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Abstract: Current dilemmas in management of the large mammalian predators (mountain lions, coyotes, and bobcats) result from various positive and negative values placed on them by society.

The size of predator populations in the Great Basin is probably limited by available native prey, although coyotes at times feed extensively on livestock and utilize carrion. In general, organized predator control programs do not depress populations except in localized areas. Current sport hunting and trapping activities are thought not to limit coyote or mountain lion numbers, but their effect on bobcats is uncertain.

Studies indicate that coyotes can have a measurable impact on jackrabbit numbers. The effect of predators on rodent and rabbit populations is probably small, but data are lacking. At certain times and places, predators may play a role in limiting numbers of large native ungulates, but overall, nutrition is believed to be a more important constraint.

Coyotes are responsible for most of the livestock, principally sheep, lost to predation. Current predator control practices seek to reduce losses rather than to reduce predator numbers over large areas. Because predation can reach economic levels unacceptable to livestock producers, they often favor more intensive predator management. Sport hunters, trappers, and persons who attach esthetic value to these species usually desire static or increased numbers of predators.

Six predator management options are outlined and their expected effects are discussed.


Predator Food Niches

Each carnivore species in the Great Basin is adapted to a particular, but not exclusive, food niche. Mountain lions, for example, preferentially feed on deer. Bobcats most commonly prey on rodents and rabbits, seldom taking larger species. Coyotes are among the most versatile feeders. They concentrate on certain classes of rodents and lagomorphs, but will utilize various fruits, insects, and carrion as well as young ungulates when available (Young and Jackson 1951). Coyotes also kill ungulates as large as adult antelope and mule deer in some circumstances. Most carnivores, on occasion, kill more than they consume and often make food caches of one form or another. The reason for surplus killing is not understood, but presumably it is associated with some evolutionary survival scheme.

We are not aware of any place in the Great Basin where livestock serves as a dietary staple for any of the major carnivore populations, although individuals may feed extensively on them for a period of time. This periodic use of livestock as prey reflects the transient nature of the livestock industry, especially sheep, in the Intermountain West. At the same time, it should be recognized that livestock may temporarily flood the food base in particular locales, encouraging "prey-switching" among opportunistic feeders. At this time we can only speculate that individual carnivores have specific preferences for prey, on the basis of experience, need, and ability. Although any of the large carnivores are capable of killing livestock, especially sheep, it is clear that many do not.

PREDATOR EFFECTS ON WILD PREY

Lagomorphs and Rodents

To ascertain the effects of predators on prey populations requires, at minimum, an analysis of the demography of both prey and predator, and estimates of the fraction of prey populations removed by the predators. One of the few studies that has assembled an array of data relevant to predator effects on prey in the Great Basin is a 15-year study of black-tailed jackrabbit and coyote populations in the Curlew Valley of northwestern Utah, a predominantly sagebrush area (Gross and others 1974, Stoddart 1977).

Results of this study suggest that
predation by coyotes is a major force in determining the form and magnitude of the jackrabbit cycle, as well as being the major constraint in determining the long-term mean jackrabbit density. With less or no coyote predation, mean jackrabbit densities would probably be higher for at least a few years. Food-habit studies and population estimates of raptors and other carnivores in the area suggest that their effects on jackrabbit populations is minor (Wagner and Stoddart 1972).

We do not know of comparable studies of the effects of predation on rabbits (Sylvilagus) and rodents. Rodents are generally preyed upon by a broader spectrum of predators than are jackrabbits and, therefore, it is unlikely that any single predatory species assumes the importance that coyotes assume in the case of jackrabbits. In general, evidence as to the effects of predators on rodent and rabbit populations in the Great Basin is not sufficient to permit statements on the subject.

Jackrabbits prefer relatively uncommon plant species which are also highly palatable to livestock and probably pronghorn antelope (Vorhies and Taylor 1933, Westoby 1973). These are plants which apparently were more abundant components of the vegetation in pre-Columbian times. Today, jackrabbits during cyclic population highs use their preferred foods so fully that they may be reducing the abundance of those plant species. If relieved of predation pressure, jackrabbits would probably increase, amplify pressure on the vegetation, and eventually alter its composition to the detriment of themselves as well as of livestock and pronghorn.

Wild Ungulates

Several predatory species prey on deer, antelope, and bighorn sheep. The most important are mountain lions, which prey primarily on mule deer, and coyotes, which prey on both young and adult mule deer and pronghorns (Knowlton 1976, Nielsen 1975, Trainer 1975). Coyotes are probably the more influential of the two.

Studies in Utah and Arizona suggest that antelope fawn survival can be increased with intensive coyote control (Arrington and Edwards 1951, Beale and Smith 1973, Udy 1953). Survival of mule deer fawns in coyote-proof enclosures in Arizona was higher than that of fawns outside enclosures (Le Count 1974, 1975; Smith and Le Count 1976).

It does not necessarily follow that a reduction in fawn mortality will lead to population increases. Fencing Texas whitetail deer in coyote-proof enclosures did increase populations above the densities outside the enclosures for a few years (Kie 1977), but eventually parasite and disease problems associated with nutritional stress compensated. Similar results might be obtained in some mule deer and antelope populations.

Food conditions operating through the nutritional state of the animal may often be much more influential than predator densities in limiting deer and antelope numbers. Most mule deer populations, and antelope populations in the Great Plains, increased markedly in the first half of the present century before toxicants were used for the reduction of coyote populations (Cain and others 1972, Julander and Low 1976).

Antelope populations in the Great Basin, however, did not increase between 1950 and the middle 1960's, the period of maximum toxicant use, although those on the Great Plains continued to thrive. The difference in productivity between the populations of these two regions may stem from nutritional causes, more specifically, from two aspects of vegetation condition. First, rainfall seasons and, therefore, periods of plant dormancy, differ between the areas. Great Basin precipitation occurs predominantly in winter and vegetation goes dormant in early summer, about when fawns are born. On the Plains, precipitation occurs throughout the summer and vegetation is active through this period providing better nutritional conditions during fawning and the early months of fawn life (Knowlton and others 1979). The second difference may lie in the more profound alteration in Great Basin vegetation as a result of livestock use. The more arid conditions of that region may make it more vulnerable to grazing impact. It may be changed more profoundly from the pre-Columbian condition, which supported sizable antelope numbers, than is the Plains vegetation.

Both aspects may be responsible for the perennially higher fawn-to-deer ratios of the Plains populations of late summer as compared with those of the Great Basin. The point is belabored here to emphasize the overriding importance of nutrition as a constraint on ungulate dynamics.

Predation losses may reflect inadequate

Studies show that some ungulate populations can be temporarily increased through intensive predator control thereby increasing fawn survival (Connolly 1978). It is also possible that deer populations may be able to react more quickly to favorable environmental circumstances. But the general press of ungulate populations against the limits of the food supply raises doubt that long-term population increases could be effected. Short-term increases in density could result in longer-term reductions in numbers.

EFFECTS ON LIVESTOCK

Losses Under Current Levels of Predator Management

Sheep are killed by a number of predatory species, with coyotes generally responsible for from 75-85 percent of predatory losses, and domestic dogs, mountain lions, and bobcats taking most of the remainder. Average predation losses for large regions or states range from 2 to 7 percent for combined stock sheep and lambs (Bowns and others 1973, McAdoo 1975, Nass 1977, Iigner and Larson 1977). Predatory losses sustained by individual ranchers are distributed over a skewed curve, with most ranchers sustaining light losses (some suffering none) and a minority of ranchers sustaining up to 25 or 30 percent (Balsen 1974, Gee and others 1977, Nielsen and Curle 1970). Lamb losses are substantially higher than ewe losses.

Cattle losses have not been measured over large areas, but they obviously occur at much lower levels than sheep losses. These losses, which are mostly calves, may assume substantial proportions at times in localized areas (Gee 1978).

Losses Under Reduced or No Predator Control

Data are not available on a regional basis on the magnitude of sheep losses in areas of no predator control. Isolated ranches have been studied in Montana, California, and New Mexico. In these locations, losses as high as 30 percent have been measured (De Lorenzo and Howard 1976, Henne 1975; McAdoo and Kelbenow 1978; Munoz 1976), and these losses are perhaps comparable to the 25 to 30 percent extremes under controlled situations. It seems highly probable that loss rates would rise if all controls were removed from coyote populations.

Some evidence suggests that average loss rates are related to the abundance of coyotes (Cain and others 1972).

Effects of Livestock Husbandry Practices

Evidence indicates that loss rates sustained by ranchers who "shed lamb" are lower than those of ranchers who lamb on the range (Gee and others 1977). This may be because of the protection afforded the lambs by the shed facilities, and also the earlier maturity of lambs that can be removed from the range before the late summer and early fall period of accelerated loss.

Evidence also indicates that herded flocks sustain lighter losses than flocks which are not herded (Bowns and others 1973, Davenport and others, 1973), although this may not always be true.

Economic Significance of Losses

Recent estimates place the profit margin of the sheep industry at roughly 4 percent (Gee 1974). This estimate results if the value of land, buildings, and capital facilities are included in the cost of operations. This margin of profit is roughly equivalent to the value of sheep lost to predators under current control programs.

PREDATOR MANAGEMENT PATTERNS AND OPTIONS

Historical Management Patterns

Before 1960, operational control programs sought to reduce depredations by general reduction of predator population levels. During this period, toxicants were used widely to manage coyote populations in particular, and relatively few restrictions were placed on control techniques. These control programs were comparatively lower in cost and less selective in removing only offending animals than are current programs.

Current Management Patterns

Current programs are designed to be more selective than pre-1960 management programs and are restricted to stopping existing livestock depredations and preventing depredations in areas of predictable loss. These programs, which are substan-
ally more costly, rely heavily on the use of aircraft (particularly helicopters) and mechanical control methods such as trapping, shooting, and denning. The toxic M-44 device is used on a limited basis only because of use restrictions and its lack of effectiveness in controlling coyotes during some periods of the year. The current programs are in operation only on about 10 to 25 percent of the total land area in the West at any given time (Balser 1974).

Management Options

There are various management options in dealing with predators in the Great Basin. We will discuss six options and their effects on predators, wild prey, livestock, and economics.

1. Maximal Predator Removal

The effects of this option are predicated on drastic reductions in populations of coyotes, mountain lions, and bobcats. For coyotes, this could be accomplished only by relaxation of current restrictions on toxicant use or extremely high funding for current programs, or both.

The effects of this option could be expected to be:

(a) A significant reduction in depredations on livestock.
(b) An improved profit margin for livestock operations, of undefined magnitude.
(c) A reduction in the predation of coyotes on other species. On the basis of ongoing studies, there would be an expected increase in mean jackrabbit densities with a potential for deterioration of range vegetation valuable to livestock (Stoddart 1977).
(d) A reduction in the availability of coyotes and bobcats as a fur resource.
(e) A reduction in the sport hunting and esthetic opportunities provided by mountain lions, coyotes, and bobcats.
(f) A change in relative species composition in favor of small carnivores (Linhart and Robinson 1972, Robinson 1961).
(g) A probable reduction in disease transmission by coyotes (hydatid cyst disease, sarcocystis, and rables).
(h) A probable short-term increase in large wild ungulates because of coyote reduction, with uncertain long-term effects.
(i) A possible increase in the stocking of sheep on Great Basin rangelands.

Maximal predator removal would require an intensive maintenance effort. It also would cause intense concern to those who object to reducing predator numbers.

2. Maximal Removal of Coyotes Only

The effects of this option would be about the same as for Option 1, with the following exceptions:

(a) Bobcat populations would increase substantially, improving their availability as a fur and esthetic resource.
(b) Increased numbers of bobcats and other small carnivores would use rodents more heavily as a food source.

3. Complete Protection of Mountain Lion, Coyote, and Bobcat

This option would require legal restrictions prohibiting the taking of the mountain lion, coyote, and bobcat by any means and for any purpose.

The effects of this option could be expected to be:

(a) An increase in coyote population density, occurring primarily in areas of previously intense coyote control.
(b) The elimination of the range sheep industry in the Great Basin.
(c) Use of suitable range for cattle production, with resulting increases in calf depredations by coyotes in particular.
(d) A decrease in the mean density of jackrabbits (based on the studies of Stoddart 1977 and Wagner and Stoddart 1972).
(e) A short-term reduction in densities of wild ungulates; this would allow vegetation changes beneficial to these prey species. This might allow subsequent ungulate increases, depending on interrelationships with livestock use.
(f) A potential increase in epizootics in coyote.
(g) A probable increase in coyote "nuisance" problems in areas of high human activity.
(h) A reduction in population densities of small carnivores and bobcats because of increased coyote numbers (Linhart and Robinson 1972, Robinson 1961).
Under current socio-political programs, this option is unacceptable.

4. Elimination of Current Operational Programs

This option would eliminate current supervised programs, but it would allow private parties to control predators and would allow sport hunting and fur trapping to continue.

The effects of this option would be expected to be similar to those of Option 3, with these exceptions:

(a) Overall coyote density would increase slightly.
(b) Sheep losses of undetermined magnitude would increase.
(c) Ungulate and lagomorph population densities would not change appreciably.
(d) Loss of non-target species would be greater.
(e) Use of unregistered toxicants and illegal control practices would probably increase.

5. Behavioral Modification of Predators (conditioned avoidance of livestock)

The efficiency of this approach has been challenged (Griffiths and others 1978). The effects of this option, assuming the technique works, would be essentially the same as for Option 3, with the following exceptions:

(a) Reduced depredation on livestock.
(b) Availability of predators as a fur and sport hunting resource.

6. Maintenance of Current Levels of Control

The effects of this option would be expected to be:

(a) A maintenance of artificially reduced coyote populations in areas of livestock depredations.
(b) Continuation of a program with the goal of selective removal of individual problem animals and localized population reduction.
(c) Continued requirement of present or increased levels of funding.
(d) A continued rate of depredation which has a depressant effect of undetermined magnitude on profit margins of sheep operations.
(e) Little effect on wild ungulate populations, because no programs are conducted specifically for their benefit in the Great Basin.

It is difficult to assess the sociopolitical factors that affect this option because of the diverse groups of the public involved.

Additional management options, which are variations of the six listed above, were not considered in depth because of constraints of time, but their effects would be expected to be variations of those listed.

INFORMATION NEEDS

In reviewing the currently available information on predators, predation, and depredations, several areas where additional information seems warranted become apparent.

1. An annual survey of the livestock industry to document trends in livestock losses, in toto as well as those attributed to predation, should be initiated. Trends in depredation should be related to changes in predator densities, predator management practices, and environmental conditions. The magnitude of cattle losses to predators is currently a major informational void.

2. Measures of the effectiveness of depredation control methodology in manipulating predator populations and reducing predations are needed.

3. Annual predator population trends, perhaps identifiable to smaller units, should be monitored.

4. Periodic assessment of societal interests, values, and preferences are needed to modify management goals.

5. More definitive information on the effect of predators on prey populations is needed. Knowledge of single and multiple species predation on rodents needs attention. Interactions of predation and nutrition upon ungulate populations needs to be explored, and conditions under which improved neonatal survival is reflected in recruitment to the mature portion of herds need to be defined.

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