Sheep and Lamb Losses to Predators and Other Causes in the Western United States

United States Department of Agriculture

Economic Research Service

Agricultural Economic Report No. 369

SHEEP AND LAMB LOSSES TO PREDATORS AND OTHER CAUSES IN THE WESTERN UNITED STATES, by C. Kerry Gee, Richard S. Magleby, Warren R. Bailey, Russell L. Gum, and Louise M. Arthur. Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 369.

ABSTRACT

Predators, principally coyotes, were the major cause of lamb and sheep losses in the western United States in 1974, according to surveyed farmers and ranchers. Rates of loss to coyotes varied considerably among individual farmers and ranchers; while many had no or minor predation problems, others reported very high losses. Overall in the western United States, losses attributed to coyotes in 1974 numbered 728,000 lambs (more than 8 percent of all lambs born) and 229,000 adult sheep (more than 2 percent of inventory), representing a third of the total lamb deaths to all causes and a fourth of the adult sheep deaths. These losses cost U. S. sheep producers some $27 million in lost returns in 1974, while consumers lost some $10 million in benefits because of higher prices for lamb and reduced quantities available.

Key Words: Sheep, Sheep losses, Coyotes, Predators, Western United States.

DEFINITIONS

Stock sheep: sheep and older lambs which make up the basic breeding herd of each producer. Excludes sheep and lambs on feed and new-crop lambs (those recently born).

Ewes: female sheep 1 year old and over.

Lambs docked: lambs with tails cut off.

Sheep farms or sheep operations: farms or ranches with one or more head of sheep or lambs.

Sheep producer: the owner or operator of a farm or ranch with one or more sheep. A partnership or corporation is considered a single producer.

Commercial sheep producers: all sheep producers with 50 or more head of stock sheep without regard to whether or not the sheep are registered or pedigreed.

Commercial sheep or ewes: all sheep or ewes owned by commercial sheep producers, including registered and pedigreed sheep.

Washington, D.C. April 1977

CONTENTS

FOREWORD

This report, the second of a series to be published on various aspects of the western sheep producing industry, provides data on the magnitude and scope of sheep and lamb losses to predators. It also contains estimates of economic losses suffered by producers and consumers as a result of predation. The first report discussed the current structural characteristics and operational practices of the sheep industry (7). 1/ Further reports will summarize reasons for the decline of sheep production in the West, and costs and returns of western sheep producers. The studies will provide basic data for input into an evaluation of the economic, environmental, and social benefits and costs of present and alternative policies for predator control. Reports on this evaluation will also be published.

These studies published by the U.S. Department of Agriculture, Economic Research Service, in cooperation with State universities, were made at the direct request of Senator Gale McGee (Wyoming) and Congressmen in the West. Special appropriations by Congress in fiscal years 1974 and 1975 funded the studies.

Synopsis of First Report in this Series

"Characteristics of Sheep Production in the Western United States"
by C. Kerry Gee and Richard S. Magleby
Agricultural Economic Report No. 345

About 80 percent of the sheep in the United States are raised in the western States where extensive private and public ranges provide the bulk of the feed requirement. Only about 41 percent of the West's sheep producers have commercial-scale operations of about 50 head or more sheep, but they own nearly 93 percent of the region's sheep. About one-third of these commercial producers have specialized in sheep while two-thirds have diversified livestock operations. More than two-thirds operate as sole proprietors, while the rest have formed partnerships and family corporations. Many have substantial equity positions, which indicate past profitability. About one-fifth will likely retire in the next 10 years, which could result in many operations going out of sheep production. About half of the feed requirement for commercial sheep comes from private range, while public range supplies about one-fifth. Over half of the commercial sheep are grazed under the care of herders, usually on open (unfenced) range. Most lambing occurs in late winter and early spring. More commercial producers practice shed-lambing than range lambing, but the number of sheep involved is less. The principal marketing problem is the few numbers of buyers bidding on lambs.

1/ Underscored numerals in parentheses refer to items in References, p. 34.

HIGHLIGHTS

Special sample surveys of farmers and ranchers in the western United States were made by mail and personal interviews to help determine the level and scope of sheep and lamb losses to predation and other causes in 1974. These data were compared with other available data on losses to identify trends. Also, analyses were made to identify factors related to predation. Here are the principal findings and implications:

1. Predation, principally by the coyote, was the major cause of sheep and lamb deaths during 1974 in the western United States, according to farmers and ranchers. Losses attributed to coyotes in 1974 numbered 728,000 lambs and 229,000 adult sheep, representing a third of the total lamb deaths to all causes and a fourth of the adult sheep deaths.

2. Lambs were attacked much more than adult sheep. Overall losses to coyotes were 8 percent of the lambs and 2.5 percent of the sheep.

3. Geographically, loss rates of lambs and sheep to coyotes were highest in States with public range grazing and mountainous terrains. Comparatively few deaths due to coyotes occurred in the Plains States of Kansas, Nebraska, and North and South Dakota.

4. Lamb loss rates to all causes have been increasing in the western States, including the Plains States, while sheep loss rates have been declining slightly. Available data for a few States suggest predation has been the principal cause of the increasing lamb death rate.

5. The gross economic loss suffered by farmers and ranchers from coyote predation in 1974 was estimated at $27 million (excluding control costs), while the benefits lost by consumers because of higher prices and reduced quantity were estimated at $10 million, for a total of $37 million. Reduction of these gross economic losses would require additional expenditures for or changes in predator control, which would have to be weighed against the economic benefits. Also environmental and social impacts would have to be considered, along with regulatory constraints.

6. Rates of loss to coyotes in 1974 varied considerably among farmers and ranchers. While most of the large-scale sheep operators reported losses from less than 5 to more than 20 percent, many small-scale producers had no predation problems at all. Hardest hit by coyotes were some 5,000 sheep ranchers, about one-tenth of the West's total sheepmen, who reported losses exceeding 10 percent of lambs born. Among these, the average loss in foregone lamb sales in 1974 was about $4,000.

SHEEP AND LAMB LOSSES TO PREDATORS AND OTHER CAUSES IN THE WESTERN UNITED STATES

C. Kerry Gee, Richard S. Magleby, Warren R. Bailey, Russell L. Gum, and Louise M. Arthur

INTRODUCTION

The issue of predation on sheep and lambs has been debated by sheepmen and wildlife protection groups, particularly in the western United States where about 80 percent of the Nation's sheep are produced (table 1). Some of the questions that have been raised, and which are addressed by this report, are as follows:

1. How is predation determined? Has it been verified?

2. How many sheep and lambs are lost to predators? Where are losses the highest?

3. Is predation increasing? How was it affected by 1972 restrictions on predator control? 2/

4. What are the economic impacts of predation on producers and consumers?

5. What factors contribute to high predation losses? What additional research is needed?

Two surveys were undertaken in this study to gather comprehensive data on sheep and lamb losses: 3/

1. A mail survey with responses from 8,910 farmers and ranchers (32 percent of 28,000 mailed questionnaires) represented all sizes and types of sheep operations and all geographical areas of 15 western States. Conducted during January 1975, this survey ascertained sheep and lamb inventory numbers and death losses in total and by cause for each of the 15 States during calender year 1974.

2/ The 1972 restrictions included Executive Order 11643, which prohibited use of chemical toxicants for predator control on Federal lands and in Federal programs, and subsequent Environmental Protection Agency restrictions on interstate shipment of the same toxicants, which soon ended their availablility in most sheep producing areas.

3/ Additional details on these surveys and copies of the questionnaires are available from Environmental Economic Studies, ERS/NRED, U.S. Dept. of Agr., Washington, D.C. 20250.

States included were Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, and Wyoming.

2. A personal interview survey was made with responses from 911 sheep producers (90 percent of the 1,012 in the sample). Also conducted during January 1975, this survey was more limited in coverage than the mail survey, concentrating only on commercial-scale sheep producers (those with herds of 50 or more sheep) 4/ and on the principal sheep producing areas (see fig. 1). Thus, many small-scale producers and areas with few sheep were excluded. Also excluded were strictly feeder operations. This survey obtained data of greater scope and detail than possible by mail regarding management practices and other aspects of each producer's operation which could be related to individual loss levels. Also, the data permitted statistical distributions to be made of producers and of sheep and lambs according to levels of loss.

Both surveys were based on probability samples to permit extrapolations and generalizations. To insure reliability of data from the mail survey a sample of those not responding was contacted by telephone and personal interviews. Data gathering was performed by SRS (USDA's Statistical Reporting Service).

Table 1--Sheep and sheep producers in the United States, 1974

Area	Stock sheep and lambs		Sheep producers	
	Number	Percent of U.S. total	Number	Percent of U.S. total
	Millions	Percent	Thousands	Percent
15 western States 1/	10.7	78	48.2	33
34 other States 2/	3.0	22	97.1	67
Total United States	13.7	100	145.3	100

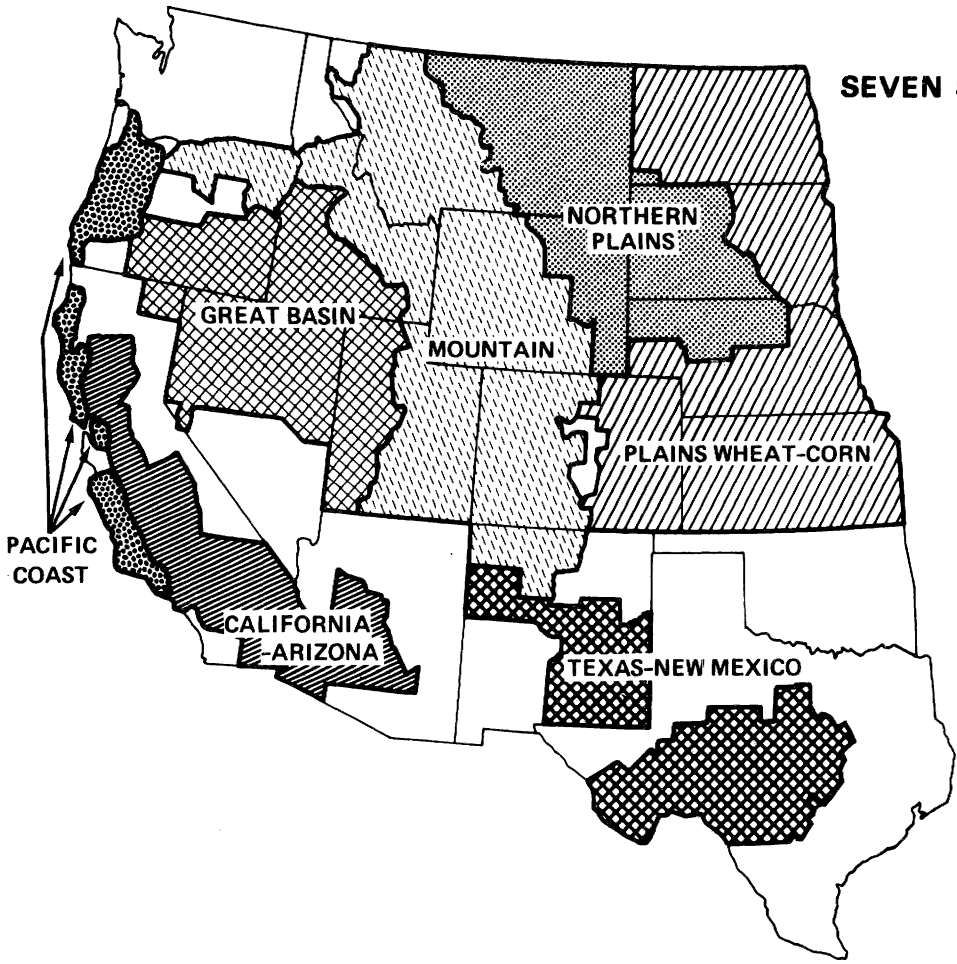
1/ Includes Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Texas, and Wyoming.

2/ No data are available for Hawaii.

Source: (17, 20).

4/ Commercial-scale producers account for more than 90% of the stock sheep in the West, even though they constitute only about 40% of the West's total sheep producers (7).

Figure 1



Plains Wheat Corn: rolling prairies of North Dakota, eastern South Dakota, Nebraska, Kansas, and eastern Colorado.

Northern Plains: dry desert and plains portions of western South Dakota, eastern Wyoming, and eastern Montana.

Texas-New Mexico: Edwards Plateau of Texas and central and southeastern New Mexico.

Mountain: mountainous portions of Montana, Oregon, Idaho, Utah, Wyoming, Colorado, and New Mexico.

Great Basin: primarily the dry desert terrain of southern Oregon, southwestern Idaho, northern Nevada, and western Utah.

California-Arizona: central valleys of California and southwestern Arizona.

Pacific Coast: coastal mountain ranges of California and Oregon.

DETERMINATION OF PREDATION LOSSES

Two approaches have been used to assess losses of sheep and lambs due to predators: (1) biological damage assessments, and (2) surveys of farmers and ranchers. Both have advantages and disadvantages.

Biological damage assessments

The most exact, although expensive, means of identifying cause of death is to have a trained biologist perform a necropsie on the carcass. Wounds are examined to determine what animal inflicted them and whether they caused the death or just represented after-death feeding on the carcass (bleeding around the wound indicates it was inflicted prior to death). Also, vital organs are examined to determine whether sickness or disease caused the death or weakened the animal.

Biological damage assessments involving carcass necropsies have been conducted by public research agencies, with the cooperation of range management and wildlife specialists and individual sheepmen, since 1972. These studies are expensive, however, with the result that to date only some 7 studies have been reported (see table 2 for a listing) involving a total of 27 ranches. Although too limited in number and coverage to permit extrapolation of losses to State or regional levels, the studies have clarified how predation is identified.

Identification criteria. Characteristics of various predator kills, as clarified by the studies, are as follows: 5/

Coyotes usually bite the neck of a ewe or large lamb just below the ear, and bite the top of the neck of a small lamb. They may or may not eat the carcasses. If they do, they usually start eating at the sternum (breast bone), chewing fat and flesh from the rib cage. Also the internal organs of small lambs may be eaten, or the carcass carried away.

Domestic dogs, in contrast to the coyote, usually slash at the victim's hind legs. Also dogs frequently mutilate the ewe's udder and rear quarters.

Foxes bite the neck, head, and face of young lambs; the tooth marks are smaller than those of the coyote.

The cougar's bite is usually on the top of the head and neck instead of the characteristic coyote throat bite.

Eagles leave talon marks on the neck, head, and back of lambs; sometimes, the ribs are snapped off at the spine. Eagles also leave a whitewash of defecation nearby.

Bears usually bite and severely damage or mutilate various parts of the victim. On ewes, the udder is frequently removed.

5/ For example, see the work in Utah as reported in (1), (2), and (4).

Table 2--Biological damage assessments completed or underway, 1975

Study location, time period, and institution	Scope and conditions	Verified predation	Unaccounted for losses	Total losses to all causes
California 1972/73 University of California at Davis (12)	7 ranches with predator control	0.9% of lambs docked (mostly lost to coyotes)	5.5% of lambs docked	8.4% of lambs docked
Idaho 1973-75 Fish and Wildlife Service (11)	3 ranches with predator control and shed lambing	1.2 to 1.7% of lambs born (mostly lost to coyotes)	0.3 to 3.3% of lambs born	12.7% of lambs born
Montana 1974 Fish and Wildlife Service and University of Montana (8)	1 ranch with no predator control or shed lambing	29% of lambs born (mostly lost to coyotes)	About 1% of lambs born	39% of lambs born
Nevada 1973-74 University of Nevada (10)	1 ranch with predator control	5% of docked lambs (mostly lost to coyotes)	2% of lambs and sheep combined	9% of sheep and lambs combined
New Mexico 1974-75 Fish and Wildlife Service (5)	1 ranch with no predator control	12 to 15% of lambs exposed to predation (mostly lost to coyotes)	1 to 5% of lambs exposed to predation	18 to 34% of lambs exposed to predation
Utah 1972 Utah State University (2, 4)	10 herds with predator control, after lambing	0.2 to 4.1% of docked lambs, depending on herd (mostly lost to coyotes)	Averaged about 2% of docked lambs	Averaged about 9% of docked lambs
Wyoming 1973-75 Fish and Wildlife Service (15)	4 ranches with predator control, range lambing	1.5 to 3.2% of lambs born (mostly lost to coyotes)	Averaged 4% of sheep and lambs	5 to 12% of lambs

Verified losses. Of the seven damage assessment studies, five were conducted in the presence of predator control, and two in the absence of control (table 2). In the five control situations, verified losses of lambs to predators ranged from 1 to 5 percent. In the two non-control studies, verified predation of lambs was substantially higher, 12 to 29 percent. In all cases, most of the predation losses were due to coyotes, with lamb losses proportionately higher than sheep losses. Unaccounted or unverified losses ranged from less than 1 percent to 6 percent of sheep and lambs under study. These sheep and lambs had either disappeared or decomposed to the point where cause of death could not be accurately determined.

The studies also found that predators kill healthy lambs as well as some sick ones, and do not always feed upon what they kill. In the Montana study about three-fourths of the sheep and lambs killed by predators were found to have been healthy at the time of death (8). In the California study, 44 percent of the lambs and 37 percent of the sheep were not fed upon (12).

Surveys of farmers and ranchers

Sample surveys of farmers and ranchers are much less expensive than biological damage assessments on a per ranch basis, permitting much greater coverage for a given expenditure. For this reason, the survey approach was selected for this study in order to gather enough data to generalize about predation in the western United States, numbers of producers affected, and geographical differences. Although previous surveys had been conducted in some States (see appendix table 1), producers in all western States except Oklahoma and Washington (which have few sheep) were included in this study to provide comparable data for the western region.

The weakness of the survey approach is that it depends upon the accuracy with which sheep producers determine and report the number of sheep and lambs lost to each cause. Understandably, most producers or their employees do not regularly perform necropsies on the dead animals, but rather by observation of the carcass and the site attribute the cause of death to predators, disease, or other causes. Doubtful cases or missing animals are sometimes attributed as losses to the most likely cause, rather than as unaccounted for losses. Thus more judgment enters in with rancher's determination of losses than with biological assessments, and this must be considered in evaluating survey data.

The survey data presented in this report provide reliable indications of which geographical areas and types of operations have the most predation. Also the total number and proportion of producers affected (without regard to loss level by coyote predation are probably quite realistic, since most producers know whether or not coyotes are preying upon their herds. The numbers and percentages of sheep and lambs lost to coyotes and numbers of producers with different levels of loss must be considered more cautiously since the degree of producer judgment is higher.

In the two surveys conducted for this study, precautions were taken in designing the questionnaire to minimize introduction of bias. The loss questions were only a part of the total number asked, and were never asked first, so as to avoid undue attention. In the section on losses, total losses

were first ascertained. Then the rancher was asked to estimate losses to unknown causes, weather conditions, disease and/or poisonous plants before being asked to attribute losses to specific predators. Losses to each cause then had to add up to the total loss. The rancher's response to all loss questions was in terms of numbers; percentage loss rates were calculated later.

Valid comparisons not yet possible between damage assessment and survey data

Too few ranches have been included in biological damage assessment studies to permit generalization as to overall loss levels which could be statistically compared with those of the producer surveys conducted for this study. The most that can be observed so far is that the loss levels found on the few damage assessment ranches and those reported by surveyed producers appear to be generally compatible. The levels of coyote predation verified in the biological studies on the ranches with predator control (1 to 5 percent of the lambs) were reported by many surveyed producers. The verified predation on the "no control" Montana ranch (29 percent of the lambs, even with control existing in surrounding areas) was above that reported by most producers. It is conceivable that if more damage assessments were conducted on a random basis, results in between the presently verified levels would be obtained, depending upon extent of control, ecological conditions, and other factors.

One way the two methods could complement each other would be to use producer surveys to identify medium and high loss areas, within which a number of limited-scope biological assessments would be made to accurately determine losses and gather data on associated conditions and factors (see later discussion on suggestions for future research, page 33).

LAMB AND SHEEP LOSSES IN 1974 AS REPORTED BY FARMERS AND RANCHERS

In the mail and personal interview surveys conducted for this study, western sheep producers were asked to report their losses of sheep and lambs to different causes during 1974. Data from the greater coverage mail survey were used to make State and western region estimates of losses to each cause. Data from the lesser coverage, but more detailed, personal interview survey were used to estimate how many producers experienced different levels or rates of loss, and to analyze associated factors (see page 2 for details on coverage, sample size, and response).

To provide a more complete accounting of lamb losses, farmers and ranchers were asked to attribute losses to various causes before as well as after docking. In most western States, only after-docking losses are reported to SRS. Docking (removing of tails) represents the first time a full count is made of the total number of live lambs on many western range operations. In 11 of the 15 western States, where range lambing is common, the docking count was obtained from the producer. To this count was added his determination of lambs lost before docking; the result was the number of lambs born. These estimates of lambs lost before docking and of lambs born are less reliable than

the estimates of after-docking losses and lambs docked. However, exclusion of the estimate would not provide a complete picture of total losses. In the other States, a direct estimate of lambs born was obtained.

Predation more serious to lambs

Among western commercial sheep producers (those with herds of 50 sheep or more) represented in the personal interview survey, coyote predation of lambs in 1974 was more frequent and serious than predation of sheep.

Percent of lambs or sheep lost to coyotes	Percent of producers losing:	
	Lambs	Sheep
0.1-- 5	18	25
5.1--10	14	5
10.1--15	7	1
15.1--20	6	1
20+	10	1
Total with losses	55	33

Differences existed among geographical areas in incidence of predation. Two-thirds to three-fourths of the commercial producers in the Mountain, Great Basin, and Northern Plains areas lost lambs to coyotes, a higher proportion than in other areas (table 3). 6/ Very high rates of loss (exceeding 20 percent of the lambs), however, occurred relatively more often among producers in the Texas-New Mexico and Pacific Coast areas. Lowest relative incidence of coyote predation occurred in the Plains Wheat-Corn area, where an estimated one-third of commercial producers were affected. Most of them had low rates of loss.

The very high-loss producers in the West were located primarily in the Texas-New Mexico area (48 percent of them), with most of the others in the Mountain (22 percent) and Pacific Coast areas (16 percent).

Small-scale producers (50-299 sheep) made up 61 percent of all commercial producers experiencing some losses to coyotes (table 4). However, only half of these small-scale producers experienced predation compared to 75 percent of the large-scale producers with 2,500 sheep and over. Part of this difference in proportions was likely due to location and part to type of management. The larger herds are more often pastured on open ranges where exposure to coyotes is greater. In comparison, smaller herds are usually located in more intensive farming areas and/or are kept more confined.

Although small-scale producers less frequently sustained losses from coyotes, their losses were often quite high. This was probably because one or two coyotes attacking a small flock did proportionately more damage than to a large flock.

6/ Descriptions of these areas are given in figure 1, page 3.

Table 3--Commerical sheep producers affected by coyote predation of lambs, western subregions, 1974

Rate of lamb loss 1/	Pacific Coast	Calif. Ariz.	Great Basin	Moun-tain	Texas-N. Mex.	Northern Plains	Plains Wheat-Corn	All sub-regions
				Estimated number 2/				
0.1--10%	451	283	317	2,162	504	1,454	1,269	6,440
10.1--20%	237	72	233	979	437	489	248	2,695
20+%	306	46	61	419	913	142	44	1,931
Total with loss	994	401	611	3,560	1,854	2,085	1,561	11,066
0 loss	985	289	284	1,417	2,129	810	2,962	8,876
Total 3/	1,979	690	895	4,977	3,983	2,895	4,523	19,942
				Percent of producers in each loss rate category				
0.1--10%	23	41	35	44	13	50	28	32
10.1--20%	12	10	26	20	11	17	5	13
20+%	15	7	7	8	23	5	1	10
Total with loss	50	58	68	72	47	72	34	55
0 loss	50	42	32	28	53	28	66	45
Total	100	100	100	100	100	100	100	100
				Percent of producers in each subregion				
0.1--10%	7	4	5	34	8	22	20	100
10.1--20%	9	3	9	36	16	18	9	100
20+%	16	2	3	22	48	7	2	100
Total with loss	9	3	6	32	17	19	14	100
0 loss	11	4	3	16	24	9	33	100
Total	10	3	5	25	20	14	23	100

1/ Losses of lambs to coyotes before and after docking as a percent of lambs born.
2/ Producers with 50 sheep or more only.
3/ May differ from other estimates due to rounding and revisions.

Source: Estimates based on personal interview survey of 911 sheep producers.

Table 4--Western commercial sheep producers affected by coyote predation of lambs, by size of operation, 1974

Rate of lamb loss 1/	Size of operation (number of sheep)				
	50-299	300-999	1,000-2,499	2,500 and over	Total 50 and over
	Estimated number 2/				
0.1--10%	3,661	1,532	728	519	6,440
10.1--20%	1,683	684	189	139	2,695
20+%	1,425	279	179	48	1,931
Total with loss	6,769	2,495	1,096	706	11,066
0 loss	6,685	1,293	661	237	8,876
Total 3/	13,454	3,788	1,757	943	19,942
	Percent of producers in each loss rate category				
0.1--10%	27	41	41	55	32
10.1--20%	13	18	11	15	13
20+%	10	7	10	5	10
Total with loss	50	66	62	75	55
0 loss	50	34	38	25	45
Total	100	100	100	100	100
	Percent of producers in each operation size category				
0.1--10%	57	24	11	8	100
10.1--20%	62	26	7	5	100
20+%	74	15	9	2	100
Total with loss	61	23	10	6	100
0 loss	75	15	7	3	100
Total	67	19	9	5	100

1/ Loss of lambs to coyotes before and after docking as a percent of the lambs born.
2/ Producers with 50 sheep or more only.
3/ Totals may vary from other estimates due to rounding.

Source: Estimates based on personal interview survey of 911 sheep producers.

According to estimates for the West, nearly 5,000 commercial producers (one-fourth of the total commercial producers) had loss rates exceeding 10 percent of lambs born. Of these producers, about 550 were large-scale operators (with 1,000 or more sheep). Although comparatively few in number, about a third of the West's total lamb losses to coyotes occurred on these operations. Large-scale operations with lamb loss rates to coyotes exceeding 20 percent were even fewer in number, around 200, but they accounted for about a fifth of the total losses to coyotes. These large-scale operations with high loss rates would be prime targets for better predator control programs. Also some could be identified and selected for biological damage assessment studies to verify extent of predation and to determine contributing factors.

Predators were largest cause of lamb losses

According to estimates from the mail survey, more than 2 million lamb deaths occurred to all causes (before and after docking) of nearly 9 million lambs born in the 15 western States in 1974. This loss represented nearly a fourth of all lambs born.

Predators were by far the largest cause of lamb losses, making up nearly half of the total (table 5). Most of the predation losses were attributed to coyotes, with only minor numbers attributed to eagles, dogs, and foxes.

High after-docking losses to coyotes

The before-docking period is usually only 2 to 4 weeks compared with 5 months or more for the after-docking period. Even so, more than half the total reported lamb losses in 1974 occurred before docking when the lambs were very young and weak (table 5). In this before-docking period, adverse weather and disease accounted for the majority of losses. Coyotes were attributed with 20 percent of the losses and other predators with 15 percent. In the after-docking death period, however, coyotes were the predominate cause of lamb losses, over half the total. Nonpredatory causes were comparatively minor.

Loss rates vary among States

Total lamb losses and loss rates (before and after docking combined) from various causes in 1974 varied considerably among the 15 western States (table 6, with before- and after-docking losses shown separately in app. tables 2 and 3). Rates of lamb loss to coyotes were highest in Nevada (29 percent of lambs born); Colorado and Montana (13 to 15 percent); and Utah, New Mexico, Arizona, and Wyoming (9 to 12 percent). Comparatively few deaths due to coyotes occurred in North and South Dakota, Nebraska, and Kansas. Rates of loss attributed to other predators were comparatively high in Arizona (11 percent, mostly dogs); Texas and New Mexico (5 to 6 percent, predominantly eagle, some dog and fox); and Montana (4 percent, predominantly fox, some eagle).

Losses to "other known causes"--unfavorable weather, disease--were relatively high in New Mexico, Nebraska, and Montana.

Table 5--Lamb losses by cause, before and after docking, 15 Western States, 1974

Cause of loss	Losses before docking			Losses after docking			Total losses		
	Total	Percentage of: Lambs born alive	Percentage of: All losses	Total	Percentage of: Lambs docked	Percentage of: All losses	Total	Percentage of: Lambs born alive	Percentage of: All losses
	Thousands	Percent		Thousands	Percent		Thousands	Percent	
Coyotes	231.8	2.6	20.2	496.4	6.4	53.4	728.2	8.1	35.0
Other predators									
Foxes	33.0	.4	2.9	18.7	.2	2.1	51.7	.6	2.5
Dogs	44.9	.5	3.9	32.6	.4	3.5	77.5	.9	3.7
Eagles	61.3	.7	5.3	32.3	.4	3.5	93.6	1.0	4.5
Other	27.5	.3	2.4	47.6	.6	5.1	75.1	.8	3.6
Subtotal	166.7	1.9	14.5	131.2	1.7	14.2	297.9	3.3	14.3
Total predators	398.5	4.5	34.7	627.6	8.1	67.6	1,026.1	11.4	49.3
Other causes									
Weather	340.4	3.8	29.6	59.4	.8	6.4	399.8	4.5	19.2
Disease-poison plant	79.7	.9	6.9	65.3	.8	7.0	145.0	1.6	7.0
Other known	147.3	1.6	12.8	40.9	.5	4.4	188.2	2.1	9.1
Subtotal	567.4	6.3	49.4	165.6	2.1	17.8	733.0	8.2	35.3
Unknown	183.6	2.0	16.0	135.8	1.7	14.6	319.4	3.6	15.4
Total all causes	1,149.5	12.8	100.0	929.0	11.9	100.0	2,078.5	23.2	100.0

Source: Estimates based on mail survey responses from 8,910 farmers and ranchers.

Table 6--Total lambs lost to various causes, 15 western States, 1974

State	Lambs born	Cause of loss: Coyotes	Other predators	Other known	Unknown	All causes
			Thousands			
Arizona	341	33.0	38.2	24.4	31.4	127.0
California	854	51.3	32.1	58.5	33.8	175.7
Colorado	615	91.9	9.5	48.1	23.3	172.8
Idaho	702	36.8	4.6	58.9	16.6	116.9
Kansas	180	5.8	0.3	10.7	3.2	20.0
Montana	619	82.7	26.0	63.0	25.4	197.1
Nebraska	170	2.9	0.2	27.1	4.8	35.0
Nevada	161	46.7	2.2	3.5	4.9	57.3
New Mexico	584	66.0	33.7	152.4	23.1	275.2
North Dakota	251	7.7	1.1	12.2	11.1	32.1
Oregon	351	20.9	10.8	26.0	10.6	68.3
South Dakota	806	17.2	6.8	64.6	22.4	111.0
Texas	1,697	99.2	101.0	81.9	50.0	332.1
Utah	644	75.3	8.1	43.5	27.1	154.0
Wyoming	976	90.8	23.3	58.2	31.7	204.0
Totals:						
15 western	8,951	728.2	297.9	733.0	319.4	2,078.5
34 other 2/	2,582	1/ NA	NA	NA	NA	369.0
United States	11,533	NA	NA	NA	NA	2,447.5
			Percent of lambs			
Arizona	100	9.7	11.2	7.1	9.2	37.2
California	100	6.0	3.7	6.9	4.0	20.6
Colorado	100	15.0	1.5	7.8	3.8	28.1
Idaho	100	5.2	0.6	8.4	2.4	16.6
Kansas	100	3.2	0.2	5.9	1.8	11.1
Montana	100	13.3	4.2	10.2	4.1	31.8
Nebraska	100	1.7	0.1	16.0	2.8	20.6
Nevada	100	29.0	1.4	2.2	3.0	35.6
New Mexico	100	11.3	5.8	26.1	3.9	47.1
North Dakota	100	3.1	.4	4.9	4.4	12.8
Oregon	100	6.0	3.1	7.4	3.0	19.5
South Dakota	100	2.1	.9	8.0	2.8	13.8
Texas	100	5.8	6.0	4.8	3.0	19.6
Utah	100	11.7	1.2	6.8	4.2	23.9
Wyoming	100	9.3	2.4	6.0	3.2	20.9
Averages:						
15 western	100	8.1	3.3	8.2	3.6	23.2
34 other 2/	100	NA	NA	NA	NA	14.3
United States	100	NA	NA	NA	NA	21.2

1/ Not available.
2/ Data not available for Hawaii.
Source: Estimates based on mail survey responses from 8,910 farmers and ranchers.

Sheep losses to coyotes were lower than for lambs

Coyote predation of western sheep was substantially less than that of lambs. Coyotes killed an estimated 229,000 head of sheep or 2.5 percent of the beginning sheep inventory in 1974 (table 7). This was only a third as great as the lamb losses. Even so, coyotes were a major cause of sheep deaths along with disease, poison plants, and old age. 7/

Coyote predation of stock sheep followed a geographic pattern similar to that of lambs. Loss rates to coyotes were again generally highest in the States with mountainous and desert grazing, and lowest in the Plains States.

New data change loss picture for West

The estimates of before-docking losses reported by this study provide a more complete accounting of lamb losses, and permit comparisons on an all-cause basis between losses in the western States and other States. For the majority of western States, SRS has traditionally published only numbers of lambs docked and losses of docked lambs. However, for the Plains States, (Kansas, Nebraska, and North and South Dakota) and other States, SRS has published the number of lambs born and numbers of lambs lost since birth (including both before- and after-docking losses). Thus, for the West, an important component of total lamb losses has been missing.

With lamb losses before docking included, the overall lamb loss rate to all causes in the 15-State region was somewhat higher than that in the other 34 States. With before-docking losses excluded, it appeared as if the loss rate were lower in the West, as can be seen below:

New estimates	Lamb losses, all causes, 1974	
	Thousands	Percent
(Before- and after-docking losses in all States)		
15 western States	2,078	23.2
34 other States	369	14.3
SRS estimates		
15 western States (after-docking losses in 11 States, before- and after-docking losses in 4 States).	989	13.3
34 other States (before- and after-docking losses in all States)	369	14.3

7/ Old ewes are of little economic value, so some producers leave them in the flock in the hope that they will raise one more lamb.

Table 7--Total adult sheep lost to various causes, 15 western States, 1974

State	Adult sheep inventory 1/	Cause of loss: Coyotes	Other predators	Other known	Unknown	All causes
		Thousands				
Arizona	311	1.7	2.5	13.5	8.3	26.0
California	874	13.3	10.0	36.7	10.0	70.0
Colorado	546	19.5	7.0	23.8	6.7	57.0
Idaho	560	10.2	1.2	28.6	7.0	47.0
Kansas	174	5.9	0.7	6.9	1.5	15.0
Montana	577	30.9	3.9	39.8	10.4	85.0
Nebraska	162	1.5	0.1	16.4	1.0	19.0
Nevada	132	15.3	0.1	1.9	.7	18.0
New Mexico	499	13.8	15.6	35.7	14.9	80.0
North Dakota	222	2.4	0.6	13.4	8.6	25.0
Oregon	321	6.5	12.9	13.2	7.4	40.0
South Dakota	727	1.8	1.3	41.4	10.5	55.0
Texas	2,241	48.2	16.6	84.2	51.0	200.0
Utah	634	26.5	6.5	29.4	9.6	72.0
Wyoming	1,089	31.9	6.1	77.1	22.9	138.0
Totals:						
15 western	9,069	229.4	85.1	462.0	170.5	947.0
34 other 2/	2,502	NA	NA	NA	NA	309.0
United States	11,571	NA	NA	NA	NA	1,256.0
		Percent of adult sheep				
Arizona	100	.6	.8	4.3	2.7	8.4
California	100	1.5	1.2	4.2	1.1	8.0
Colorado	100	3.5	1.3	4.4	1.2	10.4
Idaho	100	1.8	.2	5.2	1.2	8.4
Kansas	100	3.4	.4	3.9	.9	8.6
Montana	100	5.3	.7	6.9	1.8	14.7
Nebraska	100	.9	.1	10.1	.6	11.7
Nevada	100	11.6	.1	1.4	.5	13.6
New Mexico	100	2.8	3.1	7.1	3.0	16.0
North Dakota	100	1.1	.3	6.0	3.9	11.3
Oregon	100	2.0	4.0	4.2	2.3	12.5
South Dakota	100	.2	.2	5.7	1.4	7.5
Texas	100	2.2	.7	3.7	2.3	8.9
Utah	100	4.2	1.0	4.7	1.5	11.4
Wyoming	100	2.9	.6	7.1	2.1	12.7
Averages:						
15 western	100	2.5	.9	5.1	1.9	10.4
34 other 2/	100	NA	NA	NA	NA	12.4
United States	100	NA	NA	NA	NA	10.9

1/ Stock sheep 1 year and older, Jan. 1, 1974.
2/ Data not available for Hawaii.
Source: Estimates based on mail survey responses from 8,910 farmers and ranchers.

Unfortunately, no data exist on lamb losses by cause in the other 34 States which would indicate which causes account for the West's much higher overall death rate. However, since disease (including parasites) is generally less prevalent in the West than in other parts of the country, the major reason for the West's relatively higher lamb loss rates is most likely greater exposure to predation and adverse weather during range lambing and grazing.

TRENDS IN LAMB AND SHEEP LOSSES 8/

Up to this point, only 1974 losses have been discussed. Consideration now turns to available data on losses over time and their comparison with 1974. Unfortunately, data are available on a by-cause basis only for a few States, so the discussion will first center on trends in total losses (all causes), before examining the causal factors.

The basic data on total losses are from SRS and include annual losses of lambs after-docking in 11 of the 15 States, and lamb losses from birth in 4 States--Kansas, Nebraska, and North and South Dakota.

Lamb loss rate is climbing

Inventories of sheep and lambs in the western region have declined substantially in the last 20 years (table 8). Concurrently, numbers of lambs and sheep lost have also declined. However, total lamb losses have declined less than the lamb crop, resulting in an annual loss rate exhibiting a definite upward trend (fig. 2). In the late 1950's, the lamb loss rate was about 9 percent of all lambs, but this had climbed to 13 percent by the mid-1970's. In contrast, the loss rate of stock sheep has trended downward.

Among the 15 western States, total rates of lamb loss have been trending upward in all but Texas (fig. 3). Seven States have had increasing trends in sheep loss rates: Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, and Wyoming. Only Texas had a definitive downward trend in the rate of sheep loss. In the other seven States, sheep loss rates displayed no definitive tendencies, up or down.

Texas, the State with the most sheep and lambs, had a significant effect on the region's trend. If Texas, with its declining trend in both lamb and sheep loss rates, were excluded, the region as a whole would have had an upward trend in the sheep loss rate and an even stronger upward trend in the lamb loss rate.

8/ Dr. Clair F. Terrill, Agricultural Research Service, USDA, provided stimulus and suggestions regarding the comparison of sheep and lamb loss trends.

Table 8--Losses of lambs and sheep to all causes, 15 western States, 1956-75

Year	Lambs				Adult sheep 3/			
	Lamb crop 1/	Total losses 2/	Loss rate	Loss rate index	Sheep inventory Jan. 1	Total losses	Loss rate	Loss rate index
	-- Thousands--		Pct.	1956=100	-- Thousands --		Pct.	1956=100
1956	13,585	1,200	8.8	100	15,772	1,832	11.6	100
1957	13,068	1,182	9.0	102	14,368	1,825	12.7	109
1958	13,938	1,198	8.6	98	15,538	1,755	11.3	97
1959	14,433	1,289	8.9	101	16,249	1,876	11.5	99
1960	14,665	1,382	9.4	107	17,042	1,815	10.6	91
1961	14,662	1,378	9.4	107	17,129	1,816	10.6	91
1962	14,040	1,409	10.0	114	16,551	1,815	11.0	95
1963	13,501	1,336	9.9	112	15,925	1,738	10.9	94
1964	12,421	1,302	10.5	119	15,025	1,725	11.5	99
1965	11,980	1,264	10.6	120	14,022	1,664	11.9	103
1966	11,791	1,246	10.6	120	13,562	1,457	10.7	92
1967	10,443	1,220	11.7	133	13,168	1,483	11.3	97
1968	10,777	1,159	10.8	123	12,378	1,301	10.5	91
1969	10,245	1,137	11.1	126	11,884	1,376	11.6	100
1970	10,106	1,071	10.6	120	11,216	1,202	10.7	92
1971	9,793	1,078	11.0	125	11,102	1,102	9.9	85
1972	9,535	1,086	11.4	130	10,538	1,043	9.9	85
1973	8,720	1,057	12.1	137	9,895	1,090	11.0	95
1974	7,926	1,053	13.3	151	9,068	947	10.4	90
1975	7,448	989	13.3	151	8,240	846	10.3	89

1/ Lambs docked in all States except lambs born in Kansas, Nebraska, and North and South Dakota.

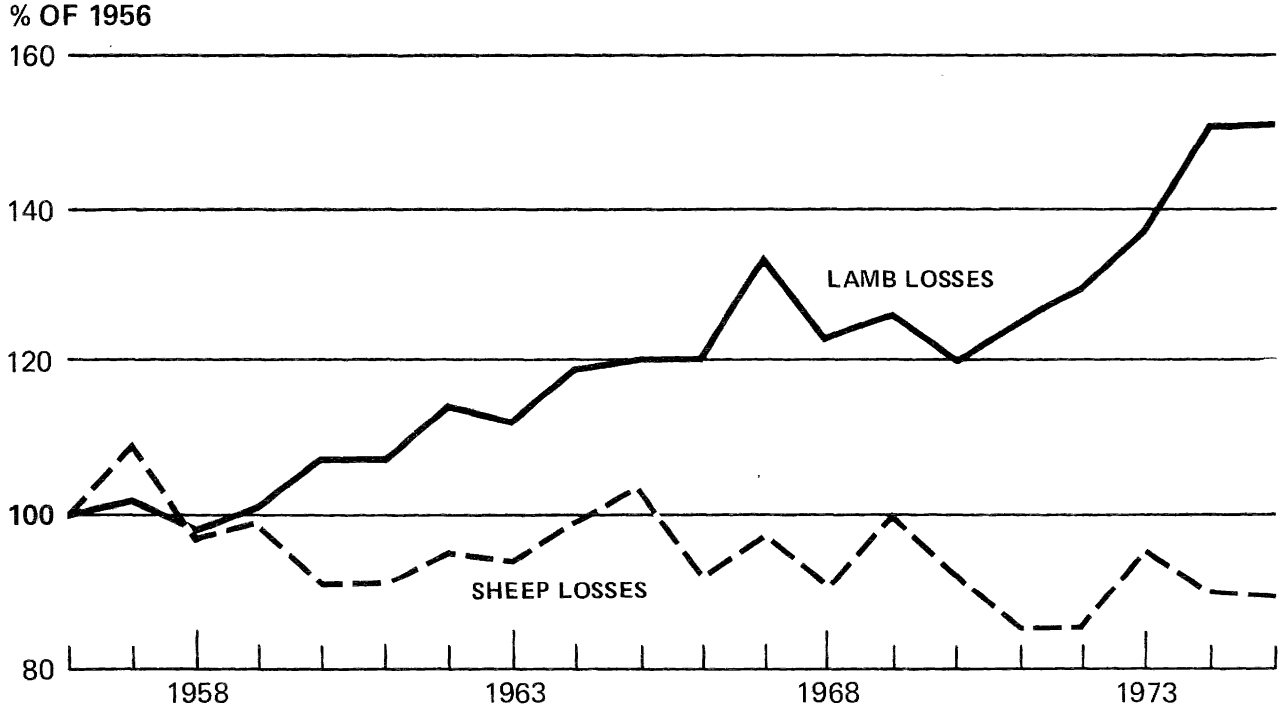
2/ After-docking losses in all States except Kansas, Nebraska, and North and South Dakota where before-docking losses are included. Inclusion of before-docking losses in all States, if data were available, would raise both the number lost and loss rate considerably.

3/ Sheep 1 year and older.

Source: (16), (19), (20)

Figure 2

INDICES OF SHEEP AND LAMB DEATH LOSS RATES IN THE 15-STATE REGION, 1956-1975



SOURCE: SEE TABLE 8.

Increases in lamb loss rates over the 20-year period, 1956-75, ranged from a doubling in Montana, Colorado, South Dakota, and Oregon to minor increases in Arizona, Kansas, Nebraska, and North Dakota. The lamb loss rate varied considerably from year to year in all States, suggesting effects of severe weather some years and likely differences in disease and predation. Lamb loss rates to all causes in 1975 were above those in 1974 in 11 of the 15 western States. The exceptions were Colorado, Nebraska, New Mexico, and Texas.

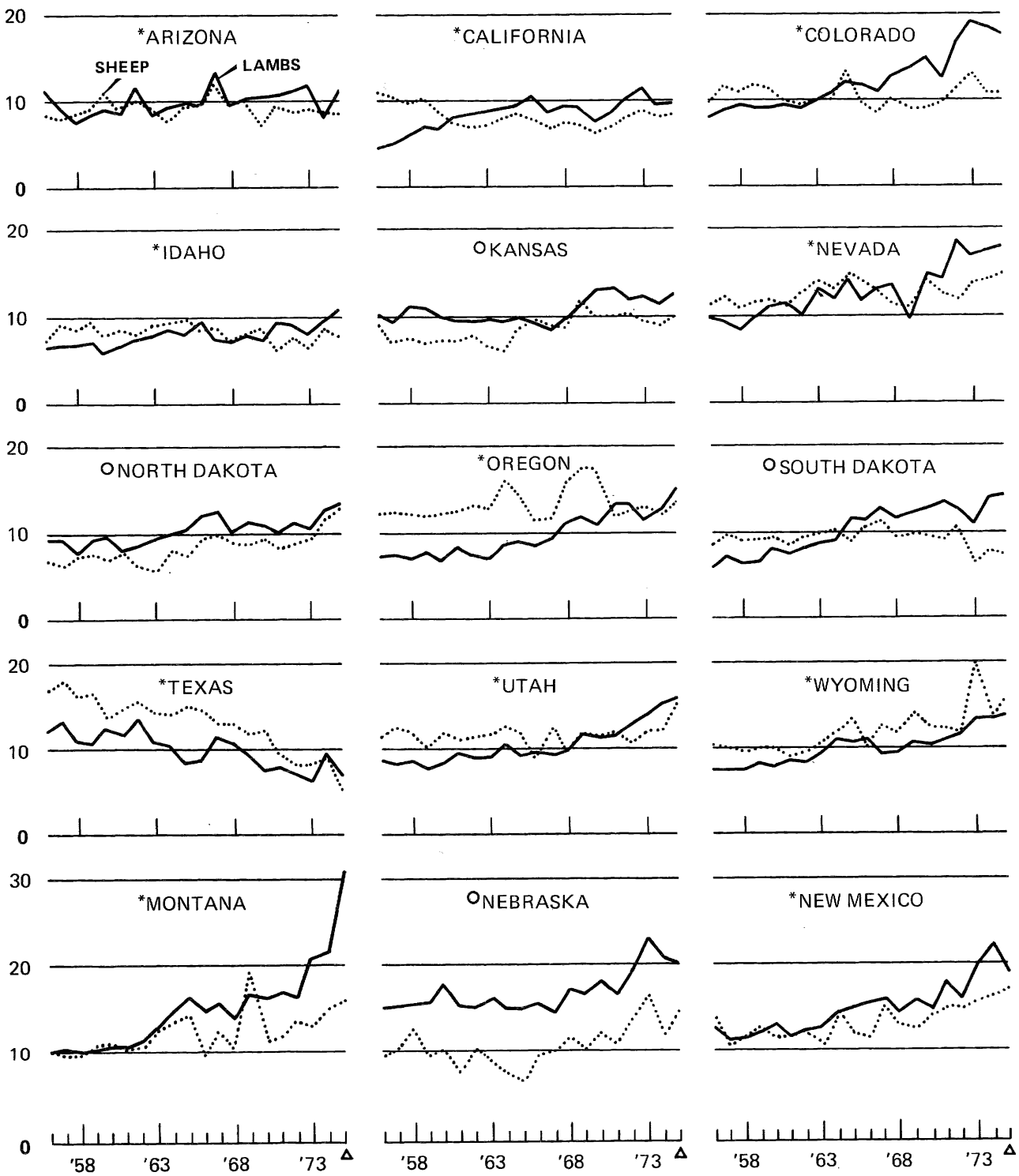
Several geographical observations can be made. One is that Texas stands out as the only State with decreasing rates of loss for both lambs and sheep. A second is that loss rates tend to be increasing in the four Plains States. A third is that the States with substantial increases in lamb loss rates tend to have mountainous terrains and extensive open-range grazing.

Trends in losses by cause outlined for six States

SRS officials in Colorado, Montana, Nebraska, South Dakota, Texas, and Wyoming assembled data on lamb and sheep losses by cause in one or more years prior to the ERS comprehensive survey in 1974. The Montana and South Dakota series provide only 2 years of data prior to 1974. The Colorado, Nebraska, Texas, and particularly Wyoming data series are longer. For Texas and Wyoming, 1975 data are available. For each of the six States, loss rates were calculated for predation and other causes as a percentage of either lambs born or adult sheep inventories. These are summarized in tables 9 and 10.

Figure 3

TRENDS IN LAMB AND SHEEP LOSSES TO ALL CAUSES, 15 WESTERN STATES, 1956-1975



O LAMB LOSSES FROM BIRTH. *LAMB LOSSES FROM DOCKED LAMBS. Δ 1975 PRELIMINARY.
SOURCE: APPENDIX TABLES 4 AND 5.

Table 9--Loss rates of lambs to predators and other causes, selected States and years for which data are available

State and cause of loss	1966	1967	1968	1969	1970	1971	1972	1973	1974 2/	1975 3/
	Percent of lambs born 1/									
Colorado										
Predators	8.2				5/ 7.2	5/ 7.7			16.5	
Other causes	10.0				5/ 5.8	5/ 5.2			11.6	
All causes 4/	18.2				5/ 13.0	5/ 12.9			28.1	
Montana										
Predators			7.8	6.1					17.5	
Other causes			15.1	23.3					14.3	
All causes 4/			22.9	29.4					31.8	
Nebraska										
Predators						7.0	8.0	8.7	1.8	
Other causes						9.7	11.0	14.4	18.8	
All causes 4/	15.3	14.6	17.1	16.7	18.3	16.7	19.0	23.1	20.6	20.0
South Dakota										
Predators	6/1.2				2.3				3.0	
Other causes	6/7.3				10.2				10.8	
All causes 4/	6/8.5	12.5	11.1	11.9	12.5	13.0	12.5	10.7	13.8	13.9
Texas										
Predators						7.3	5.3	8.0	11.8	8.0
Other causes						6.8	7.2	5.5	7.8	5.3
All causes 4/						14.1	12.5	13.5	19.6	13.3
Wyoming										
Predators	5.6		4.6	6.8	7.7	7.4	7.9	10.0	11.7	10.8
Other causes	11.1		11.0	10.2	8.2	9.0	9.7	11.5	9.2	13.7
All causes 4/	16.7		15.6	17.0	15.9	16.4	17.6	21.5	20.9	24.5

1/ Includes both before- and after-docking losses as a percentage of lambs born.
2/ Gathered as part of the 15-State sheep loss mail survey (see table 6).
3/ Preliminary.
4/ These loss rates to all causes differ from the historical series in Appendix table 4 because the latter are based on lambs docked and losses after docking only.
5/ Survey conducted by Colorado Department of Agriculture.
6/ 1963 data.

Source: (19, 20, 21, 22, 23, 24, 25, and 26).

Table 10--Loss rates of adult sheep to predators and other causes, selected States and years for which data are available

State and cause of loss	1966	1967	1968	1969	1970	1971	1972	1973	1974 2/	1975 3/
	Percent of sheep 1/									
Colorado										
Predators	2.5				4/ 2.2	4/3.5			4.8	
Other causes	7.1								5.6	
All causes	9.6	8.5	10.1	9.1	8.8	9.4	10.8	12.8	10.4	10.3
Montana										
Predators			1.6	1.5					6.0	
Other causes			8.7	17.8					8.7	
All causes	9.5	12.8	10.3	19.3	11.2	11.6	13.2	13.0	14.7	15.7
Nebraska										
Predators						3.0	3.5	4.6	1.0	
Other causes						8.8	10.2	11.7	10.7	
All causes	9.5	10.0	11.7	10.1	12.0	11.8	13.7	16.3	11.7	15.0
South Dakota										
Predators	5/1.0				1.1				.4	
Other causes	5/8.9				8.6				7.1	
All causes	5/9.9	11.0	9.5	10.0	9.7	9.1	10.3	6.3	7.5	7.1
Texas										
Predators		1.9				3.1	1.7	2.4	2.9	1.7
Other causes		10.7				6.1	6.2	5.5	6.0	3.2
All causes	14.1	12.6	12.6	11.5	11.7	9.2	7.9	7.9	8.9	4.9
Wyoming										
Predators	2.3		1.6	2.3	2.2	1.7	1.8	2.9	3.5	2.8
Other causes	7.7		9.8	11.6	9.8	10.0	9.5	17.0	9.2	12.9
All causes	10.0	12.3	11.4	13.9	12.0	11.7	11.3	19.9	12.7	15.7

1/ Based on losses of sheep 1 year and older as a percent of Jan. 1 inventory of stock sheep 1 year and older.
2/ Gathered as part of the 15-State sheep loss mail survey (see table 7).
3/ Preliminary.
4/ Based on survey conducted by Colorado Department of Agriculture. Loss rates to all causes are based on SRS data.
5/ 1963 data.

Source: (19, 20, 21, 22, 23, 24, 25, and 26).

Lamb losses to predators in 1974 were above previous percentage levels in five of the six States. The exception was Nebraska, where predation dropped in 1974 after increasing in 1971-1973. Lamb predation rates in 1975 were lower than in 1974 in both Texas and Wyoming, the only States with 1975 data. But the rates were still at or above levels of other previous years.

In Wyoming, 8 years of continuous data clearly show that predation was responsible for the upward trend in total lamb death rates in that State. In Colorado and Montana, predation rates in 1974 were more than double those existing 6 to 9 years earlier (no data in between), suggesting predation may have caused the increase in total death rates in those two States as well. In Nebraska, increased loss rates to nonpredator causes were the principal factor.

In Texas, predation rates varied considerably over the 5-year data series. The rate for lambs in 1975 was lower than in 1974, but equal to 1973 and above the 2 years previous.

Sheep losses to predators in 1974 were above previous percentage levels in three of the six States (Colorado, Montana, and Wyoming). In Texas, the 1974 predation rate was the second highest recorded. Losses to predators in 1975 were below 1974 in both Texas and Wyoming, the only States with 1975 data.

An interesting aspect stands out in Wyoming's 9 years of data. The 3 years with the highest predation rates for both lambs and sheep were 1973-1975. These 3 years followed the 1972 restrictions on use of toxicants for predator control. Was the higher predation a result, just coincidental, or some of both? After we look at loss trends in National Forest ranges, we will return to the question.

Predation rates climbing on National Forest ranges

Many western sheepmen have grazing permits on the National Forest rangelands. These lands typically are high altitude ranges affording roughly 2 to 5 months of summer grazing. Annual data are available on the total number of adult sheep grazed on National Forest ranges and the total number of deaths attributed to predators and other causes. Loss estimates are based on reports filed by sheepmen with the Forest Service. Data for the years 1951 to 1975 are shown in figure 4 and table 11.

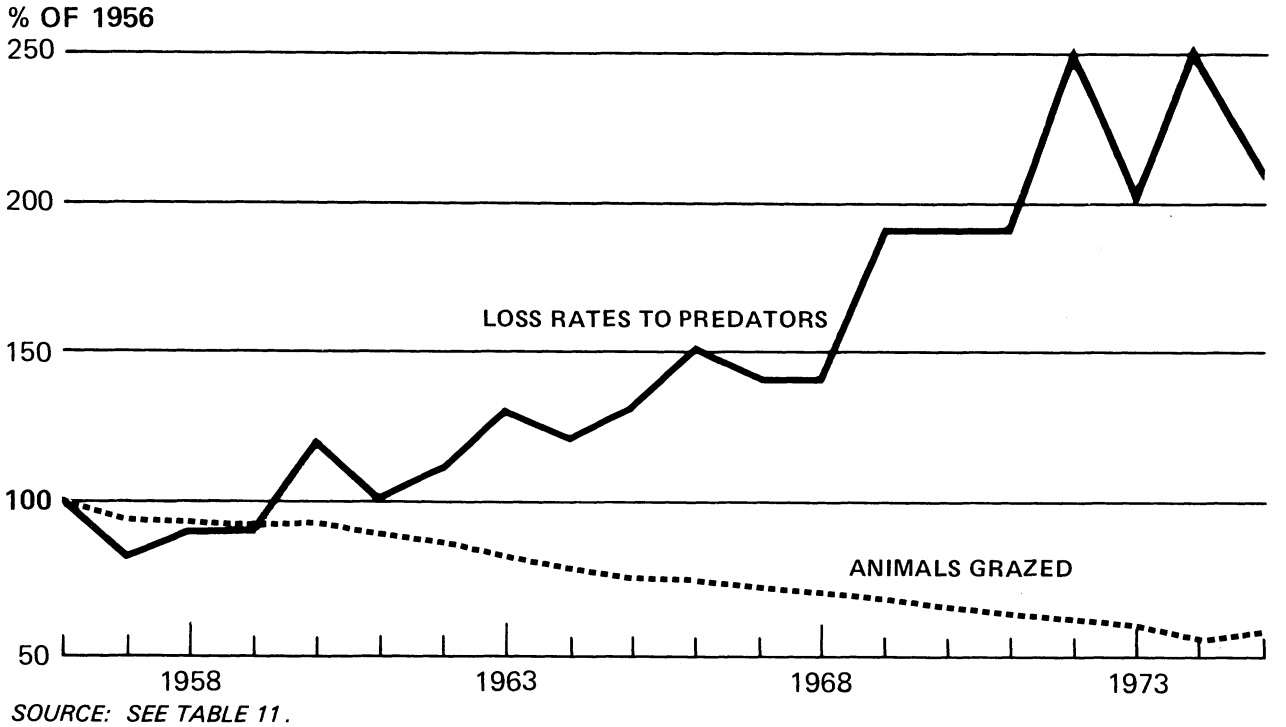
In the last two decades, the number of sheep grazed on National Forest ranges has dropped considerably. Nevertheless, losses of sheep attributed to predators (chiefly the coyote) increased, and the predation rate more than doubled. The four highest loss rate seasons, 1972-75, occurred after the additional restrictions placed during 1972 on use of toxicants for predator control, but the trend was definitely up prior to the new restrictions.

Sheep loss attributed to predators (mostly coyotes) now constitutes more than 60 percent of all sheep deaths occurring on National Forest ranges. This is up from less than 40 percent in the 1950's.

Were increasing predator losses a factor in the decreases in numbers of sheep grazed on National Forest ranges? The answer is probably yes, along with

Figure 4

SHEEP AND GOATS GRAZED AND LOSSES ON THE NATIONAL FOREST RANGES, 1956-1975



SOURCE: SEE TABLE 11.

other factors. At the same time that the number of sheep grazed was declining, grazing of cattle was increasing. Cattle are less prone to predation than sheep. In our survey of former sheep producers, many of those that had switched to cattle rated predation losses high as a factor in this decision. 9/ However, many also gave high ratings to labor shortage, low lamb and wool prices, and other problems. Also during this time, reductions were imposed on the number of sheep allowed to graze in certain areas, and some former ranges were changed into recreational and other uses.

Various factors underlie predation increases

The available, although incomplete, evidence suggests that coyote predation, which affects lambs more than sheep, is the major reason why lamb loss rates in the West have been increasing both absolutely and relative to those of sheep. Various factors have likely contributed to this predation increase. Major ones are: (1) coyotes are more numerous or are preying more upon lambs; (2) control efforts have lessened or become less effective; (3) fewer lambs and sheep exist upon which to prey; and (4) management practices have increased exposure of lambs to predation.

9/ This will be discussed in the study on factors in the decline of sheep production in the West (see Foreword).

Table 11--Sheep and goats grazed and losses on National Forest ranges, 1956-74 1/

Year	Animals grazed 2/	Reported losses to 3/			Loss rates to			Predators as a percent of all causes
		Predators	Other causes 4/	All causes	Predators	Other causes 4/	All causes	
	Thousands				Percent 5/			
1956	2,690	27.2	44.4	71.6	1.0	1.7	2.7	38.0
57	2,543	21.6	34.6	56.2	.8	1.4	2.2	38.4
58	2,534	22.8	35.6	58.4	.9	1.4	2.3	39.0
59	2,525	23.0	34.8	57.8	.9	1.4	2.3	39.8
60	2,531	28.5	32.7	61.2	1.2	1.3	2.5	46.6
1961	2,436	25.5	34.6	60.1	1.0	1.5	2.5	42.4
62	2,334	24.9	28.1	53.0	1.1	1.2	2.3	47.0
63	2,231	28.4	28.7	57.1	1.3	1.3	2.6	49.7
64	2,158	26.1	26.0	52.1	1.2	1.2	2.4	50.1
65	2,025	26.7	27.6	54.3	1.3	1.4	2.7	49.2
1966	2,027	30.7	27.6	58.3	1.5	1.4	2.9	52.7
67	1,941	26.8	28.7	55.5	1.4	1.5	2.9	48.3
68	1,879	27.2	24.2	51.4	1.4	1.3	2.7	52.9
69	1,828	35.0	28.0	63.0	1.9	1.5	3.4	55.6
70	1,741	32.6	22.2	54.8	1.9	1.2	3.1	59.5
1971	1,696	32.1	24.7	56.8	1.9	1.4	3.3	56.5
72	1,652	40.7	25.3	66.0	2.5	1.5	4.0	61.7
73	1,598	31.3	26.3	57.6	2.0	1.6	3.6	54.3
74	1,470	37.0	24.7	61.7	2.5	1.7	4.2	60.0
75	1,549	31.8	18.0	49.8	2.1	1.1	3.2	63.9

1/ Average length of time on the National Forest range is 2 1/2 months.
2/ Excludes lambs which usually accompany ewes (about 1 per ewe). Data for years before 1966 are estimates of sheep actually grazed.
3/ As reported by those holding grazing permits. Likely includes losses of lambs.
4/ Includes unknown causes.
5/ Percentage of animals grazed.
Source: (18)

Coyote numbers and food sources. The most comprehensive data on coyote numbers are the indices of predator abundance complied by the Fish and Wildlife Service. 10/ However, only 4 years of data exist, 1972-75. The coyote index for the western United States increased in 1973 and 1974, but made no significant change in 1975 (29). The 1973 and 1974 increases could have been part of an upward trend in coyote numbers, which may have leveled off in 1975 (at least the total lamb loss rates to all causes did not increase in 1975 over 1974, table 8).

Research is also being conducted by public agencies and universities on such questions as what triggers coyotes to kill sheep and lambs and to what extent this predation is affected by the availability of alternative prey. However, few results are available (discussion of what is being done can be found in (27).

Control efforts. Funds and man-years expended on the nationwide animal damage control program by the Department of the Interior and its cooperators provide an index of coyote control efforts. 11/ Since 1964, both real (deflated) dollar expenditures and man-years of effort in the control program have trended downward (fig. 5 and table 12). The drop in man-years of control effort in particular coincides with the increase in lamb loss rate to all causes, suggesting that the decreased control effort contributed to greater predatory activity. 12/ When control expenditures increased in 1975 (mostly on aerial gunning), both the coyote index and the lamb loss rate leveled off after 2 to 4 years of steady increase.

Fewer sheep and lambs as prey. The decline in lamb and sheep numbers could also be a factor in the increased rates of predation in certain areas. Even if the number of coyotes had remained constant, fewer lambs and sheep would mean relatively more coyotes per lamb and sheep. Some sheep producers interviewed felt that the reduced numbers of sheep in their ranges had contributed to increased rates of predation on the remaining sheep and lambs.

Management practices. Certain management practices could be contributing to coyote predation of lambs, particularly before docking. For example, current breeding programs encourage more multiple births which divides the attention of the ewe, sometimes causing her to abandon one lamb. Also the proportion of sheep which are pasture or range-lambed has probably increased over the past 20 years along with the proportion of total sheep on large-scale operations. Although this change in the management system reduces labor costs, it increases the exposure of young lambs to predators as well as to death by natural causes such as weather. However, most

---

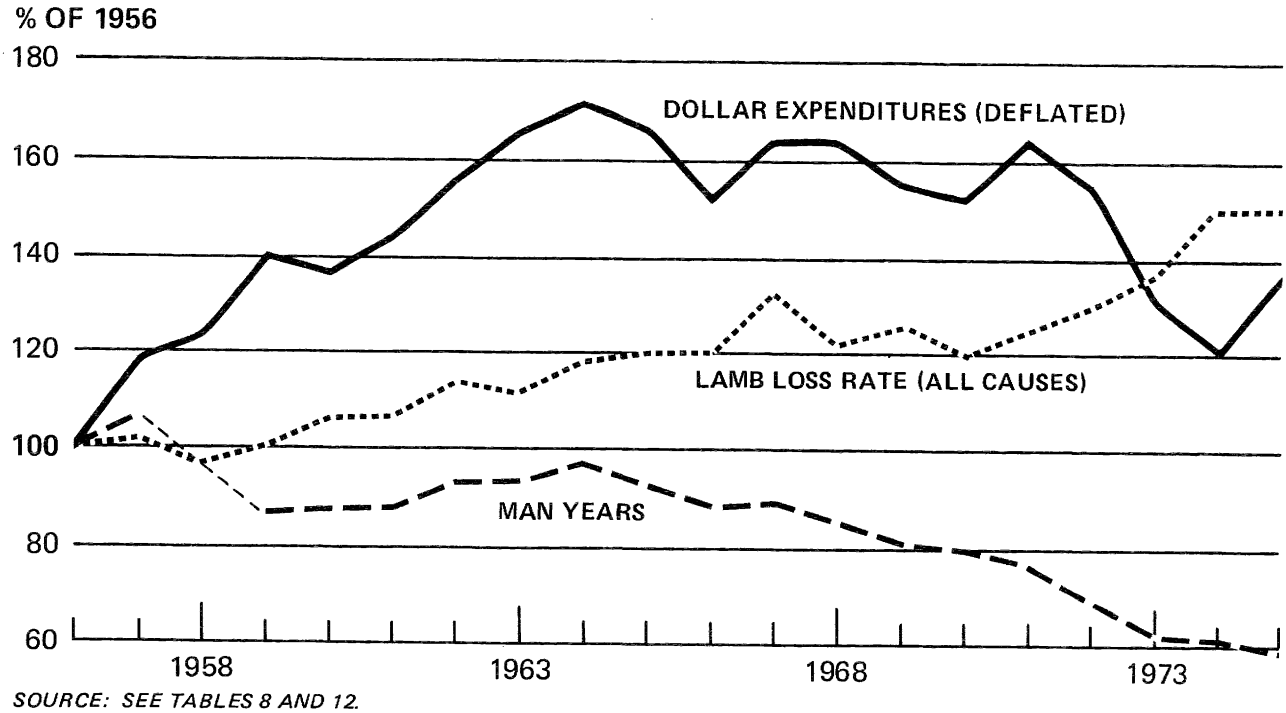
10/ These indices are based on frequency of visitations to scent posts, which in theory, should reflect differences in relative population levels.

11/ Although the data on expenditures and man-years include control efforts on other animals and birds, most of the effort was on coyotes.

12/ More discussion of the effects of changes in control expenditures on coyote predation will be contained in a report on coyote control alternatives (see Foreword).

Figure 5

ANIMAL DAMAGE CONTROL PROGRAM EXPENDITURES AND MAN YEARS



SOURCE: SEE TABLES 8 AND 12.

of the increase in lamb deaths would occur prior to docking, so these practices would explain little of the upward trend in total losses of docked lambs (as mostly reflected in the regional data, fig. 2, and for many States, fig. 3).

ECONOMIC VALUE OF SHEEP AND LAMBS LOST TO COYOTES IN 1974

This section translates the physical losses of lambs and sheep to coyotes into economic impacts on producers and consumers. 13/

Coyote predation costs producers $27 million

Predation usually reduces the number of lambs and sheep marketed for slaughter, which in turn causes prices to increase. However, market price for lamb and mutton do not normally increase in proportion to the reduction in supplies. Thus, the net effect of predation on the U.S. sheep industry is a reduction in gross sales. In 1974, coyote predation alone may have reduced gross U.S. sales of sheep and lambs for slaughter by some $27 million, 9 percent under what sales would otherwise have been (table 13). This is only approximate, but it does indicate the general magnitude of overall economic losses to sheepmen because of coyote predation.

13/ The demand analysis upon which this section is based was done by Muhammed Usman, Dept. of Econ., Colo. State Univ., Ft. Collins, Colo.

Table 12--Funds expended and man-years devoted to the animal damage control program by the U.S. Fish and Wildlife Service and its cooperators, 1956-75

Year	Funds expended: Total dollars 1/	Funds expended: Deflated index 2/	Man-years: Total	Man-years: Index
	Millions	1956 = 100	Man-years	1956 = 100
1956	3.8	100	959	100
1957	4.6	119	1024	107
1958	5.0	123	3/ NA	NA
1959	5.4	140	830	87
1960	5.4	137	848	88
1961	5.7	144	844	88
1962	6.2	156	889	93
1963	6.6	166	894	93
1964	6.9	172	931	97
1965	6.9	167	896	93
1966	6.7	153	855	89
1967	7.1	165	861	90
1968	7.3	165	821	86
1969	7.3	156	779	81
1970	7.5	153	765	80
1971	8.2	165	741	77
1972	8.1	156	664	69
1973	8.4	132	599	62
1974	9.0	121	584	61
1975	11.0	137	562	59

1/ Includes both Federal and cooperative expenditures and man-years for all animal damage control programs. However, the bulk of the funds and man-years went into coyote control.

2/ Expenditures were deflated by the wholesale price index prior to indexing to 1956.

3/ N.A. = Data not available.

4/ Preliminary.

Source: Data from annual reports of the U.S. Fish and Wildlife Service, U.S. Dept. Int.

Table 13--Estimation of gross economic impacts of coyote predation on U.S. sheep producers, 1974

Producer group	Sheep and lamb production			Value of production		
	With no losses to coyotes	Actual	Impact of coyotes	With no losses to coyotes	Actual	Impact of coyotes
	--Million pounds--			--Million dollars--		
Western producers (15 States)						
With losses to coyotes	517	423	1/ -94	2/ 171	140	-31
With no losses to coyotes	192	192	--	2/ 62	64	+ 2
Subtotal	709	615	-94	233	204	-29
Other U.S. producers	170	170	--	2/ 66	68	+ 2
Total U.S.	879	785	-94	299	272	-27

1/ Based on decreased production for slaughter of 893,000 lambs at an average weight of 105 pounds. The decreased slaughter was estimated as follows: lamb losses to coyotes in 1974 (728,000) minus lambs which would have been lost to other causes if not lost to coyotes (55,000) plus lambs needed as replacements for sheep lost to coyotes (220,000, excluding 9,000 sheep which would have been lost to other causes, if not lost to coyotes).

2/ Based on a price or value drop of 3% on actual 1974 production and a price of $37.67 per 100 pounds on the additional 94 million pounds of production.

Source: Actual data for western States and total U.S. are from (17). Distribution of production between loss- and no-loss producers within the West are based on relative number of lambs born to each according to survey data.

While some producers have economic losses, others benefit from predation. Western producers who experienced coyote predation in 1974 had their gross sales reduced by $31 million. In contrast, producers who had no losses to coyotes in 1974 likely had a $4 million increase in sales because of slightly higher prices. Adding the two groups together results in a net industry impact of $27 million in reduced sales.

Hardest hit in 1974 were some 5,000 producers who sustained lamb losses exceeding 10 percent of lambs born. Among these the average loss in foregone lamb sales was about $4,000.

No attempt was made to estimate other economic benefits and costs to producers which would result from the absence of coyote predation. Likely benefits include additional wool sales, fewer injured animals, less herding, more weight gain, and lower labor costs. The extra costs include those of producing and marketing the additional lambs. These likely would have been minor. Most lambs are sold directly off the ewe with no out-of-pocket costs for additional feed consumed by the ewe or the lamb. Also most lambs are sold at the farm gate with the buyer paying transportation costs.

Coyote predation cuts consumer welfare by $10 million

Coyote predation reduces consumer welfare by increasing the prices consumers pay for lamb and by reducing the supplies available. In 1974, consumer welfare, measured in terms of consumer surplus, was $10 million less than it would have been with no coyote predation.

This is a rough estimate, but it indicates that consumers are affected economically by predation, although the impact is substantially less than it is on sheepmen.

Total impact of predation may exceed $37 million

The economic impacts on producers and consumers can be added together to provide an indication of the total gross cost of coyote predation. In 1974, this total gross cost was $37 million. This estimate does not include control expenditures, which exceeded $7 million in 1974. Also, it does not include any indirect or multiplier impacts on other economic activities and local economies.

Benefits of reducing losses must be weighed against additional costs

Reduction of these gross economic losses would require additional expenditures for or changes in predator control which would have to be weighed against the economic benefits. Also, environmental and social impacts would have to be considered, along with regulatory constraints. A program aimed at reducing predation of sheep and lambs to near zero levels appears infeasible economically or otherwise. However, some control program changes which would reduce losses do appear feasible. 14/

FACTORS ASSOCIATED WITH DIFFERENCES IN PREDATION

Considerable variation existed in the 1974 rates of predation, both among States and among producers. This section summarizes the statistical and comparative analyses undertaken to identify factors underlying the variation noted. Some success was achieved, but much of the variation remained unexplained. Possible reasons for this are given and suggestions are made for future research.

14/ A complete discussion of the benefits and costs of alternative controls and levels of expenditure is contained in a forthcoming report (see Foreword).

Results of statistical analyses 15/

Regression, cluster, and discriminant analyses were used to examine the relationship of predation levels to control, management, and location factors. The data came from the personal interview survey, a survey of Federal trappers (cooperative effort with the Fish and Wildlife Service), and Fish and Wildlife Service's research on predator abundance in the western United States (29). Combined information from the three sources resulted in 269 variables and 766 cases.

Regression analysis was used to eliminate many variables with extremely low relationships to predation rates. Cluster analysis was then used to further limit the data set by grouping similar variables. 16/ The following nine dimensions resulted:

1. Operation size
2. Coyotes per sheep
3. Predator control expenditures
4. Coyotes killed
5. Coyote population index
6. Farm and sheep density
7. Use of public lands
8. Coyotes taken by Federal trappers
9. Shed lambing

Ranchers with similar characteristics on these nine dimensions were then grouped and discriminant analysis used to predict predation rates for each group. Although the results of these statistical analyses were complex and variable, some general tendencies were noted:

1. Smaller operations more frequently than larger ones had either zero or high rates of predation.

2. Shed lambing and private land use were associated with low to medium predation rates, while range lambing and public land use were associated with medium to high rates.

3. High 1973 and 1974 coyote population indices tended to be related to high predation rates.

4. Ranchers using Federal predator control programs more frequently than other ranchers had predation levels of less than 10 percent.

These analyses suggest that coyote control efforts reduce lamb and sheep losses, though the effect is not dramatic and considerable variation remains unexplained.

15/ This section represents only a summary. More details are presented in a forthcoming analytical report on predator control levels and effects (see Foreword).

16/ The computer program used was the BC TRY System (see 16 chap. 13).

The large amount of unexplained variation in sheep and lamb losses can be attributed to one or more of the following possibilities:

1. Predation of sheep and lambs by coyotes may frequently be a random event; that is, high variation is normal.

2. Many producers keep inadequate records or tallies of sheep and lamb losses, and sometimes the cause of death is unknown.

3. The proxy for coyote numbers--the predator abundance indices--may not reflect relative coyote population in areas where sheep are located. In most cases the predator abundance survey lines were not on the sheep ranches; in some cases, they were a considerable distance from the ranches.

4. The annual data on losses and predator control used in the analysis may have covered up the short-term leads and lags that actually occurred between the time losses were discovered and controls were applied and produced results.

5. Variables other than the ones measured in this study may be the important keys to predicting and explaining sheep and lamb losses to coyotes.

Comparison of ranchers with high and low predation losses 17/

Based on 1974 survey data, a sample of sheep producers in Colorado, Idaho, Nevada, Oregon, Utah, and Wyoming who reported the highest and lowest predation losses were identified for more intensive study. High-loss producers were those reporting coyote predation exceeding 8 percent of docked lambs. Low-loss ranchers were those with predation losses of 4 percent or less. Initially, about 40 ranchers in each group were contacted, with additional information obtained by personal interview from 37 high-loss producers and 29 low-loss producers.

Some interesting differences existed between the two groups (table 14). High-loss producers had a much lower average docking rate, 90 lambs per 100 ewes compared with 113 for the low-loss producers, primarily because of high lamb mortality due to predators and other causes prior to docking. Range lambing appeared to be a contributing factor in this mortality difference. Proportionately more of the high-loss producers range-lambed--65 percent, compared with 41 percent of the low-loss producers.

Other significant differences between the two groups were producer and sheep densities. Both densities averaged lower for the high-loss producers. A

17/ This research was performed by Darwin B. Nielsen, Professor of Agricultural Economics, Utah State Univ.

Table 14--Differences between high and low predation loss producers, selected areas, 1974-75 1/

	High predation loss producers 2/	Low predation loss producers 3/
Average coyote predation loss	14% of docked lambs	3.8% of docked lambs
Docking rate	90 lambs per 100 ewes	113 lambs per 100 ewes
Average producer density	2 producers within 10-mile radius	4 producers within 10-mile radius
Predation loss trend, 1970-74	most indicated that losses had increased	61% with increasing losses 21% with no change 18% with variable losses
Losses in 1975 compared with 1974	16% said higher 62% said lower 22% said no change	19% said higher 35% said lower 46% said no change
Reasons for lower losses in 1975	1. more effective aerial gunning 2. fewer coyotes 3. more alternative prey	1. more effective aerial gunning 2. fewer coyotes
Major reasons for predation losses being higher or lower than other producers in 1974	1. poorer coyote control 2. more coyotes 3. less alternative prey 4. poorer range conditions	1. better coyote control 2. fewer coyotes 3. better herders 4. better range conditions
Use of herders	no significant difference	
Control efforts and range conditions	data inadequate for meaningful comparisons	

1/ Included portions of Colorado, Idaho, Nevada, Utah, and Wyoming.
2/ Interviews were completed with 37 out of 40 in sample.
3/ Interviews were completed with 29 out of 40 in sample.

few high-loss ranchers specifically mentioned that decreases in numbers of producers and/or sheep in their range areas were factors in the increasing or higher rates of coyote predation experienced.

Producers were asked to rate various reasons why their losses were either higher or lower than those of other producers. The reasons most frequently identified by the high-loss producers were poorer coyote control, more coyotes, and less alternative prey. Low-loss producers generally felt that better coyote control, fewer coyotes, and better herders contributed to their success.

Both groups were asked about the 1970-74 trend in predation losses. Nearly all of the high-loss producers indicated predation losses had increased during this time period, compared with 61 percent of the low-loss producers. However, the majority of both groups said losses in 1975 were running lower or about the same as those in 1974.

Reasons given by those with lower losses in 1975 than in 1974 primarily had to do with more effective aerial gunning and fewer coyotes. A few mentioned that more alternative prey was available.

Suggestions for future research

The results of these analyses suggest that better data are needed if some of the relationships among predation losses, coyote population numbers, control efforts, and ranching practices are to be more completely defined. One method would be to use an intensive, but short-term effort as follows:

1. Specific areas with high, medium, and low levels of predation would be identified through survey and other data. Within these areas a number of ranchers (50 to 100 in total) would be selected for intensive study.

2. Biological damage assessments would be made on losses of these ranchers during 2 to 3 high-loss months of the year, including the predocking period and 1 to 2 months of the summer grazing period when losses usually are the greatest.

3. Data on abundance of predators and natural prey, weather, vegetation types, and other related data would be gathered on the ranches and surrounding areas prior to and during the damage assessment.

4. Data on sheep and lamb inventory numbers, ranching practices, and predator control efforts would be obtained on the spot.

5. Predator control would be monitored and careful note taken of the extent of predation before and following control efforts.

This type of closely coordinated data would help reduce the random or unexplained variation to a point where more defined and statistically reliable estimates of relationships might be possible. The results would contribute to a better evaluation of the extent of predation and efficiency of control efforts.

REFERENCES

(1) Bowns, James E.

1976. "Field Criteria for Predator Damage Assessment," Utah Science, March.

(2) Bowns, James E., John W. Davenport, John P. Workman, Darwin B. Nielsom, and Don D. Dwyer

1973. "Determination of Cause and Magnitude of Sheep Losses in Southwestern Utah," Utah Science, June.

(3) Cain, Stanley A., et.al.

1972. Predator Control--1971. Report to the Council on Environmental Quality and the Department of Interior by the Advisory Committee on Predator Control. Jan.

(4) Davenport, John W., James E. Bowns, and John F. Workman

1973. Assessment of Sheep Losses to Coyotes: A Problem to Utah Sheepmen, A Concern of Utah Researchers. Res. Rpt. 7, May, Agr. Exp. Sta., Utah State Univ., Logan.

(5) DeLorenzo, Donald G., and V. W. Howard, Jr.

1976. Evaluation of Sheep Losses on a Range Lambing Operation Without Predator Control in Southeastern New Mexico. Final Rpt. to U.S. Fish and Wildlife Serv., Feb., Denver Wildlife Res. Center, Denver.

(6) Early, John O., Joe C. Roetheli, and Gary R. Brewer

1974. An Economic Study of Predation in the Idaho Range Sheep Industry, 1970-1971 Production Cycle. Progress Rpt. 182, Feb., and An Economic Study of Predation in the Range Sheep Industry, 1972-73. Progress Rpt. 186, Oct., Agr. Exp. Sta., College of Agr., Univ. Idaho, Moscow.

(7) Gee, C. Kerry, and Richard S. Magleby

1976. Characteristics of Sheep Production in the Western United States. AER-345, Aug., U.S. Dept. Agr., Econ. Res. Serv., Washington, D.C.

(8) Henne, Donald R.

1975. Domestic Sheep Mortality on a Western Montana Ranch. Unpublished masters thesis, Univ. of Montana.

(9) Howard, Walter E., and Gary E. Nesse

1974. State Wide Coyote Predation Studies. Nov. 25, Div. of Wildlife and Fisheries Biology, Univ. Calif., Davis.

(10) Klebenow, Donald A. and Kent McAdoo

1976. "Predation on Domestic Sheep in Northeastern Nevada," J. Range Management, Vol. 29. No. 2, March, pp. 96-100.

(11) Nass, Roger D.

1977. "Predation Associated with Shed Lambing Sheep Operations in Idaho," J. Range Management, (forthcoming).

(12) Nesse, Gary E., et.al.

1976. Predation and the Sheep Industry in California-1972-74. Bul. 1878, Div. Agri. Sci., Univ. of Calif. July.

(13) Nielsen, Darwin, and David Curle

1970. "Predator Costs to Utah's Range Sheep Industry," National Wool Growers Magazine, V. 60, Dec.

(14) Ruttle, Jack L.

1971. Livestock Losses in New Mexico, Dept. of Animal Range and Wildlife Sciences, New Mexico State Univ., Las Cruces.

(15) Tigner, R. and G. Larson

1977. "Sheep Losses in Selected Ranches in Southern Wyoming," J. Range Management, (forthcoming).

(16) Tyron, Robert C., and Daniel E. Bailey

1970. Cluster Analysis. McGraw-Hill Book Co., N.Y., Chap. 13.

(17) U. S. Department of Agriculture

Livestock and Meat Statistics. (various), Econ. Res. Serv., Stat. Rptg. Serv., and Agr. Mktg. Serv., Washington, D.C.

(18) U. S. Department of Agriculture

Animal Grazing Statistical Reports (various), Forest Service, Washington, D.C.

(19) U. S. Department of Agriculture

Nebraska Livestock Loss Reports for 1972-74. Nebr. State-Federal Div. of Agr. Stat., Lincoln.

(20) U. S. Department of Agriculture

Sheep and Goats Reports. (various), Stat. Rptg. Serv., Washington, D.C.

(21) U. S. Department of Agriculture

1967. 1966 Sheep and Lamb Losses in Colorado. July 25. Stat. Rptg. Serv. and Colo. Crop and Lstk. Rptg. Serv., Denver.

(22) U. S. Department of Agriculture

Sheep and Lamb Losses in Montana, 1968-69. (various). Stat. Rptg. Serv. and Montana Crop and Lstk. Rptg. Serv., Helena.

(23) U. S. Department of Agriculture

1971. South Dakota Livestock and Poultry Losses, 1970. Stat. Rptg. Serv. and S.D. Crop and Lstk. Rptg. Serv., Sioux Falls.

(24) U. S. Department of Agriculture

Sheep and Lamb Deaths. Various reports for 1971-75. Stat. Rptg. Serv. and Tex. Crop and Lstk. Rptg. Serv., Austin.

(25) U. S. Department of Agriculture

Wyoming Agricultural Statistics. 1973, 1974, and 1975 reports. Stat. Rptg. Serv. and Wyoming Crop and Lstk. Rptg. Serv., Cheyenne.

(26) U. S. Department of Agriculture

1968. Texas Sheep and Goat Industry. Bul. 46. May. Tex. Crop and Lstk. Rptg. Serv., Austin.

(27) U. S. Department of Interior

1974. Coyote Research Workshop (proceedings). Nov. 14-17. Denver Wildlife Res. Center, Fish and Wildlife Serv., Denver.

(28) U. S. Department of Interior

1976. Denver Wildlife Res. Center, Fish and Wildlife Service, unpublished data used by permission.

(29) U. S. Department of Interior

1975. Indices of Predator Abundance in the Western United States, Denver Wildlife Research Center, Fish and Wildlife Serv., Denver.

Appendix table 1--Sheep and lamb loss surveys conducted by universities, 1969-74

Survey location, time period, and reference	Scope	Reported losses of lambs to		
		Predation	Unknown causes	All causes
California July 1973 July 1974 (12)	Sample of 140 producers with 30% of ewes in the State	2.7% of docked lambs; 1.1% of ewes (mostly to coyotes)	2.2% of docked lambs; 1.3% of ewes	10.5% of docked lambs; 7.6% of ewes
Idaho 1970-71 and 1972-73 (6)	Sample of ranchers with 27% of range ewe numbers in the State	About 4% of docked lambs; 2.5 to 3% of ewes (mostly to coyotes)	4 to 6% of docked lambs; 2 to 4% of ewes	15 to 19% of docked lambs; 8 to 9% of ewes.
New Mexico 1970-71 (14)	Ranchers with 26% of the State's sheep	80% of lamb losses, about 5% of lambs 1/ (mostly to coyotes)	No information	About 6% of lambs 1/
New Mexico 1972 and 1973 (28)	About 100 ranchers of all sizes in southeastern New Mexico	18 to 26% of ranchers had over 10% loss (mostly to coyotes)	Not obtained	Not obtained
Utah 1969 fiscal year (13)	Range sheep operations of 500 or more sheep	Over 5% of docked lambs; 2% of ewes (mostly to coyotes)	Not obtained	Not obtained

1/ Rate calculated by assuming 1 lamb per stock ewe.

Appendix table 2--Lamb losses before docking, by cause, 15 western States, 1974

State	Lambs born alive	Causes of loss: Coyotes	Other predators	Other known	Unknown	All causes
		Thousands				
Arizona	341	22.6	34.6	20.8	31.0	109.0
California	854	23.3	13.0	44.8	22.6	103.7
Colorado	615	19.6	3.0	38.1	12.1	72.8
Idaho	702	4.1	1.4	43.9	7.5	56.9
Kansas	180	2.3	0.1	8.9	2.4	13.7
Montana	619	9.4	13.6	51.0	8.1	82.1
Nebraska	170	1.0	---	21.8	3.1	25.9
Nevada	161	29.7	0.7	2.6	3.3	36.3
New Mexico	584	29.5	16.4	131.0	12.3	189.2
North Dakota	251	0.6	0.3	10.2	8.7	19.8
Oregon	351	2.9	2.2	16.7	6.5	28.3
South Dakota	806	1.9	2.4	46.9	13.5	64.7
Texas	1,697	44.9	66.4	55.6	30.2	197.1
Utah	644	17.8	2.4	33.4	12.4	66.0
Wyoming	976	22.2	10.2	41.7	9.9	84.0
(15 States)	8,951	231.8	166.7	567.4	183.6	1,149.5
		Percent of lambs born alive				
Arizona	100	6.6	10.1	6.1	9.1	31.9
California	100	2.7	1.5	5.2	2.7	12.1
Colorado	100	3.2	.5	6.2	1.9	11.8
Idaho	100	.6	.2	6.2	1.1	8.1
Kansas	100	1.3	.1	4.9	1.3	7.6
Montana	100	1.5	2.2	8.2	1.3	13.2
Nebraska	100	.6	---	12.8	1.8	15.2
Nevada	100	18.4	.4	1.6	2.0	22.4
New Mexico	100	5.1	2.8	22.4	2.1	32.4
North Dakota	100	.2	.1	4.1	3.5	7.9
Oregon	100	.8	.6	4.8	1.9	8.1
South Dakota	100	.2	.3	5.8	1.7	8.0
Texas	100	2.6	3.9	3.3	1.8	11.6
Utah	100	2.8	.4	5.2	1.9	10.3
Wyoming	100	2.3	1.0	4.3	1.0	8.6
(15 States)	100	2.6	1.9	6.3	2.0	12.8

Source: Estimates based on mail survey responses from 8,910 farmers and ranchers.

Appendix table 3--Lamb losses after docking, by cause, 15 western States, 1974

State	Lambs docked	Causes of loss: Coyotes	Other predators	Other known	Unknown	All causes
		Thousands				
Arizona	232	10.4	3.6	3.6	.4	18.0
California	750	28.0	19.1	13.7	11.2	72.0
Colorado	542	72.3	6.5	10.0	11.2	100.0
Idaho	645	32.7	3.2	15.0	9.1	60.0
Kansas	1/ 166	3.5	0.2	1.8	.8	6.3
Montana	537	73.3	12.4	12.0	17.3	115.0
Nebraska	1/ 144	1.9	0.2	5.3	1.7	9.1
Nevada	125	17.0	1.5	.9	1.6	21.0
New Mexico	395	36.5	17.3	21.4	10.8	86.0
North Dakota	1/ 231	7.1	0.8	2.0	2.4	12.3
Oregon	323	18.0	8.6	9.3	4.1	40.0
South Dakota	1/ 741	15.3	4.4	17.7	8.9	46.3
Texas	1,500	54.3	34.6	26.3	19.8	135.0
Utah	578	57.5	5.7	10.1	14.7	88.0
Wyoming	892	68.6	13.1	16.5	21.8	120.0
15 States	7,801	496.4	131.2	165.6	135.8	929.0
		Percent of docked lambs				
Arizona	100	4.5	1.6	1.5	.2	7.8
California	100	3.7	2.5	1.9	1.5	9.6
Colorado	100	13.3	1.2	1.8	2.1	18.4
Idaho	100	5.1	0.5	2.3	1.4	9.3
Kansas	100	2.1	0.1	1.1	.5	3.8
Montana	100	13.7	2.3	2.2	3.2	21.4
Nebraska	100	1.3	0.1	3.7	1.2	6.3
Nevada	100	13.6	1.2	.7	1.3	16.8
New Mexico	100	9.2	4.4	5.4	2.7	21.7
North Dakota	100	3.1	0.3	.9	1.0	5.3
Oregon	100	5.6	2.7	2.9	1.2	12.4
South Dakota	100	2.0	0.6	2.4	1.2	6.2
Texas	100	3.6	2.3	1.8	1.3	9.0
Utah	100	10.0	1.0	1.7	2.5	15.2
Wyoming	100	7.7	1.5	1.9	2.4	13.5
15 States	100	6.4	1.7	2.1	1.7	11.9

1/ Published lamb crop number has been reduced by the number of lambs lost before docking to obtain docked lambs.

Source: Estimates based on mail survey responses from 8,910 farmers and ranchers.

Appendix table 4--Death loss rates to lambs to all causes, 15 western States, 1956-75 1/

Year	Ariz.	Calif.	Colo.	Idaho	Kansas	Montana	Neb.	Nevada	N. Mex.	N. Dak.	Oregon	S. Dak.	Texas	Utah	Wyom.
							Percent								
1956	10.8	4.4	7.8	6.2	10.0	10.1	14.9	9.9	12.7	9.4	7.1	5.9	12.1	8.3	7.2
57	8.8	4.9	8.8	6.4	9.0	10.3	15.0	9.4	11.4	9.4	7.5	7.0	13.2	8.0	7.2
58	7.3	5.7	9.1	6.4	10.7	10.1	15.2	8.0	11.6	7.7	6.8	6.2	10.8	8.3	7.2
59	8.2	6.6	8.8	6.9	10.6	10.2	15.3	10.0	12.0	9.4	7.6	6.4	10.5	7.7	8.0
60	8.7	6.5	8.9	5.9	10.0	10.6	17.8	10.7	13.0	9.9	6.6	7.8	12.4	8.2	7.5
1961	8.3	7.9	9.1	6.2	9.7	10.4	15.0	11.2	11.4	8.2	8.1	7.3	11.5	9.4	8.2
62	11.5	8.1	8.8	7.2	9.5	11.0	14.9	10.1	12.5	8.6	7.1	8.1	13.5	8.7	8.1
63	8.1	8.5	9.9	7.6	9.8	12.9	16.0	13.7	12.6	9.2	6.8	8.5	10.6	8.9	9.5
64	9.4	8.9	10.5	8.3	9.5	14.9	14.8	11.7	14.7	10.0	8.5	8.6	10.1	10.4	10.6
65	9.6	9.2	11.9	8.1	9.9	16.4	14.8	12.9	15.2	10.3	8.6	11.4	8.2	9.3	10.4
1966	9.3	10.2	11.7	9.0	8.8	14.6	15.3	11.0	15.4	12.1	8.5	11.0	8.5	9.5	10.6
67	13.0	8.6	10.8	7.1	8.1	15.4	14.6	12.8	15.9	12.4	9.2	12.5	11.3	9.3	9.5
68	9.3	9.2	12.6	6.8	9.9	13.6	17.1	13.2	14.6	10.1	10.9	11.1	10.5	9.6	9.6
69	10.2	9.1	13.5	7.4	11.0	16.4	16.7	9.7	15.9	11.0	11.7	11.9	9.1	11.4	10.3
70	10.2	7.5	14.5	7.2	12.7	16.2	18.3	14.4	15.0	10.8	10.7	12.5	7.3	10.9	10.2
1971	10.3	8.6	12.6	8.9	12.8	16.5	16.7	14.0	17.8	10.2	13.3	13.0	7.6	11.3	10.5
72	10.6	10.0	16.7	8.8	11.5	16.3	19.0	18.2	16.1	11.1	13.3	12.5	7.1	12.5	11.1
73	11.6	11.3	19.0	8.0	12.0	20.8	23.0	16.5	20.0	10.4	11.3	10.7	6.1	13.4	13.4
74	7.8	9.6	18.4	9.3	11.1	21.4	20.6	16.8	21.8	12.7	12.4	13.8	9.0	15.2	13.4
75 2/	11.2	9.7	17.7	10.5	12.2	30.8	20.0	17.3	18.7	13.5	14.7	13.9	6.5	15.5	13.5
Average:															
1956-60	8.8	5.6	8.7	6.4	10.1	10.3	15.6	9.6	12.1	9.2	7.1	6.7	11.8	8.1	7.4
1961-65	9.4	8.5	10.0	7.5	9.7	13.1	15.1	11.9	13.3	9.3	7.8	8.8	10.8	9.3	9.4
1966-70	10.4	8.9	12.6	7.5	10.1	15.2	16.4	12.2	15.4	11.3	10.2	11.8	9.3	10.1	10.0
1971-75	10.3	9.8	16.9	9.1	11.9	21.2	19.9	16.5	18.9	11.6	13.0	12.8	7.3	13.6	12.4
Change 3/	+1.5	+4.2	+8.2	+2.7	+1.8	+10.9	+4.3	+6.9	+6.8	+2.4	+5.9	+6.1	-4.5	+5.5	+5.0
% Change3/	+17	+75	+94	+42	+18	+106	+27	+72	+56	+26	+83	+91	-38	+68	+67

1/ Based on losses of docked lambs in all States except Kansas, Nebraska, and North and South Dakota, where losses were from birth.

2/ Preliminary

3/ Change between 1956-60 average and 1971-75 average.

Source. (17, 20).

Appendix table 5--Death loss rates of adult sheep to all causes, 15 western States, 1956-75 1/

Year	Ariz.	Calif.	Colo.	Idaho	Kansas	Montana	Neb.	Nevada	N. Mex.	N. Dak.	Oregon	S. Dak.	Texas	Utah.	Wyom.
							Percent								
1956	8.3	10.8	9.8	6.8	8.5	10.0	9.5	10.8	13.1	6.7	12.0	8.4	16.5	11.1	10.1
57	8.2	10.4	11.3	9.1	6.8	9.7	10.2	11.7	10.7	6.4	12.1	9.9	17.6	12.0	10.0
58	8.3	9.8	11.0	8.3	7.1	9.7	12.8	10.7	11.3	7.1	11.9	9.0	15.9	11.5	9.4
59	8.9	10.2	11.4	9.2	6.7	10.6	9.5	11.5	12.4	7.5	11.7	8.9	16.2	10.1	9.9
60	10.7	8.8	11.2	7.5	6.8	10.8	10.1	11.4	11.3	7.0	11.8	9.4	13.2	11.4	8.8
1961	8.9	7.3	10.0	8.0	6.7	10.3	7.5	10.8	11.4	7.6	12.1	8.3	14.5	10.8	8.9
62	10.0	6.9	9.8	7.5	7.3	10.5	10.2	12.2	12.2	6.1	12.6	9.1	15.1	11.0	9.4
63	8.9	7.0	10.0	8.7	6.2	12.2	8.3	13.6	10.6	5.4	12.2	9.9	14.1	11.1	10.1
64	7.5	7.8	10.1	8.9	5.6	13.5	7.2	12.7	13.9	7.7	15.6	10.1	13.9	12.4	11.5
65	9.0	8.5	12.8	9.6	8.0	14.0	6.3	14.3	12.0	7.3	14.1	8.9	14.7	11.3	13.2
1966	9.6	7.7	9.6	8.3	9.5	9.5	9.5	13.5	11.7	9.6	11.2	10.4	14.1	8.6	10.0
67	11.7	7.1	8.5	8.4	8.6	12.8	10.0	12.7	14.9	9.9	11.2	11.0	12.6	12.2	12.3
68	9.6	7.3	10.1	7.2	8.3	10.3	11.7	10.7	12.7	8.9	15.2	9.5	12.6	9.4	11.4
69	10.0	7.2	9.1	8.1	11.1	19.3	10.1	10.3	12.3	8.8	16.9	10.0	11.5	11.4	13.9
70	7.3	6.3	8.8	8.4	10.0	11.2	12.0	13.7	13.7	9.5	16.9	9.7	11.7	11.1	12.0
1971	9.2	6.8	9.4	5.9	10.0	11.6	10.7	12.2	14.9	8.4	12.3	9.1	9.2	11.4	11.7
72	8.5	7.9	10.8	7.2	10.1	13.2	13.7	11.6	14.7	8.9	11.1	10.3	7.9	10.5	11.3
73	8.6	8.9	12.8	6.3	9.2	13.0	16.3	13.4	15.6	9.5	11.5	6.3	7.9	11.4	20.0
74	8.4	8.0	10.4	8.4	8.6	14.7	11.7	13.7	16.0	11.3	12.5	7.6	8.9	11.4	12.7
75 2/	8.3	8.4	10.3	7.2	9.9	15.7	15.0	14.3	16.9	13.1	13.2	7.1	4.9	15.0	15.7
Average:															
1956-60	8.9	10.0	10.9	8.2	7.2	10.2	10.4	11.2	11.8	6.9	11.9	9.1	15.9	11.2	9.6
1961-65	8.9	7.5	10.5	8.5	6.8	12.1	7.9	12.7	12.0	6.3	13.3	9.3	14.5	11.3	10.6
1966-70	9.6	7.1	9.2	8.1	9.5	12.6	10.7	12.2	13.1	9.3	14.3	10.1	12.5	10.5	11.9
1971-75	8.6	8.0	10.7	7.0	9.6	13.6	13.7	13.0	15.6	10.2	12.1	8.0	7.8	11.9	14.3
Change3/	-.3	-2.0	-.2	-1.2	+2.4	+3.4	+3.3	+1.8	+3.8	+3.3	+.2	-1.1	-8.1	+.7	+4.7
% change3/	-4	-20	-2	-15	+33	+33	+32	+16	+32	+45	+2	-12	-51	+6	+49

1/ Losses to all causes during the year of sheep 1 year and older as a percentage of the January 1 inventory of stock sheep 1 year and older.
2/ Preliminary
3/ Change between 1956-60 average and 1971-75 average.

Source: (17, 20)

☆ U. S. GOVERNMENT PRINTING OFFICE : 1977--241-445/ERS-171