HIGH ELEVATION MEADOWS AND GRAZING

Common Past Effects and Future Improvements

BY MICHAEL P. MURRAY

Abstract: High elevation grazing of cattle and sheep is a legal activity in wilderness areas administered by the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) and occurs in about one-third of the U.S. Wilderness System (USWS). General effects of grazing on species composition and soil properties are described based on reported findings for three extensive types of high elevation meadows-grass, herbaceous, and moist sedge. The challenge for wilderness managers is to keep grazing within limits that protect the naturalness of meadow ecosystems. In general, where excessive grazing occurs, shifts in species composition from preferred livestock forage to less desirable, nonpalatable, and exotic species is observed. Soils of each meadow type respond differently to grazing pressure, and careful management should reflect these differences. Suggestions are offered for careful control of livestock distribution, timing, and stock numbers in order to protect naturalness of high elevation wilderness meadows.

GRAZING OF CATTLE AND SHEEP is a legal activity in wilderness administered by the USFS and BLM and occurs in about one-third of the USWS (Reed, et al. 1989). But, while grazing is a legal and important use in the wilderness system, impacts and management schemes to control livestock are not well understood by many wilderness interests. High elevation meadow vegetation where grazing often occurs in wilderness is subject to extremes in temperature, wind, moisture, and sunlight. These influences can vary greatly across time and space, creating a very rich and diverse assemblage of plant communities. High elevation meadows include extensive grass, sedge, and herbaceous plant community types. This article summarizes general effects of grazing on species composition and soil properties of these meadows, and some management approaches that would help minimize negative impacts of grazing on them.

High Elevation Grass Meadows

Upper timberline plant communities in the Rocky Mountains and the Inland Northwest are extensively dominated by grasslands. These meadows occur on ridgetops and south-facing slopes, which are relatively dry and free of snow early in summer. There, abundant grasses, such as fescue (Festuca spp.), bluegrass (*Poa spp.*), timothy (*Phleum spp.*), and alpine hairgrass (*Deschampsia caespitosa*), are important forage plants for livestock. Heavy grazing is believed responsible for replacing historically natural fescue-dominated meadows with communities characterized by Columbia stipa (*Stipa columbiana*), California brome (Bromus *carinatus*), and black heads (*Rudbeckia* occident&), or other forbs (Franklin and Dyrness 1977; Hickman 1976; Johnson 1991; Pickford and Reid 1938, 1942). Grazing may redistribute native species as well such as alpine timothy (*P. alpinum*) and alpine bluegrass (*P. alpina*) (Bonham 1972).

In general, drier meadows supporting good cover of grasses or sedges exhibit greater resistance (ability to withstand grazing-induced change) but lower resilience (speed of recovery to pregrazing conditions) than wetter meadows. Greater resistance can be attributed to the extensive tightly interwoven mat of roots that resists penetration. However, when intensive grazing causes damage, drier conditions hamper productivity, which can cause the rate of recovery to be extremely slow. Rundel and others (1990) noted apparent impacts 50 years after removal of sheep from a dry shorthair sedge (*Calamagrostis breweri*) meadow in the Sierra Nevada where Crane (1950) had earlier observed pedastelled bunchgrasses, indicating r-ill and gully erosion in the Sierras.

High Elevation Herbaceous Meadows

Herbaceous meadows are sometimes pure assemblages of nongrasses (forbs) but are most often associated with at least some grass and/or sedge cover. Distribution of herbaceous communities does not conform as strictly to the soil moisture extremes as other meadow types. They are usually found on sites of intermediate moisture but sometimes occur on dry and wet soils, Important high elevation forbs include lupine (*Lupinus* spp.), valerian (*Valeriana* spp.), corn-lily (*Veratrum spp.*), and knotweed (*Polygonum spp.*).

Grazing can decrease fescue and mountain bromegrass (Bromus *marginatus*) and common forbs such as groundsel (*Senecio spp.*) and loveroot (*Ligusticum* spp.) (Branson and Payne 1958; Willard 1991). In turn, plants which increase in abundance

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include sage (Artemisia *spp.),* rubber rabbitbrush *(Chrysothamnus nauseosus),* and exotics such as timothy *(Phleum pratense)* and Kentucky bluegrass *(Poa pratensis)* (Bennett 1965; Branson and Payne 1958: Ellison 1954; Vogl and Miller 1968). Grazing can lead to tree invasion. The potential proliferation of trees in herbaceous meadows may be greater than other meadow types due to intermediate soil moisture availability. With intensive invasion, associated meadow forbs, grasses. sedges, and other plant life forms would be replaced by forest understory plant associations, which could threaten the future existence of individual meadons (Franklin 1966) and have important implications for overall biodiversity in subalpine regions. Such transformations have been linked to climate change (Brink 1959; Franklin 1966; Franklin, et al 1971; Jacobs and Romme 1993; Taylor 1995; Woodward, et al. 1995); however. improper grazing by livestock are probably an important contributing factor.

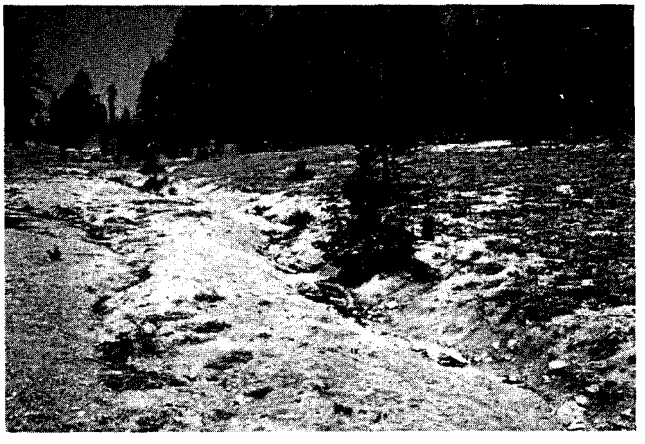
For example, livestock disturb plant cover, often cutting through the roots and exposing bare mineral soil, which is conducive for the establishment of tree seedlings. Franklin and others (1971) suggested a three-year period of cattle presence initiated invasion of a bunchgrass/lupine (Festuca *viridula/Lupinus latifolius)* meadow in the Goat Rocks Wilderness USA. Livestock were thought by Ellison (1954) to cause invasion of rubber rabbitbrush/stipa meadow communities in the Wasatch Range USA. Vale (1981) surmised that fire suppression and climate change were not as important as the presence of sheep in causing invasion of Cascade Meadows. Interestingly, tree invasions can be most pronounced under low to moderate levels of livestock use or **soon** after livestock are removed (Dunwiddie 1977; Taylor 1990; Vale 1981), possibly because under heavy use, livestock tend to trample or eat invading tree seedlings.

High Elevation Moist Sedge Meadows

Sedge meadows are typically dominated by grasslike plants, such as rushes *(Juncus spp.)* and sedges *(Carex spp.),* which commonly form a dense cover resembling a short green leafy mat at moist sites such as small basins and lake margins. Associated soils are acidic, oxygen-poor, and highly organic. These soft mucky sites offer little physical resistance to hooves and can be easily disturbed if not for the mantle of plant material that provides some protection.

Initially, grazing can cause changes in species abundance. Experiments conducted by Pond (1961) indicated that moderate season-long grazing can severely reduce or eliminate sedges *(Carex festivella* and C. *rostrata).* Less desirable or unpalatable plants can replace sedges. For example, lupine *(Lupinus spp.),* penstemon *(Penstemon spp.),* and buttercup *(Ranunculus spp.)* were found to be abundant in heavily grazed sedge meadows of the Sierras (Crane 1950).

A gross meodow that receives very little grazing pressure. Proposed West Big Hole Wilderness, Montana. Photo by Michael P. Murray. (left)



Heavily grazed meadow with loss of vegetation and erosion. Exposure of soil is conducive to establishment of young invading trees. This meadow was probably once dominated by Idaho fescue but is now dominated by buckwheat, with invading Shasta red fir. Russian Peaks Wilderness, California. Photo by Mithoel P. Murray. (below)

Herboceous meadows can better withstand grazing pressure than other types due to their naturally abundant plant cover and intermediate soil moisture. Marble Mountain Wilderness, California. Photo by Mithael P. Murray. (left)

Even herbateous meadows con be impacted when heavy grazing removes plant cover. Because high elevation meadows are subject to extremes in temperature, wind, moisture, and sunlight, thresholds of acute livestock-induced change, may occur more quickly than at lower elevations. Near McCall, Idaho. Photo by Department of Range Resources, University of Idaho. (below)

A moist sedge meadow. Very light grazing tan cause changes in the relative abundance of different species without erosion. These subtle changes can go unnoticed by the untrained eye. Russian Peaks Wilderness. Photo by Michael P. Murroy. (above)

Extremely moist soils offer little physical resistance to hooves and ran be easily disturbed. Erosion can be evident by pedastelled sedge plants. Central Idaho. Photo by Department of Range Resources, University of Idaho. (below)

When grazing removes or tramples significant plant cover, negative impacts can become more apparent. Trampled and denuded trails, for example, can persist for at least two years after removal of stock in these meadows (Ratliff 1985). Where grazing pressure is heavy enough, dramatic far-reaching impacts may occur. Bennett (1965) describes such an instance in Sequoia-Kings Canyon National Park: "Lacking the ability to form a tough sod, sphagnum areas are severely cut up by hoofed [domestic] animals, exposing the soft muck soil beneath to erosion during the spring snow melt or by summer showers. This muck erodes very rapidly and the deep channels cause the water table to lower and drain the meadow. As water drains out of the soil the air, which is admitted quickly, oxidizes and thereby destroys the finely organic soils."

Consequently, lodgepole pine *(Pinus contorta)* seedlings were invading this formerly wet meadow (Bennett 1965), probably due to the lowered water table. The progression from extensive sedge and moss-covered wet meadow to a dry, almost barren site with tree encroachment, emphasizes the potential far-reaching effects of inappropriate livestock grazing.

Range Management Principles for High Elevation Wilderness Meadows

Grazing of high elevation wilderness meadows need not be accompanied by dramatic damage to resources, and should not because The Wilderness Act of 1964 mandates that naturalness be maintained. Fortunately, today most livestock producers are aware that such damage reduces forage sustainability and reflects badly on them, threatening long-term continuation of wilderness grazing. From past mistakes, combined with our developing knowledge of the ecological dynamics of meadows, we can better manage livestock to ensure that the goals of wilderness naturalness are more closely realized. These include the following items.

1.) Tailor Use by Meadow Type: In general, meadows that are least likely to be damaged by livestock have moderate to high plant cover, soils of intermediate moisture, and gentle slopes less than 417%. Herbaceous meadows often eshibit these characteristics in addition to supporting a high variety of preferred forage species, Livestock grazing in wet meadows requires close monitoring because of the high susceptibility of succulent plants to trampling and soil compaction. Extremely dry meadows usually support low plant cover and shallow soils, which subject them to erosion.

Certain sites within herbaceous meadows should not be grazed. These include locations of high gopher use, as evidenced by many tailings mounds from tunnels. These areas are highly susceptible to erosion when sheltering plants are removed. Sites in the vicinity of snowbanks should be avoided due to wet conditions and newly emerging plant, which may not recover from excessive early grazing. The banks of alpine watercourses can be easily damaged by trampling. Exposed ridges with high potential for erosion should also be avoided.

2.) Time Use to Avoid Wet Conditions: All meadow types exhibit very moist soils in late spring and early summer. Entrance of livestock before a majority of the snow melts causes risk of damage to soils. Conversely, late-season grazing causes risk of autumn snowfall and heavy utilization of shrubs. A commonly used time-window in the western United States occurs between July 1 and October 15, but the grazing period should be tailored according to the site and regional weather for the year (Allen and Clayton 1994).

3.) *Stagger* Use *to* Reduce Impacts und Allow Recovery: The same meadow should be grazed at different times every year and allowed to be livestock-free at different times annually The goal is to avoid grazing plants at the same stage of development (e.g., seeding) every year, thus limiting consistent interference in important plant processes that are responsible for survival (carbohydrate reserves) and reproduction (flowering, seeding). The "rest-rotation" system is one method incorporating this concern and is particularly well-suited to high elevation wilderness where fencing is discouraged and terrain is mountainous (Holecheck, et al. 1995). Continuous season-long

grazing at even moderate stocking rates can lead to severe damage, especially with cattle. Livestock tend to congregate near their preferred sites for long periods of time. These sites are usually where water, shade, and forage are near each other such as in wet fragile meadows.

4.) *Avoid* Overstocking: Low forage productivity, naturally unstable soils, and long recovery periods justify conservative stocking rates at high elevations. Naturally occurring wildlife, such as bighorn sheep and mountain goats, tend to occur in low population densities limited by snow-free winter forage (Noss and Cooperrider 1994), unlike high numbers of feed-supplemented cattle and sheep.

5.) Monitor and Set Aside *Some* Meadows as Benchmarks *of* Naturalness: Selected meadow sites should remain off-limits to domestic grazing as a comparison of relative naturalness. The tradition of setting up exclosures of several square meters in size for each meadow can be useful to monitor the amount of forage consumed; however, these small exclosures may not adequately buffer against livestock effects on hydrology, seed availability, pollinators, soil organisms, and other ecosystem components. Using plant communities in their spatial entirety can better ensure a baseline of naturalness. Matches for comparison need to be made carefully because site factors and species composition can be highly variable. An additional challenge in finding sites is that few meadows were never grazed by domestic stock whose impacts can last decades. New introductions of livestock to ungrazed meadows should be discouraged due to their value as baselines of naturalness.

6.) Rehabilitate Impacted Sites: Exotic plants and invading trees should be controlled or removed using methods consistent with wilderness such as prescribed burning and hand-removal. Efforts to hamper erosion include placing small check-dams and dissipaters of, preferably, natural materials (stones, tree trunks, posts) into gullies. Seeds of native species collected as close as possible to'the site should be carefully applied.

7.) Monitor and Manage Tree Invasion *and* Other Species: It can be difficult to determine whether tree invasion is caused by livestock, climate, or fire suppression, Good records of livestock use, fire history, and climatic trends can be helpful, Tree rings of invaders should be examined for chronological patterns of trends that may help determine possible causes (e.g., climate change, fire, or overgrazing). If livestock and/or fire suppression are causes, managing for naturalness would support tree removal in order to maintain meadow communities and/or allow their recovery Removing trees is much easier than identifying why they have invaded.

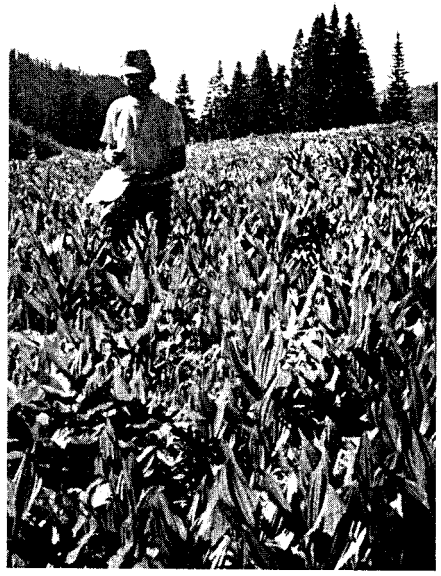
8.) Support Research: We are just beginning to understand the effects of grazing on individual plants in high elevation meadows. We also know very little about grazing inter-relationships with other high elevation ecosystem components such as pollinators, soil fauna and flora, and plant populations and ecosystems at a landscape level. Additional research is needed on both rehabilitation techniques and the ecology of ungrazed meadows, both of which are essential in maintaining or measuring progress toward goals of wilderness naturalness.

Conclusion

Excessive grazing generally causes a shift in species composition from preferred forage to less desirable, nonpalatable, or exotic species. Tree invasion may accompany grazing, especially in herbaceous meadows. Drier meadows seem to be of low resilience to heavy grazing. Moister meadows generally exhibit low resistance due to high susceptibility of soil to erosion and compaction. When vegetation and soil disturbance is significant, the ability of a site to retain water is compromised, and a subsequent shift to dryland-associated plant species may be expected.

High elevation meadows present managers with unique challenges in protecting wilderness naturalness. The short growing season, cold temperatures, and shallow soils limit the productivity and recovery of vegetation. Thresholds of acute livestock-induced change, such as shifts to drier conditions, may occur more quickly than in similar meadow types at low elevations. Furthermore, inherent differences among diverse meadow types, often occurring within a single grazing allotment, require carefully managed livestock.

Range management in wilderness to maintain a semblance of naturalness of high elevation meadows is possible and is mandated by The Wilderness Act. The foregoing has described ecological changes that can occur from improper grazing of three types of high elevation meadows and the management principles to help avoid them. IJW



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