USGS Western Ecological Research Center
Publication Brief

Management Considerations for Pack Stock and Sierra Nevada Meadows

The management of pack and saddle stock—primarily domesticated horses, mules, and burros—is an important component of land management and stewardship plans in the Sierra Nevada. In particular, the presence of pack stock in and adjacent to meadows has garnered significant controversy over their potential environmental effects, but the scant literature on pack stock effects continues to complicate planning efforts.

In *The Rangeland Journal*, USGS, National Park Service, and USDA scientists have reviewed existing literature to provide a summary of potential effects of pack stock on broad response categories relevant to Sierra Nevada meadows:

Effects on Water Quality: Nutrient levels may increase, but vary with pack stock density, duration of use, season of use, and deposition location of feces and urine.

Giardia and *Cryptosporidium* are human pathogens that can be present in pack stock manure, but they are typically present in only 1–5% of pack stock and also occur in wildlife (e.g. deer). Coliform bacteria (including *E. coli*) occur at roughly half of the sites used by both pack stock and humans, but current studies do not specify which is more responsible for its presence. Published concentrations for both water nutrients and pathogens often do not differ from background levels and generally do not exceed eutrophication or human health standards set by the U.S. Environmental Protection Agency, although they can at times exceed more stringent local water quality standards.

Removal of streamside vegetation by grazing—especially reductions in vegetation height—can increase suspended sediments and water temperature, although these effects are more typically associated with cattle grazing than pack stock use.

Effects on Soil: Pack stock use can potentially reduce or redistribute soil nutrients within a site and increase nutrient turnover rates through the facilitative process of digestion.

Direct effects of trampling may include localized fragmentation of sod, trailing, roll pits, stream bank and lakeshore erosion, increased amounts of unvegetated soil, and soil compaction and shearing. However, these impacts have been primarily documented for cattle, and the much lower intensity and duration of disturbance by pack stock may lead to very different results.

Continued on back page

Pack stock, such as this El Portal team from the early 1900's, have been used in the Sierra Nevada for more than a century. Photo: John W. Bingaman/non-commercial use only.

MANAGEMENT IMPLICATIONS

- Based on available literature, priority objectives for pack stock management in Sierra Nevada meadows could include: (1) minimizing bare ground; (2) maximizing plant cover and maintaining native plant species composition; (3) minimizing trampling, especially on wet soils and stream banks; and (4) minimizing direct urination and defecation by pack animals into water.
- The scientific basis for pack stock regulations will remain limited until more research is done linking measurable monitoring variables (e.g. plant cover) with management objectives (e.g. soil erosion processes, wildlife habitat use), and identifying specific thresholds of environmental degradation corresponding with specific pack stock use levels.

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Effects on Plants: Vegetation removal can lead to decreased plant cover and increased bare ground, although effects may be minimal after infrequent or relatively light seasonal use.

Early season grazing may have more lasting effects on productivity during subsequent years; however, it may also lead to compensatory growth among some plant species. Grazing may decrease plant diversity on poor soils, but increase it on rich soils. Removal of plant species may be selective when productivity is high, but more generalized when productivity is low.

Trampling can decrease vegetation cover, increase soil compaction, and have variable effects on bulk density. Resilience to trampling declines with elevation, slope, soil wetness, and prevalence of shrubs, and increases with growing season length, graminoid dominance, and prevalence of plants with protected buds.

Occurrence of non-native invasive plants is relatively low in meadows, but the combination of increased resource availability and the potential of propagule dispersal from human activities render them potentially invasible, mostly likely at lower elevation sites and those near corrals. Propagules can be transported within the gut of pack stock, in supplemental feed, or through adhesion to the outside of animals and equipment.

Localized pack stock disturbances and deposited feces create conditions that favor establishment of invasive plants. Moderate levels of cattle grazing may facilitate meadow encroachment by woody plants, but it is unclear if pack stock have similar effects.

Effects on Wildlife: Wildlife may be directly affected by trampling or indirectly affected through habitat modification caused by pack stock.

Reduction in vegetation cover, and the concomitant increase in bare ground, may be detrimental to small vertebrates by increasing risk of predation, promoting behavioral shifts, or affecting habitat use patterns. These changes in small prey species may secondarily affect predators.

Increased soil compaction from trampling can reduce infiltration rates and alter hydrologic patterns, potentially affecting fossorial, aquatic, and semi-aquatic species.

Context of the Research Record: This review presents the most comprehensive summary of scientific information currently available, but the relative paucity of published studies still limit current understanding of pack stock effects on meadows and other Sierra Nevada habitats.

In addition, all past studies focus only on presence versus absence of pack stock, and this significantly limits their use for land management. Information is needed on environmental effects across ranges of use levels (e.g. frequency, duration, or intensity gradients) to understand effect thresholds needed to develop regulations for pack stock use.

Most past studies have also been observational and limited by imprecise or otherwise incomplete pack stock use histories. More experimental studies could help discern and measure impacts specific to pack stock, whether independent or interacting with other factors, such as hikers, wildlife diseases, and climate shifts.

One final thing to consider is that pack stock use levels were much higher in the past, especially the early 1900s, than they are today. Livestock use was much higher in the past as well, and John Muir's writings in late 1800s describing the effects of domesticated sheep as "hooved locusts" was an important factor promoting the establishment of Yosemite National park. The lasting effects of these past anthropogenic disturbances can still be seen in a few areas, but are largely unknown across the vast majority of the Sierra Nevada. It is possible that environmental thresholds were crossed long ago in some areas, but not knowing where these areas are and what thresholds were crossed greatly complicates the evaluation of current pack stock effects in the Sierra Nevada.

This Brief Refers To:

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