WILDLIFE AND LIVESTOCK GRAZING ALTERNATIVES IN THE SIERRA NEVADA

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Abstract: The Sierra Nevada of California provides a variety of natural resources including wildlife habitat and livestock forage. Livestock grazing affects different species of wildlife in different ways, and the effects depend on how those livestock are managed. Changes in livestock numbers, changes in timing of grazing, and rotational grazing systems can all be used to insure maintenance of wildlife habitat values. This paper reviews how some of those livestock management practices affect such wildlife species as mule deer, small mammals, great gray owls, willow flycatchers, and others. This information will be useful in the revising of livestock Allotment Management plans by the U.S. Forest Service, a major public land management agency in the Sierra Nevada.

The Sierra Nevada of California provides a wide variety of natural resources including timber, livestock forage, wildlife habitat, water, and recreational opportunities. Management of those resources are the responsibility of numerous federal and state agencies, as well as a host of private landowners. The U. S. Forest Service administers over 10 million acres in 8 national forests in the Sierra Nevada, and represents one of major land management agencies in the region.

The Forest Service operates under a multiple-use mandate proscribed by the Multiple Use-Sustained Yield Act (1960), and is further guided by other laws including the National Environmental Policy Act (1969), the Endangered Species Act (1973), and the National Forest Management Act (1976). Natural resources within Forest Service jurisdiction are managed in accordance with these and other laws. For example, the National Forest Management Act requires that all national forests prepare formal land management plans (LMPs), and that permits, contracts, and other instruments for the use and occupancy of forest service lands be consistent with those plans. Livestock grazing allotments are managed under Allotment Management Plans (AMPs). Current direction within the Forest Service is to make those AMPs fully consistent with the LMPs, and insure that all AMPs have undergone appropriate environmental analyses as outlined by the National Environmental Policy Act (NEPA).

Many of the existing Forest Service AMPs have been in place for many years. For example, on the Kings River Ranger District of the Sierra National Forest, some of the AMPs on file date back to late 1950s and early 1960s. Since that time, wildlife biologists and range managers have learned much about the interactions between livestock grazing and wildlife resources.

The purpose of this paper to review some of the research that has been conducted over the past 15, and suggest alternative grazing strategies for allotments in the Sierra Nevada that still provide livestock grazing opportunities while increasing benefits to wildlife. This review applies primarily to those grazing allotments in the Sierra Nevada at mid-elevations, usually in forested habitats, that are grazed season-long during the summer months. Although some of the same principles apply to low-elevation allotments used during late fall, winter, and early spring, and to high-elevation allotments usually found above timberline in designated wilderness areas, livestock-wildlife interactions in these areas are less well known. It is hoped that this effort will help Forest Service resource managers charged with updating existing AMPs.

THE SIERRA NEVADA OF CALIFORNIA

The Sierra Nevada extends from Mount Lassen in the north to Kern County in the south (Storer and Usinger 1963). It is composed of vast amounts of molten granite injected into existing geological formations 100 million years ago. It is a relatively young, fault-block mountain range resulting from the subduction of the North American plate sliding beneath the Pacific plate. The Sierra Nevada rises gently from the central valley of California in the west to maximum elevations over 3,600 m (Storer and Usinger 1963). The eastern escarpment is abrupt, and produces spectacular scenery, particularly in the south.

Much of the Sierra Nevada's current topography has been shaped by an active period of glaciation and repeated local faulting along the eastern boundary over the last million years (Storer and Usinger 1963). The resulting channels created by snowmelt have served to transport and redistribute eroded parent material along stream courses and in basins and other low-lying areas. Soils in other areas are often poorly developed, and support plants that are adapted to rocky conditions and periodic drought.

The unique geological history of the Sierra Nevada makes it different from other mountain ranges in the western United States. Most of the soils are derived from granitic parent material and forages are often lacking in key nutrients. For example, phosphorus levels in meadow soils are often low, and the phosphorus content of meadow vegetation is below that required for optimum nutrition in mule deer (*Odocoileus hemionus*) (Kie and Myler 1987). Phosphorus levels are also low in deerbrush (*Ceanothus integerrimus*) and mountain whitethorn (*C.*

cordulatus), both of which are common shrub species in the Sierra Nevada (Kie 1986). As a result, mule deer and other ungulates such as mountain sheep (*Ovis canadensis*) (Wehausen 1980) must carefully select forages to maintain adequate levels of phosphorus intake. Low nutrient levels complicate the question of competition between wild and domestic animals beyond simply allocating forage between species.

The distribution of herbaceous forage in the Sierra Nevada is correlated with the accumulation of deeper soils with the ability to hold moisture throughout the summer growing season. Grasses, sedges, and forbs are common understory components in ponderosa pine forests in the southwest (Ffolliott 1983), and in Douglas-fir forests elsewhere in the west where the canopy is sufficiently open to permit sunlight to penetrate to the forest floor (Mitchell 1983). However, shrubs such as ceanothus and manzanita (*Arctostaphylos* spp.) are the most common understory species in Sierra Nevada mixed-conifer forests, and herbaceous plants are found primarily and with greatest abundance in meadow-riparian areas (Larson and Wolters 1983, Allen 1989). Because herbaceous forage is concentrated in meadow-riparian areas, Sierran ecosystems are more like those of the Sonoran desert than those of other western montane forests.

LIVESTOCK GRAZING ALTERNATIVES IN THE SIERRA NEVADA

CURRENT GRAZING MANAGEMENT PRACTICES

Most Forest Service grazing allotments in the Sierra Nevada are located at mid-elevations in forested habitats. These have been grazed beginning in June or early July each year since the 1800's. Although sheep grazing was common on national forests in California prior to 1950 (Longhurst et al. 1976), most allotments on the west slope of the Sierra Nevada are now grazed exclusively by cattle. Cattle will remain on these summer allotments until September when permittees bring them down to privately-owned base property on foothill rangelands.

Livestock grazing permits on U.S. Forest Service land are issued under the umbrella of the AMP. The AMP describes the boundary of the allotment, and lists the acreages of key range types. These key range types consist of meadow-riparian areas, in recognition of the concentration of herbaceous vegetation in those types. Range condition is defined by a process which takes into account soil conditions and species composition of the herbaceous vegetation. Then tabular values are used to relate the acreage of key range types in each of several condition classes with production of livestock forage, and to set allowable cattle stocking rates (USFS 1969).

Cattle on Sierra Nevada summer allotments rely heavily on herbaceous forage. However, they will also browse on shrubs that become established following logging (Kosco and Bartolome 1983). In any case, they show preferences for meadow-riparian habitats, as well as those dominated by aspens (*Populus tremuloides*) (Loft et al. 1991).

CHANGE IN LIVESTOCK NUMBERS

Where conflicts occur between wildlife and cattle under current grazing practices, one alternative is to reduce cattle numbers. In some cases, wildlife response to changes in livestock numbers may not be linear. Reductions from high to moderate numbers may yield greater benefits than reductions from moderate to low numbers (Loft et al. 1987). Because providing forage for domestic livestock is an important use of national forests, elimination of grazing is not considered a feasible nor desirable alternative.

DELAYED OR DEFERRED GRAZING

In most cases, wildlife species are most susceptible to disturbance during the time of the year that reproduction is occurring. For many species in the Sierra Nevada, that period occurs between June and mid-August. Delaying or deferring grazing until after mid-August would be an alternative that would minimize that disturbance. In addition, many plants that are important to wildlife as forage and structural components of habitat may benefit from grazing deferment until they can complete their reproductive cycles.

REST

Where wildlife-livestock conflicts are severe, eliminating grazing for the entire summer may be necessary to allow restoration of habitats. Periods of rest may consist of a single year, or may last for several years. Some plants important to wildlife such as aspen would benefit with periodic rest to enable successful regeneration.

Fencing meadow-riparian areas to exclude livestock is one method of providing long-term rest for specific sites. However, fencing is expensive. Fences in the Sierra Nevada have to be constructed to withstand substantial snow loads during winter or to allow the fence to be taken down in the fall and erected again in the spring. Where wildlife values are judged to be high, fencing to exclude livestock may be a useful technique.

Stanislaus National Forest near Sonora Pass (Loft 1988, Kie et al. in prep).

McCormick Creek Basin is used as summer range by migratory mule deer that wintered at lower elevations on both the West Slope foothills and to the east in Great Basin habitats (Loft et al. 1989). The area was grazed by cattle from early July until mid-September each year. Five habitats were described: meadow-riparian, aspen, conifer, montane shrub, and sagebrush (Loft et al. 1991).

Three fenced pastures were established and stocked at different rates with cattle for the summer grazing period. Cattle stocking rates were based on the acreage of primary range (meadow-riparian) plus and aspen habitats. One pasture was left ungrazed, one was grazed at a moderate rate based on past stocking history, and one was grazed at a heavy rate (Loft et al. 1987).

Hiding cover for deer in McCormick Creek Basin was measured using a vertical cover board in aspen, corn lily (*Veratrum californicum*), and willow (*Salix* spp.) vegetation types (Loft et al. 1987). Of particular concern was the effect of cattle grazing on hiding cover available to deer fawns. In one study between 1978 and 1985, 51% of 89 radio-collared mule deer fawns were lost to predators during the first year of life (Neal 1990). In the absence of cattle grazing, some loss of hiding cover occurred over the summer because of maturing and weathering of vegetation. But with cattle grazing, the decline was accelerated (Fig. 1).

The natural loss of hiding cover as summer progressed was of little concern. Deer fawns are most susceptible to predation, and most dependent for survival on dense hiding cover, during the first two months of life. By the time weathering had reduced hiding cover in stands of aspen, corn lily, and willows, fawns were capable of running at heel with the does. Cattle grazing accelerated the decline in a non-linear manner, with heavy grazing having a much more pronounced effect than moderate grazing (Loft et al. 1987).

In the absence of cattle grazing, deer selected home ranges with a greater percentage of meadow-riparian habitat and a smaller percentage of montane shrub habitat than were typical for McCormick Creek basin as a whole. Under moderate and heavy cattle grazing, deer selected home ranges containing smaller percentages of meadow-riparian habitat and greater percentages of montane shrub habitat (Loft et al. 1991).

Within their home ranges, deer used ungrazed aspen habitat heavily. With cattle grazing, however, the time deer spent in the aspen habitat fell significantly. With or without cattle, deer preferred meadow-riparian habitat, and avoided montane shrub and timberline sagebrush habitats. Timberline sagebrush was most heavily used by deer when cattle stocking was greatest (Loft et al. 1991).

Cattle grazing also affected deer home range sizes (Loft 1988). Using the adaptive kernel method of estimating areas of use (Worton 1989), deer home ranges averaged 212 acres in the absence of cattle, 250 acres under moderate stocking, and 299 acres under heavy stocking. The increase in home range sizes with cattle grazing helps to explain the observed patterns in how deer selected their home ranges with respect to available habitats. Without cattle grazing, deer concentrated their use in areas at the bottom of McCormick Creek Basin. These areas had a greater proportion of meadow-riparian habitat and a lower proportion of montane shrub habitat than did the basin as a whole. With cattle grazing, deer did not shift the locations of the centers of their home ranges, but simply increased their size, using in more of the steeper basin slopes away from cattle which contained less meadow-riparian and more montane shrub habitat.

Tip-switch and signal-variability information collected from the radio-collared deer in McCormick Creek Basin allowed the definition of three broad classes of behavior: feeding, traveling, and resting (Kie et al. 1991). Activity data was collected in 1984 and 1985. Of special interest was the amount of time deer spent feeding each day.

Deer spent only about 24% of their time feeding in the absence of cattle, 31% under moderate cattle stocking, and 44% under heavy stocking rates (Kie et al. 1991). These responses were related to declines in the standing crop of herbaceous forage in meadow-riparian habitats with increasingly heavy cattle grazing (Kie et al. in prep). As forage levels declined, deer had to spend more time feeding.

In addition to the research conducted in McCormick Creek Basin, a separate study was undertaken to determine the effects of cattle grazing on use of herbaceous forage by deer at about 6,500 feet in Bell Meadow, also located on the Stanislaus National Forest near Pinecrest (Winckel 1989). The study design at Bell Meadow included four small, separate pastures stocked with cattle at 4 levels for the summer period: no grazing, light grazing, moderate grazing, and heavy grazing (Winckel 1989). The study was conducted during 1984 and 1985.

Cattle grazing had few effects on forage quality such as crude protein and in-vitro digestible dry matter. Cattle grazing did reduce the quantity of herbaceous forage available to deer, and the availability of forbs in late summer in particular (Winckel 1989). Deer responded by increasing the proportion of sedges in their diet, and reducing overall diet diversity, which was lowest in the heavily grazed pasture.

Summarizing both the McCormick Creek and Bell Meadow studies, as herbaceous forage in meadow-riparian and aspen habitats is eaten and trampled by cattle, deer have to spend more time feeding. Consumption of forbs declined as did overall diet diversity. In addition, deer

available about specific relationships between grazing and small mammal populations in the Sierra Nevada, Hanley and Page (1982) reported on one such study in the Great Basin. Microtine rodents such as montane voles (*Microtus montanus*), long-tailed voles (*M. longicaudus*), and sagebrush voles (*Lagurus curtatus*) were either absence from or consistently less abundant in grazed areas than in ungrazed areas. Differences in abundance of rodent species between communities were related primarily to plant structure (Hanley and Page 1982).

Changes in small mammal populations can in turn affect raptorial birds. In Europe for example, nesting densities of European kestrels (*Falco tinnunculus*), short-eared owls (*Asio flammeus*), and long-eared owls (*A. otus*) are closely related to microtine population densities during spring (Korpimaki 1984, Korpimaki 1986, Korpimaki and Norrdahl 1991).

Great gray owls (*Strix nebulosa*) in the central Sierra Nevada, listed by the state of California as endangered, prey on both pocket gophers (*Thomomys* spp.) and microtine rodents (*Microtus* spp.). During field studies conducted in Yosemite National Park during 1980-1981, diet biomass averaged 63% gophers and 24% microtines (Winter 1982). Similar data collected on the Stanislaus National Forest in 1980 in areas grazed by cattle indicated diet biomass averaged 80% gophers and 16% microtines. No great gray owls were believed to nest in the study area that year. In 1981, however, great gray owl diets averaged 50% gophers and 36% microtines. Three pairs of great gray owls were known to establish nests that year, and 2 of those pairs successfully fledged young (Winter 1982).

It was hypothesized that the food value of gophers was lower in terms of gross food yield per unit of effort because they were more difficult to catch. In conclusion, it was suggested that gophers provide subsistence prey for great gray owls, but that for maximum reproduction, they required an abundant supply of microtines. Because microtine rodents are cyclic, and often show peak population densities about once every 3-4 years under good habitat conditions, great gray owls may also be cyclic in their reproductive success (Winter 1982).

The response of pocket gophers to livestock grazing depends on range type, intensity and season of grazing, and other factors. Heavy grazing by livestock can result in increased numbers of pocket gophers because of the abundance of deep-rooted, bulbous forbs (Buechner 1942, Ellison 1946, Tevis 1956). However, in a Colorado study, gophers were more than twice as numerous on ungrazed ranges than on grazed ranges (Turner et al. 1973). And on low-elevation, foothill rangelands in northern California, pocket gophers mounds made up 7% of the ground cover in ungrazed areas but less than 1% in grazed areas (Hunter 1991).

There is a clear relationship between the removal of herbaceous cover by livestock and the decline of microtine rodents (Hanley and Page 1982). Where herbaceous cover is reduced below some threshold level, resident populations of microtines may still persist, but not build up in numbers to the point where multi-year cycles become evident (Birney et al. 1976).

Alternative cattle management strategies that would result in improved habitat conditions for small mammals include: reduction in livestock numbers and rotational grazing.

Change in livestock numbers.—Some reductions in livestock numbers would help maintain adequate vegetative cover for microtine rodents during years when population sizes are lowest. A mosaic of ungrazed meadow vegetation might serve as refugia for small numbers of microtines during such times. However, small reductions in cattle numbers would probably not provide optimum habitat for large populations of microtines during population peaks. Furthermore, not enough is known about the affects of grazing on gopher populations in the Sierra Nevada to reliably predict how they would respond to changes in cattle numbers.

Rotational Grazing Systems.—A rest-rotation grazing system in which each allotment were grazed only 2 years out of every 3 would retain one-third of the total area in an ungrazed condition each year. Grazing each allotment only 1 year out of every 3 would increase ungrazed areas to two-thirds of the total allotment. During years of microtine population peaks, the ungrazed areas would provide the habitat conditions necessary to insure maximum population sizes. Great gray owls would be able to use those areas for foraging.

Long-term rest might not be advantageous to great gray owls. Microtine numbers would probably be higher than under a rest-rotation grazing system described above, but the abundance of deep-rooted forbs used by gophers could decline.

WILLOW FLYCATCHERS

Willow flycatchers (*Empidonax traillii*) are neotropical migrant, passerine birds that winter in Central America and breed across North America. In California, they breed exclusively in riparian-deciduous woodlands, and prefer willows as nesting substrate (Valentine et al. 1988). They have been declining in California (Remsen 1978), and recent surveys suggest that only about 102 breeding pairs can be found in the Sierra Nevada and 19 pairs elsewhere in the state (Serena 1982). Willow flycatchers were listed as endangered by the state of California in June 1990. Of particular concern are the effects of livestock grazing on nesting willow flycatchers and nest parasitism by brown-headed cowbirds (*Molothrus* *ater*).

In a study conducted in Sierra County, no evidence of willow flycatcher nest destruction by cattle was noted (Sanders and Flett 1989). However, in another study conducted in Fresno County, 4 of 20 willow flycatcher nests found between 1983 and 1986 were destroyed by cattle prior to fledging of the young, and 4 other nests were destroyed after fledging (Valentine et al. 1988). Flycatchers prefer to nest near the edges of willow clumps or along livestock trails (Valentine et al. 1988, Sanders and Flett 1989), where they are susceptible to physical disturbance. At least 16 other species also nest in willows or on the ground in Sierra Nevada meadows, and these are also susceptible to disturbance (Sanders and Flett 1989).

In the Fresno County study, cattle stocking levels were reduced by 40% in 1987, and 75% of the remaining cattle were confined to a fenced pasture away from willow flycatcher nest sites prior to 15 July. No willow flycatcher nests were lost under those conditions (Valentine et al. 1988). Both strategies, reducing livestock numbers and delaying grazing, have potential to reduce adverse effects on willow flycatchers.

Change in Livestock Numbers.—In Colorado, willow flycatchers are absent from areas grazed by livestock during the summer months (Knopf et al. 1988). In Oregon, when livestock numbers were reduced by 75% over a 10-year period, willow flycatcher abundance increased seven-fold (Taylor 1986, Taylor and Littlefield 1986). Reductions in cattle numbers clearly benefit willow flycatchers, and have been widely recommended (Laymon 1987, Valentine et al. 1988, Sanders and Flett 1989). The effect of reducing cattle numbers would be to reduce physical disturbance to nesting flycatchers. In cases when fewer cattle are present on an allotment those that are there may not use willows and associated habitats until later in the summer, often not until after willow flycatchers are done nesting (Valentine et al. 1988).

Delayed Grazing.—Delaying grazing until completion of nesting efforts by willow flycatchers could also eliminate conflicts. Recommendations usually consist of restricting grazing until mid-August (Valentine et al. 1988, Sanders and Flett 1989).

Rotational Grazing.—Deferred-rotation grazing would prevent the destruction of willow flycatcher nests in areas protected from grazing until mid-August. Coupled with some reductions in cattle numbers, as described by Valentine et al. (1988) in the Fresno County study, deferred grazing could still yield benefits to willow flycatchers and still provide a grazing resource early in the summer on some grazing sub-units. Rest-rotation grazing would provide similar benefits, but at the expense of greater reductions in overall livestock numbers.

BROWN-HEADED COWBIRDS

Brown-headed cowbirds parasitize other species of passerine birds by laying their eggs in the nests of those species, which then rear the cowbird nestlings at the expense of their own reproductive effort (Verner and Ritter 1983). Cowbirds have been implicated in decline of several species of birds elsewhere in North America. In California, they have been blamed for the elimination of Bell's vireo (*Vireo bellii*)(Verner and Ritter 1983). In the Sierra Nevada, at least 22 species are susceptible to cowbird parasitism (Rothstein et al. 1980), including willow flycatchers (Sanders and Flett 1989). Warbling vireos (*V. gilvus*) may also be particularly susceptible (Verner and Ritter 1983).

Brown-headed cowbirds have significantly expanded their range throughout the Sierra Nevada since 1940 (Rothestein et al. 1980). The reasons are unknown but it has been suggested that human developments such as pack stations, campgrounds, and grazed meadows have resulted in habitats rich in food resources (Rothestein et al. 1980). Brown-headed cowbirds feed on both plant material and insects. Females make particularly heavy use of insects during the time they are laying eggs (Ankney and Scott 1980).

Grazing in Sierra Nevada meadows reduces the height of herbaceous vegetation and provides good structural conditions for foraging brown-headed cowbirds (Laymon 1987). On the Sierra National Forest, cowbirds are often found in association with herds of cattle in mid- to late morning (Verner and Ritter 1983). Nest parasitism by cowbirds in the Sierra Nevada is strongly associated with disturbance by humans and livestock (Airola 1986).

Delayed grazing or rotational grazing could be used to reduce habitat suitability for brown-headed cowbirds.

Delayed grazing.—Delaying grazing until August would help prevent the creation of good cowbird foraging habitat in meadows and riparian areas early in the summer. Because female cowbirds appear to consume more insects early in the summer when they are laying eggs than in late summer, reducing their ability to find abundant food could help to reduce their reproductive success. On the Sierra National Forest, most adult cowbirds leave the mountains in late July (Verner and Ritter 1983).

Rotational grazing.—Deferred-rotation and rest-rotation grazing could confer similar benefits as delayed grazing. However, the presence of cattle on some grazing sub-units in early summer would likely increase cowbird numbers and rates of parasitism.

MOUNTAIN LIONS

Mountain lions (*Felis concolor*) inhabit all of the Sierra Nevada, and their numbers are as high today than at any time over the last 20 years (Neal 1990). Factors responsible for the increase include the elimination of state lion hunters in 1959, the termination of a bounty in 1963, and a moratorium on hunting since 1971 (Bertram 1984).

Mule deer are the favored prey of mountain lions, and some deer populations in the Sierra Nevada have declined dramatically at the same time lion populations have been increasing. For example, the North Kings deer herd in Fresno County was estimated at 17,000 animals in 1950, 3,500 animals in 1972, and only 2,000 animals in 1986 (Neal et al. 1987). Although it is unlikely that predation was responsible for the original decline, it may be that mountain lions are preventing the recovery of the North Kings deer herd (Neal et al. 1987).

Because predators are dependent on an adequate prey base for optimum reproduction and maintenance of population size, a question arises as to how lion populations have maintained such high numbers when their primary prey species have declined.

Lion predation on domestic livestock has increased steadily since the hunting moratorium was implemented in 1971. There were fewer than 10 reported mountain lion depredation incidents each year in 1971 and 1972. Those incidents have risen consistently until 1985, when almost 140 incidents were reported (Neal et al. 1987). In one study in the central Sierra Nevada, analysis of 62 mountain lion scats revealed that cattle made up 6% of the diet, third only to mule deer (61%) and small mammals (18%) (Boland and Briden 1985). Furthermore, the importance of cattle may have been underestimated by the collection methods used (Neal 1990).

Lions and other predators require additional prey during the time of the year that they are raising young. This may also coincide with peaks of predation on domestic livestock. For example in the intermountain region, coyotes (*Canis latrans*) prey on domestic sheep year-long but most frequently and persistently in the spring when coyotes are raising pups and lambs are available (Knowlton 1989). The presence of cattle in the Sierra Nevada during early summer may be providing a prey base to sustain high lion numbers, which in turn allows lions to continually depress mule deer numbers.

Harley Shaw, a research biologist in Arizona, has studied mountain lions for many years. He writes of his work at the Spider-Cross U Ranch: 'It should be noted that the deer herd was at a relative low during the five years we spent at Spider-Cross U. Thus cattle losses may have been higher than under conditions of higher deer numbers. One of the complicating factors in lion-cattle predation lies in the fact that the calf crop hits its peak in late winter and early spring. This is the period when the deer herd is at its annual low. In pre-livestock times, the lion population would have declined when the deer population reached a critical low. Under present conditions, the presence of an abundance of calves, exactly at the time of year a lion population would normally have been stressed, serves to prop up lion numbers in the face of low native prey numbers. This may serve to hold deer numbers down, as well as livestock. Our data from both the Kiabab and Spider ranch indicate that lions preferred deer over cattle on a ration of about 3:2, if relative abundance of the two prey species was taken into consideration. Lions would therefore continue to select deer over cattle even when deer numbers were low, but the presence of calves at the critical period would allow lions to survive. Since cattle numbers are sustained at the allotment level by the rancher, the net results could be long-termed depression of deer numbers and continued heavy predation on calves. As in most ecological matters, the best conclusion to be drawn from all of this is that things are never as simple as they seem (Shaw 1989:95-96).'

If the presence of cattle in the Sierra Nevada during early summer is helping to sustain high populations of mountain lions, and if a desirable management goal is to allow lion numbers to equilibrate with available native prey species such as mule deer, then changes in cattle numbers, and rotational grazing might be used to reach that goal.

Change in livestock numbers.—Reductions in livestock numbers could help to reduce alternate sources of prey for mountain lions, reduce their reproductive success, and ultimately lower their numbers. As stated by another research biologist, 'recovery of the (North Kings) deer herd will require major changes in the predator-deer dynamics and may only occur after the limited prey base declines to the point that it causes a crash of the mountain lion population' (Neal 1990:60).

Rotational Grazing Systems.—Rest-rotation grazing, with accompanying reductions in cattle numbers could have the same impact as simple changes in livestock numbers.

OTHER RESOURCES IN THE SIERRA NEVADA

This review has been limited to selected wildlife species for which research information has been made available over the past 15 years. It is not meant to be a complete review of livestock grazing on all terrestrial wildlife in the Sierra Nevada. Nor does it attempt to address the role of alternate livestock grazing strategies on fisheries resources. Finally, it only indirectly deals with plant resources.

For example, aspen provides valuable habitat for many wildlife species in the Sierra Nevada (Verner 1988). Aspen usually reproduces vegetatively from root suckers (Schier et al 1985). Browsing and trampling by livestock and wild ungulates can seriously affect the growth and survival of those suckers (DeByle et al. 1985). In fact, in areas of Canada where aspen is abundant and the management goal is to convert some of those stands to open grasslands, cattle grazing in late summer can be a useful tool (Fitzgerald and Bailey 1984). Conversely, successfully regenerating aspen may require the exclusion of cattle for up to 5 years (Crouch 1983). Similar long-term rest from livestock grazing may be necessary in the Sierra Nevada as part of a management program to increase the abundance of aspen.

In addition, there are over 200 plants listed by the state of California as threatened or endangered statewide, and livestock grazing was the second-most frequently cited adverse factor in over 40 instances, second only to development (DFG 1990). Many of those species occur in the Sierra Nevada, and some are also listed as federally threatened or endangered. These species need to be considered in evaluating livestock grazing alternatives.

RANGE CONDITION IN THE SIERRA NEVADA

Rangelands exist in many different successional stages and structural conditions because of the influence of fire, mechanical disturbance, herbicide treatment, and grazing by wild and domestic herbivores. Plant communities respond to ungulate grazing in a more or less predictable way, depending on the plant species present and type of ungulates (Dyksterhuis 1949, Stoddart et al. 1975). Some plant species are dominant in climax communities because they are superior competitors in the absence of disturbance. These species, referred to as decreasers, are often the most palatable to livestock and most susceptible to grazing pressure. They begin to decline in vigor and abundance with increased grazing pressure (Dyksterhuis 1949, Stoddart et al. 1975). As they decline in abundance, other plants that are present at climax but which are less palatable become more abundant with relief from competition. These species are called increasers. If grazing intensity is sufficiently heavy and occurs over a long enough period of time, the increasers also begin to decline, and new plant species called invaders, well-adapted to heavy grazing, appear in the community.

Traditionally, rangelands have been managed on a concept of range condition based on how close the existing vegetation approximates the potential of an undisturbed, climax community (Dyksterhuis 1949). Sites dominated by decreasers are classified in excellent condition, and those made up mostly by invaders are judged to be in poor condition.

This procedure is used extensively in many areas of the western United States for purposes of livestock management. However, the system cannot be used on most seeded stands, or other sites containing large numbers of introduced but naturalized plant species such as the annual grasslands of California (Smith 1978, 1988). In addition, the model is not very useful in assessing small, stringer meadows in the Sierra Nevada (Allen 1989). Production of livestock forage in such stringer meadows on the University of California's Blodgett Research Forest declined between 1977 and 1987, but species composition and total cover did not change. It was suggested that more effective grazing systems were needed to improve those meadows, and a better method for assessing condition was needed (Allen 1989).

The rangeland condition terms excellent, good, fair, and poor are all defined in terms of providing forage for domestic livestock. However, wildlife species differ in their habitat needs. For purposes of managing wildlife habitat, descriptions of range condition must be dependent on specific management goals for individual or groups of wildlife species (Smith 1978).

A better system of classifying range condition is based on management objectives for soil stability and protection, and specific management goals for other resource values such as wildlife and fish habitat (Schlatterer 1986). In this system, a rating is assigned for each resource value. Overall range condition would be judged satisfactory only if a site were judged satisfactory under all objectives, or if at least there was an improving trend.

For example, consider a situation where primary emphasis is placed on cover and forage production for mule deer, with secondary emphases on livestock forage production and other resource values (Table 1). First, a determination is made as to whether soil stability goals are being met. If not, then overall condition is unsatisfactory. If they are, then mule deer cover and forage production concerns are addressed. If those objectives are not being met and conditions are not improving, then the resource value rating for mule deer habitat and overall range condition is unsatisfactory. Management objectives for livestock forage production and other resource values are considered in turn. Again, overall condition is satisfactory only if the site is judged satisfactory under all objectives, or there is an improving trend among those objectives rated unsatisfactory. Additional goals might include nesting habitat for willow flycatchers, or cover for microtine rodents.

Table 1. Use of resource value ratings on a rangeland site where the primary emphasis is on providing cover and forage for mule deer, with secondary emphases on providing forage for livestock and meeting other resource management objectives (after Schlatterer 1986).

A. SOIL STABILITY. Soil lacks vegetation cover or other soil surface protection adequate to protect the soil from accelerated erosion.	RESOURCE VALUE RATING RANGE CONDITION	= Unsatisfactory = Unsatisfactory
AA. SOIL STABILITY. Soil is stable with vegetation cover or other soil surface protection adequate to protect the soil from accelerated erosion.	RESOURCE VALUE RATING RANGE CONDITION	= Satisfactory = Go to B
B. MULE DEER COVER AND FORAGE. Mule deer cover and forage species composition and production of key species is at an unacceptable level <u>and</u> the trend in cover and key forage species composition and production is unacceptable.	RESOURCE VALUE RATING RANGE CONDITION	= Unsatisfactory = Unsatisfactory
BB. MULE DEER COVER AND FORAGE. Mule deer cover and forage species composition and production of key species is at an acceptable level <u>or</u> the trend in cover and key forage species composition and production is acceptable.	RESOURCE VALUE RATING RANGE CONDITION	= Satisfactory = Go to C
C. LIVESTOCK FORAGE. Forage species composition and production for livestock is at an unacceptable level <u>and</u> the trend in forage species composition and production is unacceptable.	RESOURCE VALUE RATING RANGE CONDITION	= Unsatisfactory = Unsatisfactory
CC. LIVESTOCK FORAGE. Forage species composition and production for livestock is at an acceptable level <u>or</u> the trend in forage species composition and production is acceptable.	RESOURCE VALUE RATING RANGE CONDITION	= Satisfactory = Go to D
D. OTHER RESOURCE VALUES. Management objectives for other resource values such as riparian areas and fish habitat are not being met <u>and</u> satisfactory progress is not being made towards achieving those objectives.	RESOURCE VALUE RATING RANGE CONDITION	= Unsatisfactory = Unsatisfactory
DD. OTHER RESOURCE VALUES. Management objectives for other resource values such as riparian areas and fish habitat are being met <u>or</u> satisfactory progress is being made towards achieving those objectives.	RESOURCE VALUE RATING RANGE CONDITION	= Satisfactory = Satisfactory

CONCLUSIONS

Research conducted over the 15 years has greatly expanded our knowledge of the interactions between livestock grazing and wildlife resources in the Sierra Nevada of California. Furthermore, we are now poised on the brink of a new era in natural resource management within the U.S. Forest Service. Programs such as New Perspectives, Change on the Range, and Rise to the Future are leading the agency towards insuring that production of timber and livestock forage will be accomplished with renewed attention to environmental values. Heavy livestock grazing with no concern for other resource values is no longer acceptable. Fortunately, alternatives to current grazing practices exist, and can be used to provide benefits to wildlife and other resources while still allowing an important use of our national forests to continue.

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