary buds at the base of the plant that first must be activated (Hyder 1972).

The possession of a contingent of active meristems for regrowth of productive foliage following grazing is critically important for efficient use of the carbohydrate buffer. With active meristematic tissues, regrowth following defoliation may depend on the stored carbohydrate energy source for as little as two to four days (Caldwell 1984).

Stoddart (1946) concluded that damage to bluebunch wheatgrass from herbage removal was in inverse proportion to the remaining amount of photosynthetic material exposed to sunlight.

Excepting adverse climate which is beyond man's control, the greatest single factor contributing to range depletion is excessive reduction of plant growth by grazing animals. This is accomplished through too great reduction of photosynthetic area which gradually results in starved plants (Heady 1950).

Apart from labile (available) carbon pools in the plant, recovery from defoliation depends on the quantity of remaining foliage and its photosynthetic capacity as well as the rate of development of new foliage and the photosynthetic capacity of these new leaves (Caldwell 1984).

Miller et al. (1986) also stressed the importance of green leafy material remaining on grazed plants, stating that the amount of green plant material present during various stages of phenological development greatly affects the future health and ability of the plant to compete.

Defoliation not only reduces leaf area and thus capacity to utilize moisture, but also by reducing root system activity, may limit the capacity to compete for moisture and nutrients (DePuit and Caldwell 1975).

Grazing intolerant species such as bluebunch wheatgrass, which does not curtail root growth following severe defoliation, may expend valuable carbohydrates on prolonged root growth instead of directing them to shoot system regrowth (Richards 1984). This eventually leads to substantial root mortality during the winter and growing season following defoliation (Caldwell 1984, Richards 1984).