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AN ECONOMIC ANALYSIS OF THE PREDATOR PROBLEM IN THE RANGE-SHEEP INDUSTRY IN UTAH

by

David Murray Curle

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Agricultural Economics

Approved:

Major Professor

Committee Member

Committee Member

Dean of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

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David M. Curle

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ABSTRACT

An Economic Analysis of the Predator Problem in the Range-Sheep Industry in Utah

by

David M. Curle, Master of Science

Major Professor: Dr. Darwin B. Nielsen
Department: Agricultural Economics

The economic effects, to the Utah range-sheep operation and to the economy of the state of Utah, of predation upon sheep were studied by use of a personal interview survey. This survey sampled 20 percent of the range-sheep operations in Utah.

The sheep and lamb death loss from predation was found to be 61.0 sheep and lambs per 1,000 head of ewes in fiscal 1969. The survey also showed that 71.36 percent of the losses were lambs and 28.64 percent were ewes.

The total economic loss to Utah sheep ranchers was calculated to be 1,062,522 dollars, as a result of predation, in fiscal year 1969. Using the Type II multiplier of 4.330 for the livestock industry, published by the University of Utah, the total economic loss, resulting from predation upon sheep and lambs, to all sectors of the economy of the state of Utah, was determined as 3,901,854 dollars.

The bounty system was found to be the least costly method of controlling predators, followed by private control methods. The Utah District, Division of Wildlife Services, had the highest control cost per predator, and this increased drastically when a change of name

and changes in personnel and policies were instituted for this federal predator control agency.

(72 pages)

INTRODUCTION

The range-sheep industry is important in the state of Utah. In 1967 sheep and lambs were listed fifth in importance of Utah's 10 most important products when measured as a percent of the total value of production for crops and gross income for livestock and livestock products. They accounted for 6.0 percent of the total value of crops and livestock produced in Utah (Christensen and Richards, 1969). Table 1 shows the January 1 number and value of cattle and calves, and sheep and lambs in Utah from 1920 to 1969.

The 1967 gross income from sheep and lambs in Utah amounted to over 12.9 million dollars. Total value for all sheep on hand on January 1, 1968, in Utah was 26,387,000 dollars (Lee and Casey, 1969; Lee, Casey, and Gneiting, 1969).

On a larger scale, Utah ranked fourth in 1967 among the eight Mountain States with 12.2 percent of the total gross income from sheep and lambs. It also ranked fourth in value of production of wool with 14.2 percent of the total value of production among the eight Mountain States (Christensen and Richards, 1969). Utah ranked sixth in the United States in number of stock sheep and lambs on January 1, 1969 (Lee, Casey, and Gneiting, 1969).

Although no counties in Utah reported sheep production as the leading economic activity, 11 of 29 counties reported it in second place, six reported it in third place, three in fourth place, and one in fifth place (Christensen and Richards, 1969).

Table 1. Cattle and calves, sheep and lambs: January 1, number and value, Utah, 1920-1969

Year	Cattle			Sheep		
	Number (1,000)	Value		Number (1,000)	Value	
		Dollars per head	Total ($1,000)		Dollars per head	Total ($1,000)
1920	556	42.00	23,352	2,410	9.86	23,762
1925	507	26.40	13,382	2,355	11.30	26,612
1930	461	52.70	24,295	2,900	9.60	27,840
1935	411	17.20	7,081	2,535	4.40	11,150
1940	432	38.20	16,502	2,248	7.07	15,895
1945	584	69.40	40,530	1,840	10.22	18,798
1950	588	126.00	74,088	1,329	20.34	27,028
1955	749	93.00	69,657	1,481	18.15	26,877
1960	719	136.00	97,784	1,336	18.31	24,461
1961	698	134.00	93,532	1,290	16.32	21,047
1962	705	140.00	98,700	1,282	14.47	18,548
1963	712	149.00	106,088	1,282	16.52	21,178
1964	733	131.00	96,023	1,268	16.38	20,768
1965	755	118.00	89,090	1,264	18.72	23,656
1966	740	142.00	105,080	1,215	24.33	29,559
1967	747	151.00	112,797	1,100	24.70	29,561
1968	762	150.00	114,300	1,074	24.50	26,387
1969	785	160.00	125,600	1,053	28.20	29,695

Sources: Christensen and Richards, 1967
Christensen and Richards, 1969
Lee and Casey, 1969
Lee, Casey, and Gneiting, 1969

An analysis of indices of production and prices for sheep and lambs shows the index of production declined from 116 in 1925 to 79 in 1967 for Utah. The price index has increased from 165 in 1925 to 313 in 1967 (Table 2). The five-year period 1935-1939 was used as the base (Christensen and Richards, 1969).

To further attest to the importance of sheep in Utah's economy, it is noted that 93 percent of Utah's 52.7 million acres is rangeland and that 78 percent of this 52.7 million acres is used for the production of range livestock. In addition, 78 percent of the range used for livestock grazing is owned by the federal and state governments (Nielsen, 1962). Nearly half of the permitted Bureau of Land Management (B.L.M.) and national forest land in Utah is used by sheep (Christensen and Richards, 1967).

Predation upon sheep is important because it results in an economic loss to the sheep rancher. When ranchers suffer economic losses, it is reflected in losses in the other sectors of the economy. These losses, as described later in this thesis, may be over four times as great to the economy of the state of Utah as the losses to the ranching sector alone (Bradley, 1967).

Objectives

The primary objective of this study was to determine the economic loss to Utah sheep ranchers due to predators.

Several secondary problems will also be analyzed. They are:

1. Estimation of economic loss in secondary sectors of Utah's economy by use of income multipliers from an input-output study done at the University of Utah.

Table 2. Gross income and indices of production and prices for cattle and calves, sheep and lambs, Utah, 1925-1968 (1935-1939=100)

Year	Cattle and calves			Sheep and lambs		
	Production index	Price index	Income ($1,000)	Production index	Price index	Income ($1,000)
1925	106	105	6,536	116	165	8,064
1930	98	130	7,365	129	98	6,653
1935	84	87	4,350	86	99	3,988
1940	109	122	7,676	103	101	5,348
1945	146	200	19,609	90	179	9,473
1950	163	412	39,644	78	357	13,813
1955	226	246	38,468	104	256	13,080
1960	226	322	50,161	85	237	11,558
1965	243	297	47,580	72	338	11,537
1966	246	352	57,083	79	320	12,820
1967	243	357	52,576	79	313	12,924
1968			58,774			13,404

Sources: Christensen and Richards, 1967
Christensen and Richards, 1969

2. Review of the economics of present predator control policies.

3. Determination as to what extent changes in predator control personnel and policies are factors relating to the primary question.

REVIEW OF LITERATURE

Generally, little research has been done on problems as outlined in the introduction to this thesis although many articles have been written from the humanitarian and conservation viewpoints. Evanson (1967) and Frome (1967) both try to show that predator control should be terminated or at least reduced on a large scale so the benefits derived from predatory animals and birds may be realized and the general public may enjoy their presence to a greater extent.

A number of articles have been published in journals of an ecological nature (Robinson, 1953a, 1953b; Presnall, 1948). Rosko (1948) reported on the summer losses of sheep due to predators in a selected Utah county in 1948.

Rosko's special report showed the coyote to be the principle predator of sheep on summer ranges. The "periods of greatest sheep loss were June 15 to July 15, shortly after the sheep arrived on summer range, and August 1 to September 15, when young coyotes began to run." (Rosko, 1948, p. 16) A total of .29 percent of the herds were killed by predators on summer ranges. There was no correlation between herd size and sheep lost to predators, but more sheep were killed on rough and brushy ranges than were killed on open ranges free of trees and brush. Rosko also concluded that sheepmen's estimates of losses in 1947 were twice as high as observed losses (Rosko, 1948).

The National Wool Grower magazine and the various publications of state wool growers associations have occasionally included articles about the need for control. They also keep sheepmen informed about

various policy changes in connection with predator control.

The Division of Wildlife Services of The Bureau of Sport Fisheries and Wildlife publishes annual reports from which pertinent information can be obtained. The U.S. Department of the Interior published "Man and Wildlife" in May of 1967 to set forth the new animal control philosophy and policies of The Bureau of Sport Fisheries and Wildlife. Under the heading "Policy," they define animal damage control as:

> the management of damaging bird and mammal populations at levels consistent with the needs and activities of man and includes environmental manipulation, reduction, the use of repellents and cultural methods. (Man and Wildlife, 1967, p. 5)

Their objectives are given briefly as:

1. Protection of human health and safety.
2. Protection of urban areas.
3. Protection of forest and range.
4. Protection of crops and livestock.

Under objectives three and four they are very careful to state that the protection will be done where all costs will not be greater than economic and social benefits (Man and Wildlife, 1967).

Very few writers have tried to estimate the economic loss to sheep ranchers due to predators. When they have, the results have not been conclusive. Presnall (1948) estimated the annual economic loss of all western range livestock to predators in 1944 at approximately 20 million dollars. This figure was based on an estimated annual loss by predation of from 1.5 percent to 2.0 percent of the annual increase and a 1.25 million dollar gross revenue.

Evanson estimates losses of healthy sheep and lambs to be near or below 1.0 percent of the annual increase in sheep numbers or between

4 and 10 million dollars per year, nationally. He does not specify any particular year (Evanson, 1967).

Two intermountain states, Colorado and Wyoming, have calculated the sheep and lamb loss due to predators. No information was found for other states or areas.

The Wyoming report states that in 1966, 118,400 sheep and lambs were lost to predators. This represents 29.5 percent of 401,000 head, the total number lost to all causes. In 1968 the figures were 84,700 head lost to predators out of a total loss of 373,000 head, for 22.7 percent lost to predation. Dollar values on the losses indicate that the 1966 loss to predators was 1,682,200 dollars and in 1968 it was 1,322,400 dollars (Hoffman and Walsh, 1969).

Colorado reported 1966 losses of sheep and lambs from predators at 1,872,000 dollars. This figure represents 38 percent of the total loss of 5,052,600 dollars. The next greatest loss, by comparison, was from lambing complications and accounted for 13.2 percent of the total or 659,700 dollars ("Colorado Tallies Sheep, Lamb Losses," The National Wool Grower, October 1967).



METHOD OF PROCEDURE

Data on sheep and lamb losses due to predators were obtained from a personal interview survey of 56 operators and/or owners of range-sheep ranches in Utah. This sample amounted to 20 percent of the range-sheep operations in Utah. Managers, operators, and owners were interviewed to determine sheep and lamb losses due to predators during fiscal year 1969. Information was also obtained on: (1) number and value of sheep and lambs that did not die after being injured by predators, (2) number of predators killed, (3) death loss to causes other than predators, (4) government trapper frequency and efficiency, (5) individual operators' attempts to control predators on their own range and their associated out-of-pocket costs, and (6) changes in operators' normal management practices as a result of predators on their range. (See Appendix.)

Each respondent provided information for a separate questionnaire for each type of range, i.e., U.S. Forest Service, B.L.M., or private range and/or season of use, i.e., spring, winter, fall, and summer. Table 3 shows the county location of the sheep operation and number of respondents to the questionnaire. Tables 4 and 5 indicate the number of respondents for each type of range and for each season of use respectively. The totals on Tables 4 and 5 are not the same because the data are not mutually exclusive, for example, a rancher may use private land for spring, summer, and fall grazing.

Secondary data were obtained from numerous sources. Publications of the Utah Crop and Livestock Reporting Service of the U.S. Department of Agriculture, Utah Agricultural Statistics, and A Statistical View of

Table 3. Range location and number of respondents, Utah, 1969

County	Number of respondents
Iron	6
Beaver	2
Millard	9
Juab	3
Tooele	6
Box Elder	4
Rich	1
Morgan	1
Wasatch	1
Utah	1
Sanpete	4
Sevier	2
Piute	1
Garfield	1
Wayne	1
Emery	2
Carbon	3
Duchesne	1
Uintah	5
San Juan	2
Total	56

Table 4. Number of respondents for each type of range, Utah, 1969

Type of range	Number of questionnaires
Bureau of Land Management	56
U.S. Forest Service	42
Private	103
Total	201

Table 5. Number of respondents for each season of use, Utah, 1969

Season	Number of questionnaires
Spring	68
Winter	55
Fall	44
Summer	61
Total	228

Utah's Agriculture by Christensen and Richards (1967, 1969) were useful in obtaining data on sheep and lamb numbers, values, production, and death losses.

The files of the Utah District of the Division of Wildlife Services of the Bureau of Sport Fisheries and Wildlife provided information on predator control expenditures and numbers of predators killed. The Utah Department of Agriculture provided information on the bounty system and its rates and changes.

Data were analyzed by tabulating pertinent information to obtain totals and averages. Death losses were computed as a percent of the ewe population and were compared with statistics obtained from other sources and other states. Total annual dollar loss to sheep ranchers in Utah was calculated. This loss considered such factors as: (1) the general age of the sheep killed, (2) extra costs incurred from increased management and extra labor, (3) sheep given to government trappers for bait, (4) the annual mill levy on sheep for predator control, (5) the value of wool, and (6) cash donations to the Division of Wildlife Services for the purchase of sheep to be used as bait.

Total annual loss to all sectors of the economy in Utah was computed. This was done by use of income multipliers of the state of Utah input-output study published by the University of Utah.

ANALYSIS AND PRESENTATION OF DATA

Description of the Enterprise

Utah's range-sheep industry is largely equivalent to operations in other sheep raising areas of the Intermountain West. Size of operation varies greatly from under 1,000 head of breeding ewes to over 10,000 head. Many of the smaller herds are managed in conjunction with other types of farm or ranch enterprises.

Most operators own, rent, or lease some private land. In addition, they usually have grazing privileges on B.L.M. and U.S. Forest Service land. Tables 6 and 7 show the number of livestock using the Bureau of Land Management lands and the U.S. Forest Service lands respectively, from 1940 to 1965.

In the winter from about November to April, ewes and replacement ewe lambs are usually grazed on B.L.M. allotments in the desert areas of the state. Owners and/or operators must check frequently throughout the winter to see that there are no major problems developing with the herders or with the flocks. Some of the winter rangeland is rugged and timbered, but most of it is a flat, semi-desert type of terrain.

In the spring the ewes are usually brought to the base of the mountains for shearing and lambing. Generally this is private land, fenced, and fairly close to the ranch headquarters, or at least easily accessible to the ranch operator. Sheep are usually trucked to the lambing grounds because of long distances involved. Shearing may take place near the end of April and lambing begin near the first of May.

Table 6. Number of operators and permitted livestock using U.S. Bureau of Land Management lands, Utah, 1940-1965 (does not include non-use permits or exchange of use permits)

Year	Number of operators	Number of head		Animal unit months	
		Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats
1940	N.A.	192,333	2,084,175	890,617	1,857,653
1945	3,740	202,835	1,778,254	944,771	1,562,101
1950	3,365	196,171	1,313,296	1,085,229	1,275,715
1955	3,009	187,851	1,072,516	1,046,839	1,055,451
1960	2,908	166,113	1,136,799	810,569	948,897
1965	2,479	156,696	862,142	706,066	690,238

Source: Christensen and Richards, 1967, p. 56

Table 7. Number of cattle, horses, and sheep grazing on the national forests, Utah, 1940-1965

Year	Permitted number		Permitted animal months	
	Cattle & horses	Sheep	Cattle & horses	Sheep
1940	118,192	713,331	596,536	2,315,809
1945	N.A.	N.A.	N.A.	N.A.
1950	119,380	545,662	535,175	1,624,917
1955	118,052	508,047	502,050	1,453,882
1960	108,845	465,605	443,431	1,313,070
1965	95,220	376,582	359,093	1,057,671

Source: Christensen and Richards, 1967, p. 56

After lambing, the sheep are generally trailed to summer pastures in the mountains. Most of the summer pasture is on national forest land. Very little summer range is adequately fenced and herders must be used throughout the summer and fall to look after the sheep. Sheep usually go on summer ranges about the end of June or the first part of July after the snows have melted and the forage has had a chance to grow. Large herds are divided into flocks of about 1,000 ewes and left to the care of a herder until in fall when storms and grazing regulations force them off the higher elevations.

At this time the lambs are sold for slaughter or to be put in feed lots for fattening. Ewes, without lambs, may be turned on stubble fields or some other type of forage, and some are grazed on the spring range. Rams are put with the ewes at this time also. After the ewes are bred they are trucked to the desert winter range again where they remain until lambing time.

It should be remembered that this description of the range sheep operation is typical. At the extremes we have some operators who use private land exclusively while others use public land to a larger extent. Others may alter their management practices somewhat by varying their moving, breeding, shearing, lambing, and/or lamb selling dates.

The range-sheep operation, because of its complexity and rigorous time schedules, demands a high degree of management at all times. This has relaxed to some extent where more fences have been constructed because of the shortage of reliable hired labor.

The greatest amount of predation, upon ewes in particular, occurs on B.L.M. lands in the winter. These desert-type areas are typically "coyote country" because of the large open areas and very sparse human

population density. Regular herders are not used as frequently in the winter and this contributes further to coyote depredations upon ewes and ewe replacement lambs (and other predator depredations to a much lesser extent).

The amount of spring predation upon ewes is very light because of the availability of lambs to the predators. Even though supervision is much more intensive during the spring lambing season, predators still seem to prefer to kill newborn lambs. This is when most lamb losses occur.

Although predation still continues upon lambs in the summer, it is replaced somewhat by predator attacks on ewes again. This may be because larger predators such as bears and cougars are encountered and they are not so particular as the smaller predators as to the size of sheep they kill.

Predation could be expected to be more of a problem when and where the shortage of reliable herders and other help has resulted in the erection of fences to control sheep grazing behavior. Fences do not act as a deterrent to depredations as do humans.

Rosko (1948) found that the size of sheep herd had little direct correlation with the amount of losses. He did find, however, that the rougher the terrain and the more plant cover, the higher were the losses from coyotes.

Bias in Reporting Death Losses

Most sheep ranchers are naturally prejudiced against predatory types of animals. To the sheep rancher, any one of them is a potential predator of sheep and, as such, would substantially reduce his profits.

Many writers think the number of sheep and lambs lost to predators, as reported by ranchers, is biased upward in the hope that more attention might be focused on the problem and more relief gained as a result.

In an effort to reduce this bias in reporting, some writers and researchers have subsequently checked and either verified or denied ranchers' reports of losses to predators. Even if sheep had been dead for some time and their bodies eaten by scavengers or otherwise mutilated when the checks were made, unless there was visible proof that a predator had killed the animal, the ranchers' claims were denied.

Since this study covered a period of one year, there was no possibility of checking and verifying every reported loss. The enumerator reminded each respondent that he must report only kills made by predators. Most ranchers responded that they reported only those sheep, killed by predators, that had been seen by themselves or their helpers. Almost all of the ranchers who were familiar with sheep and with predation indicated that for every dead sheep seen by themselves or their helpers there were others not found. Estimates, made when the sheep were counted, placed the number killed but not found at between two and three for every sheep verified as having been killed by predators. There is no more reason to believe that reported losses are biased upward than there is to believe that they are biased downward.

Death Losses Due to Predators

Ranchers who were questioned reported the total number of ewes in their ranch operations to be 134,966. This information was used to calculate the number of sheep lost to predators per thousand head of

ewes and was further used in determining the total number of sheep and lambs killed by predators in the state of Utah is fiscal 1969.

The survey asked for total number of sheep lost to predators by type of sheep and type of predator. An analysis of this information is presented in Tables 8 and 9. Both these tables show the coyote to be the predator responsible for killing the largest number of sheep and lambs, with 78 percent of the total loss attributable to this animal. The cougar or mountain lion was second in importance as a predator, being responsible for 9 percent of the loss. Of the remaining loss, 4 percent was caused by dogs, 3 percent by eagles, 2 percent by bears, and 1 percent each by bobcats and "other" predators. "Other" predators included hunters and rustlers.

Table 8 shows that 63 percent of the lambs are killed on private land, 22 percent on U.S. Forest Service land, and 15 percent on B.L.M. land. This can be explained by the fact that lambing takes place almost exclusively on private land, and this is when lambs are the most vulnerable to attack by predators. From the private land small lambs are moved up the mountains on Forest Service land where the second largest loss occurs. When the sheep are finally moved to land administered by the B.L.M., the only lambs remaining are the replacement ewes. It is here that the lightest lamb losses occur.

Nearly the opposite picture is portrayed for ewe sheep losses with 60 percent of them occuring on B.L.M. land. The remaining 40 percent of the ewe loss is divided, 10 percent on Forest Service land and 30 percent on private land. This higher loss on private land may be attributed to at least three factors: (1) private land is used in much greater quantities than either of the other two types of land, (2) it

Table 8. Number of sheep and lambs killed by predators for each kind of rangeland, Utah, fiscal 1969.

	PREDATOR	BLM[a] (head)	% of TOTAL	FS[b] (head)	% of TOTAL	PRIVATE (head)	% of TOTAL	TOTAL (head)	TOTAL AS % OF LAMB TOTAL
		SHEEP AND LAMBS KILLED							
LAMBS KILLED	Coyote	656	12	1,371	25	3,515	63	5,542	81
	Cougar	249	37	74	11	342	52	665	10
	Bobcat	2	2	0	0	129	98	131	2
	Eagle	110	28	0	0	278	72	388	5
	Dog	12	21	2	4	42	75	56	1
	Bear	2	3	29	43	36	54	67	1
	Other	0	0	5	100	0	0	5	c
	Sub-Total	1,031	15	1,481	22	4,342	63	6,854	100
	% OF TOTAL	38	----	84	------	84	----	71	
									TOTAL AS % OF EWE TOTAL
EWES KILLED	Coyote	1,471	75	138	7	356	18	1,965	71
	Cougar	123	61	41	20	39	19	203	8
	Bobcat	0	0	0	0	0	0	0	0
	Eagle	0	0	0	0	0	0	0	0
	Dog	7	2	2	1	359	97	368	13
	Bear	31	22	78	56	31	22	140	5
	Other	25	32	13	17	39	51	77	3
	Sub-Total	1,657	60	272	10	824	30	2,753	100
	% OF TOTAL	62	----	16	----	16	----	29	
									TOTAL AS % OF GRAND TOTAL
LAMBS AND EWES KILLED	Coyote	2,127	28	1,509	20	3,871	52	7,507	78
	Cougar	372	43	115	13	381	44	868	9
	Bobcat	2	2	0	0	129	98	131	1
	Eagle	110	28	0	0	278	72	388	3
	Dog	19	4	4	1	401	95	424	4
	Bear	33	16	107	51	67	33	207	2
	Other	25	30	18	22	39	48	82	1
	Total	2,688	28	1,753	18	5,166	54	9,607	100

[a]Land administered by the Bureau of Land Management.
[b]Land administered by the U.S. Forest Service.
[c]Less than .5 percent.

Source: Personal interview survey.

Table 9. Number of sheep and lambs killed by predators, by season, Utah, fiscal 1969.

	PREDATOR	SHEEP AND LAMBS KILLED SPRING (head)	% of TOTAL	WINTER (head)	% of TOTAL	FALL (head)	% of TOTAL	SUMMER (head)	% of TOTAL	TOTAL (head)	TOTAL AS % OF LAMB TOTAL
LAMB KILLED	Coyote	2,520	46	353	6	607	11	2,062	37	5,542	81
	Cougar	283	43	0	0	48	7	334	50	665	10
	Bobcat	103	78	14	11	1	1	13	10	131	2
	Eagle	300	77	35	9	50	13	3	1	388	5
	Dog	32	57	24	43	0	0	0	0	56	1
	Bear	39	58	0	0	6	9	22	33	67	1
	Other	0	0	0	0	5	100	0	0	5	a
	Sub-Total	3,277	48	426	6	717	10	2,434	36	6,854	100
	% OF TOTAL	89	---	25	---	47	---	90	---	71	
											TOTAL AS % OF EWE TOTAL
EWES KILLED	Coyote	325	16	1,133	58	388	20	119	6	1,965	71
	Cougar	17	8	65	32	66	33	55	27	203	8
	Bobcat	0	0	0	0	0	0	0	0	0	0
	Eagle	0	0	0	0	0	0	0	0	0	0
	Dog	56	15	40	11	272	74	0	0	368	13
	Bear	2	1	8	6	55	39	75	54	140	5
	Other	10	13	20	26	36	47	11	14	77	13
	Sub-Total	410	15	1,266	46	817	30	260	9	2,753	100
	% OF TOTAL	11	---	75	---	53	---	10	---	29	
											TOTAL AS % OF GRAND TOTAL
LAMBS AND EWES KILLED	Coyote	2,845	38	1,486	20	995	13	2,181	29	7,507	78
	Cougar	300	35	65	7	114	13	389	45	868	9
	Bobcat	103	78	14	11	1	1	13	10	131	1
	Eagle	300	77	35	9	50	13	3	11	388	3
	Dog	88	21	64	15	272	64	0	0	424	4
	Bear	41	20	8	4	61	29	97	47	207	2
	Other	10	12	20	24	41	50	11	14	82	1
	TOTAL	3,687	38	1,692	18	1,534	16	2,694	28	9,607	100

[a]Less than .5 per cent.

Source: Personal interview survey.

is frequented by the sheep more often, and (3) food other than sheep is less readily available to predators when the sheep are using private land in the spring.

Most of the bear kills, 51 percent, occur on Forest Service land. Bears seldom range far from rugged and heavily timbered terrain usually found in the forests.

Table 9 presents the data slightly differently in that the range season of use is considered instead of the type of range. However, because there is a high correlation between type of range and season of use, it is interpreted in much the same manner as Table 8.

Highest lamb losses still occurred in the spring, 48 percent, with summer in second place at 36 percent. Fall and winter had 10 percent and 6 percent respectively. In the summer, 90 percent of the sheep killed were lambs and only 10 percent were ewes. In the winter the situation had changed so that only 25 percent of the losses were lambs and 75 percent were ewes. It should be noted also that 38 percent of the losses occurred in the spring with 28, 18, and 16 percent occurring in the summer, winter, and fall respectively.

Both Table 8 and Table 9 show that neither bobcats nor eagles are responsible for any predation upon ewes. It is thought that the larger size of the ewes when compared with the lambs is a factor in discouraging these predators from attacking. No rams were reported in the questionnaires as having been killed by predators.

Sheep injured that did not die

One section of the questionnaire dealt with the problem of sheep and lambs that do not die after being injured by predators. Respondents were asked to estimate both the number and dollar value of the

loss. The response indicated that most ranchers believed that injured sheep were nearly certain to die. As a result only 48 lambs and 11 ewes were listed on the completed questionnaires as being injured and recovering, with dollar values being given for only 38 lambs and 5 ewes. The loss per animal was calculated from these figures and projected to find the dollar value loss to all those indicated as being injured but with no value attached. The value of lambs was estimated by ranchers per head (Table 10).

Table 10. Number of sheep and lambs that did not die after being injured by predators and the dollar value of their loss, Utah, fiscal 1969

	Number injured	Ranchers' estimate of value per head (dollars)	Dollar value of loss
Lambs	48	17.50	840
Ewes	11	22.00	242
Total	59		1,082

Source: Personal interview survey

Predators killed

Tables 11 and 12 show the number of predators killed by type of range and by season of use respectively. They also show the numbers killed by ranchers separately from those killed by field men of the Utah District, Division of Wildlife Services. Trapper figures are those estimated by the ranchers in the sample, and because of their limited knowledge as to the trappers' activities and results, the

Table 11. Number of predators killed by type of range, Utah, fiscal 1969.

TYPE OF RANGE	PREDATOR KILLED BY	NUMBER AND TYPE OF PREDATOR												
		COYOTE (number)	% of TOTAL	COUGAR (number)	% of TOTAL	BOBCAT (number)	% of TOTAL	EAGLE (number)	% of TOTAL	DOG (number)	% of TOTAL	BEAR (number)	% of TOTAL	TOTAL (number)
	Rancher	106	70	5	3	0	0	17	11	23	15	2	1	153
	Trapper	281	82	35	10	20	6	0	0	7	2	1	a	344
PRIVATE	Sub-Total	387	40	20	8	20	4	17	3	30	6	3	1	497
	% OF TOTAL	49	----	84	----	42	----	100	----	100	----	100	--	53
BUREAU	Rancher	115	95	4	3	2	2	0	0	0	0	0	0	121
OF LAND	Trapper	195	89	0	0	24	11	0	0	0	0	0	0	219
MANAGE-	Sub-Total	310	91	4	1	26	8	0	0	0	0	0	0	340
MENT	% OF TOTAL	40	----	8	----	54	----	0	----	0	----	0	----	37
	Rancher	28	90	1	3	2	7	0	0	0	0	0	0	31
U.S.	Trapper	62	95	3	5	0	0	0	0	0	0	0	0	65
FOREST	Sub-Total	90	94	4	4	2	2	0	0	0	0	0	0	96
SERVICE	% OF TOTAL	11	----	8	----	4	----	0	----	0	----	0	----	10
RANCHER	TOTAL	249	82	10	3	4	1	17	6	23	8	2	a	305
	% OF TOTAL	32	----	21	----	8	----	100	----	77	----	67	----	33
TRAPPER	TOTAL	538	86	38	6	44	7	0	0	7	1	1	a	628
	% OF TOTAL	68	----	79	----	92	----	0	----	23	----	33	----	67
	TOTAL	787	85	48	5	48	5	17	2	30	3	3	a	933

[a]Less than .5 per cent.

Source: Personal interview survey.

Table 12. Number of predators killed by season, Utah, fiscal 1969.

SEASON OF USE	PREDATORS KILLED BY	NUMBER AND TYPE OF PREDATOR												
		COYOTE (number)	% of TOTAL	COUGAR (number)	% of TOTAL	BOBCAT (number)	% of TOTAL	EAGLE (number)	% of TOTAL	DOG (number)	% of TOTAL	BEAR (number)	% of TOTAL	TOTAL
SPRING	Rancher	92	69	4	3	1	1	17	13	19	14	0	0	133
	Trapper	265	90	14	5	10	3	0	0	7	2	0	0	296
	Sub-Total	357	83	18	4	11	3	17	4	26	6	0		429
	% OF TOTAL	45	-----	38	-----	23	-----	100	-----	86	-----	0	-----	46
SUMMER	Rancher	19	76	3	12	2	8	0	0	0	0	1	4	25
	Trapper	46	65	20	28	4	6	0	0	0	0	1	1	71
	Sub-Total	65	68	23	24	6	6	0	0	0	0	2	2	96
	% OF TOTAL	8	-----	48	-----	13	-----	0	-----	0	-----	67	-----	10
FALL	Rancher	19	76	3	12	0	0	0	0	2	8	1	4	25
	Trapper	42	86	2	4	5	10	0	0	0	0	0	0	49
	Sub-Total	61	82	5	7	5	7	0	0	2	3	1	1	74
	% OF TOTAL	8	-----	10	-----	10	-----	0	-----	7	-----	33	-----	8
WINTER	Rancher	119	97	0	0	1	1	0	0	2	2	0	0	122
	Trapper	185	87	2	1	25	12	0	0	0	0	0	0	212
	Sub-Total	304	90	2	1	26	8	0	0	2	1	0	0	334
	% OF TOTAL	39	-----	4	-----	54	-----	0	-----	7	-----	0	-----	36
RANCHER	Total	249	82	10	3	4	1	17	6	23	8	2	a	305
	% OF TOTAL	32	-----	21	-----	8	-----	100	-----	77	-----	67	-----	33
TRAPPER	Total	538	86	38	6	44	7	0	0	7	1	1	a	628
	% OF TOTAL	68	-----	79	-----	92	-----	0	-----	23	-----	33	-----	67
TOTAL		787	85	48	5	48	5	17	2	30	3	3	a	933

[a]Less than .5 percent

Source: Personal interview survey.

figures are considerably lower than those reported by the Wildlife Service.

Forty-six percent of the predators were killed in the spring with only 8 percent in the fall and 10 percent in the summer. The winter kill of 36 percent is quite high because this is the season when bobcats are trapped for their fur and when aerial hunting of coyotes on the desert areas takes place. The high kill in the spring is the result of digging young coyote pups out of dens. Ranchers also give extra protection to the newborn lambs at this time.

Following closely the trend in losses due to predators is Table 11 which shows 53 percent of the predators being killed on private land. The kill on B.L.M. land and U.S. Forest Service land is 37 percent and 10 percent respectively. All of the eagles and all of the dogs were killed on private land. Coyotes comprised 85 percent of all the predators killed.

Sheep and lamb losses to causes other than predators

The questionnaire asked for the number of sheep lost to causes other than predators. The response to this question was very disappointing. Ranchers in general seemed to know little about, or were unwilling to divulge, this information. Of the 189 questionnaires responded to, 111 or 58.7 percent said they suffered a "normal" loss. Since "normal" could be quite different for different ranch operations, the results are inconclusive.

Trapper frequency, private predator controls, and changes in management practices

Government trappers are working on 94 percent of the range operated by the sheepmen who responded to the questionnaires. However,

these same sheepmen thought that control was adequate on only 22 percent of the same range.

One question in the survey asked whether the ranchers' normal management practices had been altered because of the presence of predators on their range. Predators have always been present to some extent as long as there has been a range-sheep industry. For this reason a sheep rancher's normal management practices would probably include some type of, or arrangement for, predator control or sheep protection. This survey requested information about altered management practices beyond what was normal as a result of increased numbers of predators in the past few years. Only 24 percent of the ranchers altered their normal management practices as a result of predators on their ranges. Alterations included such things as: (1) hiring extra herders, (2) supplying rifles and ammunition to herders, (3) private trapping and poisoning programs, (4) hiring special trappers and hunters, (5) bringing sheep into camp at night, (6) more frequent visits to sheep herds, and (7) offering bounties for predators killed on the rancher's land.

The survey reported that private control of predators was practiced on 64 percent of the 189 different ranges and/or grazing periods. The cost of this control amounted to 11,266 dollars of which 49 percent or 5,556 dollars was spent on private land. Less was spent on B.L.M. and U.S. Forest Service land. The amounts spent were 4,906 dollars on B.L.M. land and 804 dollars on U.S. Forest Service land for 44 and 7 percent of the total respectively.

Tables 22 and 23 in the Appendix provide more data on these questions from the survey. Table 22 considers the answers to these

questions by the type of rangeland used, and Table 23 considers them by the season of range use.

Economic Loss to Utah Sheep Ranchers Resulting from Predation

Data gathered from 56 range-sheep operations yields a weighted average of 61.0 sheep and lambs lost per thousand head of ewes due to predators (Table 13). This information is important because it provides a base that can be used to compare predator losses over time and between areas or states if they will make the same type of calculations.

The sample used in this study covered 20 percent of the range-sheep ranches in the state. Therefore, losses for the state can be estimated by multiplying the losses determined in the sample by 5.0. Total loss of ewes and lambs was 9,607 head (Tables 8 and 9) for the sample. Thus the total loss for the state is 48,035 head (5 x 9607 = 48,035).

From the data presented earlier (Tables 8 and 9) it can be seen that 6,854 head of the losses to predators were lambs and 2,753 head were ewes over the period, fiscal year 1969. By multiplying each of these figures by five, the lamb loss becomes 34,270 and the ewe loss is 13,765 head. These two figures are necessary in calculating the economic loss.

The market weight and price of sheep and lambs must now be applied to the total number that were lost because of predation. Lee and Casey (1969) report that 75,000 sheep and 577,000 lambs were marketed in Utah in 1968 and that these marketings amounted to 62,631,000 pounds. The average weight of lambs marketed would thus be 95 pounds and that of ewes would be 105 pounds. It is further reported that the 1968 price of sheep was six dollars per 100 pounds and the price of lambs was 23.5

Table 13. Predation losses per thousand ewes, Utah, fiscal 1969[a]

Respondent	Avg. no. of ewes	Loss per 1000 ewes	Respondent	Avg. no. of ewes	Loss per 1000 ewes
1	983.0	109.08	29	1,200.0	169.17
2	2,633.0	9.57	30	1,700.0	130.00
3	3,550.0	24.22	31	2,400.0	30.83
4	1,200.0	20.83	32	3,250.0	56.00
5	950.0	22.10	33	4,200.0	16.67
6	2,267.0	12.50	34	2,000.0	15.00
7	1,167.0	40.94	35	4,500.0	35.56
8	2,533.0	10.52	36	1,500.0	103.33
9	2,550.0	132.55	37	800.0	81.25
10	1,200.0	210.83	38	6,000.0	75.00
11	2,000.0	12.50	39	4,000.0	66.25
12	1,667.0	18.57	40	4,000.0	12.50
13	1,875.0	25.60	41	2,200.0	57.27
14	3,750.0	86.29	42	900.0	44.45
15	1,400.0	89.28	43	2,500.0	38.00
16	925.0	40.54	44	10,000.0	13.20
17	1,320.0	35.93	45	600.0	171.67
18	600.0	81.67	46	1,250.0	48.00
19	1,867.0	21.94	47	400.0	50.00
20	1,380.0	17.50	48	2,000.0	64.50
21	1,425.0	50.00	49	1,500.0	4.00
22	1,375.0	8.08	50	4,400.0	46.59
23	4,167.0	94.12	51	2,600.0	267.31
24	750.0	96.00	52	5,000.0	205.40
25	2,244.0	67.01	53	5,000.0	108.40
26	1,250.0	15.38	54	300.0	123.33
27	1,350.0	62.08	55	3,250.0	81.54
28	3,100.0	2.58	56	4,000.0	45.00

[a]The weighted average, calculated from these figures, shows the death loss to be 60.97 sheep and lambs lost per thousand head of ewes, due to predators.

Source: Personal interview survey

dollars per 100 pounds (Lee and Casey, 1969). Because of lack of 1969 data, these figures will be used in calculating the sheep ranchers' economic loss for fiscal 1969.

The total weight of lambs lost to predators in fiscal 1969 is calculated by multiplying the 34,270 lambs by the average market weight of 95 pounds per lamb and arriving at a total weight of 3,255,650 pounds. At an average market value of 23.5 dollars per 100 pounds the loss would total 765,078 dollars for lambs.

The market value of the ewe loss would be arrived at similarly. For ewes the total weight of 13,765 head would be 1,445,325 pounds if they averaged 105 pounds each. At an average market value of six dollars per 100 pounds the economic loss for ewes would be 86,720 dollars.

By adding these two values the total loss for lambs and ewes, using the market value for slaughter, would thus be 851,798 dollars. However, there are other factors which must be considered and which will alter this economic loss picture.

Rancher costs of predator control

Also a loss to the sheep rancher is the money he pays to the Utah Department of Agriculture for predator control. A 65 mill levy has been placed on the assessed valuation of sheep, and in fiscal 1969 an assessed value of 2,350,470 dollars would yield 152,781 dollars for predator control (Utah State Tax Commission, 1968). Since this comes out of the rancher's pocket, his economic loss due to predators has now increased to 1,004,579 dollars.

Another expense to Utah range-sheep operators is that of private predator control programs, including the hiring of professional hunters and paying of private bounties on predatory animals killed on their range. The survey of range-sheep operations indicated that ranchers spent 11,266 dollars to control predators on their ranges. This would

mean that the state total for private predator control would be approximately 56,330 dollars. With this amount added, the total increases to 1,060,909 dollars, the economic loss caused by predators.

Range-sheep operators often donate money, both individually and through their local associations, to the Division of Wildlife Services for the purchase of sheep to be used as bait. During fiscal 1969 such donations amounted to 4,458 dollars in the Utah District (Annual Report, 1969). The total economic loss due to predators now increases to 1,065,367 dollars with the addition of these donations.

Besides the money that is donated to buy bait sheep, there are numerous donations of the animals themselves directly to the field men of the Division. Although the survey did not attempt to measure this amount, many ranchers mentioned of having donated in this manner. The Division of Wildlife Services keeps no record of the numbers of animals thus donated. Because of the lack of sufficient data, no attempt will be made to guess at the amount of economic loss involved.

In addition to the loss previously calculated, the range-sheep operator also sustains a further loss through the extra costs of the increased management that is necessary when predators become a problem. The operator, owner, or manager must spend extra time with the sheep as a result of depredations on his herds. There will be extra gasoline, food, and supplies bought for special trips to visit sheep that have been attacked by predators. Very frequently, extra labor must be hired to try to combat the problem of predation. Furthermore, many operators or herders trail their sheep into camp at night as a protection against predators. This only serves to exhaust the range in the areas near the trails and camps and contributes immensely to soil erosion and noxious weed infestations.

At this point in the thesis it is advisable to consider the nature of economic losses and possible areas where the range-sheep operators' costs might be reduced because of predation. In calculating the ranchers' economic loss the market value of both ewes and lambs was used. In the event that the economic loss to the rancher did not include the full market value of the lambs, an appropriate adjustment should be made that would consider the age of the lamb when it was killed and the associated decrease in operating costs.

Some of the major expense items common to a range-sheep operation will now be reviewed to determine those that would be reduced because of depredations upon sheep and lambs. Certainly hired labor and its associated costs are significant to the sheep rancher, with herders probably making up the larger part of this operating expense. There is no reason to believe that labor costs would be reduced because of predation, but there is some indication, according to the survey, that they might be increased as a result of predation. Many respondents who said they altered their normal management practices because of predators on their ranges, said these changes included hiring extra herders and other help.

The rancher only has the lambs from lambing time until they are marketed in the fall, usually less than six months time. If lambs are killed, it simply means that fewer are marketed and enough are held over as replacements to compensate for the ewe loss and to ensure that approximately the same number of ewes have lambs each spring.

Costs associated with fuel and lubrication, custom work hired, fertilizer, feed and seed purchased, telephones, electricity, and accounting could not conceivably be reduced because of predation.

The telephone bill may actually be increased if the sheep rancher must call long distance to the government trapper for assistance.

Range fees for B.L.M., Forest Service, and the associations, as well as pasture rent and water fees do not change because predation reduces the number of sheep and lambs. The same is true of the costs of insurance for buildings, equipment and liability, and the costs of various licenses that may be required.

The costs of contract hauling of livestock and feed (other than marketing) would probably not be altered, nor would the costs of machinery and building repairs. Breeding and shearing fees probably would not be decreased because approximately the same number of ewes are kept over each winter and spring.

Most of the range-sheep operators' expenses are fixed costs, or at least they are fixed in the short run and are not variable with the number of sheep on the range within a year's operating period. Of those that are variable very few would be reduced because of 6 or 7 percent fewer sheep. One cost that might be reduced is that of hauling sheep to market if they were not sold or contracted for sale on the range. Another one might be the cost of veterinarian services and supplies, but this is debatable and may vary with the individual ranch operation. Fewer sheep may mean fewer sheep to be treated by a veterinarian, but it could also mean increased costs if a veterinarian is called and/or treatments are made to cure sheep that were injured by predators. Because the survey was not designed to gather this information and because these costs are difficult or nearly impossible to quantify with currently available statistics, no attempt will be made to include them in this thesis.

The one thing that predation does that is definitely not an economic loss to sheep ranchers is to reduce the property tax that range-sheep operations must pay. The average assessed valuation per head in 1968 was 3.18 dollars (Utah State Tax Commission, 1968). The 13,765 ewes that were killed (most of the lambs are in feedlots when the assessors value the sheep) would have an assessed valuation of 43,773 dollars. The 65 mill levy on this value would mean 2,845 dollars that range-sheep operations would not have to pay in property taxes. If this is subtracted from the 1,065,367 dollar loss attributed to predators, the total loss is now 1,062,522 dollars. Because of the nature of the economic losses and the range-sheep operations' operating costs, both the sheep and lamb losses were calculated at full market value and deductions made where operating expenses would be reduced because of predation.

Dollar Loss to All Sectors of the Economy of the State of Utah as a Result of Predation

Assuming the economic loss to sheep ranchers in Utah to be computed correctly, the loss can now be calculated for the economy of the state. The calculations are relatively simple but must begin with a description of the methods used.

The act of spending money is not an isolated, terminal event. A dollar spent by one unit or sector of the economy will have a chain effect. This same dollar will be a payment or a receipt to another sector where part of it will be spent, which will in turn be revenue, although smaller, for other economic sectors. In theory this chain reaction would be infinite but, quantitatively, it eventually phases itself out. The extent of this change in the revenue stream that was

generated by the initial transaction can be determined quantitatively by means of a "multiplier."

To help clarify the term "multiplier," consider an industry that increases its requirements. This means increased payments to the households in the form of wages and profits. This may be called a "direct" increase in consumer income. But this "direct" increase is attended by a chain reaction in all the sectors, which leads to further changes in income payments to households by those industries that supply inputs to the industry in which the original change occurred. These may be called "indirect" changes. The sum of the direct and indirect household payments, divided by the direct household payments, makes up the Type I income multiplier.

Also, changes in the payments to households will lead to further "induced" income effects. This increased income to the household will increase demand which is the same as increasing purchases from the processing sectors of the economy. Because this demand is increased, induced payments are made to the household and another round of spending is begun.

This income multiplier is the sum of the direct, indirect, and induced income payments divided by the direct income payments. It is the Type II income multiplier, and according to Bradley (1967), "it includes the induced income payments resulting from a change in consumer expenditures as well as the interindustry reactions and their effects on income." (Bradley, 1967, p. 3)

With this background on the income multiplier it is understood why one dollar spent in the livestock sector of Utah's economy will have a much greater over-all effect. Bradley (1967) lists the Type I income

multiplier for the livestock sector as 2.781 and ranks it in second place behind food retail, which has a Type I income multiplier of 3.189 (Bradley, 1967, p. 4).

The Type II income multiplier for the livestock industry is listed by Bradley (1967) as being 4.330. This is also ranked in second place behind food retail, which has a Type II income multiplier of 4.995.

Because the 152,781 dollars that ranchers pay in property tax for predator control, the 56,330 dollars that they spend on private control, and the 4,458 dollars that they donate to buy bait sheep will all be recirculated in the economy of the state, they should not be used in calculating the economic loss to the state of Utah by use of the income multiplier. They should, however, be added in after the multiplier has been used because they are losses to the individual ranchers. This leaves 851,798 dollars on which to apply the income multipliers.

If predation was eliminated from the sheep-raising industry the exports from the livestock sector of the economy of the state of Utah could be expected to increase by 851,798 dollars yearly. As a result of this additional export value, the economy of the state would increase 2.781 times or 4.330 times as much as the original 851,798 dollars for a Type I and Type II multiplier respectively. These are potential increases in economic activity that would be realized if there were no predation, and as they are not realized, they can be considered as losses.

Using the value of 851,798 dollars, the total economic loss to the state could be expected to be 2.781 times as great using the Type I income multiplier. Performing this calculation shows the total economic loss to the state of Utah to be 2,582,419 dollars as a result of

predation, after the individual loss of 213,569 dollars has been included.

When one uses the same value of 851,798 dollars and applies to it the Type II income multiplier of 4.330, then the resulting calculated loss is 3,688,285 dollars. After adding the 213,569 dollars, the total economic loss to the state becomes 3,901,854 dollars. This is another estimate of the total economic loss to the state and is one that this writer thinks is the most applicable. When calculating total economic loss, one should not overlook the effects of the induced income payments resulting from changes in consumer expenditures, for they are an everyday fact of life. A tabular account of the calculation of the economic losses to sheepmen and to the state is shown in Table 14.

Review of the Economics of Present Predator Control Policies and Relationship Between Predator Control and Changes in Personnel and Policies of the Bureau of Sport Fisheries and Wildlife and the Division of Wildlife Services

Private control policies, hunter control, and bounties

Predators of sheep and lambs on Utah's ranges are controlled by many different methods. Most ranch managers, owners, and operators, as well as their hired labor, carry firearms for the time that they might encounter a predator or potential predator. Besides the casualness of the control effected by those who just "carry" a rifle, there are those owners, managers, operators, and laborers or herders of range-sheep operations who actively pursue a predator control program. Some attempt to call the predators within shooting range by the use of a predator or coyote call which imitates a rabbit that is wounded or otherwise in distress. Some use dogs for running down and killing coyotes and others

Table 14. Economic loss to sheep ranchers and to the state of Utah, fiscal 1969

Type of loss	Value (dollars)	
Direct losses		
Lambs	765,078.00	
Ewes	86,720.00	
Direct losses, subtotal		851,798.00
Control costs		
Sixty-five mill levy	152,781.00	
Private predator control costs	56,330.00	
Donations for sheep for bait	4,458.00	
Control cost, subtotal		213,569.00
Reduction in property tax	-2,845.00	
Sheep ranchers' total loss	1,062,522.00	
Base loss for calculating total economic loss	851,798.00	
Multiplier (multiply by)	4.330	
Primary and secondary losses to Utah's economy	3,688,285.00	
Control costs	213,569.00	
Economy of Utah, total loss	3,901,854.00	

use them to find the trail, follow, and "tree" the feline predators so they can be shot or captured by the hunters. Perhaps the costliest, but certainly the most effective form of control practiced by ranchers is airplane hunting of coyotes.

Some ranchers hire professional hunters when a certain predator, perhaps a bear or mountain lion, is causing a problem. This professional may be called in by a rancher if the government hunter cannot get on the case soon enough, or even to work on the same problem animal at the same time in order to bring the costly depredations to a halt sooner.

For fiscal year 1969 the survey indicates that ranchers or their helpers killed a total of 305 predators, of which 249 or 81.6 percent were coyotes. Since the survey represented a fifth of the population, it can be assumed that about 1,500 predators were killed in Utah in fiscal 1969 by the owners or helpers of range-sheep operations (Table 15).

Table 15. Number of predators killed by ranchers or their helpers, Utah, fiscal 1969

Predator	Survey number killed	Percent of total	Survey number expanded to population
Coyote	249	81.6	1,245
Mountain lion	10	3.3	50
Bobcat	4	1.3	20
Eagle	17	5.6	85
Domestic dog	23	7.5	115
Bear	2	0.7	10
Total	305	100.0	1,525

Of the 189 separate ranges or grazing periods represented by the survey there were 121 "yes" answers and 68 "no" answers by the respondents to the question, "Do you attempt to control predators on this range?" This means that some type of control was practiced by the ranchers or helpers themselves on 64 percent of the range.

A total of 11,266 dollars was calculated in answer to the question, "How much has it cost you in direct out-of-pocket costs to control predators on this range?" Expanded to the population this would mean that 56,330 dollars was spent in private predator control in Utah in fiscal 1969. These figures show the cost of control to be 36.94 dollars per predator, to the rancher, for private control programs.

In addition to the predators killed by ranch owners, managers, operators, and their helpers, there are always a few killed by big game and bird hunters, and by other sportsmen. The number of predators killed annually by these sources would be nearly impossible to calculate.

Bounties are an important part of Utah's predator control program. The Utah Department of Agriculture, in fiscal year 1969, paid bounties on 4,732 predators (2,677 coyotes and 2,055 bobcats). The total bounties paid amounted to 20,458 dollars for a control cost per predator of 4.32 dollars (Table 16).

The bounty payment is primarily made possible by a 65 mill levy on the assessed valuation of sheep and a two mill levy on the assessed valuation of cattle. There is also a small mill levy on turkeys. Some of the money thus collected and administered by the Utah Department of Agriculture is used by the Division of Wildlife Services in its operations and in paying government hunter and trapper salaries.

Table 16. Number of predators, bounties paid, and control cost per predator, Utah, 1915-1969

Fiscal year	Number of predators bountied	Total cash (dollars)	Control cost per predator (dollars)
1915	18,437	31,908	1.73
1920	17,519	69,914	3.99
1925	No bounty paid		
1930	17,366	96,422	5.55
1935	No bounty paid		
1940	No bounty paid		
1945[a]	15,569	94,448	6.07
1950[a]	4,685	36,399	7.77
1955[a]	4,715	23,128	4.91
1960[a]	6,156	24,624	4.00
1964[b]	2,906	5,423	1.87
1969	4,732	20,458	4.32

[a]Calendar year
[b]1965 data not available

Source: The files of the U.S. Department of the Interior, Utah District, Division of Wildlife Services, and the Utah Department of Agriculture

In 1968, sheep with an assessed valuation of 2,350,470 dollars yielded 152,781 dollars with the 65 mill levy for predator control (Utah State Tax Commission, 1968). The amount provided by the sheep industry is typically over 90 percent of the total. All the money that is used to pay bounties on predators comes from the livestock sector of the economy.

Federal predator control

The U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Division of Wildlife Services, maintains a force of salaried hunters or trappers for the sole purpose of predator control. The Division in each district is funded from joint federal, state, Fish and Game, and cooperative sources. Table 17 shows the source of funds and expenditures by the Utah District, Division of Wildlife Services, for fiscal years 1917 to 1969 inclusive.

The field men of the Division of Wildlife Services use a variety of predator control methods. Traps, poisons, cyanide guns, and shooting are some of the methods employed. Compound 1080, a poison used in baits, is a product of chemical research during World War II. The first indication of its use in Utah is found in the 1948 Annual Report on Predator Control of the Utah District, Division of Wildlife Services. The same annual report also indicated that coyote-getters or cyanide guns were used state-wide for the first time. The Division acquired the use of an airplane for coyote control work in 1955, and its success is indicated in Table 18. The table also shows the number of predators taken and the method used by salaried hunters and trappers of the Division of Wildlife Services, Utah District.

Table 19 shows the number of predators killed by the field men of the Division of Wildlife Services, the Division's expenditures, and the control cost per predator killed in five-year intervals, Utah District, fiscal 1920-1969.

Table 20 shows the total number of predators killed, the total costs, and the total control cost per predator, in five-year intervals, Utah, fiscal 1920-1969.

Table 17. Source of funds, and expenditures, Utah District, Division of Wildlife Services, fiscal years 1917-1969.

Year	Funds expended						Man days worked
	Federal WPA	Federal	State	Fish & Game	Cooperative	Total	
1917		$ 38,076.50				$ 38,076.50	3,824
1918		33,718.54	$ 31,801.11			65,519.65	---
1919		Only total expenditure given				45,002.72	---
1920		41,707.33	75,607.79			117,315.12	90
1921		39,276.88	53,315.00			92,591.88	23,500
1922		36,598.16	26,660.87			63,259.03	16,685
1923		34,373.74	21,684.95			56,058.69	9,432
1924		25,530.50	12,301.55		$ 2,478.59	40,310.64	12,700
1925		25,116.77	13,587.51		1,248.92	39,953.20	6,791
1926		26,864.01	25,552.55			52,416.56	20,176
1927		28,692.03	29,173.18			57,865.21	21,764
1928		28,118.54	30,354.84			58,473.38	21,700
1929		29,578.58	30,330.54			59,909.12	20,838
1930		27,914.62	30,224.99			58,139.61	10,494
1931		34,452.52	27,806.34			62,258.86	24,314
1932		26,689.71	26,924.25			53,613.96	10,609
1933		23,756.92	20,198.70			43,955.62	9,710
1934		15,885.44	11,190.67			27,076.11	5,720
1935	$41,494.30	16,087.67	8,298.97			65,880.94	13,428
1936	56,245.56	23,471.53	9,129.10			88,846.19	5,007
1937	79,203.92	22,173.14	10,789.53			112,166.59	21,460
1938	64,495.69	17,982.15	11,125.97		4,615.40	98,219.21	29,694
1939	70,341.66	19,755.83	12,588.66	$ 1,320.00	45,679.37	149,685.52	36,689
1940	70,375.15	29,592.12	38,149.57	4,976.43	21,736.00	164,829.27	39,896

Table 17. continued

Year	Funds expended						Man days worked
	Federal WPA	Federal	State	Fish & Game	Cooperative	Total	
1941	77,503.38	37,988.56	24,486.37	4,993.42	29,667.38	174,639.11	42,371
1942	77,153.64	43,216.73	19,838.83	4,963.73	36,595.57	181,768.50	41,742
1943	77,847.87	35,462.28	43,190.12	4,002.94	31,089.95	121,593.16	23,533
1944		36,571.54	42,732.78	4,967.95	24,098.56	108,370.83	18,528
1945		30,824.82	37,630.62	5,071.32	16,633.82	90,160.58	13,096
1946							
1947		36,425.59	20,917.92	14,979.78	2,855.80	75,179.09	6,996
1948		32,794.50	99,924.81	8,020.94	10,328.57	151,068.82	15,878
1949		36,478.43	93,939.83	14,859.14	5,851.82	151,129.22	14,886 1/2
1950		37,730.85	92,271.59	17,808.54	3,257.37	151,068.35	14,520 1/2
1951		33,037.07	104,819.43	15,777.13	1,234.16	154,867.79	14,640 3/4
1952		33,150.19	91,056.42	15,696.67	5,980.64	145,883.92	12,943
1953		33,527.73	102,118.46	10,000.00	3,758.00	149,404.19	11,825
1954		33,551.97	101,223.88	16,347.80	3,094.73	154,218.38	12,274 1/2
1955		34,018.46	92,781.69	22,679.54	5,574.76	155,054.45	11,977 3/4
1956		34,193.46	101,417.77	23,143.29	7,762.58	166,517.10	12,571 1/2
1957		85,458.48	93,594.65	21,726.55	3,437.30	204,216.98	13,727
							Man years
1958		81,027.46	105,289.84	22,849.03	3,446.80	212,613.13	40 11/12
1959		87,040.89	88,760.42	35,106.29	3,880.10	214,787.70	38 6/12
1960		93,452.89	101,776.38	25,279.92	4,433.44	224,942.63	36 11/12
1961		95,949.10	105,387.26	23,750.00	2,091.70	227,178.06	37 17/24
1962		122,453.00	98,293.00	25,000.00	2,718.00	248,464.00	37 9/12
1963		126,573.00	105,198.00	18,600.00	3,641.00	254,012.00	37
1964		119,682.00	106,895.00	15,000.00	3,032.00	244,609.00	36 4/12

Table 17. continued

Year	Funds expended						Man days worked
	Federal WPA	Federal	State	Fish & Game	Cooperative	Total	
1965		123,264.00	111,540.00	10,000.00	979.00	245,783.00	36 4/12
1966		104,304.00	130,890.00	10,000.00	3,630.00	248,824.00	
1967		134,143.00	138,292.00	10,000.00	14,754.00	297,189.00	
1968		138,852.00	149,976.00	10,000.00	6,417.00	305,245.00	
1969		137,830.00	145,761.00	10,000.00	5,280.00	298,871.00	36 9/12

Source: Files of the Utah District, Division of Wildlife Services.

Table 18. Consolidated report of predators taken by field men of the Utah District, Division of Wildlife Services, fiscal 1961-1969

	Accredited						How taken						
Year	Wolf	Bear	Bobcat	Coyote	Lion	Total	Traps	Poison	Denned	Shot[a]	Getter[b]	Dogs	Total
1916	21	-	188	934	1	1,444							1,144
1917	33	2	406	3,029	30	3,600							3,500
1918	48	4	461	3,300	11	3,824	3,328	277	103	97		19	3,824
1919	18	7	494	2,865	16	3,399	2,876	345	81	80		17	3,399
1920	17	11	479	3,246	6	3,759							3,759
1921	26	13	521	3,831	22	4,413							4,413
1922	1	4	303	2,569	10	2,887							2,887
1923	1	-	281	1,982	5	2,269	1,125	199	84	63		6	2,269
1924	7	2	207	1,662	5	1,883							1,883
1925	1	1	144	1,673	6	1,824							1,825
1926	8	3	180	2,139	7	2,337							2,337
1927	-	8	238	2,425	14	2,685							2,685
1928	-	7	276	1,587	18	1,888							1,888
1929	1	16	315	1,851	28	2,211							2,211
1930	1	10	287	1,608	32	1,938							1,938
1931	-	16	286	1,856	25	2,183							2,183
1932	-	7	223	1,928	57	2,215	1,285	499	338	40		53	2,215
1933	-	11	242	2,283	57	2,693	1,583	384	508	64		54	2,693
1934	-	-	201	1,792	33	2,026							2,026
1935	-	5	415	3,711	95	4,226	2,817	610	669	38		92	4,226
1936	-	8	1,266	8,416	64	7,754	5,778	506	1,330	104		26	7,754
1937	-	20	1,378	9,836	58	11,292	9,193	359	1,467	204		69	11,292
1938	-	15	1,280	9,960	83	11,338	9,823	350	938	94		133	11,338
1939	-	18	1,513	12,559	69	14,159	11,598	680	1,590	200		91	14,159
1940	-	26	2,124	14,513	56	16,719	13,783	876	1,780	228		52	16,719
1941	-	28	1,620	14,213	64	15,909	12,031	1,086	2,507	372		161	16,157
1942	-	23	1,620	14,213	53	15,909	12,054	705	2,855	400	14	81	15,909
1943	-	22	1,120	10,729	25	11,896	9,382	678	1,415	223	236	62	11,896
1944	-	7	717	6,657	48	7,429	5,778	510	782	106	189	64	7,429
1945	-	11	465	5,077	61	5,614	3,933	598	739	77	214	53	5,614

Table 18 cont.

	Accredited					How taken						
Year	Wolf	Bear	Bobcat	Coyote	Lion	Total	Traps	Poison	Denned	Shot[a]	Getter	Dogs	Total
1946		3	30	179	-	212							212
1947		3	78	1,464	14	1,580	469	157	394	43	490	7	1,660
1948		14	292	3,731	49	4,086	1,080	210	689	76	2,015	18	4,086
1949		23	276	3,295	29	3,624	741	98	649	56	2,060	20	3,624
1950		19	1,003	2,990	58	4,070	1,366	58	679	78	1,857	32	4,070
1951		38	1,499	2,984	77	4,598	2,099	51	626	104	1,663	55	4,598
1952		32	1,243	2,343	53	3,671	1,613	87	506	66	1,314	85	3,671
1953		26	1,946	2,619	55	4,646	2,421	58	643	76	1,349	99	4,646
1954		61	1,568	2,697	74	4,400	2,024	56	836	69	1,297	118	4,400
1955		48	1,242	2,228	39	3,557	1,470	47	562	62p.-68	1,818	167	3,557
1956		50	1,882	2,143	57	4,132	2,250	87	377	144	1,089	215	4,132
1957		55	2,120	2,026	56	4,257	2,530	81	468	75p.-52	866	185	4,257
1958		47	2,173	1,734	56	4,010	2,522	62	549	44p.-35	651	147	4.010
1959		23	2,464	1,833	55	4,386	2,891	78	499	57p.-40	724	97	4,386
1960		26	1,857	1,856	61	3,800	2,264	42	542	76p.-47	687	161	3,800
1961		36	2,055	2,311	71	4,473	2,717	60	757	14p.-85	722	118	4,473
1962		22	1,424	2,180	76	3,702	1,965	64	632	14p.-74	787	163	3,702
1963		30	1,685	2,446	99	4,260	2,431	98	541	4p.-83	850	143	4,260
1964		18	1,453	2,060	103	4,180	2,904	71	815	7p.-	760	173	4,180
1965		20	1,084	2,502	117	3,723							
1966		14	747	1,883	88	2,737	1,163	74	533	40p.-268	542	112	2,732
1967		26	544	1,688	52	2,310	986	79	516	55p.-207	390	77	2,310
1968		8	527	1,693	49	2,277							
1969		16	449	2,308	37	2,810	871	69	491	256 ground 357-plane	706	58	2,810

[a]Shot from airplane
[b]Cyanide gun or coyote getter

Source: Files of the Utah District, Division of Wildlife Services.

Table 19. Number of predators killed, expenditures, and control cost per predator, Utah District, Division of Wildlife Services, fiscal 1920-1969

Fiscal year	Number of predators killed	Expenditures (dollars)	Control cost per predator (dollars)
1920	3,759	68,152	18.13
1925	1,825	63,821	34.97
1930	1,938	58,140	30.00
1935	4,226	65,881	15.59
1940	16,719	81,322	4.86
1945	5,614	90,161	16.06
1950	4,070	151,068	37.12
1955	3,557	155,054	43.59
1960	3,800	224,943	59.20
1965	3,723	245,783	66.02
1969	2,810	298,871	106.36

Source: Files of the Utah District, Division of Wildlife Services

Table 20. Predators killed, costs, and control per predator; bounty system and Division of Wildlife Services, in five-year intervals, Utah, fiscal 1920-1969

Fiscal year	Number of predators killed			Costs (dollars)			Control cost per predator
	Bounty	Trapper	Total	Bounty	Trapper	Total	
1920	17,519	3,759	21,278	69,914	68,152	138,066	6.48
1925[a]		1,825	1,825		63,821	63,821	34.97
1930	17,366	1,938	19,304	96,422	58,140	154,652	8.01
1935[a]		4,226	4,226		65,881	65,881	15.59
1940[a]		16,719	16,719		81,322	81,322	4.86
1945[c]	15,569[b]	5,614	21,183	94,448	90,161	184,609	8.71
1950	4,685[b]	4,070	8,755	36,399	151,068	187,467	21.41
1955	4,715[b]	3,557	8,272	23,128	155,054	178,182	21.54
1960	6,156[b]	3,800	9,956	24,624	224,943	249,567	25.07
1964[d]	2,906	4,180	7,086	6,423	244,609	250,032	35.28
1969	4,732	2,810	7,542	20,458	298,871	319,329	42.34

[a]No bounty paid
[b]Calendar year
[c]Average of 1943-1945 bounty
[d]1965 bounty figures not available

Source: Files of the Utah District, Division of Wildlife Services

The Secretary of the U.S. Department of the Interior, in 1964, appointed an Advisory Board on Wildlife Management. This board was headed by Professor A. Starker Leopold and, besides himself, it contained four professional wildlife people and no representation from the livestock industry (Clyde, 1966). The Secretary accepted the report of this board, commonly called the Leopold Report, on June 22, 1965, and on July 1, 1965, the new Division of Wildlife Services came into being as a successor to the Division of Predator and Rodent Control. New personnel were also installed at this time (Gottschalk and Berryman, 1966).

The Leopold Report recommended:

> a complete reassessment of the goals, policies and field operations of the Division of Predator and Rodent Control, with a view to limiting the killing program strictly to cases of proven need, as determined by rigidly prescribed criteria. (Gottschalk and Berryman, 1966, p. 24)

It also recommended many other changes, including the change of names for the Division of Predator and Rodent Control, designed, it seems, to decrease emphasis on predator control.

Although no data are directly available that will allow a comparison of the levels of depredation upon sheep and lambs by predators before and after the acceptance of the Leopold Report by the Secretary of the Interior, it is possible to compute the costs of predator control by the new Division of Wildlife Services and compare these with the control costs of the old Division of Predator and Rodent Control. This comparison indicates an increased cost of predator control per predator of 38 percent between fiscal 1965 and fiscal 1966. It will also be noted that the number of predators killed by the Division during the same period was reduced by 27 percent (Table 21).

Table 21. Number of predators, expenditures, and control cost per predator, Division of Wildlife Services, Utah District, fiscal 1960-1969

Year	Number of predators killed	Expenditures (dollars)	Control cost per predator (dollars)
Division of Predator and Rodent Control			
1960	3,800	224,943	59.20
1961	4,473	227,178	50.79
1962	3,702	248,464	67.39
1963	4,260	254,012	59.63
1964	4,180	244,012	58.52
1965	3,723	245,783	66.02
Division of Wildlife Services			
1966	2,732	248,824	91.08
1967	2,310	297,189	128.65
1968	2,277	305,245	134.06
1969	2,810	298,871	106.36

Source: Files of the Utah District, Division of Wildlife Services

Ecology of Predation

Traditionally, predator control has not been a controversial issue. As American frontiers gradually invaded the wilderness it was taken for granted that domestic livestock must be protected from marauding predators by the quickest and most efficient means available. Usually, in frontier situations, this meant killing the predators.

Recently, however, concern about the kind and amount of predator control has been voiced by many. Perhaps this is a result of the disappearing frontier. "Purists," "conservationists," and "sportsmen" claim the predator is being eliminated from the American scene.

The coyote is the principle predator of sheep on the western range and the one toward which most control work is directed. The survey shows that the coyote was responsible for over 78 percent of the sheep and lambs killed by predators. There is an indication that coyote numbers have not dwindled, but may actually have increased since the advent and employment of newer, more sophisticated, and deadlier control techniques (Presnall, 1948). Concern is strong about the possibility of upsetting this segment of the balance of nature.

The problem is intensified with the current population trend shifting from rural to urban. The current farm population of 10.5 million people, representing only 5.2 percent of the total population, makes it rather difficult for this very small minority to compete with the opposing desires of conservation and similar groups composed largely of urban dwellers.

Danger of 1080 compound poisons to wild animals

Nearly all animals have some susceptibility to compound 1080 although the canines are most severely affected. Martens, for example, are 10 times as resistant to 1080 as coyotes (Robinson, 1953b). Other animals, it is thought, exhibit equal or lesser degrees of resistance to the poison.

Extensive laboratory studies and laboratory controlled field studies by Weldon B. Robinson of the Wildlife Research Laboratory, U.S. Fish and Wildlife Service, in Denver, indicate that with careful placement of lethal stations of the compound 1080, it is possible to effectively reduce coyote numbers with little or no danger to nearby wildlife (Robinson, 1953b).

In another very carefully supervised and controlled study, Robinson (1953a) found that fur bearers and predators such as kit foxes, raccoons, badgers, skunks, and bobcats increased in numbers through a 10-year period of poisoning with thallium and 1080 for coyotes. Skunks increased 60 percent and raccoons, 800 percent, with the others ranging between these two extremes. Coyotes, on the other hand, were reduced from 77 to 18, a reduction of 77 percent (Robinson, 1953a). In either case his experiments have shown that predation upon the rodent-rabbit population would still be adequate after controlling coyotes with compound 1080, because other animals which are predators of rodents and rabbits will have increased in numbers to take the place of the coyotes.

Need for predators to control big-game herds, rodents, and rabbits

Big-game herds and larger mammals can be controlled by properly regulated hunting. This is contrary to the belief of many writers and "defenders of wildlife." As an argument against predator control, they often cite the example of deer on the Kiabab Plateau of the Grand Canyon (Evanson, 1967; Frome, 1967). This, they claim, is what happens when large game animals are allowed to overpopulate their range. While the results of overpopulation cannot be disputed, careful analysis of the facts discloses that hunting was disallowed at the same time that the predators were eliminated. Had hunting pressure been continued and even increased, it is probable that overpopulation would never have taken place, even with the decline in predator numbers.

To support this point, one need only study the case history of the deer herds in Pennsylvania, where, obviously, large predators have become relatively scarce. When "antlered-bucks-only" hunting laws were

in force, deer herds multiplied rapidly and the deer soon began to starve. Despite outrageous opposition from "sportsmen" and "knowing" politicians, the Game Commission of the state declared a state-wide "clean up season" and two years later repeated with the same type of operation. As a result, deer herds were reduced in number and they now have a high sustained yield by hunting bucks and does together (Gordon, 1968). All of this reconstruction of the deer herds was done without the help of large predators, just with proper hunting management. With this country's relatively affluent 200 million plus inhabitants it is unlikely that a shortage of hunters will ever be realized. Instead, the reverse situation seems more likely to occur. Not true - different types of country and different hunter density

Presnall (1948) points out that he has been unable to find any foundation for the widespread belief that coyotes prevent an overabundance of rodents. To support his case, he points to the Buena Vista mouse plague in California and other studies in Central California which showed no correlation between population trends of coyotes and their common prey species--cottontails, ground squirrels, pocket gophers, kangaroo rats, and wood rats.

The "balance of nature" and changes

Clifford C. Presnall researches the topic of livestock predation from an ecologist's viewpoint. He notes the importance of man and his domesticated species as being "responsible for profound and rapid adjustments in ecological patterns that presumably had been comparatively stable prior to the relatively recent dominance of mankind over wilderness conditions." (Presnall, 1948, p. 155) In other words, the balance of nature has been modified.

As an example of this modification he cites an area in South-Central Texas, where 30,000 square miles had been kept practically coyote free for at least 16 years. As a result, the population of gray foxes had greatly increased at the time of his writing. Quoting Presnall:

> Thus, predation on rodents has continued with but slight modification, despite elimination of predation on livestock and game. It seems doubtful that foxes will follow the coyote-wolf pattern of predator succession against grazing animals, although a few isolated instances of small predators' success against deer are known. Hence, even though predation may have slight relation to rodent populations, it is reassuring to know that this and other rodent-predator relationships are not necessarily disrupted by elimination of predation on ungulates. (Presnall, 1948, p. 160)

As an example of Presnall's reference to "coyote-wolf pattern of predator succession," when wolves were eliminated from the western range, coyotes gradually took over and became more numerous, and this resulted in increased coyote predation upon the large game and livestock.

SUMMARY AND CONCLUSIONS

The primary objective of this thesis was to determine the economic loss to Utah sheep ranchers attributable to bird and animal predators. A secondary problem closely associated with the primary one was an estimate of economic losses suffered by the entire state of Utah by use of an income multiplier.

Two other secondary problems were (1) a review of the economics of present predator control policies in Utah and (2) determination as to what extent changes in predator control personnel and policies were factors relating to the primary question.

A random sample of 56 range-sheep operators and/or owners were questioned by personal interview survey. This sample, which amounted to 20 percent of the range-sheep operations in Utah, showed the death loss from predation in fiscal year 1969 to be 61.0 sheep and lambs per 1,000 head of ewes. It also showed that 71.36 percent of the losses were lambs and 28.64 percent were ewes. The total economic loss to Utah sheep ranchers was calculated to be 1,062,522 dollars as a result of predation in fiscal year 1969.

Using the Type II multiplier of 4.330 for the livestock industry, published by the University of Utah, the total annual economic loss, resulting from predation upon sheep and lambs, to all sectors of the economy of the state of Utah, was determined as 3,901,854 dollars.

It was concluded that the bounty system in the state of Utah was a more economical method of controlling predators than either private control methods or control methods of the Division of Wildlife Services.

Under the bounty system the control cost per predator was still nearly the same in 1969 as it was in the 1920's, at 4.32 dollars.

Private control of predators by ranchers cost 36.94 dollars per predator killed in fiscal 1969, and for the same period the Division of Wildlife Services, Utah District, showed a control cost per predator of 106.36 dollars.

There was a change of name and changes in personnel and policies of the federal government's predator control program near the end of fiscal year 1965. The control cost per predator was 66.02 dollars in fiscal 1965 and 91.08 dollars in fiscal 1966, a 38 percent increase in costs. During the same period, the number of predators killed by the Division was reduced by 27 percent.

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APPENDIX

Table 22. Answers to survey questions, by type of range, Utah, fiscal 1969.

QUESTION	"YES" ANSWER TYPE OF RANGE: BLM[a]	% OF TOTAL	FS[b]	% OF TOTAL	PRIVATE	% OF TOTAL	TOTAL "YES"	TOTAL %	TOTAL YES AND NO ANSWERS	YES AS % OF TOTAL YES AND NO
Are government trappers working this area?	50	28	36	20	92	52	178	100	189	94
If yes, are they providing enough control?	16	40	9	23	15	37	40	100	178	22
How much has it cost you in direct out-of-pocket costs to control predators on this range? (dollars)	4,906	44	804	7	5,556	49	11,266	100	---	---
Has the presence of predators on this range caused you to alter your normal management practices?	14	27	7	14	30	59	51	100	213	24
	"NO ANSWER" TYPE OF RANGE						"NO"			
Are government trappers working this area?	2	18	3	27	6	55	11	100	189	6
If yes, are they providing enough control?	34	25	28	20	76	55	138	100	178	78
Has the presence of predators on this range caused you to alter your normal management practices?	46	28	40	25	76	47	162	100	213	76

[a]Land administered by the Bureau of Land Management.
[b]Land administered by the U.S. Forest Service.

Source: Personal interview survey.

Table 23. Answers to survey questions, by season of range use, Utah, fiscal 1969.

QUESTION:	SEASON OF RANGE USE "YES" ANSWER											
	SPRING	% OF TOTAL	WINTER	% OF TOTAL	FALL	% OF TOTAL	SUMMER	% OF TOTAL	TOTAL "YES"	TOTAL %	TOTAL YES AND NO ANSWERS	YES AS % OF TOTAL YES AND NO
Are government trappers working this area?	58	33	45	25	30	17	45	25	178	100	189	94
If yes, are they providing enough control?	13	33	14	35	4	10	9	22	40	100	178	22
How much has it cost you in direct out-of-pocket costs to control Predators on this range? (dollars)	5,250	47	3,844	34	1,112	10	1,060	9	11,266	100	---	---
Has the presence of predators on this range caused you to alter your normal management practices?	21	41	15	29	8	16	7	14	51	100	213	24
	"NO" ANSWER								TOTAL "NO"			
Are government trappers' working this area?	3	17	1	10	2	18	5	45	11	100	189	6
If yes, are they providing enough control?	45	33	30	22	27	20	36	25	138	100	178	78
Has the presence of predators on this range caused you to alter your normal management practices?	44	27	36	22	33	20	49	31	162	100	213	76

Source: Personal interview survey.

Figure 1. Questionnaire used in gathering sheep loss and predator data, Utah, 1969

Name:_____ Address: _____

Range location: _____ County: _____

No. of sheep run: _____

	Type of predator						
Total # of sheep lost to predators	Coyote	Mtn lion	Bobcat	Eagle	Domestic dog	Bear	Other
Lambs:							
Ewes:							
Rams:							

General area where losses occurred: (national forest, general county area, etc.)

_____

_____

Total # of sheep injured that didn't die: Estimate $ value of loss

Lambs:_____ $_____

Ewes: _____ _____

Rams: _____ _____

How many predators were killed on this range for this grazing period?

	Type of predator						
Killed by	Coyote	Mtn lion	Bobcat	Eagle	Domestic dog	Bear	Other
Yourself or helpers:							
Govt trapper:							

How many sheep were lost to causes other than predators on this range?

	Cause (general)
Lambs:	
Ewes:	
Rams:	

Figure 1. Continued

Are government trappers working this area?	Yes	No
If yes, are they providing enough control?	Yes	No
Do you attempt to control predators on this range?	Yes	No
How much has it cost you in direct out-of-pocket costs to control predators on this range?	$_____	

Has the presence of predators on this range caused you to alter your normal management practices? Explain.

Kind of range: BLM FS Private
Grazing period: Sp W F Su

VITA

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