1-1-1998

Non-Lethal Predation Control by U.S. Sheep Producers

Guy Connolly
USDA Animal and Plant Health Inspection Service

Bruce Wagner
USDA Animal and Plant Health Inspection Service

NON-LETHAL PREDATION CONTROL BY U.S. SHEEP PRODUCERS

GUY CONNOLLY, Wildlife Biologist, USDA Animal and Plant Health Inspection Service, Wildlife Services, 12345 W. Alameda Parkway, Suite 204, Lakewood, Colorado 80228.

BRUCE WAGNER, Statistician, USDA Animal and Plant Health Inspection Service, Veterinary Services, 555 S. Howes, Suite 100, Fort Collins, Colorado 80521-2865.

ABSTRACT: The USDA National Agricultural Statistics Service (NASS) surveyed U.S. sheep producers to determine the kinds of non-lethal (NL) predator control measures they used in 1994. An analysis of responses from 8,451 sheep producers showed that 34% of the nation's sheep producers used fencing, 25% used husbandry, 20% used guard animals, 4% used frightening tactics, 0.3% used aversion, and 3% used other methods. Because NL methods tended to be used more in large sheep operations than on small farms, the percentages of sheep protected by each NL control method were higher than the percentages of sheep producers using the method. Approximately 33% of all sheep in the U.S. were protected by fencing, 40% by husbandry, 39% by guard animals, 12% by frightening tactics, 2% by aversion, and 5% by other methods. Overall, 55% of U.S. sheep producers used one or more NL predator control methods in 1974, and 70% of the nation's sheep were protected by one or more NL methods.

KEY WORDS: Predators, predation management, sheep, non-lethal methods, fencing, husbandry, guard animals, frightening tactics, aversion

Proc. 18th Vertebr. Pest Conf. (R.O. Baker & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. 1998.

INTRODUCTION

The U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) and Animal and Plant Health Inspection Service (APHIS) have cooperated on many surveys of wildlife damage to agriculture. Several national surveys have estimated sheep and goat (NASS 1991, 1995a,b) or cattle and calf (NASS 1992, 1996a) losses to predators and other causes. These studies have shown that the coyote is the most important predator of sheep and lambs in the U.S.

In January 1995, NASS asked sheep producers to report their predator control practices and expenditures during 1994. The results showed that fencing and husbandry practices were the leading non-lethal (NL) control measures used in that year (NASS 1995a). This brief summary did not estimate the percent of sheep producers who used each control method or the percent of sheep protected by specific methods, nor did it compare NL predation management practices on sheep operations of different sizes. The authors undertook additional analyses to obtain these estimates. The findings are summarized in this paper.

METHODS

NASS and its cooperating state agricultural statistics services surveyed a random sample of U.S. agricultural producers by mail, telephone, and face-to-face personal interviews in January 1995. All sheep and lamb producers, regardless of size, had a chance to be included in the survey; however, Alaska was excluded. Large producers were sampled more heavily than small operations. Producer responses were voluntary. Survey procedures and results were presented in detail by NASS (1995a,b).

Sheep producers who participated in this survey were asked which of the following NL predator control methods or groups of methods were used on their farms or ranches during 1994:

a. Husbandry practices (herders, corrals, carrion removal, pasture selection and grazing variation, habitat changes, season and location of lambing, etc.)
b. Frightening tactics (lights, bells, radios, propane exploders, strobe lights, sirens, etc.)
c. Aversion (repellents, aversive conditioning, etc.)
d. Fencing (net-wire, electric, etc.)
e. Guard animals (guard dogs, donkeys, llamas, etc.)
f. Other (specify)
g. No NL predator controls used

Sheep producers' responses (n = 10,798) to this survey were obtained, together with sampling weights, electronically from NASS. Weights were recalculated to account for 807 nonrespondents. Respondents (n = 531) who had no sheep on January 1, 1995 were dropped from further analysis. In addition, it was found that the records for 1,009 respondents were unusable because they failed to indicate whether or not respondents used NL control measures. The analysis was based on the remaining 8,451 responses.

It was hypothesized that the use of NL predation control methods would vary with the size of sheep operations, large producers being more likely than small operations to use such methods. To elucidate this, respondents were sorted into flock size classes based on the number of sheep and lambs on each farm on January 1, 1995. Four size classes were defined: class 1 = 1 to 49 sheep; class 2 = 50 to 199 sheep; class 3 = 200 to 999 sheep; and class 4 = 1,000 or more sheep.

Two weighted analyses were performed—one to estimate the percentages of sheep producers who used

each method and another to estimate the percent of sheep protected by each method—using SUDAAN software (Software for the Statistical Analysis of Correlated Data, Research Triangle Institute Release 7.00, April 1996).

Percentages of respondents (unweighted data) and sheep producers (weighted) who used each NL method, or used no NL method, were estimated by state for each flock size class. Weighted percentages of sheep protected or affected by producers' use of each method were computed similarly. Similar estimates also were prepared for eastern and western regions of the U.S. and for the U.S. as a whole. Eastern and western regions were defined as APHIS Wildlife Services Eastern and Western regions. The eastern region includes Minnesota, Iowa, Missouri, Arkansas, Louisiana, and all states east of these; the western region consists of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas and all more westerly states.

The original report on this survey (NASS 1995a) noted that the results were subject to sampling variability but did not provide statistical estimates of variability. The authors quantified sampling variability by computing 95% confidence intervals (CIs) for each percentage estimate. Each CI was calculated as the estimate plus or minus a "t" value times a standard error (SE). Student's "t" values for $p = 0.95$ were obtained from a standard "t" table (Simpson et al. 1960:422). SEs for unweighted data were computed using the normal approximation for binomial distributions (Simpson et al. 1960). SEs for weighted estimates were provided by the SUDAAN software.

CIs were used to distinguish genuine differences from chance sampling variations. In general, it was considered any apparent difference between any two percentage estimates to be statistically significant when neither estimate was included within the CI of the other.

This analysis yielded a series of large tables that were too voluminous for presentation in this paper. The findings are summarized here, and are described in greater detail in Connolly and Wagner (1998).

RESULTS

This survey provided information about sheep producers' use of 6 NL predation control methods or method groups in 1994. Based on the authors' weighted estimates, 34% of the nation's sheep producers used fencing during 1994. Twenty-five percent used husbandry, 20% used guard animals, 4% used frightening tactics, 0.3% used aversion, and 3% used other methods. An estimated 45% of U.S. sheep producers used no NL predator control methods (Table 1).

Guard animals and frightening tactics were used by higher percentages of sheep producers in western states than in eastern states. Other methods were used by generally similar percentages of western and eastern producers, although large operations (size class 4) in the west used aversion at a higher rate than those in the east (Connolly and Wagner 1998).

A general pattern of association was seen between flock size and use of each NL method or method group (Table 1). The percentages of operators using each method were lowest for small flocks (size class 1), higher for intermediate size classes 2 and 3, and highest for large operations (class 4). Conversely, the percentage of producers who reported using no NL methods was largest for small flocks and smallest for large operators.

Weighted estimates for numbers of sheep revealed that 33% of all U.S. sheep were protected by fencing in 1994. Forty percent were protected by husbandry, 39% by guard animals, 12% by frightening tactics, 2.4% by aversion, and 5% by other methods. Overall, 70% of the nation's sheep were protected, and 30% were not protected by one or more NL predator control methods in 1994 (Table 2).

Except for fencing, the percentages of sheep protected by each NL method were greater in western states than in eastern states. Conversely, the percentage of sheep not protected by any NL method was 38% in eastern states, but only 28% in western states.

Estimated percentages of sheep that were protected by NL control methods tended to increase with flock size (Table 2). Except for fencing, the percentages of sheep protected by each method were lowest on small farms (flock size 1), higher in flocks of intermediate size, and highest on large operations (flock size 4). Fencing, in contrast, protected 37% of the sheep on both small and large operations, and smaller fractions of the sheep in operations of intermediate size.

For all NL methods except fencing, the percentage of sheep protected by each method (Table 2) was greater than the percentage of producers who used that method (Table 1). Consistent with this observation, only 30% of the nation's sheep were not protected by NL methods even though 45% of U.S. sheep producers used no NL method.

Unweighted survey data also showed different rates of use for the six control methods or method groups, as well as differences among flock size classes in the percentages of respondents who reported using each method (Connolly and Wagner 1998). For most control methods and flock size categories, the percentage of respondents who reported using the method was intermediate between the corresponding, weighted estimates for percentages of sheep producers (Table 1) and percentages of sheep protected (Table 2). These results are consistent with the sampling design that intentionally oversampled large operations (NASS 1995a).

DISCUSSION

The information presented in this paper is based on information from 8,451 sheep producers—10.3% of the nation's 82,120 sheep operations at the time of the survey (Table 1, footnote 1). This sample size is regarded as more than adequate to yield accurate information on predation management practices of the U.S. sheep industry. It should be noted, however, that the 1995 NASS survey did not question producers about all predation controls. It concentrated on NL control measures even though most sheep producers use both lethal and NL methods.

This analysis confirms the conclusions of NASS (1995a) regarding the relative frequency of use for various NL predation control measures. Fencing, guard animals, and husbandry were used most, frightening tactics and other methods less, and aversion was used very little.

Table 1. Use of non-lethal predation control methods by U.S. sheep producers in 1994.

Flock[1] Size	Fencing	Husbandry	Guard Animals	Fright Tactics	Aversion	Others	No NL Method
	Non-lethal Methods and Methods Groups						
	Percent of Producers Who Used Each Method[2]						
1	35 27-43	24 17-30	17 12-23	3 1-4	0.2 0.0-0.3	2 1-3	47 37-56
2	28 24-33	29 25-34	26 23-30	6 4-7	0.5 0.1-0.9	4 3-5	40 35-45
3	25 20-31	30 24-35	36 30-41	7 6-8	1.0 0.5-1.5	6 5-8	38 34-43
4	30 28-32	43 40-45	42 39-44	15 13-17	2.4 1.8-2.9	7 6-8	28 26-31
ALL	34 28-40	25 19-30	20 16-24	4 3-5	0.3 0.2-0.4	3 2-3	45 38-53

[1]Size class 1 = 1 to 49 sheep; 2 = 50 to 199 sheep; 3 = 200 to 999 sheep; and 4 = 1000+ sheep. On January 1, 1995, the United States had approximately 82,120 sheep operations (NASS 1996b). Their distribution by flock size was class 1—79.2%; class 2—14.3%; class 3—5.0%; and class 4—1.6%
[2]Hyphenated numbers are 95% confidence intervals.

Table 2. Percentages of sheep in the U.S. protected by non-lethal predation control methods in 1994.

Flock[1] Size	Fencing	Husbandry	Guard Animals	Fright Tactics	Aversion	Others	No NL Method
	Non-lethal Methods and Methods Groups						
	Percent of Sheep Protected by Each Method[2]						
1	37 30-43	27 20-33	20 14-26	3 2-4	0.2 0.1-0.3	2 1-4	41 35-47
2	28 24-31	30 26-34	28 24-32	6 5-8	0.5 0.2-0.9	4 3-5	39 35-43
3	26 19-32	31 25-37	37 32-43	7 6-9	0.9 0.5-1.3	6 5-8	37 32-41
4	37 34-39	49 46-52	48 45-51	18 16-20	4.0 2.8-5.2	6 5-7	22 20-25
ALL	33 31-35	40 38-42	39 37-42	12 11-13	2.4 1.8-3.0	5 5-6	30 28-32

[1]Size class 1 = 1 to 49 sheep; 2 = 50 to 199 sheep; 3 = 200 to 999 sheep; and 4 = 1000+ sheep. On January 1, 1995, the United States had approximately 8.886 million sheep and lambs (NASS 1996b). Their distribution by flock size was class 1—12.0%; class 2—13.9%; class 3—21.9%; and class 4—52.2%
[2]Hyphenated numbers are 95% confidence intervals.

This analysis went beyond that of NASS (1995a) in estimating the percentages of sheep producers who used each method and the percentages of sheep protected by each method. These estimates showed that most U.S. sheep producers used one or more NL predation management practices in 1994, and that about 70% of sheep in the U.S. were protected by one or more NL predation control measures. Both measures of NL method use were higher in western states than in eastern states.

The results of the analysis by flock size classes confirmed the hypothesis that NL predation controls were used more in large sheep operations than in small ones. In addition, weighted estimates reveal that the percentages of sheep protected or affected by the use of NL control measures were much higher than could have been inferred from the original report (NASS 1995a).

Comparing the authors' weighted estimates to the unweighted survey data, it was concluded that the unweighted statistics did not represent either sheep producers or sheep numbers as well as the weighted estimates. This finding seems logical, considering that the original analysis was not designed to estimate either the percentages of U.S. sheep producers who used various predation controls or the percentages of the nation's sheep industry that were protected by such methods.

It follows that reanalysis, including weighting as appropriate, is warranted whenever users of survey data want information that was not extracted in the original analysis. In this case, weighted analyses yielded useful information that was not presented in the original summary (NASS 1995a). NASS is commended for devising a recording system that preserved the original data in a form that was conducive to reanalysis.

An important finding in this survey is that many U.S. sheep producers reported using no NL predation control measures in 1994. As noted previously, the highest percentage rates of method non-use were on small operations (size class 1) and the lowest rates were on large operations (class 4; Table 1).

Why did not all sheep producers use NL predation controls? Part of the answer to this question, the authors believe, is that the risk of predation differs among sheep ranches. Balser (1974), for example, showed that approximately half of 111 ranchers interviewed in Utah and New Mexico had losses below 5% annually, while one-fourth reported over 10% predator losses. It is speculated that sheep producers' predation management efforts in 1994 varied with their perceived risk of predation. Those lucky producers who expected to have little or no predation probably did not devote major effort to predation control.

This study indicated that aversion was used by few sheep producers in 1994. "Aversion," as defined in the NASS questionnaire, included both repellents and aversive conditioning. No known repellents or aversive conditioning products that are effective and practical for protecting livestock from predators. None were registered or legally available in 1994, so it was not expected to have even small numbers of respondents to report the use of such materials.

As noted above, approximately 3% of U.S. sheep producers reported using "other" NL predation control measures. The "other" measures were not further identified in NASS (1995a) or in unpublished data available to the authors. They may have included shed lambing, harassment, scarecrows, and other practices that were not specified in "husbandry" or other method categories as defined in the survey instrument.

It should be recognized that the 1995 survey dealt rather superficially with sheep producers' predation management practices. Survey data based solely on producers' statements that they used or did not use specific methods give no weight to the quality or intensity of method use. A thorough analysis of predator management practices would entail better documentation of producers' level of effort with each method, coupled with assessments of effectiveness in reducing losses. The 1995 survey was a good start toward improved documentation of livestock producers' NL predation management practices, but much more remains to be done.

Another study of sheep producers' predation management practices was carried out in January 1996 as part of an animal health survey by APHIS's National Animal Health Monitoring System (NAHMS 1996a,b). This mail survey improved upon the 1995 NASS survey in two important respects—it included both lethal and NL predation control methods, and producers were asked for subject evaluations of method effectiveness. Approximately 66% of the operators used at least one lethal or NL predator management practice.

NAHMS' study found that 41% of U.S. sheep operations used one or more lethal methods, and 34% used guard animals. Among species of guard animals, llamas and dogs were rated as more effective than donkeys. However, the highest effectiveness rating went to "other" methods including night penning, other lights and noises, and "USDA:APHIS Animal Damage Control".

More recent NASS surveys also have recorded producers' assessments of predator control method effectiveness in selected states. Sheep producers in Colorado (CASS 1998) and Montana (MASS 1998) were asked to rate each of the NL control measures they used in 1997 as "very effective," "somewhat effective," or "not effective." The most effective methods in both states included herding, night penning, and shed lambing. Guard animals and fencing received higher effectiveness ratings in Montana than in Colorado. Similar data may have been collected in other states in 1998.

Perhaps the most detailed survey to date of livestock producers' NL predator management practices was carried out by APHIS Wildlife Services (WS) personnel in New Mexico in 1994. Livestock producers and other WS program cooperators were surveyed to determine what NL methods had been tried, how much it cost to implement the methods, which methods were successful, why some methods were discontinued, and whether lethal methods also were used to reduce agricultural and other property losses. The results were summarized by May (1996).

Livestock producers in New Mexico reported total expenditures of approximately $43.5 million on NL predation controls; most of these expenditures were for net wire fencing. Most of the NL methods implemented by livestock producers were still in use at the time of the

survey, even though many producers had discontinued using specific methods because they were ineffective or too costly. When New Mexico livestock producers were asked if specific NL methods they used reduced losses to an acceptable level, 80% of the responses were "no." Ninety percent of survey respondents used both lethal and NL methods.

Considering this study in conjunction with others cited in this paper, two basic conclusions seem to be warranted. First, most U.S. sheep producers use NL as well as lethal predation management methods. Second, livestock producers tend to select and use the control methods that they believe will be most practical and effective in their operations.

ACKNOWLEDGMENTS

The authors thank NASS Livestock Specialists L. Simpson and J. Hand for providing unpublished survey data and related information. The authors also thank P. Groninger, N. Wineland, and G. Hill for advice and assistance with statistical analysis, and M. Fall for suggestions to improve the manuscript.

LITERATURE CITED

BALSER, D. S. 1974. An overview of predator-livestock problems with emphasis on livestock losses. Trans. N. American Wildl. & Nat. Resources Conf. 39:292-300.

COLORADO AGRICULTURAL STATISTICS SERVICE (CASS). 1998. Colorado sheep and lamb losses—1997. CASS, Lakewood CO, February 1998, 4 pp.

CONNOLLY, G., and B. WAGNER. 1998. Non-lethal predation control measures used by sheep producers in the United States in 1994. APHIS Wildlife Services, Lakewood CO and APHIS VS Centers for Epidemiology and Animal Health, Fort Collins, CO. Unpublished report; available from the authors.

MAY, J. ALAN. 1996. Results of a non-lethal survey and report provided to the New Mexico legislature. Proc. Vertebrate Pest Conf. 17:225-229.

MONTANA AGRICULTURAL STATISTICS SERVICE (MASS). 1998. Montana sheep and lamb losses—1997. MASS, Helena, MT. February 20, 1998, 4 pp.

NATIONAL AGRICULTURAL STATISTICS SERVICE (NASS). 1991. Sheep and Goat Predator Loss. USDA NASS, Washington, DC. Lv Gn 1 (4-91). April 24, 1991, 12 pp.

NATIONAL AGRICULTURAL STATISTICS SERVICE (NASS). 1992. Cattle and Calves Death Loss. USDA NASS, Washington DC. Mt An 2 (5-92). May 1, 1992, 24 pp.

NATIONAL AGRICULTURAL STATISTICS SERVICE (NASS). 1995a. Sheep and Lamb Death Loss 1994. USDA NASS, Washington, DC. NASS Staff Report, LDP Number 95-01. May 1995, 36 pp.

NATIONAL AGRICULTURAL STATISTICS SERVICE (NASS). 1995b. Sheep and Goat Predator Loss. USDA NASS, Washington, DC. Lv Gn 1 (4-95). April 27, 1995, 16 pp.

NATIONAL AGRICULTURAL STATISTICS SERVICE (NASS). 1996a. Cattle Predator Loss. USDA NASS, Washington, DC. Mt An 2 (5-96). May 17, 1996, 23 pp.

NATIONAL AGRICULTURAL STATISTICS SERVICE (NASS). 1996b. Sheep and Goats. USDA NASS, Washington, DC. Lv Gn 1 (1-96). January 26, 1996, 16 pp.

NATIONAL ANIMAL HEALTH MONITORING SYSTEM (NAHMS). 1996a. Reference of 1996 U.S. Sheep Health and Management Practices. USDA APHIS VS Centers for Epidemiology and Animal Health, Fort Collins, CO. Publication N206.996, 26 pp.

NATIONAL ANIMAL HEALTH MONITORING SYSTEM (NAHMS). 1996b. Reference of 1996 U.S. Regional Sheep Health and Management Practices. USDA APHIS VS Centers for Epidemiology and Animal Health, Fort Collins, CO. Publication N211.996, 42 pp.

SIMPSON, G. G., A. ROE, and R. C. LEWONTIN. 1960. Quantitative Zoology, Revised Edition. Harcourt, Brace and Co., New York. 440 pp.