Interior Columbia Basin
Ecosystem Management Project
Science Integration Team
Terrestrial Staff
Range Task Group

REVIEW DRAFT

Herbivory in the Interior Columbia River Basin: Implications of Developmental History for Present and Future Management

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1st Draft: September 11, 1995

HERBIVORY IN THE INTERIOR COLUMBIA RIVER BASIN:

IMPLICATIONS OF DEVELOPMENTAL HISTORY FOR PRESENT AND FUTURE MANAGEMENT

This report is developed to address divergent views relative to the joint adaptation of plant communities and herbivores in the Columbia River Basin and the implications for livestock grazing both historically and present. Presentation of divergent views is based on a contract report Herbivory in the Intermountain West: An Overview of Evolutionary History, Historic Cultural Impacts, and Lessons from the Past by J. Wayne Burkhardt[1] and review comments and responses by Elizabeth L. Painter[2]. Discussion and conclusions are based on additional review of major range management and grazing management texts and literature cited therein. Miller, Svejcar, and West (1994) also provide an overview of developmental history and implications of livestock grazing on plant composition in the Intermountain sagebrush region. This overview is pertinent to the Columbia River Basin sagebrush steppe communities and associated salt desert shrub and juniper communities.

Viewpoints based on the evolutionary history:

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[1]Burkhardt, J. Wayne. 1994. Herbivory in the Intermountain west-an overview of the evolutionary history, historic cultural impacts and lessons from the past. 49 p. Contract report. On file with: Interior Columbia Basin Ecosystem Management Project, 112 E. Poplar, Walla Walla, WA 99362.

[2]Painter, Elizabeth L. 1994. Review comments concerning Herbivory in the Intermountain west-an overview of evolutionary history, historic cultural impacts, and lessons from the past. 41 p. Review. On file with: Interior Columbia Basin Ecosystem Management Project, 112 E. Poplar, Walla Walla, WA 99362.

Burkhardt (1994)

1. Pleistocene mega fauna co-evolved with vegetation over several million years.

2. Pleistocene mega fauna included "grazing herds of elephants, mammoths, rhinos, camels, horses, burros, ground sloths" and others including prehistoric cattle.

3. According to one estimate, the Pleistocene carrying capacity must have equaled or exceeded the livestock numbers supported now.

4. Massive extinctions 10,500 - 7,000 yrs B.P. created "empty niches" which neither evolutionary substitution nor immigration have filled. The loss of most large herbivores and their predators left a natural rangeland grazing ecosystem with vacant large fauna niches.

5. There is emerging evidence that bison survived the extinctions and continued to populate the ... entire Intermountain Region until just prior to historic times. Regional extinction at this time may have been in part related to native hunting.

6. Conditions encountered at the time of European exploration and settlement have been considered the pristine natural state and may have been anomalies compared to the long term development. Perceptions of vegetation potential and adaptation to grazing therefore may be flawed.

7. It is possible that cattle and definitely horses represent a potentially functional replacement for the Pleistocene mega fauna. Cattle could occupy closely the bison niche and horses were part of the original mega fauna.

8. The past "experiment" with the introduction of cattle as "surrogate" mega fauna and "reintroduction" of horses has been less than successful because of overstocking, introduction of exotic plants, change in fire regime and other cultural impacts rather than simply filling "vacant niches".

9. Probable characteristics of Pleistocene herbivory and grazing "strategies" may lead to more sustainable and environmentally sensitive grazing practices. For the Intermountain Region, this centers around seasonal grazing:

a) Winter grazing in low elevation valleys, allowing complete regrowth in spring/early summer.

b) Spring grazing following greenup to high elevation summer ranges, thus allowing for regrowth and fuel accumulation for periodic summer fires.

c) Return to lower elevations in fall facilitating seed dispersal and planting and "herd effect" associated with hoof action.

d) Predation may have prevented sedentary behavior as currently associated with riparian areas.

In addition, the complex assemblage of herbivores (grazers and browsers) may have reduced selective influences on the plant community.

10. Given the evolutionary history of the Intermountain Region, grazing and fire might be considered requisite functional processes rather than disturbances.

11. Current management practices that are inconsistent with the evolutionary history (as described) include:

a) Livestock grazing tends to be monocultural even though a combination of cattle, wild horses, and wildlife species provide some vestige of diverse herbivory in places.

b) Breed selection favors a more "sedentary" animal for meat production.

c) Management has emphasized confined pastures rather than extensive open range grazing.

d) Past season long grazing was detrimental to plants as well as suppressing fire frequency.

e) There is no prehistoric analogue to rotational or deferred grazing. (Improvement may have been due largely to reduced stocking rates.)

f) There is no prehistoric analogue to "range readiness" concepts. Grazing at the reproductive period often associated with range readiness criteria may actually be damaging unless partially offset by deferred or rotational grazing.

g) There is no prehistoric analogue to utilization limits; it does not apply to early growing season grazing where grazing ceases before annual growth ceases.

Painter (1995)

1. Plant communities do not co-evolve with more or less generalist herbivore species, nor do entire regional floras and faunas. Joint or concurrent evolution is more accurate.

2. Inference of true "grazers" or social association in "herds" from modern congeners does not work well for Bison in North America and may not work well for other fossil mammals.

3. Hypothetical carrying capacities cited were extrapolated from very small databases. Lack of hard data from the Intermountain Region and documented environmental changes make these precarious estimates at best.

4. A niche is the set of resources required by a particular species, not the structuring of resources in a habitat. Empty or vacant niche is an oxymoron; there is no niche if there is no species. Further, significant evidence indicates all habitats have changed and at no time has the entire biotic environment been static.

5. Other citations indicate that the genus Bison survived, but only in the form of a new species. Additional information suggests that B. bison residency west of the Rocky Mountains was discontinuous and was neither abundant nor widespread except possibly near Malheur Lake and the Snake River Plain.

6. Evidence is provided that suggests there is no reason to assume that any adaptations by plant taxa during the Pleistocene would necessarily be maintained in modern populations. Selective agents of the Holocene operated more recently than Pleistocene factors. Studies of Great Plains grass species with different grazing histories indicate interpopulational genetic differences in less than 50 Yrs.

7. The inference that there is a mutualistic function between plants and large herbivores is contested through many studies. Cattle exploit resources different than either extinct or extant Bison species. Extinct Equus species were different species than modern alien horses. Therefore neither could "closely occupy" these niches. Also see 4. above.

8. Alien livestock are functionally different. Environ-mental conditions are considerably different. It is biologically impossible for live-stock to be considered "surrogate" mega fauna.

9. Generally, the strategies proposed are speculative and totally inappropriate considering the lack of referenced support. In particular, herbivory is deleterious (sometimes more, others less) to plants that suffer it. Regrowth after being eaten can only be advantageous over being eaten continually. Speculation on the advantages of post-herbivory seed set is contradicted in the literature, especially for certain taxa common to the Intermountain Region. The herd effect refered to is particularly deletrious rather than beneficial considering the role of microbiotic crusts.

Substantial literature discussing the negative impacts of domestic livestock is greatly under-discussed (e.g. nutrient export) or trivialized (e.g. riparian areas).

10. Introduction of alien taxa, including livestock and other exotic grazers, must always be treated as a significant ecological change. Negative impacts of all aspects must be anticipated and minimized.

11. Even if large-animal grazing were a natural part of the ecosystem, alien livestock would require intensive management to minimize negative impacts.

If cattle and horses actually "complimented" wildlife species cited, then interspecific competition and negative impacts should be similar to those reported for native herbivores on the Great Plains, which does not appear to be the case based on other literature.

The contention that certain communities were "fire-proofed" by livestock grazing appears to contradict a significant portion of the more recent fire literature. The introduction of cheatgrass and medusahead and their relationship to disturbances including livestock grazing has greatly increased fire frequencies.

Use of scientifically unsubstantiated opinions as a basis for management can leave agencies and their personnel vulnerable to accusations of 'management by myth' and vulnerable to those opposing livestock grazing on public lands.

The viewpoints presented are only a portion of the points and counterpoints submitted; hopefully those that are most pertinent. Many, if not most, of the viewpoints as presented here have been paraphrased by this author. It is hoped that the overall context of each viewpoint has been preserved; however, readers with additional interest in this topic are encouraged to obtain copies of both submissions complete with references cited.

Discussion

In his book Wild Horses of the Great Basin, Berger (1986) states that "Most, if not all, mountain-dwelling, northern temperate ungulates migrate altitudinally during some time of the year (Autenrieth and Fichter 1975; Darling 1937; Geist 1971; McCollough 1964; Oosenberg and

Theberge 1980)." Most horses in the Granite Range and other ranges of northern Nevada move from low to high altitude sites in late spring/early summer (May-June), presumably in accordance with newly emerging vegetation, although other factors such as temperature and insects may also affect movements. Movement back to low altitudes occurs in the fall, usually in October or November. Proportionately greater time is spent at lower elevations and a few bands apparently remain throughout the year at low elevations. Movement between the fall-winter-spring range and summer range and return movement varies between two weeks and two months but generally occurs within one to one and a half months.

The present day "grazing strategy" of free-roaming horses does resemble the "Pleistocene model" presented above. Horses, like cattle, feed primarily upon grasses (Berger 1986). Preferred grasses cited by Berger included bluebunch wheatgrass, Idaho fescue, Sandberg's bluegrass, needle-and-thread grass, and Thurber's needlegrass which are also principle grasses in many of the Columbia River Basin potential vegetation types. Horses, also like cattle, are considered alien introduced species in the North American environment. However, horses have been in the Intermountain Region since the 1700's (Berger 1986, Robbins and Wolf 1994). It is possible that some selection of adapted phenotypes may have preceded the introduction of cattle.

Whether or not some selection may have occurred, there are other significant traits of horse use of native ranges that might be considered when comparing livestock use to "wild" large ungulates. Although estimates vary widely, Ryden (1970) estimated perhaps 2 million wild horses in the United States a hundred years ago. This would be slightly more animal unit months of grazing capacity than authorized under current management on BLM and USFS lands (USDI 1994). It is impossible to tell whether that might have related to some "natural carrying capacity" or not around the time livestock enterprises were expanding; only that large animal densities were probably lower.

Wild horse use of vegetation communities reported by Berger (1986) is considerably different than that associated with traditional cattle grazing. Low altitude fall-winter-spring ranges are smaller in size and used proportionately longer than high altitude summer ranges. This suggests that although some areas are used for longer times and at higher animal densities at low elevations, other areas are not used at all. Shrubland and grassland habitats receive the most use followed by juniper woodland then moist meadows, although meadows receive the greatest use relative to availability. Riparian zones receive very little use during the fall-winter-spring period. The use of summer ranges for a relatively shorter period and larger area indicates dispersed use at moderate levels compared to fall-winter-spring. The rapid transition between fall-winter-spring ranges and summer ranges indicates relatively light use in between. Shrublands and moist meadows accounted for 99% of the use in summer, but horses tended to rest most often adjacent to or in snow, along ridgecrests, and near tops of slopes rather than bottomlands. Under presettlement conditions, the grazing pattern described for wild horses may well have produced a mosaic of ungrazed, lightly grazed, moderately grazed and heavily grazed areas that Laycock (1994) suggests would probably maximize diversity in most landscapes.

Presettlement conditions no longer exist. In addition to the unprecedented ecological changes described by Miller, Svejcar, and West (1994) above, land ownership and administrative precedence relative to allotted areas of livestock use may limit implementation of alternative strategies proposed as mimicking either "Pleistocene herbivory" or introduced "wild" ungulates (horses) even if they were proven strategies. Pertinent questions might then be 1) Can we restore altered ecosystem functions attributable to improper livestock management in the past by removing livestock? and 2) Can we manage livestock in a manner compatible with native plant communities in the Columbia River Basin?

<u>Can we restore altered ecosystem functions attributable to improper livestock management in the past by removing livestock?</u>

Laycock (1994) provides a review of literature comparing the implications of livestock grazing versus no grazing on todays rangelands and concepts of state-and-transition models versus traditional "climax" models to explain succession and retrogression. The more mesic rangeland vegetation types seem to follow the traditional "climax" model where the removal of grazing pressure will result in improvement through secondary succession. Potential vegetation types in the Columbia River Basin that best fit this model include riparian areas, aspen types, and mixed grass and Palouse prairie types which would include all bluebunch wheatgrass, Idaho fescue, and open ponderosa pine/grassland types. There are exceptions in extreme cases of past grazing abuse. Continuous heavy grazing that has eliminated aspen would result in a new herbaceous steady state if conifers were not already established. High elevation parks in the Rocky Mountains are likely to remain in Kentucky bluegrass once it has become dominant, even in the absence of grazing. This may also be the case in graminoid riparian and moist meadows of the Columbia River Basin (Kovalchik 1987).

In contrast, most arid and semi-arid rangeland types remain stable at one or more lower successional states for long periods of time following removal of livestock and without some additional intervention. Nearly all sagebrush steppe potential vegetation types, with or with out juniper, and salt desert shrub potential vegetation types are included in this category. Archer (1994) reviewed causes and implications of increases in dominance and encroachment of woody plants in rangeland environments. In much of the Intermountain Region, past livestock use has at least contributed to increased dominance of sagebrush species and encroachment or increased dominance of juniper through modification of microclimate, plant competitive interactions, soil fertility, and fire frequency. Removal of livestock will not necessarily reverse the present situation. Removal or modification of livestock use may result in somewhat improved soil stability, soil moisture, and nutrient status relative to reestablishment of microbiotic crusts in those vegetation types where woody plant dominance does not result in complete canopy closure (also see report on microbiotic crusts, this assessment). However, changes in vascular plant composition and associated interrelationships are doubtful without reduction of woody species by fire or other means.

Present vegetation types dominated by the flammable exotics cheatgrass and/or medusahead represent another apparently stable vegetation state (Laycock 1994) common in some sagebrush steppe types (particularly the warm Wyoming sage type) and recently appearing in some salt desert shrub (West 1994) potential vegetation types. Frequent fires resulting from the establishment of these flammable exotics represent an opposite extreme of woody plant encroachment. Fire-return frequencies as low as five years do not allow perennial grasses or shrubs to establish and set seed, even if a seed source is close by. Removal of livestock will not reduce fire frequencies and may exacerbate fire susceptibility by the resulting accumulation of litter.

Can we manage livestock in a manner compatible with native plant communities in the Columbia River Basin?

It is becoming more accepted that domestic livestock grazing that closely emulates evolutionary patterns of herbivory are desireable (Platou and Tueller 1985). While the evolutionary implications of livestock grazing can still be debated, as presented herein, it is generally accepted that man has "substantially changed its frequency, intensity, extent, and magnitude with the introduction of livestock (Archer and Smeins 1991)." Land ownership and tenure patterns greatly affect the way rangeland is managed (Stoddart et al. 1975). The mix of private, tribal ownership, and public ownership often fragments landscapes that might have comprised more "natural" grazing units. The individual grazing preferences associated with federal permits and differences between agency policies and guidelines exacerbate this fragmentation within public ownership. In addition, the entrepreneurial aspects of grazing management must consider meeting the lows of forage availability and taking advantage of the highs (Vallentine 1990) in as profitable a manner as possible. In many cases the net result has been (Archer and Smeins (1991):

"- In contrast to wild herbivores, whose numbers or patterns of grazing may vary from year to year, concentrations of domestic livestock can be artificially maintained at consistently high levels.

- Fences prevent the emigration of livestock to new areas when the abundance of desired forages decreases, resulting in higher frequencies and intensities of defoliation than would occur otherwise.

- Supplemental feeding is used to

    - Minimize animal mortality that would otherwise reduce grazing pressure when over-utilization of forage occurs; and

    - Maintain grazing pressure over a greater portion of the year and over a higher frequency of years than would have occurred with native herbivores, both present and prehistoric.

- In grasslands or savanna systems that occur in areas climatically and edaphically capable of supporting trees and shrubs, prolonged grazing may decrease the capacity of grasses to competitively exclude woody plants, while at the same time reducing fire frequency and (usually) intensity by preventing the accumulation of fine fuels."

Grazing systems are often promoted as means to mitigate or prevent detrimental effects associated with past alterations in frequency, intensity, extent, and magnitude described by Archer and Smeins (1991) as well as meet animal and economic objectives (Vallentine 1990). Despite the array of grazing systems conceived and promoted during the last 40 years in the United States, there is considerable debate over their effectiveness in general as well as in the Columbia River Basin ecosystems.

Rest-rotation, deferred, deferred-rotation and seasonal grazing systems have all been demonstrated to sustain rangeland vascular plant communities within the sagebrush steppe and pine-bunchgrass rangelands of the Columbia River Basin under specific circumstances (Vallentine 1990). However, none have necessarily been conclusively proven to be more effective than light to moderate stocking levels under continuous seasonal use (Heady 1975; Stoddart et al. 1975; Hart and Norton 1988; Vallentine 1990). Vallentine (1990) explains that a variety of improved practices are often implemented at the same time a grazing system is begun. The grazing system is often credited with the total benefits rather than a partial contribution. Initiation of a grazing system is also often accompanied by a renewed commitment to improved management on a broad scale.

Platou and Tueller (1985) suggest that rest-rotation grazing resembles the way native ungulates may have grazed the Great Basin shrub steppe. This could apply just as well to the Columbia River Basin. Repeated seasonal grazing as described by Vallentine (1990) might also be considered as resembling grazing by native ungulates if constraints of land ownership, tenure, or administration are not a problem. However, no grazing system can be considered as a solution for correcting all rangeland problems, cannot substitute for other principles of grazing management, and all require greater rather than less management input to be successful. Vallentine (1990) and Heady (1975) provide fairly comprehensive reviews of grazing systems with discussion of advantages and limitations relative to some major vegetation types. Readers are cautioned to also consider limitations relative microbiotic crusts and interspersed riparian areas (discussed in other sections of this assessment) when considering applications of potential grazing strategies using one or a combination of systems described.

It is unlikely that grazing systems (or no grazing) will return many plant communities in lower successional steady states to higher successional states, even with large inputs of energy and nutrients (Archer and Smein 1991). Therefore, the goal of sustainable grazing management should be to anticipate critical thresholds and manipulate livestock so as not to exceed them. Vallentine (1990) states that continued stocking at near normal levels during moderate to severe drought is probably the greatest cause of range deterioration. A combination of reduced forage production and increased grazing pressure if stocking levels remain constant is most likely to occur in a multiple-pasture rotation grazing system with high stocking density (Hart and Norton 1988). Reduced grazing intensities both during drought and for some time following drought are necessary to minimize damage and hasten recovery of perennial vegetation. Periodic drought may also facilitate woody plant establishment and canopy development (Archer 1994) in some instances or result in high weed biomass, including flammable exotics, in succeeding years of high rainfall in others (Vallentine 1990). It is imperative that stocking rates and grazing intensities compatible with drought occurrence and magnitudes be incorporated into any grazing strategy considered to avoid critical thresholds.

Seedling establishment on rangeland requires two or more favorable years in succession (Williams 1977 as cited by Hart and Norton 1988). The occurrence of two or more favorable years in a row occurs infrequently in the Columbia River Basin, is unpredictable in timing, and in most cases is either preceded or succeeded by at least moderate drought conditions. To minimize drought effects and take advantage of the infrequent opportunities for recruitment, it would seem that management strategies must either employ conservative stocking levels over the long term or be able to maintain very responsive flexible stocking rates. Limited flexible stocking of 70 to 110% of average was considered a good system in the Southwest (Martin 1975) if properly managed. Constant stocking at 90% of average was easiest to manage, produced relatively high income and had a moderate hazard of overstocking but required some additional adjustment during severe drought years. Constant stocking at 80% of average further reduced chances of overstocking but was less profitable. It is not known if these values are applicable to the Columbia River Basin, but might be starting points from which to monitor.

An evaluation of drought and favorable years for seedling establishment was based on precipitation time series analysis of climate divisions within the Columbia River Basin over the past one hundred years. Precipitation values and time series charts were provided by the Western Regional Climate Center, Desert Research Institute in Reno, Nevada. A high proportion of annual precipitation available for plant growth in the arid and semiarid portions of the Columbia River Basin is received during the winter months. The period October through March was chosen for analysis. Drought thresholds were evaluated at 80% of normal and 70% of normal for the period. The devastating series of drought years in the 1920's and 1930's generally ranged between 75 to 85% of normal for the period evaluated while only 1 to 15% of years were drier than 70% of normal during this period. Any value greater than 10% above normal was considered "favorable" relative to seedling establishment.

Climate divisions in the Columbia River Basin can generally be characterized as follows:

- Although some skew is detectible, distribution of precipitation is nearly normal about the mean resulting in near equal probability of being above or below normal.

- The more arid the division, the greater the variance from the mean. Drought years as well as years above normal precipitation occur with greater frequency and greater magnitude. The same relationship can be expressed for precipitation zones within a division (Redmond, personal communication)[3].

- Drought years 80% of normal or below for the October through March period occur 20 to 25% percent of the years in most Divisions with about 6 to 8 inches of precipitation during the period (about 10 to 12 inches annually). Extremes within the Basin range from 14 to 38% of the years. About half of these will be 70% or greater below normal.

- Drought years 80% of normal can be as high as 38% of the time with 26 of these being 70% of normal or less (Northwest Division, Nevada, Average 5.66 inches).

- Favorable conditions of 110% or greater precipitation two or more years in a row occur only 4 to 12 times within the 100 year record with 8 to 10 periods more common. Distribution of favorable conditions is episodic and may have only one year between periods to as high as 61 years; 20 to 30 years is common in many divisions. Successive occurrences of above normal precipitation is less important for plant recruitment in higher precipitation areas because moisture is seldom limiting for that function.

While precipitation at this scale provides some indication of frequency and distribution of relative degrees of drought and favorable years, the relationships with productivity and grazing pressure are not necessarily of equal magnitude. There are also other factors such as trends in precipitation distribution, temperature, day length and others that could affect productivity relationships at the broad scale. Soil properties must also be considered at smaller scales. Additional research and development is highly recommended to establish better soil, climate, growth relationships at various scales.

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[3]Personal communication. 1995. Kelly Redmond. climatologist, Western Regional Climate Center, Atmospheric Sciences Center, Desert Research Institute, PO Box 60220, Sage Bldg. 5625 Fox Ave., Reno NV 89506.

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