

# The Marin County Livestock Protection Program: 15 years in review

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**Abstract:** Predation by wild carnivores challenges livestock producers worldwide. To reduce or offset losses due to predation, a variety of predator control methods and compensation schemes have been developed. In 2001, Marin County, California, USA replaced its U.S. Department of Agriculture Wildlife Services (WS) cooperative predator damage management program with a county-run program that emphasized nonlethal methods for preventing and controlling coyote (*Canis latrans*) predation on domestic sheep (*Ovis aries*). This new Livestock Protection Program (LPP) cost-shared with livestock producers' efforts to improve fencing, obtain and maintain guard animals, and other such nonlethal methods, and initially it compensated producers for documented losses to predators. In 2006, 5 years into the program, 17 sheep producers were surveyed to compare the former WS program to the LPP with regard to rancher satisfaction and preferences, lethality to predators, livestock losses, uses of nonlethal predator deterrent techniques, and costs. In 2016, 15 years after the program was replaced by a county-administered nonlethal program, we surveyed sheep producers to determine if their perceptions of the program had changed. Although the lack of standardized data collection complicated our evaluation, the number of sheep and lambs produced in Marin County has continued to decline; 5 producers left the sheep business and others who remain graze less acreage with smaller flocks, predation by coyotes remains a high concern to producers, and producers are generally dissatisfied with the Livestock Protection Program. Recommendations include increased programmatic funding for management practices, payments for losses, and seasonal hiring of wildlife specialists during critical times, especially during lambing seasons.

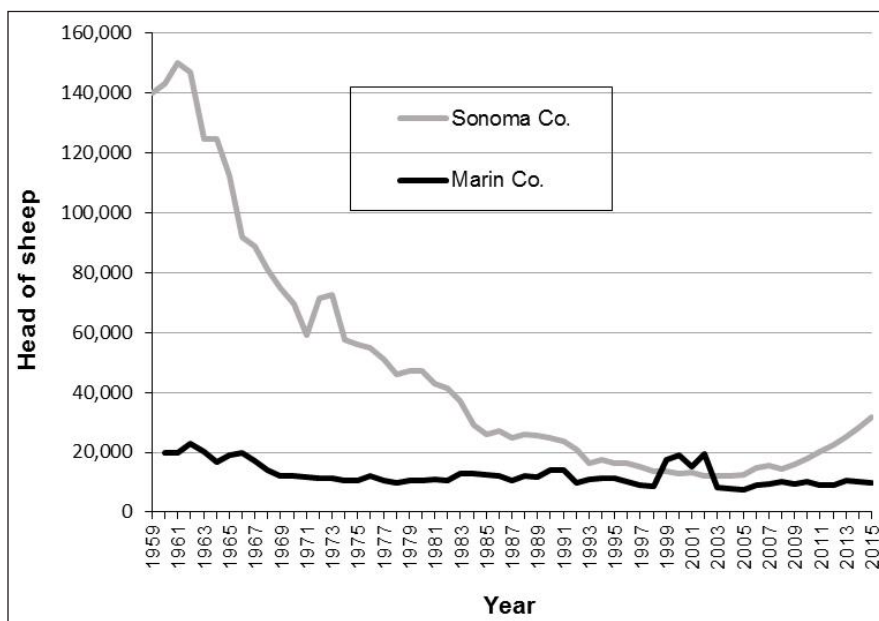
**Key words:** *Canis latrans*, coyotes, damage assessment, economics, livestock predation, Marin County California, nonlethal methods, predation loss, predator control, sheep and lamb loss, survey, U.S. Department of Agriculture Wildlife Services

PREDATION BY WILD CARNIVORES is a major source of human–wildlife conflict for livestock producers worldwide. In North America, the coyote (*Canis latrans*) causes substantial damage to livestock, especially sheep (*Ovis aries*; Mitchell et al. 2004). Control methods can include selective and non-selective lethal practices such as hunting, trapping, and poisoning, as well as nonlethal practices meant to deter predators; the relative costs, efficacy, and social acceptability of nearly every control practice are widely debated (Conner et al. 2008, McManus et al. 2015).

Other approaches to wildlife–livestock conflict include financial instruments such as compensation, in which producers are directly paid for livestock losses due to predation (Dickman et al. 2011). While monetary compensation can incentivize agricultural

expansion into previously undeveloped predator habitat (Bulte and Rondeau 2005), its effectiveness has been demonstrated in long-settled agricultural areas facing coyote predation, such as western North America (Morehouse et al. 2018).

Coyote predation has been an increasing problem for sheep producers in California's north coast region (Larson and Salmon 1988, Timm and Connolly 2001, Larson 2006). Even when employing all legal and available methods, including both nonlethal and lethal strategies, loss of sheep and lambs to coyotes was a main reason for producers going out of the sheep business (Larson and Salmon 1988). This led to a long-term decrease in total sheep numbers, with steady declines of >75% in Sonoma County and 50% in Marin County (Marin County 2016, Sonoma County 2016; Figure 1).



**Figure 1.** Sheep (*Ovis aries*) numbers, Sonoma and Marin Counties, California, USA (Marin County 2016, Sonoma County 2016).

During the 1970s and 1980s, sheep ranchers in Sonoma and Marin Counties suffered few losses from predators in comparison to those in inland areas of California's more northern coastal counties (i.e., inland Mendocino and Humboldt Counties). Through time, coyotes expanded their range and became more numerous in Sonoma County while moving southward into Marin County. Sheep and lamb losses began to occur by the mid-1980s, and the problem continued to spread and increase (Larson and Salmon 1988, Larson 2006).

In the late 1980s, to help reduce predation losses, Marin County began a cooperative animal damage control agreement with the California Department of Food and Agriculture and the U.S. Department of Agriculture Animal Plant Health Inspection Services, Wildlife Services (WS), which provided professional assistance from a wildlife specialist. During much of the 1980s and 1990s, methods used on sheep ranches in Marin County to control coyote predation included traditional lethal methods such as calling and shooting, leghold traps, and snares, as well as den hunting and removal of pups. Nonlethal techniques used by producers included conventional and electric fencing (cross and perimeter), placement of lambs or sheep near areas of human activity, use of herders, and a single instance of gathering livestock at

night. By the 1990s, use of livestock guarding animals such as dogs (*Canis lupus familiaris*) and llamas (*Lama glama*) had become more prevalent. Electric fencing and use of herders were found to be effective, while 6 producers who tried it did not find use of night pastures effective (Larson and Salmon 1988).

For producers who chose to request assistance from the WS specialist, certain tools and materials available only to WS could also be used on their property: M-44 sodium cyanide ejectors and the Livestock Protection Collar (following its registration in California in early 1996; Timm et al. 1997, Larson 2006). The WS specialist preferred the leghold trap because nontarget species were at low risk of serious injury or death, allowing most captured nontargets to be released (G. J. Alfonso, former Marin County WS specialist, personal communication).

Subsequently, voter approval of California's ballot initiative (Proposition 4) in November 1998 banned the use of leghold traps (except in human safety emergencies) as well as the active ingredients used in the M-44 and in the Livestock Protection Collar (Timm and Connolly 2001, Animal Legal and Historical Center 2006). Thus, removal of problem coyotes came to rely primarily on calling and shooting, and to a lesser extent, snares. Landowners were

still able to remove coyotes from their property by using any method legally available to private citizens.

### **Marin County's Livestock Protection Program**

In late 2000, the Marin County Board of Supervisors decided to replace the WS program with a county-administered predator management program supervised by the County Agricultural Commissioner's office. This program is described elsewhere as Marin County's Ranch Improvement/Nonlethal Control and Indemnity Plan (Shwiff et al. 2005, 2006) but is known locally as the Livestock Protection Program (LPP).

Through this program, qualified ranchers could request funding to assist in the implementation of nonlethal management methods (e.g., fencing improvements, guard animals, scare devices) to attempt to reduce coyote depredation. This program became effective during the county's 2001–2002 fiscal year (beginning July 1, 2001). In actuality, the WS program ceased operation in Marin County on December 1, 1999, when the WS Specialist position became vacant.

To participate in the new county-administered predator program, ranchers needed to utilize any combination of 4 categories of methods to deter predation: 1) new fence construction or improvements to existing fences; 2) guard animals (dogs and llamas); 3) scare devices; and 4) changes in animal husbandry, including shed lambing, use of herders, and other techniques. Initially, for each method, a rancher could receive a cost-share payment of \$500 per practice up to a maximum of \$2,000 annually. Producers also qualified for compensation for livestock lost to predators (market price per head lost) upon instigation of at least 2 of the 4 categories, subject to inspection and verification.

At first, the LPP compensated all losses from coyote depredation, paying market value for the animals lost to predation. The Marin County Agricultural Commissioner's staff and University of California Cooperative Extension (UCCE) personnel verified sheep and lamb losses due to coyotes. By the third year of the program (2003), the compensation payments were capped at 5% of the total ewe herd (e.g.,

producers with a 200-ewe flock could be reimbursed for a predation loss not to exceed the market value of 10 ewes).

Fox (2008) reported the results of a 2006–2007 survey conducted to determine if the LPP had reduced livestock losses for a majority of participating ranchers along with assessing other aspects of the program in its first 5 years. Fox (2008) concluded that nearly 90% of sheep in Marin County were covered under the program, and the program had support from a majority of participating ranchers; had helped to reduce livestock losses, and likely had reduced the number of predators killed to protect livestock.

Our objective was to compare sheep producers' responses to the LPP 15 years after its inception to responses obtained a decade earlier. We contrasted our survey results with those from Fox (2008), focusing on producers' satisfaction with the LPP compared to the former WS program. Both surveys included questions regarding program funding and expenditures, the use of nonlethal predation deterrent techniques amongst participating producers under the LPP, sheep losses due to predation, the number of predators killed to protect livestock, and which predator control techniques were most preferred by producers. In addition, we asked producers if their labor, expenses, and management changed with the introduction of the LPP.

### **Methods**

Our 2016 survey (Appendix 1), which was modeled after the Fox (2008) survey, assessed the LPP 15 years following initiation of the program. It covered similar topics that were addressed by Fox (2008): 1) program cost differences between WS and LPP; 2) level of satisfaction with the WS program compared to the LPP in regard to cost share, compensation, and predator control methods; 3) whether sheep and lamb losses to predation changed with the LPP; 4) whether the number of predators (coyotes) killed changed with the LPP; and 5) what predator control techniques were preferred by participating ranchers. A sixth topic, not included in Fox (2008) was added to assess the level of management changes: in our survey (Appendix 1, question 15), we asked respondents to rank their level

of satisfaction with various predation control methods. We infer that respondents who rated a method (as opposed to marking “no opinion”) had employed or attempted to employ the particular method.

A producer meeting was held, allowing producers to openly discuss the LPP, including their satisfaction, concerns, and suggestions for changes; 14 sheep producers attended. The meeting also served to encourage producers’ participation in the survey, which was subsequently provided to them as well as to other sheep producers who did not attend.

Approved by the University of California–Davis Internal Review Board (Protocol 840718-2), the survey included a pre-addressed reply envelope and was mailed to 19 producers who we identified as having raised sheep in Marin County during the period 2001–2015 and who participated in the LPP: 13 producers raised sheep, and 6 were no longer in business.

Survey responses were anonymous, though respondents were given the opportunity to include their name and a request to speak directly with the senior author. Four producers who completed the survey indicated an interest in discussing the LPP, and the senior author met individually with each of them. Authors also met with 4 producers who did not complete the survey but had been in the LPP. We interviewed them, soliciting survey data relevant to their history, including reasons they ceased sheep production.

Additionally, we requested and received data from the Marin County Agricultural Commissioner’s office, including funding and expenditures, number of program participants, sheep numbers, and any evaluations conducted by that office, during the period FY95–FY96 through FY14–FY15.

### Statistical analysis

The survey instrument (Appendix 1) consisted of 21 questions of the following types and topics: producers were asked to hand-enter the number and type of livestock raised, sources of mortality, and extent of predation; check off predator control methods used among a list of legal practices; enter handwritten responses to questions about WS and the Marin County LPP; and answer 5-point Likert-style questions (those with scaled choices; e.g., on a scale of

highly satisfied to highly dissatisfied) about changes in management cost and labor during the LPP and satisfaction with control method effectiveness and compensation.

We calculated an agreement index and estimated confidence intervals for responses to each Likert-style question following a procedure implemented in the R statistical environment (R Core Team 2017). This method provided inference into 2 aspects of the responses: whether a trend toward positive or negative responses can be considered significantly different than zero, as well as the magnitude, or strength, of the response. Calculating the index began with an effect size for the difference between the observed data and the null expectation (i.e., an equal number of responses across all categories) based on multinomial distributions as in the EMT package for the R statistical environment (Menzel 2013). This effect size was then multiplied by the mean response (as in R package Likert; Bryer and Speerschneider 2016), which has been scaled so that negative responses got a negative sign, positive responses were positive, and ambivalence or no opinion was made to be zero. The 95% confidence intervals were calculated from 1,000 simulations of the observed data using the procedure available in McGranahan et al. (2017).

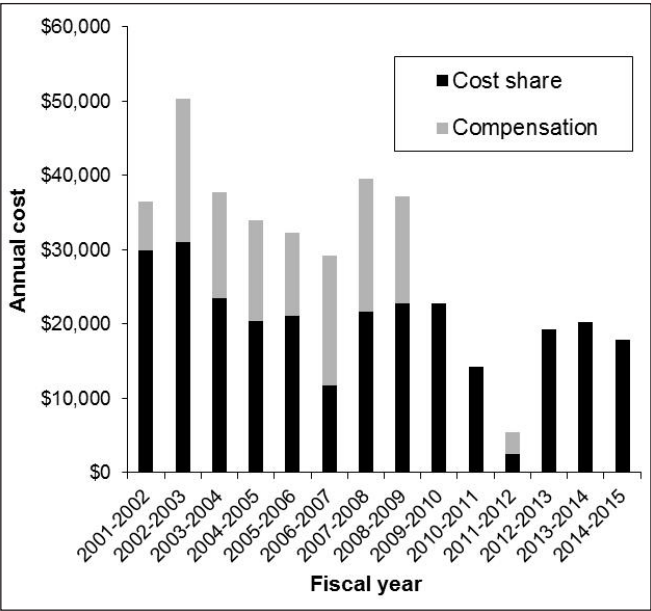
## Results

### Survey response rate

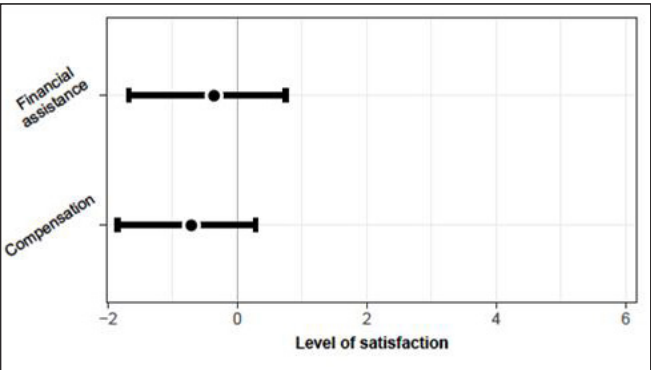
Of the 19 surveys we sent to sheep producers, 11 surveys (58%) were completed and returned. Cattle (*Bos taurus*) and poultry (chicken, turkey) producers currently participating in the LPP were not surveyed, as they were not in the program at its inception. As noted above, 4 producers who received but did not complete the survey due to no longer raising sheep, agreed to a follow-up meeting. Data received verbally at these meetings were not included in the survey analysis but were noted in our discussion. When these individuals were also considered respondents, our response rate to the survey was 15 of 19 (79%).

### Costs

When the LPP began, the Marin County Board of Supervisors allocated \$50,000 for distribution



**Figure 2.** Livestock Protection Program (LPP) cost-share and compensation payments, FY01–FY02 through FY14–FY15. Marin County, California, USA (data provided by Marin County Agriculture Commissioner’s office). Starting in 2007, poultry and beef producers were allowed to participate in the LPP; cost associated with these industries are reflected from 2007–2015.



**Figure 3.** The level of satisfaction with financial assistance (cost-share) and compensation among producers participating in the Marin County Livestock Protection Program, Marin County, California, USA from 2016 survey results. Positive numbers indicate satisfaction, while negative numbers indicate dissatisfaction; 95% confidence intervals overlapping zero indicate pooled data not significantly different from “no opinion.”

to participants once they met program qualifications to cover both cost-sharing for nonlethal tools as well as compensation payments for predator-caused losses (Figure 2). When the LPP compensation component was discontinued in 2009, the cost-share amounts were increased so that producers with  $\geq 300$  sheep received \$3,000 and those with  $< 300$  head received \$1,500 annually (Figure 2). In FY11–

FY12, only 3 producers were paid for cost-share (\$2,500 total) while 3 producers (including a cost-share producer) were compensated for losses (\$2,900 total; Figure 2).

The county’s annual cost has ranged from a low of \$5,400 in FY11–FY12 to a high of \$50,354 in FY02–FY03 (A. T. Sauber, Marin County Agricultural Commission, personal communication). The average annual cost to the county for the LPP from FY01–FY02 through FY14–FY15 was \$28,349. During the 5 years prior to the LPP, the county’s annual contribution to the WS program averaged \$21,230; through this cooperative program, state and federal funding provided additional funding totaling approximately \$40,000. Marin County’s budgetary cost for the LPP was approximately 1.3 times the amount the county spent to operate the WS program.

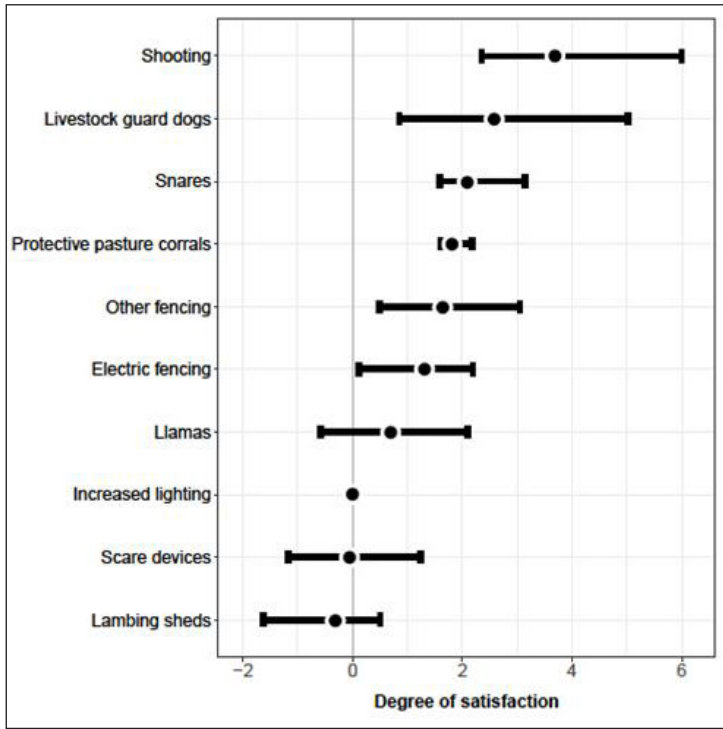
**Producer satisfaction**

The opinion of survey participants regarding cost-share and predation loss compensation programs administered through the LPP was generally negative, though these results were not significantly different from zero (Figure 3). In our interviews, producers discussed the lack of funding for the compensation of losses due to predation. In the first year of the LPP, producers received full compensation for all losses incurred. There was an increase in total compensation payments in the second year of the LPP, indicating a greater depredation occurrence just 1 year after the removal of WS (Figure

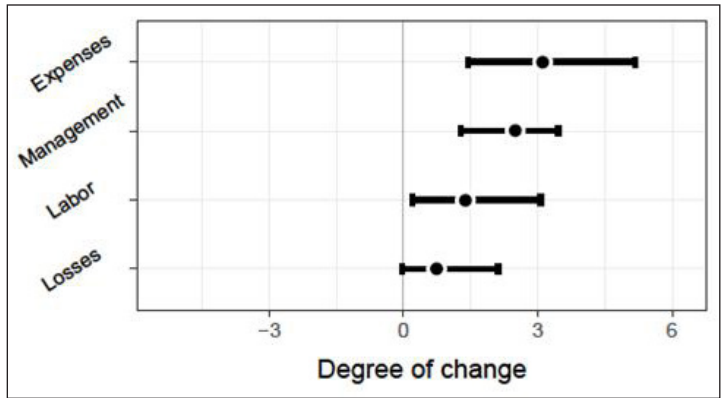
2). Even after the 5% loss cap was implemented, the amount paid for compensation remained high until this component was eliminated in 2009.

Use of shooting, employing livestock guard dogs, and use of snares were the methods deemed most effective by producers who responded (Figure 4). It should be noted that while snares were considered a useful tool, if guard dogs are used, snares present a risk to





**Figure 4.** The level of satisfaction with predator control methods as reported in 2016 by producers participating in the Marin County Livestock Protection Program, Marin County, California, USA. Positive numbers indicate satisfaction, while negative numbers indicate dissatisfaction. Where 95% confidence intervals overlap zero, we interpret these results to indicate that producers as a whole were ambivalent about the method.



**Figure 5.** Responses of survey participants in regard to managing sheep and lamb predation under the Marin County Livestock Protection Program, FY01–FY02 through FY14–FY15 (after the end of the U.S. Department of Agriculture, Wildlife Services program, Marin County, California, USA). Positive numbers indicate an increase, while negative numbers indicate a decrease. Pooled data indicate that ranchers’ expenses, management inputs, and labor all significantly increased. Ranchers’ responses also indicated an overall increase in predation losses; however, overlap of the 95% confidence interval with zero indicates absence of statistical significance.

the dogs. General satisfaction was also expressed with use of protective pasture corrals, “other” (i.e., non-electric) fencing, and for 1 producer, electric fencing.

From our survey responses, the use of llamas and of lambing sheds were satisfactory for 1 producer but highly unsatisfactory to 3 producers. In discussions with producers, they often reported that guarding animals (dogs and llamas) worked well only in smaller pastures (<50 acres). No producers provided opinions about increased lighting, which we interpret to mean that they did not employ the method, or if they did, they were ambivalent about its effect on predation. Regarding scare devices (i.e., radios, flashing lights, alarms, scarecrows, etc.), producers either had no opinion or checked the responses “somewhat dissatisfied” or “highly dissatisfied” (Figure 4).

**Sheep and lamb losses to predation**

When asked if their losses of livestock to predation decreased, increased, or remained the same after the WS program was discontinued in Marin County, 7 of 11 producers reported losses had increased, 3 producers reported they remained the same, while 1 producer reported losses decreased. Our survey respondents indicated that overall sheep and lamb losses generally increased, although our analysis showed, because of small sample size, slight overlap of the 95% confidence interval with zero (Figure 5).

## Coyotes removed

Producers were asked to estimate the number of coyotes lethally removed over 3 5-year periods since cessation of the WS program. With >50% of producers we surveyed responding to this question, we estimate that from 2000–2005, 191 coyotes were taken; from 2006–2010, 221 coyotes were taken; and from 2011–2015, 291 coyotes were taken. In comparison, Larson (2006) reported that during the WS program, 111 coyotes were taken during the period FY96 through FY00. Granted, there is no third party documentation with the LPP as there was with the WS program; still, these numbers indicate that a dramatic increase of coyotes taken occurred during the 15-year LPP.

## Preferred predation control techniques

Producers were asked to indicate their level of satisfaction with a list of predation control methods. The majority (8 of 11, 73%) of active sheep producers responding stated they wouldn't still be in business if it weren't for their guard dogs, and several (4 of 11, 36%) also felt that improved fencing was their best tool to reduce predation losses (Figure 4).

## Producer management changes

Producers were asked whether, since participating in the LPP, their efforts in managing predator losses had increased or decreased. The question focused on specifying labor, expenses, and management techniques. Ranchers' responses indicated that overall, their expenses increased substantially, and labor as well as management efforts increased (Figure 5).

## Discussion

Fox (2008) stated there were 18 sheep producers participating in the LPP as of November 1, 2006. The participating producer numbers increased in subsequent years because poultry, beef, and goat (*Capra aegagrus hircus*) producers were included in the program.

In FY14–FY15, the LPP participation covered 3,782 sheep (J. Stiles, Marin County Agricultural Commission, personal communication). Currently, sheep numbers in Marin County are listed as 10,000 in the county's annual Crop Report (Marin County 2016); if this estimate

based on the Agricultural Commissioner's annual survey results and assumed death losses and lambing rates is accurate, then only 38% percent of the total sheep in Marin County are enrolled in the program. As of the beginning of 2016, we believe the total number of commercial sheep producers in Marin County (with  $\geq 200$  head of sheep on pasture or range) is  $<10$ . This includes all producers, not just those in the LPP, and the number of commercial producers continues to decline (local producers, personal communication). However, during the past decade, the number of smaller-scale producers ( $<200$  head) has increased, with approximately 6 producing milk for specialty cheeses. These new milk sheep operations tend to be on small properties where sheep are generally confined, thus not likely subject to coyote predation. Smaller flocks might make nonlethal tools more effective, so if documented total losses continued to increase, this would be evidence of the LPP not being effective in dealing with a growing predation problem.

There was no way to confirm whether sheep and lamb losses reported following the cessation of the WS program (beginning in FY00–FY01) were representative of actual losses countywide. Further, O'Gara (1982) noted that while some ranchers undoubtedly report higher predation losses than actual, others report fewer than actual because carcasses and other evidence of predation are often difficult to locate. Data on lamb losses from past studies indicated that lamb losses can be 4–10 times those of adult sheep losses to coyotes (DeLorenzo and Howard 1977, Gee et al. 1977, McAdoo and Klebenow 1978).

Field research also provided evidence that cessation of lethal removal of coyotes from rangelands can result in significant increases in predation losses. O'Gara et al. (1983) found that when lethal predator control was discontinued on a western Montana sheep ranch, predators (primarily coyotes) killed approximately 27% of available lambs during spring and summer over a 2-year period; in that study, nonlethal methods were not added to compensate for absence of lethal control.

Since the program's inception, 4 sheep producers in Marin County have gone out of business (only 1 producer participated in the survey); 2 producers passed away and their

heirs chose not to continue in the sheep business. Only 3 sheep producers raise only sheep; the remaining 7 producers added a cattle business because they could no longer remain profitable with just sheep. Producers who stated that it became harder to raise sheep in brushy areas or that they could not meet the LPP requirements ceased sheep production. This likely placed more pressure on remaining producers, who were no longer buffered by neighboring sheep ranches (Timm and Connolly 2001).

Fox (2008) concluded from survey data obtained in 2006–2007 that the LPP had support from a majority of participating ranchers. Fox (2008) also stated the LPP was preferred over the traditional predator management program of WS by the majority of participating ranchers. Our data, however, indicate that since 2008, 6 producers went out of business, likely placing more predation pressure on those that remained in business. One producer stated that after 84 years of his family raising sheep on the property, he was selling and getting out of the sheep business due to increased coyote depredation. Results from our survey contrast with those reported by Fox (2008), who stated that of 12 respondents, 3 reported increased livestock losses, 5 reported the same magnitude of loss, and 4 reported decreased losses. In our survey, 7 of 11 producers reported losses had increased, 3 reported they remained the same, while 1 reported losses decreased.

Livestock producers and other landowners are still allowed to lethally remove coyotes. All producers reported they have predator calls and rifles, and they or their agents still hunt and kill coyotes found on their properties; however, these animals may or may not be depredating their livestock. Respondents acknowledged the difficulty of individual ranchers trying to effectively target and remove livestock-killing coyotes, as not all ranchers have the aptitude or training to become efficient at predator control. Lethal control is much more likely to reduce predation when coyotes responsible for losses are selectively targeted (Timm and Connolly 2001, Sacks et al. 1999). Larson (2006) concluded that more coyotes were being killed under the LPP than during the WS program, perhaps significantly more.

Fox (2008) stated that because of variability in data collection, monitoring, and reporting, it

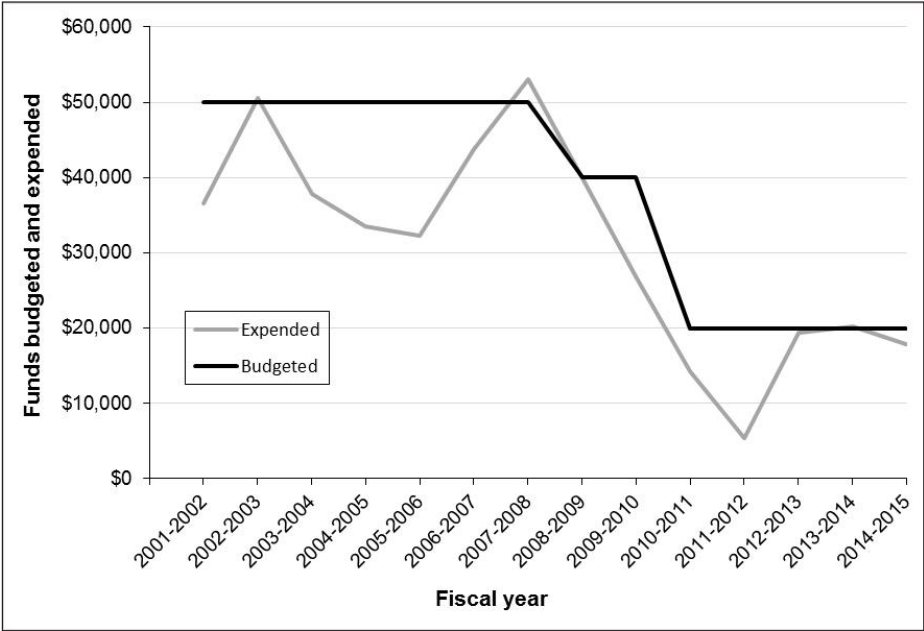
is difficult to assess differences in the numbers of predators killed under both programs. There are no data on the number of nontarget species taken after 2000. However, successful use of snares, which remained among the few legal capture tools following the passage of California's Proposition 4 in late 1998, requires considerable expertise to avoid capturing nontarget species (Huot and Bergman 2007, Proulx et al. 2015).

Our survey allowed producers to provide comments; 8 of 11 producers commented that there were insufficient funds to run the program. Four of 11 producers went even further to suggest that the compensation program be reinstated and pay for all losses without a cap. Bulte and Rondeau (2005) noted that compensation programs increase the return to agriculture and can therefore be viewed as a subsidy toward crop and livestock production.

Fox (2008) stated that the LPP has helped to reduce livestock losses and has resulted in an increase in the use of nonlethal predation deterrent methods by a majority of participating ranchers; our survey concurred regarding the increased usage of guard dogs. While McManus et al. (2015) suggest that nonlethal methods of human–wildlife conflict mitigation can reduce depredation and can be economically advantageous compared to lethal methods of predator control, the LPP cost-share does not adequately cover the costs of dog acquisition, feeding, or veterinary services. Further, Gehring et al. (2010) note that many accounts of the effectiveness of guard dogs in reducing livestock losses from predators are anecdotal and may lack objectivity. Guard dogs are more effective in flat, open areas while rough topography and brush may require that multiple dogs be employed, particularly if sheep are scattered (Coppinger et al. 1988, Green 1990). While some of our respondents found installation or improvement of fencing to be effective, it is also expensive, and it would not be feasible for ranchers on leased pasture. In regard to the overall success of nonlethal methods in protecting livestock, Shivik and Martin (2000, 122) stated "...they are all limited in their applicability. There have been no unqualified successes using nonlethal tools...and managers require a wider variety of thoroughly tested alternative methods..."

Two producers suggested that funding was





**Figure 6.** Annual Marin County, California, USA budget vs. expenditures for the Livestock Protection Program.

needed to hire a WS specialist during lambing season. Three producers, all involved in the program creation, expressed dissatisfaction with the current program direction; they noted that it was developed to address both environmentalists’ and ranchers’ wishes and needs, but it has not evolved to address the impacts of increasing coyote depredation. Wagner et al. (1997) noted that compensation programs may be less acceptable to livestock producers than to those producing crops because of their sense of responsibility for the well-being of their livestock. They also noted that replacement of current damage management techniques by compensation programs can be considerably more expensive.

Despite an initial annual budget of \$50,000 from Marin County, funding for the LPP has declined dramatically since its inception (Figure 6). In addition, producer participation declined, according to ranchers’ opinions expressed during discussions at the private meeting, due to lack of program funding, excessive lamb losses to coyotes, and decreased revenue, resulting in 3 producers changing from sheep production to cattle.

The difficulty in making a comparison between the former WS program and the current county-run LPP was not unexpected. The Marin County Agricultural Commissioner noted, during

discussion of the potential change in programs, that “privatizing predator control would eliminate the ability to...maintain public records of control activities [and] would make reporting of livestock and wildlife losses and damage speculative at best” (Carlsen 2000). We also note that various organizations promoting the current Marin County LPP as a model for other geographic areas tout this program as a nonlethal alternative to the Wildlife Services approach (San Diego Loves Green 2015, Project Coyote n.d., Little Blue Society 2016). In our opinion, this ignores the reality that Marin County landowners and their agents continue to implement lethal control, are likely killing more coyotes than were taken previously, and that predator removal may now be practiced in a less selective manner than when it was done by WS professionals.

Further, Shwiff et al. (2006, 359) stated that “The Wildlife Services program achieves certain economies of scale that individual replacement programs do not...,” achieving greater efficiency through use of the broader array of available tools and methods, noting their economic analysis showed that multiple returns on invested funds were provided to cooperating counties in California. While the work of WS primarily protected agriculture, it also benefitted health and human safety,

natural resources, and property.

Replicating the LPP in other jurisdictions may not be financially feasible (i.e., in a county with hundreds of livestock producers); even Marin County was unable to fully compensate livestock lost to predators for more than a few years and then found it necessary to abandon the compensation component of its program. Also, based on geographical and demographic differences, it may be difficult to transfer this program to other areas (Carlsen 2000). These same animal welfare proponents and their organizations have even stated that “Marin County may work for Marin County; however, this model may not be directly applicable or feasible in all other communities” (Fox 2008, 74).

### Management implications

Regarding the future of the Marin County LPP, we believe that along with the continuation of the cost-share program, a compensation program should be reinstituted for sheep losses, providing there is a verification process in place. We also suggest either the re-negotiation of a contract with Wildlife Services, or the employment of a county-based specialist to respond with professional expertise when livestock-killing coyotes need to be removed. Currently, some counties in California have such programs that are successful in reducing losses.

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Associate Editor: James C. Beasley

**Appendix 1.** Marin County Livestock Protection and Compensation Programs rancher survey, 2015.

1. What livestock do you raise and how many of each did you own as of December 31, 2015? (Check all that apply)

\_\_\_\_\_ Sheep

(# of adult head \_\_\_\_\_ : # lambs \_\_\_\_\_)

\_\_\_\_\_ Beef cows

(# of adult head \_\_\_\_\_ : # calves \_\_\_\_\_)

\_\_\_\_\_ Dairy cows

(# of adult head \_\_\_\_\_ : # calves \_\_\_\_\_)

\_\_\_\_\_ Poultry

\_\_\_\_\_ Other

(list species \_\_\_\_\_ and  
# of adult head \_\_\_\_\_ : # young \_\_\_\_\_)

2. Please indicate the **ESTIMATED TOTAL** number of head of livestock you’ve raised (to final stage) during the following time periods:

2000-2005

sheep \_\_\_\_\_ lambs \_\_\_\_\_ cows \_\_\_\_\_ calves \_\_\_\_\_ poultry \_\_\_\_\_

Other \_\_\_\_\_

2006-2010

sheep \_\_\_\_\_ lambs \_\_\_\_\_ cows \_\_\_\_\_ calves \_\_\_\_\_ poultry \_\_\_\_\_

Other \_\_\_\_\_

2011-2015

sheep \_\_\_\_\_ lambs \_\_\_\_\_ cows \_\_\_\_\_ calves \_\_\_\_\_ poultry \_\_\_\_\_

Other \_\_\_\_\_

3. What were the three most common causes of livestock mortality (e.g., weather, predation, disease, birth complications, etc.) for your operation during the following time periods: one (1) being most common?

2000-2005	2006-2010	2011-2015
1. _____	1. _____	1. _____
2. _____	2. _____	2. _____
3. _____	3. _____	3. _____

4. Please indicate the **ESTIMATED TOTAL** number of sheep, lambs, cow, calves, poultry, or other livestock you have lost due to predation during the following time periods:

2000-2005

sheep \_\_\_\_\_ lambs \_\_\_\_\_ cows \_\_\_\_\_ calves \_\_\_\_\_ poultry \_\_\_\_\_

Other \_\_\_\_\_

2006-2010

sheep \_\_\_\_\_ lambs \_\_\_\_\_ cows \_\_\_\_\_ calves \_\_\_\_\_ poultry \_\_\_\_\_

Other \_\_\_\_\_

2011-2015

sheep \_\_\_\_\_ lambs \_\_\_\_\_ cows \_\_\_\_\_ calves \_\_\_\_\_ poultry \_\_\_\_\_

Other \_\_\_\_\_

5. Please list the top 3 predator(s) that cause livestock losses or agricultural damage on your property (e.g. badgers, bobcats, coyotes, foxes, free roaming dogs, golden eagles, mountain lions, ravens, etc.) **in order of most to least problematic species:**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

*Continued from previous page.*

6. Did you receive predator control services through the USDA Wildlife Services program prior to Marin County's adoption of the cost-share program?

\_\_\_\_\_ Yes \_\_\_\_\_ No

7. Please list the **ESTIMATED TOTAL** number of predators that were lethally removed by Wildlife Services to protect your livestock **during the following time periods**:

1990-1995 hogs \_\_\_\_\_ bobcats \_\_\_\_\_ coyotes \_\_\_\_\_ foxes \_\_\_\_\_ mountain lions \_\_\_\_\_  
Other (please specify species and total removed) \_\_\_\_\_

1996-2000 hogs \_\_\_\_\_ bobcats \_\_\_\_\_ coyotes \_\_\_\_\_ foxes \_\_\_\_\_ mountain lions \_\_\_\_\_  
Other (please specify species and total removed) \_\_\_\_\_

2001-2005 hogs \_\_\_\_\_ bobcats \_\_\_\_\_ coyotes \_\_\_\_\_ foxes \_\_\_\_\_ mountain lions \_\_\_\_\_  
Other (please specify species and total removed) \_\_\_\_\_

2006-2010 hogs \_\_\_\_\_ bobcats \_\_\_\_\_ coyotes \_\_\_\_\_ foxes \_\_\_\_\_ mountain lions \_\_\_\_\_  
Other (please specify species and total removed) \_\_\_\_\_

2010- 2015 hogs \_\_\_\_\_ bobcats \_\_\_\_\_ coyotes \_\_\_\_\_ foxes \_\_\_\_\_ mountain lions \_\_\_\_\_  
Other (please specify species and total removed) \_\_\_\_\_

8. If you had experience with the USDA Wildlife Services livestock protection program, what do you believe are its strengths and weaknesses?

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9. What predator defense techniques did **you** use on your ranching operation **PRIOR to the implementation of the Marin County Livestock Protection program (before 2000)? (Please check all that apply and please note that all methods listed below are legal under California law).**

_____ Livestock guard dogs	_____ Increased lighting
_____ Livestock guard llamas	_____ Lambing shed
_____ Electric fencing, Protective pasture corrals	_____ Snares
_____ Other improved fencing (i.e. patch, cross, etc.)	_____ Shooting
_____ Scare devices (i.e. radios, flashing lights, alarms, scarecrows)	_____ None
_____ Other, please specify: _____	

10. Upon the removal of USDA Wildlife Services in 1999, did you participate in the **Marin County Livestock Protection** program and receive financial assistance for implementing predation deterrent techniques (fencing, guarding animals, scare devices, husbandry practices)?

\_\_\_\_\_ No, (if not, please state why you did not participate):

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\_\_\_\_\_ Yes (if yes, please check each fiscal year (starting July 1) that you participated)

2000 _____	2004 _____	2008 _____	2012 _____
2001 _____	2005 _____	2009 _____	2013 _____
2002 _____	2006 _____	2010 _____	2014 _____
2003 _____	2007 _____	2011 _____	2015 _____

11. Through the Marin Co. **Livestock Protection Program (2000 forward)**, which predation deterrent techniques did you use and receive financial assistance from the county? (Please check all that apply)

\_\_\_\_\_ Guard dogs

*Continued on next page...*



Continued from previous page.

\_\_\_\_\_ Which breed of dog(s)

\_\_\_\_\_ Guard llamas

\_\_\_\_\_ Guard animal maintenance (food and vet bills)

\_\_\_\_\_ Electric fencing

\_\_\_\_\_ Other improved fencing (i.e. patch, cross, etc.)

\_\_\_\_\_ Scare devices (i.e. radios, flashing lights, alarms, scarecrows)

\_\_\_\_\_ Increased lighting

\_\_\_\_\_ Lambing shed

\_\_\_\_\_ Protective pasture corrals

\_\_\_\_\_ Other, please specify: \_\_\_\_\_

12. Since participating in the Marin County Livestock Protection program, have your efforts in managing predator losses increased or decreased:

Labor:

\_\_\_\_\_ Increased greatly

\_\_\_\_\_ Increased moderately

\_\_\_\_\_ Remained the same

\_\_\_\_\_ Decreased moderately

\_\_\_\_\_ Decreased greatly

Expenses incurred:

\_\_\_\_\_ Increased greatly

\_\_\_\_\_ Increased moderately

\_\_\_\_\_ Remained the same

\_\_\_\_\_ Decreased moderately

\_\_\_\_\_ Decreased greatly

What Expenses: \_\_\_\_\_

Management Techniques used:

\_\_\_\_\_ Increased greatly

\_\_\_\_\_ Increased moderately

\_\_\_\_\_ Remained the same

\_\_\_\_\_ Decreased moderately

\_\_\_\_\_ Decreased greatly

What Management Techniques: \_\_\_\_\_

13. Did your losses of livestock to predators decrease, increase, or remain the same after the Wildlife Services Program was discontinued in Marin County?

\_\_\_\_\_ Decreased

\_\_\_\_\_ Increased

\_\_\_\_\_ Remain the same

14. Did you personally, or did you hire someone (alone, or in cooperation with other producers) to remove predators? If so, estimate how many predators were taken and which species.

2000-2005

hogs \_\_\_\_\_ bobcats \_\_\_\_\_ coyotes \_\_\_\_\_ foxes \_\_\_\_\_ mountain lions \_\_\_\_\_

Any non-targeted ones (please specify species and total removed) \_\_\_\_\_

2006-2010

hogs \_\_\_\_\_ bobcats \_\_\_\_\_ coyotes \_\_\_\_\_ foxes \_\_\_\_\_ mountain lions \_\_\_\_\_

Any non-targeted ones (please specify species and total removed) \_\_\_\_\_

2011-2015

hogs \_\_\_\_\_ bobcats \_\_\_\_\_ coyotes \_\_\_\_\_ foxes \_\_\_\_\_ mountain lions \_\_\_\_\_

Any non-targeted ones (please specify species and total removed) \_\_\_\_\_

15. Please indicate your level of satisfaction with each method with an X in the appropriate category (please check all that apply and please note that all methods are legal under California law):

Method	Highly satisfied	Somewhat satisfied	No opinion	Somewhat dissatisfied	Highly Dissatisfied
Livestock guard dogs					
Llamas					
Electric fencing					

*Continued from previous page.*

Other fencing					
Scare devices*					
Increased lighting					
Lambing sheds					
Protective pasture corrals					
Snares					
Shooting					

\*Scare devices = radios, flashing lights, alarms, scarecrows, etc.)

16. **Looking back on all of your experiences**, what is your preferred method of preventing predation on livestock? \_\_\_\_\_

17. Are you able to use your preferred method(s) currently?

\_\_\_\_\_ Yes \_\_\_\_\_ No (if no, why not? \_\_\_\_\_)

18. Please indicate your level of satisfaction with the amount of financial assistance you received through the **Marin Co. Livestock Protection Program**?

\_\_\_\_\_ Highly satisfied \_\_\_\_\_ Somewhat dissatisfied

\_\_\_\_\_ Somewhat satisfied \_\_\_\_\_ Highly dissatisfied

\_\_\_\_\_ No opinion

Please explain your answer in the space provided: \_\_\_\_\_

**In this section, questions pertain to the Marin County COMPENSATION PROGRAM (payment for losses), which started in 2000 and ended approximately 2007.**

19. Did you receive **compensation for livestock** that were killed by coyotes or other predators through the Main indemnification/compensation program?

\_\_\_\_\_ No \_\_\_\_\_ Yes (if yes, please check each year that you participated):

\_\_\_\_\_ 2000 \_\_\_\_\_ 2004

\_\_\_\_\_ 2001 \_\_\_\_\_ 2005

\_\_\_\_\_ 2002 \_\_\_\_\_ 2006

\_\_\_\_\_ 2003 \_\_\_\_\_ 2007

20. Please indicate your level of satisfaction with the amount of compensation **you've received overall and how does that pay for your expenses?**

\_\_\_\_\_ Highly satisfied \_\_\_\_\_ Somewhat dissatisfied

\_\_\_\_\_ Somewhat satisfied \_\_\_\_\_ Highly dissatisfied

\_\_\_\_\_ No opinion

Please explain your answer in the space provided: \_\_\_\_\_

21. Please express any additional comments you'd like to provide about **Marin County's Livestock Protection Program and/or Compensation Program** (feel free to provide additional comments on the back):

*Continued on next page...*

*Continued from previous page.*

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If you would like to speak with me as a follow up to this survey, please provide your phone number and email address below and a convenient time to reach you. Phone: \_\_\_\_\_ Email: \_\_\_\_\_  
Preferred method of contact and best time to reach you: \_\_\_\_\_

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**Thank you for participating in this survey. We greatly appreciate your help in evaluating this program.**

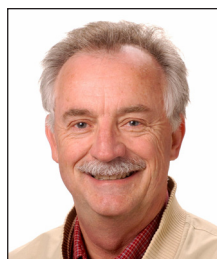
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