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# SHEEP DEPREDAATION BY GOLDEN EAGLES IN MONTANA

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ABSTRACT: A limited study on two ranches near Dillon, Montana, near the end of the lambing season in 1974 revealed that 44 domestic lambs were killed by golden eagles (Aquila chrysaetos). This was 76 percent of all deaths recorded during the short study. Using an average docking percent of 90 (based on years before severe eagle problems developed), the 76 percent eagle predation, and the 1974 docking percentages, the ranchers estimated an eagle kill of 1,092 lambs valued at about \$38,000. The U.S. Fish and Wildlife Service livetrapped and removed 249 golden eagles from the ranches during the next three springs. During 1975, when 145 eagles were removed, docking percentages were even lower than in 1974, and the ranchers estimated a loss of \$48,000. During 6 hours on one ranch in 1975, I found 15 fresh eagle kills. Less severe eagle problems occurred during 1976 and 1977, and the docking percentages improved. The effect of the trapping program on predation could not be evaluated. Lamb losses were greatest during the years of greatest trapping success. Decreasing lamb losses in 1976 and 1977 may have resulted from increasing populations of jackrabbits (Lepus spp.) throughout the West. Juvenile and subadult golden eagles caused most of the predation. A decline of jackrabbits may have caused these young birds, which had no established territories, to concentrate on the lambing grounds. As numbers of sheep decline on western ranches, eagles may take a greater percentage of lambs from the remaining herds. With golden eagles totally protected, increasing predation on lambs should be expected, especially when natural prey is scarce. Because of the expense and the relative scarcity of qualified personnel, the trapping and moving of depredating eagles is not a practical operational procedure. Non-lethal methods of eagle management show little promise for alleviating lamb losses. Experiments should be conducted combining scare tactics, including shooting near the birds, with limited killing for reinforcement. Illegal control may endanger juvenile bald eagles (Haliaeetus leucocephalus) and result in the killing of many golden eagles if ranchers are not assured of aid when a serious depredation problem occurs.

The extent, or even existence, of predation by golden eagles on livestock is controversial. In fact, for many admirers of this majestic bird, simply discussing it at a pest conference is sheer heresy. However, the hunting of golden eagles, from the ground and air, was common throughout the West until the Bald Eagle Act of 1940 was amended in 1962, providing protection for the golden eagle. The Act allows the shooting or trapping of golden eagles when serious depredations to the livestock industry are determined but forbids shooting from aircraft and poisoning, except for research purposes.

Until 1970, governors could, at the discretion of the director of the U.S. Fish and Wildlife Service (USFWS), obtain "blanket" permits for taking golden eagles in specified areas (usually a county or block of counties) for a specified period of time. The occasional shooting of juvenile bald eagles, mistaken for golden eagles, was feared and added to public sentiment against killing any eagles. Awareness of a general threat to birds of prey from pesticides during the 1960's heightened public concern for all raptors.

On 5 March 1970, then Secretary of Interior W.J. Hickel sent a memorandum to the director of the USFWS. Excerpts follow:

The several staff papers, studies, and reports relating to the question of controlling golden eagles to prevent livestock depredations have been studied very carefully.

The studies referred to indicate that depredations are not widespread and that they do not threaten either the local economies or the livestock industry generally. . . .

In processing applications from the Governors of the several western States, you are instructed to make a detailed investigation into the question of economic hardship and to exercise the most careful judgment regarding the question of whether or not the situation is so critical that extraordinary measures must be taken for the protection of any particular domesticated flock or herd in said States. "Blanket" permits as such will no longer be issued. This action is not intended to preclude the issuance of necessary permits for scientific exhibition, or religious purposes, or the issuance of individual permits where, after investigation and report to me, I conclude that such individual permit is necessary. [Emphasis mine.]

Some idea of the resistance to eagle control can be gathered from the following. In 1976, the Governor of Texas requested a depredations control order for the purpose of taking golden eagles. The director of the USFWS denied the request partly on the following basis:

- 1) Relying, as the March 5, 1970, order does, on scientific knowledge about the behavior of eagles, there is no cause to reconsider the said order unless data are presented demonstrating the fallacy of currently accepted knowledge on the behavior of eagles or demonstrating a change in the actual behavior patterns of golden eagles. No such data have been submitted...

<sup>1</sup>The U.S. Fish and Wildlife Service, The Montana Fish and Game Department, The University of Montana, and the Wildlife Management Institute, cooperating.

- 3) In addition to the total lack of any scientific justification for the issuance of this depredation control order, the Director notes that, although notice and opportunity for public comment need not be provided in considering the merits of depredation control order applications, the public has volunteered comments on this proposal, and that these comments are among the most vehemently and bitterly critical comments ever received by the Service with respect to action under consideration. [Emphasis mine.]

Of 129 comments received, only 1 favored granting the order. That letter did not offer data to support the writer's position. The vast majority of the comments challenged the request as benefiting only a special interest group which, many of the opponents asserted, was acting on prejudice and ignorance. Many citizens further challenged the existence of any scientific basis for assuming that any benefit would result (Federal Register 1976:50355-50356).

The above sets the tone for the history and public attitudes toward eagle predation and control in the western United States.

Secretary Hickel's memorandum and Director L.A. Greenwalt's rationale for denying the Texas request for a depredations control order reflect the lack of documentation concerning golden eagle predation.

In Montana, the Governor received "blanket" permits from 1962 through 1968, allowing control of golden eagles in counties where sheep were raised and livestock predation had occurred. The open season was generally in the spring before, during, and after lambing. In 1969, the Governor's request was held in abeyance, and in 1970, Secretary Hickel set the new policy.

Studies of golden eagles in the Big Timber-Livingston area of Montana generally indicated little or no predation on domestic animals (McGahan, 1968; Reynolds, 1969). However, most ranchers in that area practiced shed lambing very early in the spring before eagle migrations. Thus, eagle migration patterns and sheep management practices were not conducive to eagle predation. Certain ranchers in Montana apparently did suffer significant losses. At a 1976 meeting in Dillon, Norton Miner, USFWS Animal Damage Control (ADC) Chief for Montana, reviewing the problem of eagle predation on lambs, noted that it was not a new problem, that it was widespread in the State, and that some ranchers had been driven out of the sheep business by eagle predation.

Documentation of eagle predation is generally lacking. The public seldom accepts rancher's accounts of any type of predation, apparently suspecting ulterior motives. Indoctrination by animal protection groups has convinced many people that predators prey only on species that are detrimental to man. Another theme stemming from the same source is that predation on domestic livestock is always the result of poor animal husbandry, and that slight changes in management would solve the problem.

This paper is intended as a limited documentation of one instance of golden eagle predation on domestic lambs. The results are based partly on my work, but draw heavily on the work and reports of others. I am grateful for the cooperation of the many people who contributed to this project, and especially thank ranchers Joe Helle and Peter Rebish; USFWS personnel Donald Balser, Norton Miner, Erwin Boeker, Carter Niemeyer, and Mike Lockhart; and graduate students Max Zahn and Van Jameson. This research was partly funded by the Denver Wildlife Research Center under contract 14-16-008-1135.

#### METHODS OF IDENTIFYING EAGLE FEEDING AND KILLS

Five or six golden eagles were kept at the Montana Cooperative Wildlife Research Unit for more than 10 years. Observations of those eagles' feeding (and occasionally killing) habits aided me in interpreting whether or not lambs were killed or fed upon by eagles in the field. Occasionally, ranchers or hunters in western Montana asked me to view the remains of white-tailed and mule deer (*Odocoileus virginianus* and *O. hemionus*) which they had seen killed by eagles. I always conducted extensive necropsies on such carcasses. In 1973, I attended a course at Colorado State University, Fort Collins, on identification of sheep diseases and predator kills. Numerous slides were shown of wounds on lambs that had been observed being killed by golden eagles.

Thus, I felt confident in identifying eagle kills. The following criteria were used to determine whether or not lambs were fed upon or killed by eagles.

#### Feeding

Carcasses, heavily fed upon by eagles, appear to be turned inside out; backbones are usually intact though devoid of ribs, and leg bones are pulled out of the skin and most of the flesh is gone. Some ribs of young lambs are neatly clipped off close to the backbone and swallowed by the birds. Mammalian carnivores, especially canines, sometimes eat ribs, but they chew the soft lower ends, leaving ragged portions attached to the backbone. Eagles sometimes open the skulls without crushing them and eat the brains. Some birds hook their beaks into the foramen magnum and lift off the top of the skull. Others eat through the throat, taking the tongue and opening the skull from the bottom. Where an eagle feeds, "whitewash" and small, downy feathers are evident.

Carrion-eating birds also "hollow-out" ungulate carcasses but generally are unable to move them, reach the meat on the side next to the ground, or break off ribs. These birds pull meat away from the tendons, leaving frilly white tufts on the bones, whereas eagles cut the meat and tendons cleanly.

Feeding is not evidence of a kill. However, carcasses fed upon by eagles often have the head and neck intact and hemorrhaged talon wounds in those regions do indicate a kill.

### Kills

Lambs weighing 30 pounds or more are usually killed by multiple talon stabs through the tops of the ribs or into the small of the back. Eagles' talons are ideally shaped to close around the backbone of a mammal and puncture the aorta. The victims bleed out internally after the large arteries are punctured, often in the vicinity of or just anterior to the kidneys. Eagles sometimes seize young lambs by their heads. Lambs seem unafraid of eagles and apparently do not flee, as the wounds indicate that the lambs often are struck head-on. A single puncture from the claw of the hallux appears in the top or front of the skull and punctures from the opposing talons are at the base of the skull or top of the neck. Eagles simply land on some very young lambs and start feeding. The lambs die from bleeding as the entrails are pulled out, resulting in the spraying of considerable blood on the ground. Such kills are difficult to diagnose because young lambs recently dead from other causes seem to have a slow clotting time and also bleed on the ground when fed upon. Unless clear evidence of arterial spurts are seen on the ground or vegetation, carcasses without talon wounds and subcutaneous hemorrhages are not classified as eagle kills, even though some of them undoubtedly are.

Except for one lamb that was seen being struck by an eagle, eagle kills were determined by examining the pattern of wounds. Eagles grasp their prey with three toes opposing the hallux on each foot. The middle toe is the longest; consequently, if the prey is large enough, the toe talons leave wounds 1 or 2 inches apart in a row or a shallow V. The hallux wound is 4 to 6 inches from the middle toe wound. In lambs killed by mammalian predators, four punctures or bruises from canine teeth are almost always evident. Lambs and deer heavier than 50 pounds often have so many talon wounds that the patterns described above are obscured. The birds must repeatedly stab such prey until it bleeds to death. I have seen golden eagles grab jackrabbits, about the size of newborn lambs, and the mammals never struggled. Apparently the grasp was strong enough to kill or paralyze those rabbits instantly. Commonly, in animals the size of small lambs, fewer than four talon marks are evident, one made by the hallux and one or two by the opposing toes.

Talon punctures are deeper than tooth punctures, and crushing is seldom noted between the talon wounds. Crushing results when mammalian predators seize lambs by the head. If clear punctures cannot be seen from the outside, carcasses must be skinned to ascertain the patterns of talon or tooth marks.

Subcutaneous hemorrhaging was considered evidence that an animal was alive when struck. When carcasses were completely eaten, the hemorrhaged blood was apparently eaten off of the skin. The eagles kept at the Montana Cooperative Wildlife Research Unit were not observed puncturing the skins of dead animals or of those small enough to be eaten alive. However, talon punctures without subcutaneous hemorrhages were not used as evidence of a kill, since different birds kill and feed in different ways.

The criteria used were conservative. Carcasses classified as eagle kills could hardly have been anything else. Inasmuch as many fed-upon carcasses not classified as kills undoubtedly were killed by eagles, the percentages of kills attributed to eagles must be considered absolute minimums.

### THE STUDY AREA

The Rebish Brothers and Rebish and Helle, Inc. Ranches, sometimes referred to as Rock Creek and Sweetwater Basin, are about 25 and 15 miles southeast of Dillon, Montana. The former covers about 23,000 acres of rolling grassy hills, is located at the head of Rock Creek and includes some State and Bureau of Land Management (BLM) lands. Lava formations, protruding from hillsides and surrounding mountains, form ideal perches for eagles. Deep coulees create thermals and updrafts that aid flying eagles. The Rebish and Helle, Inc. Ranch, consisting of about 7,000 acres of mixed sagebrush grasslands, is along the west border of the North Fork of Sweetwater Creek and includes one section of BLM land. Large boulders and rock outcroppings are common along with scattered patches of aspen and pine. Both ranches provide excellent terrain for the birds.

Historically, the Rock Creek-Sweetwater Basin Area was used primarily for raising sheep. The terrain and precipitation are such that sheep are more efficient than cattle in using the available vegetation. In the sheep industry in this area, as in Montana generally, total numbers of sheep have progressively declined in recent years. Increased management costs, labor problems, and predators, among other things, have been responsible for the decline.

### RESULTS

During the spring and early summer of 1972 and 1973, Joe T. Helle, acting for himself and on behalf of Peter W. and George M. Rebish, complained to the USFWS of lambs being killed by golden eagles on their ranches. Mr. Helle indicated a desire to cooperate in a livetrapping and removal or documentation project. Because of funding and time limitations, no action was initiated by the Service.

During early June 1974, Mr. Helle again complained of eagle predation on his lambs. On 6 June, a USFWS Law Enforcement Agent (E.V. Cofer) spent 2 hours with the herds and picked up 16 lambs apparently killed by eagles that day. All had talon punctures through their backs into the lungs and kidneys. Hemorrhages on the punctures indicated that the lambs were alive when the punctures were made. On the same day, Agent Cofer estimated that at least 40 golden eagles were in the vicinity of the sheep herds (20 were seen in the air at one time). He issued the ranchers rockets and explosive shotgun shells to disperse the eagles, but all attempts failed.

Later, two applications requesting a permit to take golden eagles, which were killing lambs, were received from Peter W. and George M. Rebish, and from Rebish and Helle, Inc. The ranchers estimated their daily losses since the start of lambing in early May at 20 to 30 lambs. When the applications reached USFWS Headquarters, biologists and ADC agents were sent to investigate. Eugene Knoder, western representative of the Audubon Society and I accompanied the group.

The spring of 1974 was unusually cold in western Montana, but the weather turned hot the second week in June, just as the group arrived at the ranches. Numerous golden eagles, mostly juveniles and subadults, were near the sheep herds, but few were hunting. An aerial survey revealed many eagles among the lambing herds, but only one eagle nest. Young ground squirrels (*Spermophilus richardsonii*), recently emerged from burrows, were numerous. Hollowed-out carcasses, typical of eagle feeding but too old and dry for determination of cause of death, were found. Captive eagles at the Montana Cooperative Wildlife Research Unit had fed daily during the cold spring weather, but immediately reduced their intake to three or four feedings per week with the onset of hot weather. The wild eagles seemed to be following a similar feeding pattern.

The ranchers agreed to withdraw their requests for kill permits and cooperate in a documentation study providing the USFWS paid for documented eagle kills. Lambing was more than 50 percent complete when the study began and the weather remained warm. Three USFWS employees, several sheep herders, and two University of Montana graduate students searched for carcasses. The students spent several days with D.R. Henne, who was conducting a study on a western Montana ranch (Henne, 1977), necropsying lambs to learn about sheep diseases and predator kills before joining in the searches. The students determined that some lambs had died at birth or from various diseases, but I verified the identity of predators responsible for kills.

Since fresh eagle kills were not reported by herdsmen in the Sweetwater Basin, efforts were concentrated at Rock Creek. Thirty-six carcasses that had been almost totally consumed by eagles, were found. Because all had been dead for more than a week, documentation of the causes of the deaths was impossible. Since the probability of finding an old kill in 27 sections of range land must be low, the finding of 36 carcasses indicated that heavy feeding by eagles must have occurred before the study began.

Finding fresh carcasses was easier than finding old ones because the searchers knew where the sheep had bedded the night before, and could confine their searches to smaller areas. Frequently, golden eagles were still feeding when the morning searches began. On one occasion, a USFWS searcher watched an eagle attacking a lamb. Eagles killed mostly the larger lambs; apparently they became particularly vulnerable when straying away from their ewes. Of 42 fresh carcasses found and necropsied, 28 were killed by eagles and 8 by coyotes (*Canis latrans*), 3 had starved, 1 had died of pneumonia, 1 was stillborn, and the cause of death of 1 very young lamb was not determined. Addition of the 16 eagle kills found by Agent Cofer brought the total to 44 such kills (76%) among the 58 fresh carcasses found.

In 1974, Rebish Brothers had a docking percentage of only 47.5 (witnessed and documented by USFWS personnel) and Rebish and Helle, Inc., 63.8 percent. Using an average docking percentage of 90 (which they had recorded over a period of years before 1970), the 76 percent eagle predation documented by Agent Cofer and me, and the 1974 docking percentages, the Rebishes and Helle estimated their losses to eagles during that year at 1,092 lambs valued at about \$38,000 (Table 1).

Table 1. Lamb docking data and estimated monetary losses at two ranches, 1974-77.

Year and ranch	Total ewes	Lambs		Estimated loss (\$)
		No. docked	Percent	
<b>1974</b>				
Rebish Bros.	2,248	1,068	47.5	38,220
Rebish and Helle	1,848	1,180	63.9	
<b>1975</b>				
Rebish Bros.	2,118	900	42.5	48,960
Rebish and Helle	1,924	1,013	52.7	
<b>1976</b>				
Rebish Bros.	1,860	1,302	70.0	18,350
Rebish and Helle	1,826	1,490	81.6	
<b>1977</b>				
Rebish Bros.	1,731	1,143	66.0	16,380
Rebish and Helle	1,883	1,698	90.2	

In February 1975, 12 USFWS personnel met at the Denver Regional Office to formulate a management plan for 1975. All agreed that a study was needed on the extent of the problem, the existing food base, and the eagle population structure as a basis for management and related legal decisions. I estimated that a properly conducted study, including reimbursement of losses to the ranchers so predation could run its course and be documented, would cost about \$100,000 a year. In the absence of funding for such an approach, the group concentrated on various alternatives and their consequences. An interim plan,

the live removal of eagles before range lambing, was decided upon. This action would serve the double purpose of trying one feasible solution and precluding the need to consider a kill permit.

A field project leader, raptor specialist, and field assistant position were established specifically for the project. Trapping operations began on 4 March and continued through 8 July. Two bald eagles and 145 golden eagles were caught (Table 2). The bald eagles were immediately released; the golden eagles were released in known Montana and Colorado habitats where the probability of depredation on domestic lambs was deemed small. Severe lamb losses occurred in 1975, but factors responsible for all of the losses were not determined. On 30 May, I spent 6 hours on the Rebish Brothers' Ranch. Care was taken to avoid the lambing herds because young lambs followed any large moving object, often becoming lost from their mothers. However, 17 fresh lamb carcasses were found, of which 15 had been killed by eagles. The other two were very small lambs; one was fed upon so extensively by ravens (*Corvus corax*) that the cause of death could not be determined, and one had died of pneumonia. Golden eagles feeding on carcasses, or sitting on the ground nearby, facilitated finding seven of the kills. Most of the eagle kills were found within a half day of death. A few older, dried-out carcasses had been fed on by eagles but causes of deaths could not be determined.

Table 2. Age classification of 249 golden eagles trapped in 1975-77 in the Rock Creek area of Montana, and approximate costs involved.

Year	Age classification of eagles caught			Total	Cost (\$)
	Juvenile	Subadult	Adult		
1975	40	43	62	145	23,600
1976	29	14	14	69	13,750
1977	22	8	5	35	14,550

Docking percentages in 1975 were even lower than in 1974 (Table 1). Because of bad weather, the ranchers expected a docking count of 85 instead of 90 percent. They again used the 76 percent eagle predation figure and estimated a loss of about \$48,000.

From 1975 through 1977, four additional eagle management planning meetings were held in Dillon and Denver. Representatives of many federal, state, and private organizations, as well as ranchers, attended. Every conceivable management practice, from providing an artificial food source for eagles to a permit to kill all the eagles, was discussed. However, the Montana ADC Division was committed to continue livetrapping and translocation programs by the Director of the USFWS in 1976 and by the Region Six USFWS Director in 1977 (Niemeyer, 1976, 1977). The number of eagles captured and lamb losses decreased each year (Tables 1 and 2). All eagles were released in Yellowstone National Park. Documentations of predation was not attempted in 1976, but something was obviously still depressing docking percentages. Lamb losses to eagles appeared to be greatly reduced in 1977 when compared with 1974 through 1976. On the Rebish and Helle, Inc. Ranch, the docking count reached the 90 percent expected in a good year without serious predation; however, the Rebish Brothers recorded only 66 percent. Extensive documentation of causes of deaths was not attempted but the eagle trappers picked up 31 lamb carcasses as they were found. When I necropsied those carcasses, I found only two that were definitely predator kills--one by an eagle and one by a coyote. Three carcasses were so extensively fed on by eagles, and two by coyotes, that causes of death could not be determined. Other carcasses were too decomposed for determination, but most of the lambs had died at birth or soon after, without having fed.

Aerial and ground censuses on the depredation area showed that golden eagle numbers declined steadily in 1975 from January to mid-May. Natural dispersion of wintering birds from, or movement of migrants through, the area and removal of about 70 by trapping during this period undoubtedly accounted for the decline. In late May, during the peak of the lambing season, numbers of eagles (mostly juveniles and subadults) suddenly increased. Trapping success increased markedly, as evidenced by the capture of 65 eagles during June (Niemeyer, 1975).

Censuses in 1976 showed that golden eagle numbers declined from January to mid-March, probably reflecting the dispersion of wintering birds from the area. By the end of March, many golden eagles again appeared in the area. By mid-April, numbers had declined significantly. This build-up and decline probably represented a migratory population of eagles, predominantly adult birds, moving through. In late April, golden eagle numbers again increased. At that time, a higher proportion (50-70%) of juveniles and subadults appeared. Numbers of eagles fluctuated but increased during lambing in the Rock Creek area (Niemeyer, 1976).

Eagles were not censused in 1977 because so few appeared on the ranches. The average number of golden eagles sighted per day by the trappers was five and no significant fluctuation in numbers was noted that year (Niemeyer, 1977).

The spring of 1974 was late but not particularly severe in the Dillon area. The spring of 1975 was very severe. The winters and springs of 1976 and 1977 were unusually mild, resulting in good lambing conditions.

## DISCUSSION

Few documentation studies of livestock depredations were conducted in the United States before the early 1970's. Then studies were directed primarily at coyote problems; only two studies revealed any eagle predation. Tiger and Larson (1977), working on five ranches in southern Wyoming during 1973 through 1975, found 1,030 predator kills. Golden eagles were responsible for only 9 percent of that number. Henne (1977) found 449 lambs and sheep killed by predators on a western Montana ranch from the spring of 1974 to the spring of 1975. Only two were killed by eagles. Those lambs were killed after golden eagles had become accustomed to scavenging coyote kills. When the coyotes did not kill lambs or sheep for a couple of days, the eagles killed two lambs, each weighing 50-60 pounds. Thus, the short study reported here indicated higher levels of eagle predation than have been reported elsewhere. However, this was the only study directed primarily at an eagle problem. Further studies to document the extent of the problem are needed, solutions to unidentified problems are unlikely. Any studies undertaken should be adequately funded. While searching for fresh carcasses, researchers may separate young lambs from their dams, resulting in starvation. The owner should be compensated for such losses, as well as predator losses, if the study is to continue for several years.

The most important factor leading to excessive predation in the Dillon area during 1974 and 1975 was apparently a drastic decline in the jackrabbit population throughout the West. Few data are available, but biologists I talked to from the 17 western states all believed that jackrabbits were scarce during that time. Stoddart (1977), who studied the population ecology of the black-tailed jackrabbit (*L. californicus*) in Curlew Valley, Utah, from 1962 through 1977, showed that his index of spring density peaked at 130 in 1971 and fell to only 2.2 in 1975. During 1976 and 1977, densities increased somewhat to 7.0 in spring 1977. BLM records (Anonymous, 1972-1977) indicate a similar trend in jackrabbit numbers near Boise, Idaho, with an extreme low in 1973 followed by fluctuating low numbers and an increase starting in 1976. Marked eagles from the Boise area were seen on the Dillon ranches during lambing.

Local jackrabbit declines, especially in areas where breeding eagles hold territories, do not always lead to lamb predation. McGahan (1968) and Reynolds (1969) studied golden eagles in south-central Montana from 1962 to 1967. They identified 1,989 prey items at nests but found few domestic species--two cats, a chicken, a lamb, and an adult sheep. A reduction in local numbers of white-tailed jackrabbits (*Lepus townsendi*) and cottontails (*Sylvilagus auduboni* and *S. nuttali*) during those studies caused a decline in the eagle population, and some pairs failed to nest when rabbits were at their lowest numbers.

The uncanny ability of scavenger birds and some raptors to find food sources is well known but poorly understood. The problem area near Dillon had few nesting eagles, so there was little or no intraspecific pressure to keep young, non-territorial eagles out. Because of a scarcity of food in early spring, young eagles congregated on the lambing grounds to survive. Predation became less severe each spring after 1975 as jackrabbits became more numerous. Also during the springs of 1974 and 1975, predation seemed to decline as young ground squirrels left their burrows and became available.

Another aspect of the food shortage and heavy depredation rates involves the number of sheep. As the West was settled and native ungulates were reduced in numbers, domestic sheep became numerous. Lambs probably supplied food before young ground squirrels emerged in years when rabbits were scarce. When some 50 million sheep were on the range, predation was probably not excessive on many flocks. Now, with less than one third as many sheep, predation by a similar number of eagles would naturally take a higher percentage of lambs from the remaining herds. The only logical conclusion I can reach is that continued predation will occur, especially during periods of jackrabbit scarcity.

The effect of weather on the lamb losses is hard to evaluate. The spring of 1975 was especially severe. There is no way of knowing whether the 5 percent reduction for weather losses allowed by the ranchers was sufficient. Lambing success correlated inversely with numbers of eagles trapped, which apparently reflected numbers present, from 1975 through 1977, except for 1977 at Rock Creek. The low docking count there in 1977 is especially difficult to understand. A late spring snowstorm allowed ADC personnel to take a significant number of coyotes in the vicinity of Rock Creek and the Sweetwater Basin. Snow conditions allowed easy tracking and aerial taking of the already paired and denning coyotes, removing them as a prime factor in serious lamb losses (Niemeyer, 1977). The lambs I necropsied indicated a low level of predation and no unusual disease problems.

During 1974 and 1975, lamb carcasses that I necropsied were primarily from Rock Creek. In 1977, nearly equal numbers were picked up from Rock Creek and the Sweetwater Basin. Since lamb survival was good in Sweetwater Basin, few predator kills would be expected. Most of the carcasses were picked up late in the lambing season (C. Niemeyer, personal communication). Possibly eagle predation was important in Rock Creek earlier, but the removal of eagles or emergence of young ground squirrels, or both, alleviated the problem before the time when carcasses were gathered.

Care of the herds did not appear to be inadequate. Dr. J.L. Van Horn (Agriculture Department, Montana State University) reported at a meeting in Dillon, Montana, that he had investigated the problem ranches from the standpoint of management, and that he could not suggest a better feeding program. He also believed that the breed of sheep being used was well adapted to the range conditions. Dr. Van Horn and Dr. J. Drummond (Wool Laboratory, Montana State University) doubted that shed lambing would be economically feasible. They noted that good help is hard to get and expensive, and that shed lambing would reduce the period during which lambs were exposed to eagles by only about 2 weeks. Each lamb

taken by eagles then would result in a greater financial loss. We had noted that eagles usually took lambs that were old enough to wander away from their dams. Thus, shed lambing would protect the lambs primarily during the time they are least vulnerable. The use of more herders may have been of some value, but herders have the same problems researchers do with orphaning lambs. Larger numbers of herders, besides being expensive, would probably have done little good.

Tolerance and cooperation of the Dillon ranchers provided an opportunity to evaluate a livetrapping and translocation program. Undoubtedly, it reduced predation. However, the program did not appear to have a sizeable or lasting effect on the problem. Lamb losses were highest in the years of greatest trapping success, and vice versa. The only meaningful correlation appeared to be between the numbers of eagles present and the numbers of lambs lost. Numbers of eagles increased during years of low jackrabbit numbers, in spite of trapping.

The trapping program was expensive (more than \$17,000 per year) and was not the type of control that could be instigated in a short time. If many eagle trapping programs were underway at one time, the finding of suitable release sites for the birds would become a serious problem.

In my opinion, livetrapping and translocation should be attempted only in situations involving endangered species or small numbers of predators.

The concentrations of eagles and the levels of predation on the Rebish Brothers and Rebish and Helle Inc. ranches were startling during the lambing seasons of 1974 and 1975. However, the magnitude of losses to predation remains speculative. The ranch operators believed that they had lost over \$100,000 worth of lambs to golden eagles from 1974 through 1976. The short study in 1974 and observations in 1975 lend credence to the ranchers' convictions. Even if the losses were only half of what they believed them to be, they certainly should qualify as critical and justify the issuance of individual permits as specified in Secretary Hickel's memorandum, which is still in effect. Yet, the operators had no recourse, short of breaking the law.

Kill permits are distasteful to almost everyone involved, but they were issued for many years without eliminating the golden eagle from the western scene. Eight years without kill permits have not resulted in any noticeable increase in numbers of eagles. Boeker (1974) summed up the status and future of golden eagles in the western states as follows. The USFWS is conducting studies over a large portion of the golden eagle ranges in the western United States. In general, the results show a healthy and stable population--for the present. Efforts are being made to reduce losses from electrocution and shooting, but the ever-increasing intrusion of humans into all portions of golden eagle habitat will most likely have a detrimental effect on the future of the species.

Boeker (1977) estimated from USFWS surveys that 41,850 golden eagles were present in the 17 western states. Those surveys indicated a slight decrease in numbers and percentage of immatures seen along aerial transects from 1972 through 1976. The nesting activity index decreased from 1972 to 1973, remained low for 2 years, and then recovered somewhat in 1976. To me, these population trends seem more closely related to the trends in jackrabbit numbers discussed earlier than to human control or lack of it. At the 1975 meeting in Denver to discuss eagle problems, Dr. John Craighead volunteered that Montana had a wintering eagle population of about 9,000. He further stated that if all of the immature birds causing damage at Dillon were killed, scant effect on the population would result.

I can see no workable method of alleviating eagle depredations without limited kill permits. Even with kill permits, the eagle act, which prohibits aerial hunting, may make it impossible to protect livestock on many ranches.

If kill permits are again issued, some documentation of loss should be required. However, there are not enough biologists or ADC personnel available to document levels of predation on more than a few ranches. From an economic standpoint, determining losses would be unfeasible for the government because of the personnel required, and disastrous for the rancher because of the time required.

Some non-lethal methods of scaring birds from an area, "chitter" distress calls and pyrotechnic devices, may become effective when reinforced by a limited number of kills. A study, conducted on a ranch where eagles congregate to prey on lambs, of aerial harassment, and use of dead birds as "scarecrows" reinforced by limited aerial kills, is needed.

Since 1970, ranchers have essentially had no recourse if faced by serious eagle predation. Public pressure, abated by animal protection groups, is directed at "saving" every golden eagle, no matter how much damage that eagle may do to personal property. A number of field biologists I talked to believe that more eagles are being killed now than when governors could get blanket permits. Some ranchers apparently reason that they can expect no relief if eagle problems develop during the lambing season, so it is safest to shoot eagles whenever the opportunity presents itself. Such shooting undoubtedly endangers young bald eagles more than any control method would. A recent trial in Texas showed that some people were carrying illegal control far beyond the "sniping" stage. Ignoring the problem is not a good solution for either the eagle or the rancher. Knowing that no one has received a kill permit since 1970, many ranchers will continue to take the law into their own hands, and occasionally one will be caught. The ethics of forcing a rancher to break the law or go out of business must be considered.

In a situation like the one I saw at Rock Creek in 1975, a couple of weeks delay in getting a kill permit would be enough to negate a year's profits. If a kill permit were received, the losses probably could not be stopped without the use of aircraft, which is now illegal. So the USFWS, charged with protection of livestock, and ranchers who are not allowed to protect their livestock, are both placed in a nearly impossible situation.

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