

**ANALYSIS OF THE MARIN COUNTY STRATEGIC PLAN
FOR PROTECTION OF LIVESTOCK & WILDLIFE:
AN ALTERNATIVE TO TRADITIONAL PREDATOR CONTROL**



Camilla H. Fox



Prescott College

January 2008

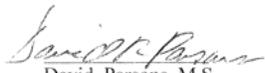
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Camilla H. Fox

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Approved as to style and content by:


David Parsons, M.S.
(Graduate advisor)

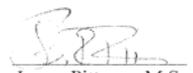
12/26/07
Date


Michael Soulé, Ph.D.
(Third Reader)

12-18-07
Date


Adrian Treves, Ph.D.
(Second reader)

12-11-07
Date


James Pittman, M.Sc.
(Core Faculty)

12/17/07
Date

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Requests for such permission should be addressed to:

Camilla H. Fox
P.O. Box 5007
Larkspur, CA 94977

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ABSTRACT

Livestock-predator conflicts in the U.S. have historically been managed by the U.S. Department of Agriculture's (USDA) Wildlife Services program (formerly Animal Damage Control) through cooperative agreements with states, counties, municipalities, and other entities. USDA Wildlife Services (WS) relies heavily on lethal methods including traps, snares, poisons, and aerial gunning. In 2006, WS killed more than 100,000 predators in the contiguous United States, of which 87,883 were coyotes (*Canis latrans*). Greater understanding of the ecological importance of native carnivores and increasing public opposition to lethal control has led to growing demand for humane and ecologically sound management methods. In 2000, as a result of controversy over the use of Compound 1080 and other lethal methods employed by USDA WS in the northern California county of Marin, the county Board of Supervisors voted to cease contracting with the federal agency. In place of the USDA WS program, the Board of Supervisors approved an alternative pilot program — known as the Marin County Strategic Plan for Protection of Livestock and Wildlife — designed to assist ranchers with implementation of non-lethal predator deterrent methods. A county indemnification program was added to the plan to compensate qualified ranchers for verified livestock losses resulting from predation.

To date, more than 89% of Marin's 7,500 sheep are covered under the program and almost all commercially viable sheep ranches participate in the program. This study compares the former USDA WS program to the Marin County Strategic Plan for Protection of Livestock and Wildlife with regard to rancher satisfaction and preferences, lethality to predators, livestock losses, use of non-lethal predator deterrent techniques, and costs. This study showed the Marin Program has support from a majority of participating ranchers; is preferred over the USDA Wildlife Service's traditional predator management program by a majority of participating ranchers; has helped to reduce livestock losses; has resulted in an increase in the use of non-lethal predation deterrent methods by a majority of participating ranchers; has likely reduced the total number of predators killed to protect livestock; and has reduced the spectrum of species of predators killed to protect livestock. Marin's Strategic Plan for Protection of Livestock and Wildlife sets a precedent for meeting a wider compass of community needs and values where both agriculture and protection of wildlife are deemed important by the community.

INTRODUCTION

History of Predator Control in the U.S.

In the U.S., conflicts between livestock and predators have historically been managed by the federal government through the U.S. Department of Agriculture's Wildlife Services (USDA WS) program (formerly called Animal Damage Control). This program, administered through cooperative agreements with states, counties, municipalities, and other entities, operates under the 1931 Animal Damage Control Act (7 USC 426-426c), which authorizes the U.S. Secretary of Agriculture to "determine the best methods of eradication, suppression, or bringing under control mountain lions, wolves, coyotes, bobcats, prairie dogs, gophers, ground squirrels, jack rabbits, brown tree snakes, and other animals injurious to agriculture, horticulture, forestry, animal husbandry, wild game animals, fur-bearing animals and birds...The Secretary is also directed to conduct campaigns for the destruction or control of these animals." This Act, which remains virtually unchanged today, expanded the federal government's role in predator control, authorizing funding and Congressional support for killing native predators to benefit private ranchers (Di Silvestro 1985). USDA WS relies heavily on lethal methods including traps, snares, poisons, and aerial gunning (Cain et al. 1971; USDA WS 2006). Following a consistent trend, in 2006, USDA WS killed more than 100,000 predators in the contiguous United States, of which 87,883 were coyotes (USDA WS 2006).

Public opposition to the widespread use of lethal control (Leopold et al. 1964; Cain et al. 1971; Braband and Clark 1992; McIntyre 1995; Reiter et al. 1999; Fox and Papouchis 2005; Robinson 2005), as well as uncertainty over its effectiveness and ecological impacts have contributed to scientific concern and greater demand for humane, socially acceptable, and ecologically sound management methods (Kellert 1985b; Braband and Clark 1992; Haber 1996; Reiter et al 1999; Fox and Papouchis 2005; Miller et al. 2006; Fox 2006; Hadidian et al. 2006; Miller 2007). Over the last thirty years, the USDA WS program has come under increasing scientific and public scrutiny. Concerns about the effectiveness, humaneness, and ethical acceptability of killing large numbers of predators to benefit livestock ranchers have been expressed through peer reviewed journal articles and public media outlets (Haber 1996; ASM 1999; Musiani and Paquet 2004; Robinson 2005; Treves and Naughton-Treves 2005; Berger 2006; Agocs 2007; AP 2007).

Efforts to shift USDA WS's emphasis from lethal to non-lethal predator management have been largely ineffective. For example, a floor amendment to the 1998 Agricultural Appropriations bill that would have reduced funding for USDA WS's lethal predator control program passed the House by an initial vote of 229 to 193 but subsequently failed to move beyond the House floor.

History of Predator Control in Marin County

In 1996, in the northern California county of Marin, a region characterized by a mix of urban and rural communities and known for its environmental consciousness and strong support of agriculture, controversy arose over USDA WS's proposed use of the poison Compound 1080 Livestock Protection Collars (LPCs) to kill coyotes. LPCs are filled with sodium fluoroacetate (commonly called Compound 1080), a poison developed during World War II as a rodenticide, and later used in the U.S. by the federal government for predator control after biologists discovered it was highly toxic to canids. Used in the 1940's and 50's in pellets dropped from planes or inserted into dead sheep as bait to kill wolves, coyotes, and other livestock predators, the poison was then banned by the Environmental Protection Administration (EPA) in 1972 because of its non-selectivity and history of misuse and abuse. EPA administrator William Ruckelshaus called Compound 1080 "one of the most dangerous [toxins] known to man" (Jacobs 1991).

In 1985, the livestock industry convinced President Reagan to sanction Compound 1080 for use in LPCs. The collars, which contain two bladders of Compound 1080, are designed fit around the necks of sacrificial sheep or goats and rupture when bitten by a predator, releasing the poison. Death from Compound 1080 in canids results from cellular breakdown, progressive depression of the central nervous system, and/or cardiac arrest. It takes between 4 and 10 hours for a coyote to die after ingesting Compound 1080. Critics of the LPCs argue that because Compound 1080 has no antidote and each collar contains enough poison to kill six healthy human adults (USEPA 1995), continued use of the poison poses an unacceptable danger to wildlife and humans (Fox and Papouchis 2005). Critics also argue that the poison is poorly monitored and administered by the federal government pointing to a 1995 report by The Texas Center for Policy Studies titled, *TDA's Failed Enforcement for Predator Poisons: Texas Ranchers Betrayed*, which concluded

that the Texas Department of Agriculture had consistently failed to enforce use restrictions for LPCs and did not conduct mandatory inspections of LPC users (Fox and Papouchis 2005).

In Marin County, controversy over use of Compound 1080 in 1996 led to a heated debate about management of native carnivores countywide (Hall 2000; Fox 2001). On one side were animal advocates who questioned the ethics of using taxpayer dollars to employ a USDA WS trapper to kill native wildlife (Fox 2001). On the other side were sheep ranchers who argued that federal assistance with predator management was necessary and that loss of such assistance would drive them out of business in a market that already undermined by inexpensive lamb imports (Hall 2000; Fox 2001). Marin County, like most California counties (39 of 58 counties), had received federal funding through USDA WS to pay a federal trapper to control predators and began contracting with the agency in 1989 (Cooperative Agreement Between County of Marin and U.S. Department of Agriculture Animal and Plant Health Inspection Service Animal Damage Control, 11-02-88, #12-34-73-0259-RA). The program, administered through a Memorandum of Understanding (MOU) between the USDA and the Marin County Agricultural Commissioner's office, allocated county and federal funds annually toward the salary and equipment of a part-time federal trapper. At the time the controversy arose in 1996 over use of Compound 1080, the total amount allocated toward the program was \$22,518 as shown in Figure 8 (Stacy Carlsen, Marin Co. Agricultural Commissioner, pers. commun). Marin County subsequently obtained a full-time USDA WS trapper in 1998 in part to administer and oversee the Compound 1080 Livestock Protection Collars, costing a total of \$48,768.

Ten species were targeted by the USDA WS program in Marin County including badgers (*Taxidea taxus*), coyotes (*Canis latrans*), red foxes (*Vulpes vulpes*), gray foxes (*Urocyon cinereoargenteus*), bobcats (*Felis rufus*), and raccoons (*Procyon lotor*) (Table 2). Primary methods of control employed by the agency in 1996 included snares, leg-hold traps, M-44 sodium cyanide devices, and shooting. In April of 1997 LPCs were pilot-tested by USDA WS on 175 lambs on seven ranches in Marin, Sonoma, and Mendocino Counties in Northern California (Hall 2000). The intended target of LPCs were coyotes, whose populations were believed to be increasing in all three counties (Hall 2000). Five lambs wearing LPCs were killed but the poisoned coyotes were never found (Hall 2000).

Table 1. Reported predators killed by the U.S. Department of Agriculture’s Wildlife Services from 1996/97 through 1998/99 when the agency operated in the county and by ranchers participating in the Marin Program from 2003/04 through 2005/06.

	USDA WS Program	Marin Program
Species*	#Killed (FY 1996/97-98/99)**	#Killed (FY 2003/04-2006/07)**
Badger***	42	1
Bobcat	34	29
Coyote	52	60
Dog (feral)	1	0
Fox****	36	17
Opossum	1	0
Raccoon	36	0
Striped Skunk	20	0
TOTAL=	222	107

* In WS’ last year of operation in Marin County in fiscal year 2000/01, the agency killed 574 feral pigs so the total number of targeted species by the agency during its tenure in Marin County was 10.
 **USDA WS Fiscal Year: Oct. 1-Sept. 30; Marin County Fiscal Year: July 1-June 30.
 *** In fiscal year 1998/99 the number of badgers killed by USDA WS was 30 compared to 14 coyotes killed.
 ****Includes both gray and red fox (WS killed 22 gray fox and 14 red fox from FY 1996/97 through 1998/99).

The Marin Coalition for California Wildlife — a coalition of conservation and animal protection organizations — actively opposed the use of the poison in Marin County (Hall 2000; Fox 2001). Controversy over the program led to a series of roundtable meetings between members of the Marin Coalition for California Wildlife, the ranching community, the Marin County Agricultural Commissioner, and other interested stakeholders (Hall 2000; Fox 2001). One of the primary objectives of these facilitated meetings was to identify an alternative to Compound 1080 that would meet both the ranching community’s needs and those who opposed use of predator poisons in the county (Hall 2000; Fox 2001).

In November 1998 California voters passed Proposition 4, which prohibited two poisons used by the USDA WS to kill predators — Compound 1080 and sodium cyanide. The initiative also banned the use of steel jawed leg-hold traps and the use of body-gripping traps for commercial and recreational trapping (CADFG 1998). Snares and Conibear kill traps (traps designed to kill animals) remained legal for animal damage/predator control purposes. The measure was approved by more than 60% of voters in Marin County (Hall 2000).

History of Marin County Strategic Plan for Protection of Livestock and Wildlife

Despite the ban on Compound 1080, which put an end to the LPC pilot project in Marin and surrounding counties, controversy over the continued killing of predators with snares and other lethal devices persisted (Fox 2001; Carlsen 2005; Hadidian et al. 2006). Steve Kinsey, President of the Marin County Board (whose district covers a large portion of the West Marin ranching community), pledged in a July 29, 1999 letter to the Marin Coalition for California Wildlife:

Our Board is dedicated to achieving a totally non-lethal predator program as quickly as we realistically can...Agriculture has a special place in our County's history and its future. Our Board's actions are intended to protect the viability of this important industry while immediately reducing wildlife deaths. By carefully monitoring progress and by working with interested organizations, I am confident that Marin will become the first county in this state to achieve a totally non-lethal program. I pledge my own effort to vigilantly work for that outcome.

Acknowledging public dissent over the issue, the County Board of Supervisors also attempted to reach a compromise with the USDA over the federal predator control program in the county. The Supervisors offered to renew the MOU with the federal agency with stipulations that denning (the killing of pups in their den) and poisons not be employed in the county and that neck snares only be used as a last resort after non-lethal methods had been tried and proven unsuccessful (Fox 2001; Hadidian et al. 2006). Concurrently, the Supervisors accepted the County Agricultural Commissioner's recommendation to approve the proposed "Strategic Plan for Livestock and Wildlife Protection" providing cost-share funding for non-lethal predation deterrents and increased training in non-lethal predation deterrents and livestock husbandry techniques.

In response to this proposal, USDA Wildlife Services Western Regional Director, Michael Worthen wrote in a letter to Kinsey (letter dated February 3, 2000):

In our opinion these mandates [to restrict methods USDA WS could employ in Marin County] are not necessary and hamper the effectiveness of providing needed services. The plan appears to have been developed without the input of Wildlife Services' personnel who deal with wildlife-related problems on a daily basis and understand the value of each tool and technique as they relate to the efficacy of a program. Because of these concerns I have no other alternative than to decline signing this Cooperative Agreement.

In response, the County Board of Supervisors decided at its October 2000 meeting to cease contracting with the agency and voted to end its MOU with Wildlife Services. A sunset provision allowed USDA WS to phase out its operations as the County Department of Agriculture further developed the alternative non-lethal Strategic Plan for Livestock and Wildlife Protection that would ultimately replace the federal predator control program. Marin's MOU with the federal agency was officially terminated on June 30, 2002.

In place of the federal program, the Marin County Board of Supervisors approved a non-lethal county-administered program initially put forth by the Marin Coalition for California Wildlife and ultimately designed and administered by the Marin County Agricultural Commissioner's office with input from various stakeholder groups (Fox 2001; Fox and Papouchis 2005; Fox 2006; Hadidian et al. 2006). The program, initially called the Marin County Strategic Plan for Livestock and Wildlife Protection, was designed as a five-year pilot project aimed at supporting the ranching community by redirecting the county's former costs for USDA WS to assist ranchers with implementing non-lethal predation deterrent methods including guard dogs, llamas, improved fencing, and lambing sheds (Appendix 1). While the non-lethal program ended funding for a federal trapper (after the phase out period with the USDA WS), it did not preclude ranchers from removing predators from their own properties by shooting or snaring.

The total amount of money ranchers can receive in cost-share reimbursements annually under the program depends on the size of their herd. Ranchers with 200 head or more are eligible to receive up to \$2,000 (the program maximum), while ranchers with herds of between 25 and 200 head can receive up to \$500. Operations with less than 25 head are not considered commercial

and are not eligible to participate in the program. Projects eligible for cost-share reimbursement are animal husbandry methods or material or property improvements that are aimed at deterring depredation including: 1) new fence construction, or improvements to existing fences; 2) guard animals (dogs and llamas); 3) scare/noise devices; and 4) changes in animal husbandry practices such as shed lambing and use of herders (Appendix 2).

At the request of the ranching community, an indemnification program was added to the Marin County program to compensate qualified ranchers for verified livestock losses resulting from predation. To be eligible for reimbursement of verified livestock losses, a rancher must be an active participant in the proactive cost-share predation prevention program and have at least two non-lethal livestock predation deterrents in place. The County Agricultural Commissioner's office conducts an on-site ranch review to document and verify that the ranch qualifies. Once the ranch is deemed eligible for indemnification, the rancher can submit claims for sheep and lamb losses from predation. Compensation is capped at 5% (with a \$2,000 annual maximum) of the flock and claims are reimbursed at the market value of the lost animal (calculated on a 3-year average of market rates for lamb at a weight of *ca.* 100 lbs).

To receive compensation for livestock losses resulting from predation, ranchers must report losses to both the Marin County Agricultural Commissioner's office directly by telephone after a loss occurs and to the University of California Cooperative Extension Service through a monthly mailed "livestock loss" card. Providing third party verification, the U.C. Cooperative Extension Service maintains the central database on reported livestock losses resulting from predation for all ranchers who participate in the Marin Program. When deemed necessary, the Marin County Agricultural Commissioner's office conducts onsite verification of livestock losses (Stacy Carlsen, Marin Co. Agricultural Commissioner, pers. commun.). Payments for verified livestock losses resulting from predation are made twice a year (June and December) through the Marin County Agricultural Commissioner's office. At the end of the year, ranchers must sign an affidavit verifying their livestock loss claims. A County Inspector or the Livestock Advisor makes an annual on-site visit of participating ranches to verify implementation of non-lethal predation deterrents reimbursed under the program and to recommend ways to deter further depredations if predation is a problem (Stacy Carlsen, Marin Co. Agricultural Commissioner,

pers. commun.). In addition, the Marin County Department of Agriculture conducts an annual meeting with ranchers to evaluate the program and to solicit recommended changes to program operations.

Research Objectives

Whereas initial data from the County Agricultural Commissioner's office has indicated the program has reduced livestock losses for a majority of participating ranchers (Carlsen 2005; Hadidian et al. 2006; Agocs 2007), no formal survey has been conducted to date of participating ranchers to corroborate this finding or to assess other aspects of the program. This study compares the former USDA WS program with the current program and quantitatively and qualitatively assesses:

- 1) Whether ranchers report being more or less satisfied with the Marin Program compared to the former USDA Wildlife Services program;
- 2) Whether sheep and lamb losses due to predation increased, decreased, or remained the same for participating ranchers;
- 3) Whether the number of predators killed to protect livestock of participating ranchers decreased, increased, or remained the same since inception of the Marin Program;
- 4) Whether the number of species of predators killed on participating ranchers' lands changed since implementation of the Marin Program compared to the number of species killed under the USDA Wildlife Services program;
- 5) Whether the use of non-lethal predation deterrent techniques amongst participating ranchers changed under the Marin Program;
- 6) Program cost differences;
- 7) What predator control techniques are most preferred by ranchers who participate in the Marin Program;
- 8) The strengths and weaknesses identified by participating ranchers of the Marin Program and the Marin County Department of Agricultural and areas where they see room for improvement.

Data was obtained for these eight objectives from a 35-question survey sent to all participating Marin ranchers, personal qualitative interviews, USDA WS program reports, and data provided by the Marin County Agricultural Commissioner.

Importance and Projected Implications

Marin County may be the only county that has voted to cease contracting with the USDA WS program because of controversy over the agency's methods and its refusal to work within guidelines requested by the local governing board (Stacy Carlsen, Marin Co. Agricultural Commissioner, pers. commun.). In addition, Marin County is likely the only county that has developed its own locally administered program aimed at reducing predator-livestock conflicts that includes both a cost-share and compensation program. The import and precedent-setting nature of these decisions was significant enough that the Marin County Agricultural Commissioner said that the USDA WS was fearful it would "set a precedent that other counties might follow nationwide" if the agency agreed to abide by Marin's guidelines (Stacy Carlsen, Marin Co. Agricultural Commissioner, pers. commun. and verbal testimony before the Marin County Board of Supervisors).

Testament to their concern over this precedent, in 2005 USDA WS commissioned a statewide cost-benefit analysis of their own program with the stated objective: "To compare benefits and costs of livestock protection afforded by USDA WS program activities versus a predation-compensation program recently begun in Marin County" (Shwiff et al. 2005: preface, p. iv). Upon completion of the report, USDA WS provided a copy to all counties that contract with the agency in California and conducted public presentations on their findings with the presumed aim of discouraging other counties from considering alternative programs. That USDA WS decided it needed to compare its statewide predator management program in California to a relatively small community-based alternative program in Marin speaks to the deep-seated concerns of an agency struggling for continued funding and legitimacy against the backdrop of shifting public attitudes toward wildlife and wildlife management. While a full assessment of this cost-benefit analysis is beyond the scope of this study, the report lacks scientific rigor and reveals USDA WS's political biases, fears about losing control over wildlife damage management, and its desire to retain

cooperative support and funding (see “Areas for Improvement and Future Goals of Program” within Results section).

PROJECT SETTING

Marin County: A Diverse Landscape

Marin County is characterized by a mix of urban and rural communities, highly educated, affluent residents, strong support for environmentalism, protection of open space and agriculture and a concomitant diversity of perspectives and cultural values, which have undoubtedly influenced the way that predators are perceived and managed in the county. The county ranks 15th nationwide as having the highest per capita income with median income at \$99,713 compared to the national median of \$58,832 according to the 2006 United States Census Bureau. In addition, Marin County’s residents are generally well educated with over 50% of adult county residents having a Bachelor’s degree or higher (United States Census Bureau 2006).

Located on the central coast of California, just north of San Francisco, Marin County is 520 square miles in area but stretches approximately 31 miles from north to south along the State Highway 101 corridor (Figure 1).



Figure 1. Map of Marin County and San Francisco Bay area.

Approximately 40 percent of the county has been set aside as public open space and parks, the majority of which are in West Marin, the center of agricultural production and livestock operations in the county (Figure 2). The Marin Agricultural Land Trust (MALT), which was formed in 1980 by a coalition of ranchers and environmentalists to preserve farmland in Marin County, has permanently protected over 40,000 acres of land on 59 family farms and ranches (MALT 2006; Figure 2). MALT acquires agricultural conservation easements on farmland in voluntary transactions with landowners and also encourages public policies that support and enhance agriculture in the county. Protected open space and strict zoning laws have slowed county population growth. Between 2000 and 2006, population growth slowed to less than 1 percent countywide over the 6 year period, with a reported population of 248,742 in 2006 (United States Census Bureau 2006). Most of this growth occurred in the eastern portion of the county, closest to San Francisco, while western Marin has remained largely rural.

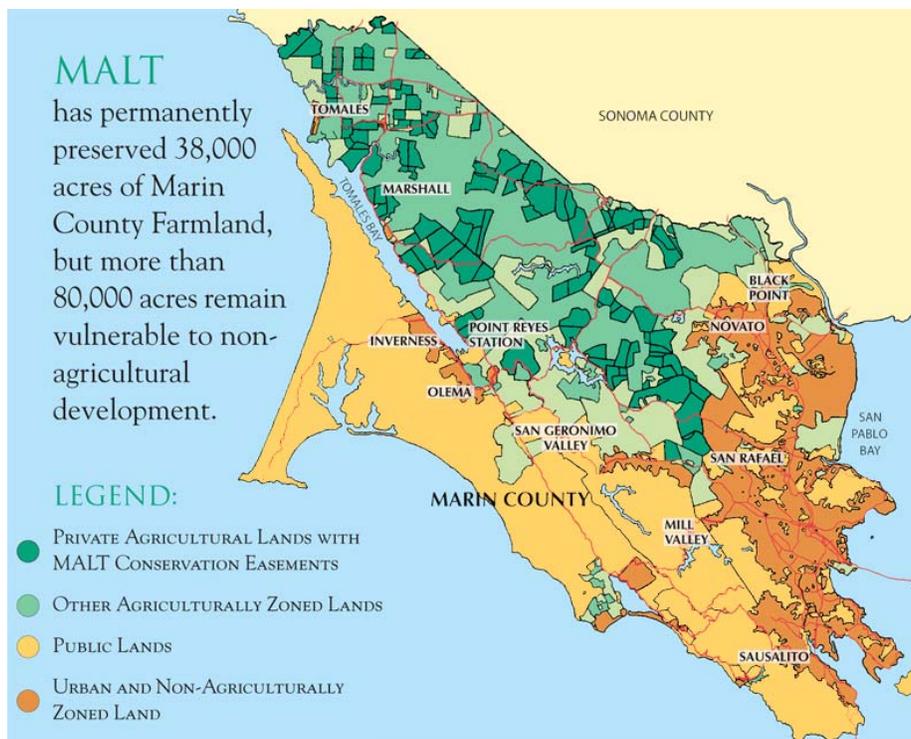


Figure 2. Marin Agricultural Land Trust (MALT) was the first land trust in the United States to focus on farmland preservation. Founded in 1980 by a coalition of ranchers and environmentalists to preserve farmland in Marin County, California, MALT acquires agricultural conservation easements on farmland in voluntary transactions with landowners. MALT also encourages public policies that support and enhance agriculture. It is a model for agricultural land preservation efforts across the nation. MALT has so far permanently protected over 40,000 acres of land on 59 family farms and ranches. © MALT (with permission).

History of Sheep Ranching and Livestock-Predator Conflicts in Marin County

Since the first Europeans began ranching in Marin County in the mid-19th century, the county's economy has been tied to livestock agriculture. Point Reyes became known as the birthplace of the California dairy industry during the Gold Rush era with butter becoming a staple product of the county. Today, agriculture is still the largest private land use in the county with sheep ranching focused in the western part of the county both on the Point Reyes peninsula and along the eastern shore of Tomales Bay (Figure 2). The county's rolling hills and cool climate are well-suited for grazing, and Marin sheep ranchers raise approximately 7,500 sheep and lambs annually for both meat and wool. In addition, there are about 30 dairies in Marin County which provide approximately 20% of the San Francisco Bay Area's milk supply, and ranchers raise about 9,000 head of beef cattle, predominantly red-and-white Herefords and Black Angus.

Many of Marin's livestock producers abut protected lands and some historic ranches still remain within National Park Service boundaries. For example, West Marin County hosts the Golden Gate National Recreation Area and Point Reyes National Seashore, both units of the National Park System. This overlap in livestock and open space creates the potential for conflict between livestock and predators. As with many livestock producers in the western United States, conflicts between livestock and predators in Marin County have largely focused around sheep and coyotes (Hall 2000; Larson 2006). A local bounty enacted by the Marin County Board of Supervisors in the late 1880s combined with the use of poison baits, snares, traps, and guns, led to eradication of coyotes from Marin County by the late 1930s (Hall 2000). However, coyotes were never eradicated further north in Sonoma County and within a century, coyotes began to recolonize Marin. By the early 1980s conflicts between sheep ranchers and coyotes began to make local newspaper headlines, often with sensationalist rhetoric and unsubstantiated claims of unbridled coyote attacks on sheep (Hall 2000). In 1984 the county hired Tim Furlong to trap and kill coyotes in West Marin (Hall 2000). The decision created a countywide controversy with the Marin Humane Society and other local organizations opposing the use of taxpayer funds to hire a county trapper (Hall 2000). Controversy over predator control erupted again in 1996 when the USDA Wildlife Services began testing Compound 1080 Livestock Protection Collars in Marin

and surrounding counties.

As coyotes continued to recolonize Marin County and other parts of the Bay area (Hall 2000; Rubenstein 2003; Sacks et al. 2006), sheep rancher complaints about conflicts with the species increased concurrently (Larson 2006; Agoos 2007; Stacy Carlsen, Marin County Agricultural Commissioner, pers. commun.). While some ranchers have been able to implement a variety of methods to reduce or eliminate coyote predation, others have not been as successful. As with livestock predation in other parts of the nation, predation losses can be significant for some ranchers. While it is beyond the scope of this study to analyze the specific reasons as to why some Marin ranchers experience consistently greater levels of predation than others, it is the author's hope that further research will be conducted in this area and that this study will identify areas within the program that could be improved, including more site-specific assessment and assistance to those ranchers experiencing greater losses.

LITERATURE REVIEW

To fully assess Marin County's Strategic Plan for Livestock and Wildlife Protection and place it in context of predator management in the United States, I review the literature as it pertains to lethal and non-lethal predator control, coyote ecology, livestock loss compensation programs, and human attitudinal studies regarding predator management and coyotes in the U.S.

Predator Control in the U.S.

Government subsidized predator control was justified in the early 1900s as a means of expanding livestock production in the west (Cain et al. 1971; Hawthorne et al. 1999; Robinson 2005). Because native carnivores were also seen as a threat to game species such as deer and pronghorn, sportsman's clubs joined western ranchers' call for increased government assistance with predator control efforts. In 1915, Congress responded by allocating \$125,000 to the U.S. Bureau of Biological Survey (BBS), a division of the U.S. Department of Agriculture specifically established to carry out predator control programs (Di Silvestro 1985; Hawthorne et al. 1999). In its early years, the BBS emphasized the use of poison baits which, unlike traps and snares, could

kill multiple predators at a single bait station; the BBS first used strychnine-laced carcasses, and later used the even more deadly poisons Compound 1080 and thallium sulfate. A shortage of steel and ammunition during the Great Depression and the two World Wars also hastened the shift away from traps and bullets to poisons. As early as 1923, the use of such predacides sparked debate amongst scientists who expressed concerns about the effects on both the environment and non-target species including golden eagles (*Aquila chrysaetos*), striped skunks (*Mephitis mephitis*), and American badgers, which were frequently killed as a result of feeding at poison bait stations set out to target wolves (*Canis lupus*), coyotes, and other large carnivores (Worster 1985; McIntyre 1995).

Predator control has had its critics since its early inception in the U.S. (Leopold et al. 1964; Cain et al. 1971; ASM 1999; Robinson 2005; Feldman 2007; Miller 2007). As early as 1930, professional scientists within the American Society of Mammalogists passed a resolution calling the Bureau of Biological Survey “the most destructive organized agency that has ever menaced so many species of our native fauna” (Edge 1934). One year later, Congress codified the government’s involvement in predator control efforts at the federal level with passage of the 1931 Animal Damage Control Act. Predator killing subsequently increased with a record 111,076 coyotes killed under the program in 1942 (Cain et al. 1971). By this time, larger carnivores including wolves, grizzly bears (*Ursus arctos horribilis*), and mountain lions (*Felis concolor*) had been extirpated in much of their former range (McIntyre 1995; Robinson 2005). Cooperative funding mechanisms with states, counties, and local ranching associations also helped to expand the federal predator control program during this era (Cain et al. 1971). Between 1930 and 1950 the program functioned with little public outcry as the country was largely focused on the Great Depression and pre and post World War instability. During this time the program was administered under the Department of the Interior’s U.S. Fish and Wildlife Service and was first known as the Bureau of Biological Survey (subsequently, in 1985, Congress transferred administration of the Animal Damage Control program to the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture. The program was renamed “Wildlife Services” in 1997).

With the birth of the U.S. environmental movement in the early 1960s, public and scientific debate increased over the efficacy, ethics, and appropriateness of federally subsidized predator control. Urbanization and the concomitant diversification of values challenged the institutional model of wildlife management, leading to public distrust of government agencies (Patterson et al. 2003). Public attitudes about wildlife were also shifting during this time as the developing field of ecology highlighted the interdependence between living beings and the important role predators and other strongly interactive species play in maintaining healthy ecosystems and species diversity (Carson 1962; Mowat 1963; Dunlap 1988). Scientists once again began to speak out about the destructive ecological impact of removing large numbers of predators from the environment (Leopold et al. 1964; Cain et al. 1971).

Unable to ignore increasing public concern for wildlife and opposition to the widespread use of poisons and other lethal predator control methods, in 1963 Secretary of the Interior Stewart Udall commissioned Dr. Starker Leopold (son of Aldo Leopold) to chair a committee to investigate and make recommendations on the Animal Damage Control program. Out of this committee came the Leopold Report, which charged that the program practiced indiscriminate and excessive killing of predators and posed a significant threat to imperiled species. Secretary Udall took the criticisms and recommendations seriously and accepted the Leopold Report as a “general guidepost” for Interior Department Policy (U.S. Congress 1966). Over the next five years, the agency went through a major overhaul to change its public image with substantial changes implemented in the agency’s policies, philosophies, public messaging, and personnel. Even terminology was changed — into euphemisms — in an attempt to reverse negative perception; “poison” was now called “toxicant” or “chemical compound”; “kill” became “reduction” or “removal” (Feldman 2007). However, despite the significant resources spent in trying to improve public perception of and support for the agency, these superficial changes largely failed (Feldman 2007).

In 1966, Congressman John D. Dingell led congressional hearings on the federal predator control program which strongly condemned the government’s efforts to eradicate native carnivores and elicited the following condemnation (U.S. House of Representatives 1966):

It is well known that over the years predator controls actually practiced by governmental and private organizations have been considerably in excess of the amount that can be justified, particularly when total public interest is considered. In fact, indiscriminate trapping, shooting, and poisoning programs against certain predators have been so effective that it has resulted in reducing their number to such an extent that their continued existence is now endangered. In some cases, methods of control, such as poisoning, are producing secondary killings of certain species that are already on the endangered list.

In 1971, Secretary of Interior Rogers Morton commissioned the Cain Report (Cain et al. 1971). The Cain Report found that the predator control program:

...contains a high degree of built-in resistance to change. . . the substantial monetary contribution by the livestock industry serves as a gyroscope to keep the bureaucratic machinery pointed towards the familiar goal of general reduction of predator populations, with little attention to the effects of this on the native wildlife fauna.

Guidelines and good intentions will no longer suffice. The federal-state predator control program must be effectively changed. It must take full account of the whole spectrum of public interests and values, not only in predators but in all wildlife. This will require substantial, even drastic, changes in control personnel and control methods, supported by new legislation, administrative changes, and methods of financing.

Among other recommendations, the Cain Report urged an immediate prohibition of all existing poisons used for predator control. Subsequently, the use of poisonous baits was banned in 1972 because of concerns about misuse and the widespread killing of non-target animals (Buys 1975; Dunlap 1988). Two decades later in 1994, the Thoreau Institute released an economic audit (O'Toole 1994) of the USDA's Animal Damage Control Program which in part found the following:

- ADC's livestock-protection mission has apparently failed. In general, states with active ADC livestock programs experienced higher predator losses than states with minimal or no livestock programs. The starkest contrast: Farmers in Kansas who had no federal ADC livestock program, suffer significantly lower predation rates than those in neighboring Nebraska and Oklahoma, which each spends hundreds of thousands of dollars to kill thousands of predators each year.
- ADC's livestock protection program creates perverse incentives for ranchers to use submarginal land, overgraze public land and rely on taxpayers rather than their own actions to protect their herds.
- Although ADC has expanded its scope of activities, western livestock protection, which mainly means killing coyotes, still accounts for most (53%) of its total operational budget.

The report concluded that there was:

...little legal or economic justification for continuing a federal animal damage control program. Few benefit from such a program and those who do ought to pay for the program themselves. In any case the federal government should not be involved in what are essentially state and local problems.

But even Congressional directives failed to change policy. A 1995 Government Accounting Office (GAO 1995) report concluded that:

ADC personnel in western states use lethal methods to control livestock predators despite written USDA policies and procedures giving preference to the use of non-lethal control methods where practical and effective.

Critics of the federal program argue that it perpetuates an endless cycle of conflict and killing with an emphasis on non-selective methods, that it lacks accountability to the public, needlessly kills millions of animals for the benefit of a relatively small number of livestock producers, and

fosters a dependence on taxpayer-funded assistance instead of promoting effective long-term solutions to conflicts (Jacobs 1991; O’Toole 1994; PCA 2001; Treves and Karanth 2003; Mitchell et al. 2004; Fox and Papouchis 2005; Robinson 2005; Feldman 2007). In response to such criticism, the agency has put more resources into researching alternative predator control methods through its research arm, the National Wildlife Research Center, and has acknowledged that public scrutiny of its programs and shifting public attitudes regarding the welfare of animals demands that “new, innovative solutions to these problems be identified and that each response to wildlife damage be conducted professionally, and in an ecologically valid and biologically sound manner,” (Clay 2007). While the research arm of the federal agency has spent significant resources toward researching non-lethal methods for reducing human-wildlife conflicts, the emphasis of the agency is still on lethal predator control as evidenced by the agency’s annual kill data. In 2006, USDA WS killed more than 100,000 native carnivores including more than 85,000 coyotes, 5,000 foxes, 2,500 bobcats, 340 mountain lions, and 275 gray wolves (USDA WS 2006; Table 2). Until annual kill reports reveal a clear shift toward implementation of non-lethal controls in the field, public criticism will likely persist.

Table 2. A select list of mammalian carnivores killed and methods used by the U.S. Department of Agriculture’s Wildlife Services in fiscal year 2006.

Methods Used														
Species	Trap					Shoot				Poison		Den	Other	Total
	Cage	Kill	Leghold	Leg Snare	Neck Snare	Aerial Gunning	Spot	Call	Shot	M-44	LPC/1080	Denning		
Badgers	6	2	284	2	156		3		57	2				512
Black Bears	12		2	139	4				69				90	316
Bobcats	72	4	1,101	1	652	449	4	94	103	1			51	2,532
Coyotes	8		6,536	105	14,420	25,349	112	3,126	23,317	12,564	42	1,128	1,176	87,883
Arctic Foxes		11	209						36				9	265
Gray Foxes	157		1,028		509		1	267	54	450			13	2,479
Kit Foxes			9		6				2	24				41
Red Foxes	57	2	521		641	81	1	23	486	394		322	17	2,545
Swift Foxes			4							24		1		29
Mtn. Lions	19		51	18	106				137				15	346
Wolves (Gray)			163		4	56			54	1			2	280
Wolves (Mex)						1			2					3
TOTAL	331	19	9,908	265	16,498	25,936	121	3,510	24,317	13,460	42	1,451	1,373	97,231

Despite the continued emphasis on lethal predator control to reduce conflicts between predators and livestock, an increasing body of literature raises questions about the efficacy, ethics, and social acceptability of such an approach (Haber 1996; ASM 1999; Crabtree and Sheldon 1999; Mitchell et al. 2004; Musiani and Paquet 2004; Musiani et al. 2005; Robinson 2005; Treves and Naughton-Treves 2005; Berger 2006; Povilitis et al. 2006). Large-scale predator population reduction efforts are often inherently non-selective (Connolly and Longhurst 1975; Mitchell et al. 2004.). Such programs generally fail to consider the ecological value of maintaining large carnivores and strongly interacting species and fail to manage for ecological effectiveness (Soulé et al. 2005). Soulé et al. (2005:175) postulate that the failure of many wildlife management agencies to incorporate a doctrine of “best conservation practices based on the best science,” is because such agencies still function under anachronistic laws and policies that are based on old and simplistic scientific concepts (i.e. predators are bad and need to be eradicated).

A recent study (Berger 2006) that examines predator control in the U.S. in relation to sheep production suggests that the decline of the sheep industry is more closely associated with unfavorable market conditions than predation and raises serious questions about the effectiveness of lethal predator control programs. The number of sheep raised in the U.S. has declined by approximately 85 percent since the industry's peak in the 1940s, when 56 million sheep grazed U.S. pastures and public rangelands (Stolzenburg 2006). A study of wolf control in the northwestern United States and Canada found that lethal removal does not decrease wolf depredation at a regional scale or in the long-term (Musiani et al. 2005). The authors also found that the practice of killing wolves as a corrective, punitive measure did not resolve wolf-livestock conflicts and in fact led to an endless cycle of conflicts and lethal control.

Not all predators kill livestock (Treves and Naughton-Treves 2005). However, the dominant practice in the U.S. is based on the theory that by killing a large number of predators the "offending animal" will be among the casualties (Wagner 1988). Wagner (1988:113) suggests that the federal government's approach is “something of a sledge-hammer one: If enough coyotes are shot, trapped, and exposed to M-44s...their numbers can be reduced and the chances are that the offending animal(s) will be among those taken and the losses reduced.”

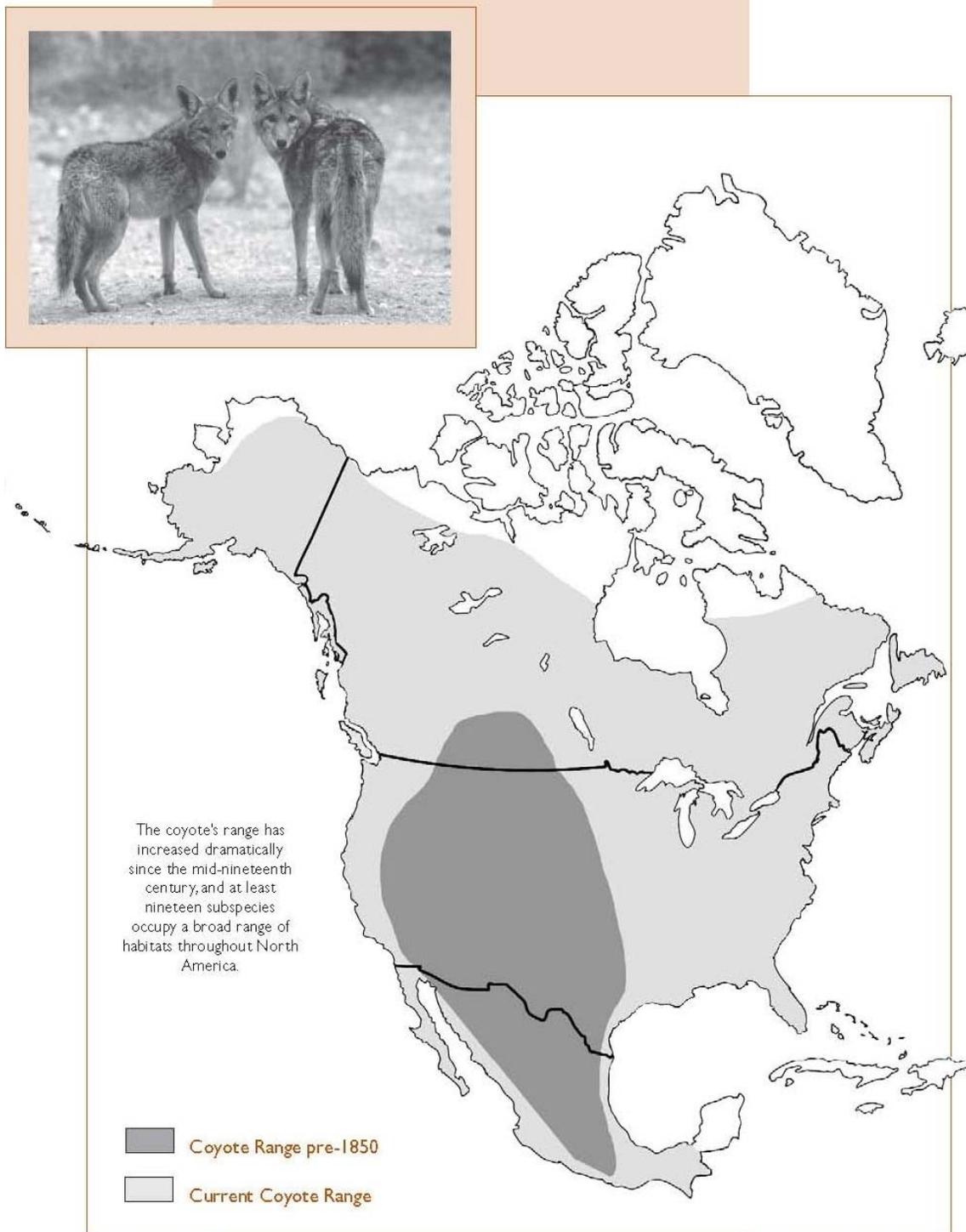


Figure 3. Map of historical and current coyote range in North and Central America (from *Coyotes in Our Midst* published by the Animal Protection Institute).

However, many non-offending animals may be killed in the process — up to 81.3% according to one study that looked at lethal carnivore management programs across the globe (Treves and Naughton-Treves 2005).

Lethal control of coyotes may actually exacerbate livestock conflicts by stimulating improved reproductive success and pup survival in the remaining coyote population (Connolly and Longhurst 1975; Connolly 1978; Davison 1980; Sterling et al. 1983; Stephenson and Kennedy 1993; Parker 1995; Crabtree and Sheldon 1999). Despite research conducted over 30 years ago showing that suppression of a coyote population over the long-term requires removing more than 75% of the population annually because of the reproductive rate of the species, (Connolly and Longhurst 1975), USDA WS continues to emphasize lethal coyote control in its national livestock protection program. While millions of coyotes have been systematically killed through subsidized predator control programs over the last century, their range has expanded three-fold since 1850 as shown in Figure 3 (Crabtree and Sheldon 1999).

Human Attitudes Regarding Predators and Predator Management in the U.S.

Historically, fear and distrust largely defined the public's attitude toward predators in the United States, which has influenced predator management over the past four centuries (Matthiessen 1959; Nash 1967; Lopez 1978; Kellert 1985a; Robinson 2005). When European colonists first settled North America in the early 1600's and encountered wolves, grizzly bears and mountain lions along the eastern seaboard, they viewed these predators as a threat to livestock, as competitors in the human hunt for food or sport, and as an impediment to progress (Young and Goldman 1944; Matthiessen 1959; Nash 1967; Casey and Clark 1996; McIntyre 1995; Smith and Ferguson 2005). Bounties were enacted and in a short period of time, large carnivores were eradicated from much of their historical range. These attitudes persisted throughout North America for the next 300 years. At the turn of the 20th century, while a new awareness and appreciation for wildlife and wilderness spawned an era of protectionist policies, negative attitudes toward large carnivores persisted with the wolf as the most emblematic icon of this perspective (Lopez 1978; Kellert 1985a). President Theodore Roosevelt, often championed as

the first environmental president, described the wolf as “the beast of waste and desolation,” and advocated for their eradication (Lopez 1978).

In one meta analysis of 38 different quantitative surveys conducted between 1972 and 2000 regarding human attitudes toward wolves and wolf recovery/ reintroduction efforts, Williams et al. (2002) found that a majority (51%) of 109 survey records reported positive attitudes toward wolves and 60% supported wolf restoration. The authors also showed that tolerance for predators and positive attitudes toward wolves are associated with urban, educated, affluent populations, especially women and people whose economic activities are not tied to natural resources. Kellert (1980) speculated that increased education often brings a greater awareness and appreciation of wildlife and the environment. Urban residents and members of environmental groups (who often have more education and affluence) showed greater support for wolves and wolf reintroduction (Bath 1987; Kellert 1987). Williams et al. (2002) also showed that social groups with higher potential for direct experience with wolves (e.g. ranchers and rural residents abutting wolf recovery areas) tended to have more negative attitudes as did males and older people.

The authors of this study found that attitudes towards wolves and other large carnivores generally became more positive in the twentieth century. They suggest that attitudinal changes around predators and wildlife took place predominantly between the 1930s and 1970s in the United States and that attitudes towards wolves have not changed significantly since the 1970s. In addition, the authors speculated that positive attitudes towards wolves may actually decrease with successful wolf recovery as an increasing populace has more direct experience with wolves in their communities. This theory posits that urban populaces, that are often far removed from wildlife and predators, may have more romanticized perspectives about wild animals until they actually have to coexist with them side by side. Similar findings have been made in other countries (Williams et al. 2002).

A more recent survey of rural Wisconsin residents’ attitudes towards wolves, many of whom have had direct experiences with wolves, (in 2007 the estimated statewide wolf population was approximately 550) found that deep-rooted social identity and occupation are more powerful predictors of tolerance of wolves than individual encounters (Nauhgton-Treves et al. 2003). Those who identified themselves as bear hunters or livestock producers expressed the least

tolerance for wolves. Such findings corroborate other studies that show that deeply entrenched attitudes, beliefs, and values about nature and wildlife are formed early in life and are often connected to individual social identity and occupation (Knight 2000) as well other societal factors such as level of education, income, degree of mobility, and place of residence (urban vs. rural) (Kellert 1985a; Manfredo et al. 2003).

In a national survey that looked at people's attitudes toward a variety of mammalian species, coyotes and wolves were ranked the least favorable among 33 different animals (Kellert 1985a). While wolves were listed as an endangered species at the time the survey was conducted, the species still retained an unfavorable public image. In a similar survey, Arthur et al. (1977) found that of 16 species tested, dislike for coyotes and wolves was exceeded only by skunks. Johnson (1974) speculates that this antipathy toward wolves may have been fueled by folkloric legends such as *Little Red Riding Hood*, *The Three Pigs*, and *Peter and the Wolf*. In his study of human attitudes toward wolves, he found that children under 10 years of age had the least favorable views of the species, suggesting that folkloric legends influence children's perceptions of wild animals and specific species.

In addition to historically ingrained antipathies toward predators, Kellert (1985a) suggests that negative attitudes towards wolves and coyotes may also be related to real and perceived fears of predators that are able to attack, injure and/or kill both people and livestock and to wolves' association with wilderness and wildness. Both Williams et al. (2002) and Kellert (1985a) showed that negative attitudes towards predators are not uniformly shared by all demographic groups. Age, gender, education, and other demographic variables were associated with perception and tolerance of predators. Kellert (1985a) demonstrated that the most negative views were shared among these groups: livestock ranchers, the poor, and non-whites from the South. Not surprisingly, those most associated with "animal activity" (birdwatchers, environmentalists, "scientific study hobbyists," and "nature hunters" as described by Kellert) had the most favorable opinions about predators and the most knowledge about them (with the exception of livestock ranchers who had the least favorable opinions about predators). Those expressing the greatest appreciation for wolves and other predators included college students and those who infrequently attend religious services (Kellert 1985a). Those positively oriented towards predators also

showed greater opposition toward a wide range of exploitative animal-use activities and lethal predator control. Nauhgtton-Treves et al.'s (2003) study of rural Wisconsin residents' attitudes toward wolves found that of three cohorts (bear hunters, livestock producers, and general rural residents) bear hunters had the least tolerance for wolves followed by livestock producers. Both bear hunters and livestock producers expressed significantly greater support for lethal wolf control than general rural residents although all social groups expressed support for lethal control if they had personally lost a domestic animal (livestock, pet, hunting dog) to any predator. However, social identity and perceived risk were more important factors than real and direct experiences with predators in shaping attitudes about wolves.

In reviewing human attitudes toward wildlife and nature over the past century, Kellert noted a shift from what he defined as a dominionistic/utilitarian valuation toward one that is more humanistic/moralistic oriented (Kellert 1985a; Kellert 1996). Kellert (1985a) defines these terms as follows:

Dominionistic: Primary satisfaction derived from mastery and control over animals typically in sporting situations.

Utilitarian: Primary concern for the practical and material value of animals.

Humanistic: Primary interest and strong affection for individual animals, principally pets. Regarding wildlife, focus on large attractive animals, with strong anthropomorphic associations.

Moralistic: Primary concern for the right and wrong treatment of animals, with strong opposition to exploitation of and cruelty toward animals.

Those showing more humanistic/moralistic orientation were generally opposed to utilitarian uses of animals and exploitative activities whereas those demonstrating dominionistic/utilitarian valuations tended to support a wide range of animal uses and wildlife control methods. Kellert (1985a) noted significant public opposition to the shooting and/or trapping of as many coyotes as possible, and over 90% of survey respondents opposed the use of poison (this was in significant

contrast to sheep and cattle ranchers who strongly supported the killing of as many coyotes as possible through trapping, shooting, and poisoning campaigns).

Teel et al. (2007) suggest that wildlife values are changing as part of a broader global societal shift in values. They cite trends such as the decline in hunting, trapping, and fishing, increased social conflict over wildlife issues, and the growth of animal protection organizations as reflective of this shift. The authors suggest that economic development across cultures has allowed for a shift from materialist values focused on security and economic stability to post-materialist values focused on belongingness, quality of life, and self actualization. Post-materialist values allow for people to think beyond their own survival needs and to consider the health and well being of others, including non-human animals and the environment. Concomitant with post-materialist values is a mutualist orientation toward wildlife where wild animals are viewed as “capable of relationships of trust with humans and as deserving of rights and caring” (Teel et al. 2007:297).

With this shift in values amongst a large segment of the populace has come an increased demand for humane and ecologically sound management strategies for addressing conflicts between people and wild animals (Stuby et al. 1979; Kellert 1985b; Braband and Clark 1992; Haber 1996; Reiter et al. 1999; Miller et al. 2006; Miller 2007). A 1999 (Reiter et al.) national study of public attitudes toward wildlife management concluded that a majority of Americans favor the use of non-lethal methods over lethal in managing wildlife. In that study, survey respondents were asked to rank importance of factors to be considered when selecting management techniques; human safety ranked highest, followed by animal suffering, effectiveness, and environmental impacts, severity of the problem, and ability to target the specific problem animal. The lowest ranked factor was public opinion, followed by monetary cost, suggesting a willingness to invest more money to develop methods that ensure public safety and mitigate animal suffering. These findings echo a study conducted 20 years earlier by Stuby et al. (1979) on human attitudes and beliefs regarding the control of coyotes on western sheep ranges which found that humaneness was a more important evaluation criteria than selectivity (the ability of a particular control method to target the offending animal) or cost.

While public attitudes have significantly shifted in regard to predators and predator management over the last century, wildlife managers and natural resource professionals often have attitudes and values that differ from those of the general public (Matthiessen 1959; Scheffer 1976; Peyton and Langenau 1985; Langenau and Peyton 1982; Shaw 1980; Gill 1996; Clark et al. 2005). Gill (1996:60) argues that this disparity between the wildlife management profession and the general public reflects how wildlife management agencies have not kept pace with this societal change “remaining trapped in a time warp between past and future...Faced with this knowledge, wildlife professionals, when they notice, argue that the public is wrong and attempt to re-educate them back to ‘proper’ wildlife values.” Such incongruity with public sentiment can lead to public distrust of the wildlife management profession. Wildlife managers and scientists are under growing scrutiny by a concerned public who question not only how funds are used to support wildlife management practices and various scientific research projects, but who also want wildlife managers and scientists to be less arrogant and authoritarian and more accountable to those who support them (Scheffer 1976; Kirkwood et al. 1994; Gill 1996; Kellert 1996; Broom 1999; Nie 2004; Clark et al. 2005; Bekoff 2006a,b; Rollin 2006).

Clark et al. (2005) and Patterson et al. (2003) argue that the institution of wildlife management has failed to keep pace with shifting public values and attitudes, which has led to public distrust of government agencies and of the democratic process itself. When a majority of citizens feel their beliefs and values are not represented by their government (in this case state and federal wildlife management agencies) and that their voice and participation in public processes is meaningless, this can lead to increased conflicts, decreased public participation, and more entrenched bureaucracies that become increasingly resistant to change (Scheffer 1976; Gill 1996; Nie 2004; Clark et al. 2005). History has shown that when the public begins to distrust government, they seek redress through direct democratic processes (Jost 1990). Such processes “give voters a direct say in the law and circumvent special interests and unresponsive legislatures,” (Jost 1990:463). One such direct democratic process that has been increasingly employed by wildlife and animal advocacy organizations over the last two decades is the public ballot initiative process. Allowed in 27 states, ballot initiatives “allow citizens to gather petition signatures to place a proposed statutory or constitutional amendment before the voters” (Jones 1997:24). Since 1990, at least 20 wildlife protection measures have been put before voters that

affect the way wildlife is managed at the state level. Successful ballot measures have restricted trapping, snaring, and poisoning in several states, and banned or restricted certain hunting practices in others. Critics of the use of public ballot initiative process to influence wildlife management policies and practices argue that wildlife management should be left to the professionals and the agencies charged with managing wildlife (Harbo and Dean 1983; Mansfield 1991; Torres et al. 1996; Whittaker and Torres 1998). Whittaker and Torres (1998) suggested that ballot initiatives are the single greatest threat to the institution of wildlife management. Supporters argue that ballot initiatives are a last recourse when the government (state wildlife management agencies, elected officials, and legislative bodies) fails to represent the views of the majority of the citizenry and the public has lost faith in the wildlife management bureaucracy (Jones 1997; Minnis 1998; Pacelle 1998; Cockrell 1999).

Gill (1996) suggests the rural, agrarian background of most wildlife agency staff predisposes them to be more responsive to hunting, fishing and agricultural interests than to the general public and non-consumptive wildlife users. Clark et al. (2005) suggest that the U.S. institutional system of wildlife management reflects a bureaucratic structure that “divides rather than unites the community” (Clark et al. 2005:237). The authors suggest that such a system is unsustainable and in need of significant reform to ensure that the interests, attitudes, and values of all of the various groups who make up “the public” — as well as the interests of the wild animals being “managed” — are understood and considered when management decisions are deliberated and common-interest solutions are sought.

Ecological Importance of Coyotes

Coyotes may play an ecologically important keystone role in ecosystems lacking wolves (Sovada et al. 1995; Rogers and Caro 1998; Crabtree and Sheldon 1999; Crooks and Soulé 1999; Henke and Bryant 1999; Gompper 2002; Soulé et al. 2005). Indeed, the famed behavioral plasticity and demographic resiliency to exploitation of the coyote may be an evolutionary result of coexisting with its greatest competitor – the gray wolf (Crabtree and Sheldon 1999). Like wolves, coyotes can have a top-down effect on ecosystems by regulating prey as well as smaller predators, such as foxes, raccoons, skunks, and feral cats through competitive exclusion and direct killing

(Sovada et al. 1995; Rogers and Caro 1998; Crooks and Soulé 1999). Research in the fragmented habitats of coastal southern California showed absence of coyotes allowed smaller predators such as foxes and feral cats to proliferate, leading to a sharp reduction in the number and diversity of native ground-nesting birds (Crooks and Soulé 1999). Studies of mesopredator release (Crooks and Soulé 1999) conducted in more rural areas have found similar indirect effects of coyote removal on songbirds and waterfowl (Sovada et al. 1995, Rogers and Caro 1998). Henke and Bryant (1999) documented a reduction of rodent diversity from 12 species to 1 as a result of coyote removal and an increase in the numbers of black-tailed jackrabbits (*Lepus californicus*), badgers, gray foxes, and bobcats. They concluded that removing coyotes to protect livestock could actually be counterproductive: “Increased jackrabbit density caused by a lack of predation could cause increased competition for forage between jackrabbits and livestock...consequently, a reduced stocking rate [of livestock] may be required to offset competition, which may financially negate the number of livestock saved from predation” (Henke and Bryant 1999:1078). In other studies, coyotes have been found to control Canada goose (*Branta canadensis*) (Brown 2007) and white-tailed deer (*Odocoileus virginianus*) populations (Crabtree and Sheldon 1999; Gompper 2002). Crabtree and Sheldon (1999) suggest that it may be useful to reassess the functional role of coyotes where deer are overabundant, or where red fox and other mesopredators inflict significant predation on ground-nesting birds, livestock, or poultry. Hence, where coyotes are the apex mammalian predator in a given ecosystem, their removal can precipitate ecological chain reactions that lead to profound degradation of the trophic cascade structure and species loss (Crabtree and Sheldon 1999; Crooks and Soulé 1999; Terborgh et al. 1999).

While research is beginning to elucidate the important and complex role coyotes can play in maintaining ecological health and species diversity within a variety of ecosystems, more research is needed to understand this role in both rural and more developed environments.

Coyote Control

Lethal Methods of Control

Traditional coyote control techniques employed by the federal government and private ranchers have often focused on lethal, non-selective methods including trapping, snaring, poisoning, aerial

shooting, and denning (killing of pups in the den). The effectiveness of such methods in reducing coyote populations and livestock conflicts is coming under increasing scientific and public debate (Crabtree and Sheldon 1999; Knowlton et al. 1999; Treves and Karanth 2003; Jaeger 2004; Fox and Papouchis 2005; Gese et al. 2005; Treves and Naughton-Treves 2005) and raises serious ethical questions about broad scale population reduction efforts (Leopold et al. 1964; Cain et al. 1971; Fox 2001; Sillero-Zubiri et al. 2004; Fox and Papouchis 2005; Feldman 2007). Because lethal removal may stimulate improved reproductive success, larger litter sizes, and greater pup survival in the remaining coyote population, such practices may not be effective over the long-term (Knowlton 1972; Connolly and Longhurst 1975; Connolly 1978; Davison 1980; Sterling et al. 1983; Stephenson and Kennedy 1993; Parker 1995; Crabtree and Sheldon 1999; Jaeger 2004).

Research indicates that to suppress a coyote population over the long-term, a minimum annual removal of 75% of the breeding population is needed to consistently lower coyote population densities (Connolly and Longhurst 1975). Heavily exploited coyote populations are characterized by younger age structures, lower adult survival rates, increased percentages of yearlings reproducing, increased litter size, and relatively small packs (Gier 1968; Knowlton 1972; Berg and Chesness 1978; Davison 1980; Andelt 1987; Crabtree and Sheldon 1999). Crabtree and Sheldon (1999:155) argue that “federal programs to limit coyote numbers have proven ineffective and costly” and point to the tripling of the coyote’s distribution across North America during the past century to bolster their claim (Figure 3). Indeed, the coyote has proven to be one of the most successful, opportunistic, resilient, and ubiquitous predators in North America (Bekoff and Wells 1986; Fox and Papouchis 2005).

More than a century of killing coyotes has not diminished overall livestock losses nor has it increased economic returns for sheep ranchers (Berger 2006). This is largely because lethal control does not address the underlying cause of livestock predation, which is the presence of an attractive prey (e.g., domestic sheep) in the habitat of an adaptable, opportunistic carnivore. Domestic sheep are particularly vulnerable to coyotes and other carnivores when they are unaccompanied on open range far from human activity, as occurs on public lands throughout the West (Robel et al. 1981). Moreover, different breeds of sheep exhibit differences in group

cohesiveness, sociality, grazing dispersion, attentiveness, and maternal protection, all of which may affect vulnerability to predators (Knowlton et al. 1999). Compounding the vulnerability of sheep to coyotes and other predators, is spring lambing, which generally coincides with coyote birthing, and coyotes with pups may be more prone to select novel prey to feed their young (APHIS 1994).

Many techniques used to kill coyotes and other depredating predators are not selective (Conner et al. 1998; Sacks et al. 1999; Blejwas et al. 2002; Jaeger 2004; Treves and Naughton-Treves 2005). A study that looked at coyote, wolf, and bear removal indicated that 29-81% of predators killed by trained wildlife-control agents showed no evidence of involvement in livestock predation (Treves and Naughton-Treves 2005). As Treves and Karanth (2004:1494) point out, “In the United States from 1996 to 2001, federal agents killed 13.7 million animals to control agricultural damage...If error rates resemble those cited above, 1.5-9.7 million animals were killed without cause.” In another study of selective trapping of depredating coyotes, it was determined that only 1 of every 3 coyotes trapped following predation complaints fed on items reported — hence resulting in the deaths of up to 60-70% of uninvolved individuals (Gipson 1975).

Gese et al. (2005) and Shivik (2004) suggest that since not all coyotes prey on livestock, maintaining “non-problem” resident coyotes may be an asset to landowners by defending a territory against other coyotes and potentially keeping smaller species of predators away or at lower densities. Moreover, research has shown that territorial alpha pairs that are breeding are more likely to kill livestock to provision pups than non-breeding individuals or pack members (Till and Knowlton 1983; Windberg and Knowlton 1990; Sacks 1996; Knowlton et al. 1999; Sacks et al. 1999; Blejwas et al. 2002; Jaeger 2004). Hence, by using potentially indiscriminate methods such as traps, poisons, and M-44s, “non-offending” juvenile beta or transient coyotes may be removed (Jaeger 2004; Gese et al. 2005). Research at the Hopland Field Station in northern California showed that coyote removal using snares, traps, and M-44s had a limited effect on reducing sheep losses (Connor et al. 2002). The authors posited that this was likely because depredating alpha coyotes were not being removed. They also speculated that such non-selective removal methods may select for young juveniles, betas, and transients and select

against adult, breeding, territorial coyotes, in areas where animals have prior exposure to capture efforts. These findings are similar to other studies that showed that alpha coyotes may be difficult to remove with conventional control methods (Winberg and Knowlton 1988, 1990; Sacks 1996).

Non-Lethal Predation Deterrents

While implementation of non-lethal predator deterrents like fencing, lambing sheds, and protective pasture corrals may have higher up-front material and labor costs than a neck snare or bullet, the costs can be amortized over several years after the initial investment (Gese et al. 2005). Moreover, lethal removal may become an endless cycle of killing as conflicts frequently recur in the same location after removal of a few individuals (Evans 1983; Karanth and Madhusudan 2002; Treves et al. 2004) making the long-term efficacy and cost-effectiveness of such programs questionable (Berger 2006; Fox and Papouchis 2005; Robinson 2005). While USDA WS will provide lethal predator removal services free of direct charge to livestock producers, “Most non-removal depredation control procedures fall within the operational purview of livestock producers” (Knowlton et al. 1999:404), providing little incentive for ranchers to implement non-lethal predator deterrents and to instead depend on continued subsidized predator removal services.

A variety of non-lethal alternatives to the practice of killing predators that prey on livestock exist (Andelt 1996; Smith et al. 2000a,b; Breck et al. 2003; Musiani et al. 2003; Shivik et al. 2003; Shivik 2004 and 2006). How effective these methods are in resolving conflicts with predators depends on various factors including geography, grazing dynamics, the species and breed of livestock to be protected, etc. Careful consideration must be given to each livestock operation situation (terrain, flock size, budget, labor-power, predators likely to be encountered) in evaluating what methods to employ (Knowlton et al. 1999; Shivik 2004).

Animal husbandry practices such as keeping pastures clean of livestock carcasses, protecting newborn lambs when they are most vulnerable, and confining animals at night (night corralling) are often the first line of defense in protecting livestock from predators (Robel et al. 1981; Wagner 1988; Accorn and Dorrance and Bourne 1998; Knowlton et al. 1999). Historically

proven husbandry practices include livestock guard dogs (Linhart et al. 1979; Green et al. 1984; Rigg 2001), employing herders or shepherds to manage livestock on the range (Mertens and Promberger 2001), herding sheep and cattle together (flocks), and synchronizing lambing in autumn to avoid overlap with coyote pup rearing (Smith et al. 2000a,b; Shivik 2006). Such low-tech traditional predation deterrent methods not only generally cost less than many high-tech modern devices but may also contribute to carnivore conservation in areas where large carnivore populations are imperiled by reducing revenge killing (Ogada et al. 2003).

Contemporary tools used to deter livestock predation include electric fencing, guard llamas and donkeys and a variety of visual and acoustic devices including scarecrows, electric lights, radios, belled sheep, propane or acetylene exploders, and the Electronic Guard (Pfeifer and Goos 1982; Linhart et al. 1984; Linhart et al. 1992; Koehler et al. 1990; Knowlton et al. 1999; Smith et al. 2000a,b; Shivik 2006).

For many livestock producers, a combination of non-lethal methods is most effective, as single interventions rarely work for long periods of time (Bangs and Shivik 2001; Ogada et al. 2003; Shivik et al. 2003; Treves et al. 2006) particularly for species like coyotes that can quickly adapt and are keenly intelligent (Knowlton et al. 1999; Gese et al. 2005). Methods evaluated below include only those that have been employed in Marin County through the cost-share program and are designed to deter coyotes since this species has been at the center of livestock-predator conflicts in Marin (Hall 2000; Carlsen 2005; UCCE 2005; Fox 2006; Agocs 2007) and nationally (Knowlton et al. 1999).

Livestock Guard Dogs

Although livestock guard dogs (LGDs) have been used for millennia in Europe and Asia as a predator deterrent, their use in the United States was limited until the 1970s when many poisons were discontinued (Green and Woodruff 1983; Coppinger et al. 1983 and 1988). By 1993, 65 percent of sheep producers in Colorado were using livestock guard dogs (Andelt 1999; Andelt and Hopper 2000) though their use today varies by state and region (Gese et al. 2005). From Tibet to Portugal, LGDs have been bred over the centuries to be aggressive toward predators, independent, intelligent, calm, and wary of strangers (Rigg 2001). Considered behavior-

contingent, multisensory disruptive stimulus producers (Shivik 2006), LGDs have the potential to establish strong, protective bonds with livestock — particularly sheep — reflecting the tight socialized structure of their wolf cousins and a devotion to family members — even if those family members are not their next of kin. Unlike herding dogs that exhibit stalking behavior toward livestock, if raised properly LGDs behave towards livestock as if they were siblings (Rigg 2001).

Ginsberg and Macdonald (1990) argued that LGDs represent “perhaps the most cost effective method of non-lethal predator control” with distinct advantages including reducing labor costs and input (lessening the need for night corralling), alerting owners to disturbances in the flock, providing additional protection to the owner’s family and property, and allowing for more efficient use of pastures and potential expansion of the flock (USDA 1998; Rigg 2001). The use of LGDs may have also helped further carnivore conservation efforts in some countries such as Italy where wolves and sheep have historically coexisted because of the traditional presence of LGDs (Rigg 2001).

In past decades, the use of LGDs has been evaluated extensively and has proven highly successful in reducing predation on livestock in many situations (Linhart et al. 1979; Coppinger et al. 1983; Green et al. 1983; Black and Green 1985; Green and Woodruff 1987; Coppinger et al. 1988; Andelt 1992; Andelt 1999). Livestock guard dogs in the U.S. are often used with small flocks of sheep (< 300 head) in fenced pastures, as well as with large flocks (> 1,000 head) on open range.

A number of surveys have looked at rancher satisfaction with guard dogs. A ten-year study in the northeastern U.S. concluded that livestock guard dogs reduced predation on farms and ranches by 60% to 70% or more (Coppinger 1988). Livestock producers in Idaho, Oregon, Washington and Wyoming reported that 90% of their dogs helped reduce livestock predation (Green and Woodruff 1990). Thirty-six ranchers in North Dakota reported that guard dogs reduced predation on their flocks by 93% (Pfeifer and Goos 1982). A 1986 survey of U.S. and Canadian ranchers found that 92% of 399 ranchers polled considered their guard dogs to be effective (Green and Woodruff 1988). Colorado ranchers taking part in a 1993 survey reported that losses of domestic

sheep to coyotes were significantly reduced by the use of guard dogs, with many reporting declining losses over several years of using dogs (Andelt and Hopper 2000). Guard dogs were rated as excellent or good by 84% of 160 ranchers polled and estimates provided by 125 of these ranchers indicated that their 392 guard dogs saved \$891,440 worth of sheep in 1993. On average, each guard dog in the study saved \$3,610 worth of open range sheep. These savings were far greater than the purchase price and maintenance expenses associated with the dogs. Ninety-six percent of the surveyed ranchers said they would recommend guard dogs to other livestock producers.

The most well-known dog breeds used as guard animals in the U.S. include Akbash, Anatolian Shepherds, Great Pyrenees, Komondor, and Maremma. Andelt (1999a) reported that the most commonly used LGD breeds in the U.S. are Akbash and Great Pyrenees, which my survey indicated are also the two most common breeds used by Marin County sheep ranchers (Figure 4). While no difference in performance between breeds was reported among livestock producers using only one breed (Green and Woodruff 1988; Andelt 1999), reports from producers using multiple breeds suggest that Akbash dogs may be the most effective in deterring predation in fenced pastures and rangelands (Andelt 1999).



Figure 4. Great Pyrenees livestock guard dog. © Camilla H. Fox.

Guard dogs' most important behaviors are attentiveness, trustworthiness, protectiveness (Coppinger et al. 1983; Andelt 1999) and aggressiveness (McGrew and Blakesley 1982; Andelt 1999). Various factors can limit the effectiveness of LGDs, including arid climates, scattered livestock, rough terrain, heavy vegetative cover, abundant carnivores, inadequate feeding and poor training (Green and Woodruff 1983). Moreover, LGDs are incompatible with certain lethal methods such as snares, leghold traps, and M-44 cyanide ejectors as dogs may also be injured or killed by these devices. It is important to use a sufficient number of LGDs for the livestock that needs to be protected. Using multiple dogs can garner better results because they can cover more ground, protect more sheep and deter more coyotes. Problems with LGDs are generally the fault of untrained humans, not of the guard dogs (Duckworth 2000).

Livestock Guard Llamas

Llamas have been successfully used as sheep guards in North America since the early 1980s (Franklin and Powell 1993; Andelt 1999a). Llamas are naturally aggressive toward canids, responding to their presence with alarm calls, approaching, chasing, pawing and kicking, herding sheep or by positioning themselves between sheep and canids (Franklin and Powell 1993; Andelt 1999a). No training or previous association with sheep or goats is required for a llama to be an effective guard animal. Most guard llamas remain continually with the flock and prevent it from dispersing widely, although some stay separated but near the flock (Figure 5). Many take complete control of the flock and keep the sheep together, herding them to feed, water, or shelter. Unlike livestock guard dogs, they do not require special feeding programs, can be kept in fenced pastures (guard dogs may roam) and they can live over 20 years (Meadows and Knowlton 2000).

In a 1993 survey of 145 Iowa sheep producers using guard llamas, nearly 80% of respondents reported that they were either "very satisfied" or "satisfied" with their guard llamas (Franklin and Powell 1983). Eighty-seven of these producers reported average annual savings of \$1,253 (1983 prices) by using llamas. On average, sheep producers used one gelded male llama pastured with 250 to 300 sheep on 250 to 300 acres and reported that multiple guard llamas were not as effective as one gelded male llama.



Figure 5. Llama guarding sheep. © Camilla H. Fox.

In addition, this study found that half of guard llama owners reported 100% reduction in losses due to predators; sheep and lamb losses dropped from an average of 26 head per year (21% of the flock) before using guard llamas to eight head per year (7% of the flock) after their use; 85% of surveyed sheep producers said they would recommend guard llamas to others. While some ranchers reported problems with the use of llamas including attempts to breed ewes, overall, this study concluded that guard llamas require no training and minimal care and are effective at reducing predation by small to medium-sized canids. While pilot tests in the western United States indicated llamas can deter sheep predation by coyotes, they appear less effective than livestock guard dogs in many situations (reviewed by Rigg 2001).

Fencing

Properly constructed, maintained electric and non-electric predator-proof fencing has been shown to significantly reduce or prevent livestock predation by coyotes (DeCalesta and Cropsey 1978; Gates et al. 1978; Thompson 1979; Dorrance and Bourne 1980; Linhart et al. 1982; Shelton 1984; Shelton and Gates 1987; Nass and Threade 1988) reducing the demand for lethal control (Dorrance and Bourne 1980). Fencing offers several advantages besides protecting livestock, including greater control of grazing and impact on vegetation, eliminating the need for herding, and potentially reducing parasitic infestations by minimizing contact with adjacent herds (Wade 1982; Shelton 1984) (although over-use of small corrals raises the specter of infectious disease transmission within livestock herds).

Predator fencing usually follows one of three general designs: net-wire and barbed wire, electric fences of varying heights and numbers of strands and combinations of these designs. Constructed of smooth, high-tensile wires, electric fences have been built with both alternating charged wires and grounded wires and with all charged wires. A buried wire apron or a barbed or electric wire placed at ground level can deter coyotes from digging under the fence. According to Shelton (1984), a charged “trip wire” placed at the bottom of the fence 6” either outside or inside where coyote traffic is expected can be the single most important addition a rancher can make to existing fencing. However, such a charged wire close to the ground requires continued maintenance to keep vegetation from interfering with the electrical current. A wire overhang, barbed wire, or single electric wire at the top of the fence can discourage climbing by coyotes (Shelton 1984; Figure 6). In tests at the USDA’s U.S. Sheep Experiment Station, an electric fence with 13 strands completely excluded coyotes. A Canadian study in the mid 1970s showed a 90 percent reduction in sheep lost to predation in pastures with electrified fences (Anon. 1997).



Figure 6. Net wire predator fencing with barbed wire overhang. © Camilla H. Fox.

Electric fences generally require more maintenance than netwire fencing (Shelton 1984), but can be cost-effective when benefits are realized through reduction in livestock losses (Dorrance and Bourne 1980; Linhart et al. 1982; Mertens et al. 2001). However, as Knowlton et al. (1999) point out, cost effectiveness is often dependent on the size of the operation. Materials for a kilometer of seven-wire electrified fence in a straight run (no corners) costs about \$1,740 (excluding the

cost of the energizer and labor costs) while a similarly constructed high tensile net-wire fence runs about \$2,200. These fences can last over 30 years, translating into a cost per year of roughly \$58 and \$73, respectively. Existing netwire fences can be supplemented with 1–3 electrical wires outside the fence to limit coyote access (Shelton 1984; DeCalesta 1983).

The effectiveness of fencing is influenced by factors such as density and behavior of coyotes, terrain and vegetative conditions, availability of prey, size of pastures, season of the year, design of the fence, quality of construction and maintenance (Shelton 1984; USDA 1994). Therefore, it is imperative with electric fencing that fences are checked frequently to ensure proper functioning as equipment failures and grounding from loose wires can happen if not monitored on a regular basis (Shelton 1984). Coyotes are incredibly adaptable and while they often use the same travel paths when trying to cross fences and other barriers, they can quickly adapt to perceived changes by altering behavior and seeking alternative routes and means to reach their destination (Thompson 1978). The benefits of predator fencing can be maximized if used in conjunction with guard dogs or llamas. Most importantly, well constructed and maintained fencing can keep coyotes out of a pasture while keeping guard animals in. Any coyote that manages to bypass the fence can then be kept away from livestock by the guard animal.

While permanent fencing is an excellent option for use in small pastures, it is impractical on the vast semi-arid public lands of the West, where high costs make it untenable for most ranchers (Knowlton et al. 1999). Its impact on movements of other wildlife species (Knowlton et al. 1999), including mule deer (*Odocoileus hemionus*) and pronghorn (*Antilocapra americana*) are also undesirable. Fencing should not be constructed in a manner that blocks migration corridors for wildlife. Larger operations might consider fencing a smaller area in which to confine sheep at night or ewes and lambs for the first month or so after birth. Temporary or portable fencing can be used to keep livestock together so that they can be guarded more effectively. For example, in Romania, portable electric fences significantly reduced sheep losses to wolves and bears (Mertens et al. 2001). Nighttime sheep corrals were created using “Ghallagher” mobile fencing with 5 electrified wires. Sheep losses in camps with electric fences were only 2.6% of the losses in other camps without the mobile electric fencing. While the upfront costs for the fence was approximately \$250, the authors determined that these costs would be recouped by the reduction

in livestock losses within one year. Portable electric fencing is easy to set up and allows herders and guard animals to monitor both livestock and intruders.

Confinement

Confinement is one of the simplest, most effective ways to reduce predation by coyotes (Wade 1973; Robel et al. 1981). Because sheep predation most often happens at night, ranchers who keep sheep in corrals at night have significantly fewer losses than those who do not (Wade 1973; Robel et al. 1981; Wade 1982). However depending on the type of operation, it may be more practical to confine livestock in corrals at night, when coyotes are most active (Andelt 1996). This method may not be convenient for large, open-range operations, but it may be economically beneficial if losses are concentrated in a specific area. As previously mentioned, portable fencing can work well for temporarily confining and protecting livestock in open-range operations.

Shed Lambing

The practice of lambing, calving and kidding in sheds has the benefit of protecting young from both predation and inclement weather (Wade 1973; Boggess et al. 1980; NCAT 2002). Typically, ewes and lambs are confined to corrals next to the lambing shed for as long as two weeks after birth. Besides protecting lambs from predation when they are most vulnerable, shed lambing can lead to higher survival rates because ranchers can care for sick and orphaned lambs.

Night Lighting

Lighting night corrals or lambing sheds can help keep predators away and allow the rancher to keep a visual watch on the corral or shed. Lighting does not usually negatively affect the livestock, as they adapt quickly (APHIS 1994). In a 1977 Kansas study involving 109 Kansas sheep producers, lighting corrals at night had the most obvious effect on reducing losses from predators (Henderson and Spaeth 1980; Robel et al. 1981). Of the 79 sheep killed by coyotes in corrals, only 3 were lost in corrals with lights. The net protection offered by the use of lights combined with night corralling was substantial (Robel et al. 1981).

Disposal of Livestock Carcasses

Leaving the carcasses of dead livestock on the range encourages scavenging and may lead to predation as coyotes and other carnivores that feed on carcasses learn that livestock is a source of food and that potential prey is in the area (Lehner 1976; Todd and Keith 1976; Robel et al. 1981; Fritts 1982). In winter, coyotes can travel far to obtain food and may congregate in areas where livestock carrion is available. Additionally, carcasses increase the amount of food available to coyotes and may help raise their density (Todd and Keith 1976). In one study in Canada it was found that on ranches that promptly removed dead livestock, livestock losses to predators were lower than on ranches where dead livestock were not removed (McAdoo and Glimp 2000). In another study in Kansas, sheep ranchers who buried livestock carcasses or had them hauled away had lower losses to coyotes than producers using other disposal methods (Robel et al. 1981).

Multi-Species Stocking

Raising sheep and cattle together in “flerds” can be an effective way to deter coyote predation. The flerd is created by pen bonding a small group of approximately 7 weaned lambs of the same gender with 3 non-aggressive or non-abusive heifers or cows for one to two months (Anderson 1998). This process conditions the sheep to bond with the cattle and stay close to the cattle when they are foraging in the pasture, rather than forming two separate groups. When coyotes approach such flerds, the cattle often encircle the more vulnerable sheep, discouraging attacks. Moreover, because cattle are generally less vulnerable to coyotes, their presence around sheep can deter coyotes.

Frightening Devices

Visual and acoustic devices designed to frighten or deter coyotes from attacking livestock include scarecrows, electric lights, radios, belled sheep, propane or acetylene exploders, and various electronic devices (Pfeifer and Goos 1982; Linhart et al. 1984; Linhart et al. 1992; Koehler et al. 1990; Knowlton et al. 1999; Smith et al. 2000b; Shivik et al. 2003; Shivik 2006). These devices are generally effective only when livestock is confined in small pastures; and because of their intrusive nature, they may be more appropriate in areas of low human population density (Knowlton et al. 1999). Electronic frightening devices such as the Electronic Guard which emit high bursts of sound and light have been shown to provide significant protection (8–103 days) to sheep from coyotes when multiple units were used and their locations altered

(Linhart et al. 1992). In one field study' the Electronic Guard was found to have reduced sheep predation by about 60%, with savings of \$2,400 per sheep flock (Linhart et al. 1992). Eighty-four percent of ranchers who participated in the study reported decreased predation of lambs by coyotes.

Propane and gas exploders that ignite a small amount of propane or gas at timed intervals, resulting in a bright flash and a loud boom, show some ability to temporarily deter coyotes from preying on domestic livestock (Pfeifer and Goos 1982; Linhart et al. 1984; Andelt 1996). Such devices are easy to operate, portable and inexpensive. Field studies on gas and propane exploders found they deterred predation between 1-180 days with an average of 31 days (Pfeifer and Goos 1982).

While frightening devices maintained at the same location may produce only variable, short-lived benefits (Bomford and O'Brien. 1990), altering their placement, varying the frequency of sound and light bursts and utilizing larger numbers of devices could retard habituation of coyotes to the devices (Linhart et al. 1992). Even simple devices available in garden catalogs such as such as motion-activated Critter Gitters (Amtek Pet Products, San Diego) or motion-activated sprinkler systems (Contech Electronics Inc., Victoria, Canada) designed to protect vegetation from deer may also provide protection for sheep and other livestock in some predation management situations (Shivik 2006). More sophisticated electronic disruptive-stimulus devices that combine auditory and visual stimuli are currently being developed at the National Wildlife Research Center in Colorado (Shivik 2006) and rigorous field tests are needed to test their efficacy (Shivik et al. 2003).

Livestock Loss Compensation Programs

Compensation programs, which provide livestock producers with financial compensation for livestock losses due to predation, have been implemented throughout the world in a variety of capacities (Angst et al. 2001). Such programs may have multiple objectives including increasing tolerance for the presence of carnivores, reducing livestock-carnivore conflicts by requiring

predation deterrent improvements, promoting carnivore conservation, and reducing retaliatory killing of rare and endangered carnivores. But do compensation programs achieve these goals?

In the United States and Canada most predator related compensation programs are focused on areas where wolves and livestock come into conflict (Mech 1998; Naughton-Treves et al. 2003; Musianni and Paquet 2004). These programs are typically funded from a variety of government and/or private sources. Financial compensation amounts are generally based on current livestock market values and typically reimburse between 85% and 100% of the estimated value of confirmed kills. In the U.S., Defenders of Wildlife (DOW), a non-profit organization, offers to compensate ranchers who lose livestock to wolves in the Rocky Mountain West and the Southwest (Phillips and Smith 1998; Stone 2006). To receive compensation through this program, ranchers are expected to “utilize reasonable non-lethal methods in response to conflicts” (Stone 2006: 34). How rigorously this requirement is enforced is unclear in the available literature. A DOW survey showed that some ranchers feel the program is unfair because not all livestock losses can be verified. Decomposition and/or scavenging of carcasses can prevent an accurate assessment of the cause of death, a common criticism of compensation programs in general (Oakleaf et al. 2003; Stone 2006).

While this study focuses on predator conflicts in the U.S., it is worth mentioning compensation programs in Europe and parts of Asia as some of these countries have been implementing such programs for a longer duration than those in the U.S., and there are some valuable lessons to be learned from them. A review of government and privately sponsored compensation programs in Austria, France, Greece, Italy, Portugal, and Spain aimed at protecting imperiled canids, felids, and ursids found wide variability in the ways these programs are run and in the amounts of total compensation offered to ranchers in Europe (Fourli 1999). In some countries, compensation amounts exceed market costs related to livestock losses, thereby encouraging ranchers to reduce their preventive measures and allow their livestock to be depredated (Fourli 1999). In such scenarios, compensation programs may be increasingly less capable of covering livestock predation as predation increases concurrently with increases in large carnivore populations (Fourli 1999). In Bulgaria, for instance, a private compensation program run by the non-governmental organization, the Fund for the Wild Flora and Fauna (FWFF), provides for direct

replacement of livestock losses due to confirmed predator attacks (Stoynov 2005). The program, initiated in 2000, addresses predation on sheep and goats by brown bears, wolves, and other native carnivores. This program, however, requires that ranchers take proactive measures to protect their animals. Ranchers are only compensated if they implement preventive predation deterrents such as livestock guard dogs, shepherds, and night corrals (Stoynov 2005). FWFF also provides Karakachan livestock guard dogs to ranchers as part of the program. According to FWFF, the program has been very effective in reducing revenge killing of native carnivores and has resulted in positive improvements in animal husbandry and preventive measures (Stoynov 2005). It has also helped build bridges between Bulgaria's environmental community and the rural ranching community, increasing both trust and understanding around the importance of large carnivore conservation.

Conversely, in Ladakh, India, a government-run compensation program begun in 1996 aimed at reducing conflicts between local herders and snow leopards and wolves, nearly bankrupted the Ladakh wildlife department within a four-year period and may have ultimately been counterproductive in helping to conserve endangered carnivores (Jackson et al. 2001). By 2000 the program had consumed close to 60 percent of the department's annual operating budget; furthermore, slow responses to loss claims that often returned less than 30 percent of the estimated livestock value led to retaliatory killing of carnivores and a breakdown in trust between herders and the governing authority.

A more effective approach to protecting imperiled snow leopards and wolves in Ladakh has been to involve local communities in developing creative approaches to reducing conflicts through shared shepherding and night penning (Jackson et al. 2001). Key to the success of these measures has been a "bottom-up" approach to predator-livestock conflict resolution that necessitates a participatory governance process involving all affected community members (Jackson et al. 2001). Such a process involves affected community members from inception of conflict identification to program design and implementation, to ensuring follow-through on commitments from all involved (Brunner et al. 2002; Clark et al. 2005). This approach differs markedly from the conventional top-down approach employed by USDA WS that ensures

federal agency control over decision-making policies, processes, and practices at the expense of local community concerns (Patterson et al. 2003; Clark et al. 2005).

Increasing tolerance for the presence of carnivores is frequently stated as an objective of compensation programs. But it is important to determine if they accomplish this goal. A Defenders of Wildlife survey of ranchers who participate in the DOW compensation program found that 60 percent of surveyed ranchers said the program did not increase their tolerance level for wolves (Stone 2006). However, DOW notes that 59 percent said their tolerance for wolves would be lower if the compensation program ended and posits that these survey results “demonstrate that compensation can prevent erosion of tolerance among the stakeholder group most opposed to wolf restoration” (Stone 2006:33). A study that assessed tolerance of the presence of wolves in Sweden found that the proportion of sheep ranchers who had received financial assistance for predator proof fence construction was significantly associated with increased tolerance (Karlsson and Sjoström in press). Bangs et al. (1998) suggest that even if compensation has not increased tolerance towards wolves, stopping a compensation program may reduce tolerance and increase conflicts as Stone (2006) concluded with her survey. Similarly, Karlsson and Sjoström (in press) suggest that ending a cost-share program that assists ranchers with implementing proactive predation deterrents would produce a net loss in public tolerance for large carnivores and large carnivore management.

Other studies have suggested that compensation programs do not increase tolerance for wolves (Linnell and Broseth 2003; Naughton-Treves et al. 2003; Nemptzov 2003; Treves et al. 2007) and may actually decrease tolerance and exacerbate conflicts if ranchers perceive compensation payments as slow, unfair (e.g., if not all losses are verified and compensated for or reproductive status such as pregnancy is not compensated for) or if funding sources run dry (Jackson et al. 2001; Montag 2003; Bulte and Rondeau 2005). For example, a 2001 study conducted in Wisconsin of residents in wolf occupied areas found that while the existing compensation program for wolf depredations was very popular, individuals who received compensation payments for reported depredations were no more tolerant of wolves than were individuals claiming losses but who were not paid (Naughton-Treves et al. 2003).

Another criticism of compensation programs is that such programs may be socially and/or economically unsustainable over the long-term, particularly if they result in the decreased use of preventive measures by removing the impetus to protect livestock and crops (Musiani and Paquet 2004; Bulte and Rondeau 2005). An overall reduction in the use of preventive measures may have the net effect of driving up losses over the long-term, which may deplete funding sources for the compensation program, especially if they are reliant on outside sources. Hence, some researchers contend that compensation should only be provided to ranchers for livestock losses due to predation if it is carried out concurrently with a program aimed at encouraging or requiring ranchers to improve preventive management methods (Ciucci and Boitani 1998). However, even with incentive programs aimed at increasing preventive measures, sustained funding for compensation programs may still pose a significant problem over the long-term, particularly when they are dependent on outside sources of funding (Bulte and Rondeau 2005).

Bulte and Rondeau (2005) argue that even with a behavioral component requiring that compensation recipients increase their use of preventive measures, compensation programs generally fall short of attaining the goal of maintaining or increasing imperiled carnivore populations. They argue that compensation programs may actually be detrimental to overall carnivore conservation efforts by potentially exacerbating human-wildlife conflicts while reducing incentives to implement proactive preventive measures. Moreover, they contend that by offering another subsidy to ranchers, compensation may result in a further expansion of ranching and other agricultural operations, which would require more habitat conversion and farm laborers thereby potentially increasing human-wildlife conflicts. In some developing nations, they argue, compensation programs may ultimately encourage farmers to stay in marginal agricultural/livestock production in areas where it would be more beneficial to wildlife conservation for these farms to be abandoned and revert to wildlife habitat. With the risk of predation covered by compensation, farmers would then have more incentive to increase production and forage for livestock, which in turn would reduce forage for native ungulates. With reduced ungulate populations, carnivores may then shift predation to domestic livestock, thus providing another factor that may increase local livestock-carnivore conflicts. Such a scenario has unfolded in the Gir forests of India, the authors explain, where a compensation program designed to protect imperiled Asiatic lions has resulted in increased grazing and

livestock stocking levels in key forest habitat. The end result has been an increase in human-lion conflicts and negative repercussions for overall lion conservation. The authors suggest that a more effective approach might be to provide incentives that are directly tied to carnivore conservation, such as providing payments to local communities that are based on carnivore abundance not damage. Such an approach, which is based on ecosystem service theory, encourages habitat conservation instead of conversion, which is essential for carnivore restoration.

Sweden has implemented a government-run livestock-loss compensation program that is gaining increasing public attention and appears to foster both carnivore conservation and improvements in preventive livestock loss measures (Linnell et al. 1996, Wabakken et al. 2001). Herders of semi-domesticated reindeer are provided compensation for the presence of carnivores (particularly breeding carnivores) on their grazing area. The herder may then use the compensation funds in any way he or she chooses; however, it is in the herder's best interest to encourage the presence of carnivores on his or her land and to implement measures to reduce predation as the program does not allow for additional compensation reimbursements for losses. In addition to fostering carnivore conservation and improved animal husbandry (Wabakken et al. 2001), the program has reduced administrative overhead since only one lump sum is provided instead of case-by-case compensation for individual losses that require verification (Fourli 1999). However, the program has received criticism for providing yet another subsidy for reindeer herding and for being a fixed system that fails to take into account fluctuating damage levels (Fourli 1999).

Marin County's compensation program is different than most in that it is not aimed specifically at furthering restoration of imperiled large carnivores; in fact, the most common livestock predator in Marin is the most ubiquitous carnivore in North America: the coyote. However, because ranchers cannot participate in the compensation program unless they already participate in the cost-share program, the county requires that participating ranchers proactively implement a variety of non-lethal predator deterrents. While some studies have indicated that compensation for wildlife damage on private lands may not have broad acceptance from those outside of the agricultural community (Kellert 1979; McIvor and Conover 1994; Reiter et al. 1999; Elmore et

al. 2007), this does not appear to be the case in Marin County. To date, the program has received support and high praise from the Marin County Board of Supervisors, the Marin County Agricultural Commissioner's office, non-profit wildlife advocacy organizations, and favorable media coverage (Brenner 2005; Carlsen 2005; UCCE 2005; Agocs 2007; Charles 2007).

In and of itself, compensation does not reduce livestock losses from predation or provide incentives for ranchers to implement livestock protection techniques and improve their animal husbandry methods to reduce predation. Instead, most compensation programs are designed as an intervention strategy and are generally aimed at increasing tolerance for the presence of carnivores. However, compensation programs may lead to revenge killings if ranchers perceive that the program is administered unfairly or that not all predator losses can be verified and compensated. Compensation programs may also be difficult to finance over the long-term if they are reliant on outside sources of funding and if local carnivore populations increase and agricultural/ranching operations expand. If not administered properly, compensation programs can also lead to fraudulent claims and to feelings of distrust between ranchers and authorities and between individual ranchers. If directly linked to the level of preventive measures implemented by the rancher, compensation programs may prevent extreme economic hardship for ranchers and herders who are exposed to high levels of depredation and may increase the level of non-lethal livestock protection strategies employed.

As shown in Sweden, compensation programs can be designed in such a way as to not only increase implementation of preventive measures but also encourage rancher participation in carnivore conservation by linking payments to conservation outcomes. Such a program — that focuses the economic incentive on protecting carnivores while simultaneously encouraging ranchers to implement preventive strategies to mitigate negative encounters — has the potential to foster carnivore conservation and reduce livestock-predator conflicts. Key to the success of compensation programs is strong institutional support and clear guidelines, quick and accurate verification of damage, prompt and fair payment, sufficient and sustainable funds, and implementation of monitoring measures to gauge effectiveness (Nyhus et al. 2003). As demonstrated by Karlsson and Sjostrom (in press), Stone (2006) and Bangs et al. (1998), compensation and cost-share programs can prevent erosion of tolerance among stakeholder

groups and the general public which is pivotal for the success of carnivore restoration and conservation efforts.

METHODS

Rancher Questionnaire and Collection of the Data

I chose a questionnaire format to collect data from participating ranchers; and I conducted in-person and phone interviews to obtain additional qualitative information. With input from the Marin County Agricultural Commissioner, select ranchers, my graduate school advisor (David Parsons), and thesis committee members (David Parsons, Adrian Treves, Michael Soulé, and James Pittman). I developed a 35-question survey that included both quantitative and qualitative questions pertaining to livestock predation and predator control (Appendix 3). On November 1, 2006, I sent the survey to all 18 Marin County sheep ranchers who participate in the Marin Program. Included with the questionnaire was a cover letter explaining the purpose and objectives of the survey project (Appendix 4) and providing assurance of confidentiality. Also included was a letter of support for the project from Stacy Carlsen, Marin County Agricultural Commissioner (Appendix 5), and a self-addressed, stamped envelope in which to return the completed questionnaire. Nine (50%) sheep ranchers initially responded to the survey questionnaire. Thirty days later, I sent a follow up letter to those ranchers who had not responded, which elicited 2 more completed surveys. On February 21, 2007, I sent a third letter along with another copy of the survey to those ranchers who had not responded to date, which elicited 1 additional completed survey for a total of 12 responses (67%).

Interviews and Personal Communications

In addition to the 35-question survey, I conducted in-person interviews with four of the twelve ranchers who responded to the survey to gather more qualitative and attitudinal data. Selection was based upon willingness to meet in person. Site visits also allowed for tours of individual ranches and a better understanding of site-specific issues ranchers were addressing. In addition, I conducted phone interviews with six of the twelve survey respondents. I also met with Stacy Carlsen, Marin County Agricultural Commissioner, several times in person to discuss and gather additional data about the Marin Program and the former USDA WS predator control program.

Mr. Carlsen provided support for the survey project by commenting on drafts of the survey questionnaire, writing a letter to all participating ranchers that was included with the survey (Appendix 5), and following up with ranchers who had not responded to the survey encouraging them to respond.

Limitations

With five years of data on Marin's Strategic Plan for Protection of Livestock and Wildlife that came into effect during the county's 2001-2002 fiscal year and close to 100% participation of Marin County commercial sheep ranchers, adequate information exists for analyzing the effectiveness of the program. However, not all ranchers who participate in the current Marin Program participated in the previous USDA Wildlife Services program. In addition, data collection and reporting is not consistent between the two programs making a direct comparison difficult for certain hypotheses. Where data are incomplete or unavailable, I do not attempt statistical tests; instead, trends are acknowledged if evident.

Hypotheses and Statistical Analyses

Question: Do ranchers report being more or less satisfied with the Marin Program compared to the former USDA Wildlife Services program?

Null Hypothesis: Ranchers' level of satisfaction with the Marin Program is the same as their level of satisfaction with the former USDA Wildlife Services program.

Alternative Hypothesis: Ranchers' level of satisfaction with the Marin Program is not the same as their level of satisfaction with the former USDA Wildlife Services program.

Statistical Analysis: I perform a Wilcoxon Signed Rank Test to analyze responses to two survey questions that ask ranchers to rank on a scale from 1-10 their level of overall satisfaction (10 being the highest level of satisfaction) with Marin County's cost-share and compensation program and their level of satisfaction with the previous USDA Wildlife Services program.

Question: Have sheep and lamb losses due to predation increased, decreased, or remained the same for ranchers since participating in the Marin Program?

Null Hypothesis: Sheep and lamb losses due to predation under the Marin Program are the same as losses were under the USDA WS program.

Alternative Hypothesis: Sheep and lamb losses due to predation were greater under the USDA WS program than under the Marin Program.

Statistical Analysis: I use a Mann-Whitney Test to compare the annual number of sheep and lamb losses resulting from predation per rancher under the USDA WS program from October 1, 1995, through September 30, 2001 to the annual number of sheep and lamb losses resulting from predation per rancher participating in the Marin Program for from July 1, 2001, through June 30, 2007. I used a Mann-Whitney Test because my sample size was small and there was no guarantee of normal distribution. The number of ranchers participating under each program varied year to year as did the total head of livestock covered under each program. However, annual variation in numbers of participating ranchers under both programs was factored into this analysis. According to the Marin County Agricultural Commissioner, approximately 21 sheep ranchers contracted annually with the USDA WS for the years 1995 through 2001; hence this number was used to determine mean annual sheep and lamb losses per ranch during this time period. Exact numbers of ranchers participating in the Marin Program was known; therefore, these figures were used to determine mean annual sheep and lamb losses per ranch for the years 2001 through 2007.

Other Questions Analyzed through Descriptive Analyses

Question: Has the number of predators killed to protect livestock of participating ranchers decreased, increased, or remained the same since inception of the Marin Program?

Analysis: I use two data sets for comparison: USDA data on predators killed on Marin ranches for the years 1996 through 1999, and data regarding predators killed on Marin ranches as reported by ranchers in response to my survey for the years 2003 through 2006 (chosen for comparison because almost all commercial sheep ranchers were participating in the program by 2003; hence, this time period is assumed to provide a more accurate picture of rancher participation than earlier years in the program). Under the USDA Wildlife Services program, only those predators killed on ranches that were under a federal contract were recorded; the agency did not monitor or record numbers of predators killed directly by ranchers. According to

the Marin County Agricultural Commissioner, approximately 21 sheep ranchers contracted with the USDA WS on an annual basis for the years 1996 through 1999; hence this number was used to determine mean annual predator killed per ranch during this time period. Since a total of 12 ranchers responded to the survey questionnaire, this figure was used to determine the mean annual predator killed per ranch for the years 2003 through 2006. Variability in data collection is acknowledged in the discussion section.

Question: Has the number of species of predators killed on participating ranchers' lands changed since implementation of the Marin Program compared to the number of species killed under the USDA Wildlife Services program?

Analysis: I compare data received from ranchers in response to my survey to data from the USDA Wildlife Services program when the agency operated in the county.

Question: Has the use of non-lethal predation deterrent techniques amongst participating ranchers changed under the Marin Program?

Analysis: I quantify rancher response to my survey question: "Since participating in the cost-share program, has **your use of non-lethal predation deterrent techniques** (e.g. livestock guard dogs, llamas, fencing, scare devices, etc.)

- Increased Greatly
- Increased Moderately
- Remained the same
- Decreased Moderately
- Decreased Greatly"

Question: How much does the Marin County Program cost compared to the USDA Wildlife Services program?

Analysis: Based on data provided by the Marin County Agricultural Commissioner, I compare known costs for the Marin Program and the USDA Wildlife Services program. Because additional costs in administration for both programs are unknown, only direct county and/or federal contributions to the programs are included in this analysis.

Question: What predator control techniques are most preferred by ranchers who participate in the Marin Program?

Analysis: I quantify rancher response to my survey question: “If you’ve used any of the predation deterrent techniques listed below, please indicate your level of **satisfaction** with each method with an **X** in the appropriate category.”

RESULTS

I sent the survey to all 18 ranchers who participate in the Marin Program. Six did not respond, yielding a response rate of 67%. Of the 12 survey respondents, 6 (50%) said livestock production is their principal occupation. Eleven of the twelve respondents raised sheep and cows (beef and/or dairy), although sheep farming is the primary operation for the majority of ranchers who participate in the Marin Program.

Rancher Satisfaction:

Ranchers were asked to rank their level of satisfaction on a scale from 1-10 (with 10 being the highest score and greatest level of satisfaction). Only responses from ranchers who indicated they participated in both the Marin and the USDA WS programs were used in this analysis (7 out of 12). The mean level of satisfaction of ranchers who participated in the USDA WS program was 5.4 (± 2.8) (mean \pm sd), compared to a mean level of satisfaction with the Marin Program of 7.9 (± 1.9) (mean \pm sd). This reflects a mean increase of 2.5 points (or 25% on a scale from 1 to 10). A Wilcoxon Signed Rank Test showed this difference to be significant ($z=-2.02$; $P=0.043$). Three participating ranchers gave the Marin Program a score of 10 while the highest score for the USDA WS was an 8. Scores ranged from 5-10 for the Marin Program and from 1-8 for the USDA WS program.

Nine of the 12 survey respondents (75%) said they were either “highly satisfied” or “somewhat satisfied” with the amount of financial assistance they received through the cost-share program as well as with the way that the program is run; one had no opinion, and two expressed dissatisfaction (17%). Of the two that were dissatisfied both provided additional comments; one said “We lose a lot more to predators than we get credit for” and the other expressed frustration that because he had less than 200 ewes, he only qualified for the \$500 cost-share reimbursement instead of the \$2,000 for ranchers with more than 250 head of livestock.

Eight of the 9 respondents (89%) who participated in the compensation program said they were either highly ($n=2$) or somewhat ($n=6$) satisfied with the amount of compensation they received for livestock losses due to predation. Only one rancher expressed dissatisfaction with the amount of compensation he received; this was one of the two ranchers who expressed dissatisfaction with the amount of money they received through the cost-share program.

Of the 9 respondents who participated in the compensation program, 7 (78%) said they were either highly satisfied ($n=2$) or somewhat satisfied ($n=5$) with the way the compensation program is implemented. Two (22%) expressed dissatisfaction with the handling of the program, with one stating that the county is “not doing a good job in payment process in terms of timing, but they’re trying to figure it out.” Both ranchers were the same ones who had issues with the cost-share program.

Reported Predators Killed:

For the years 2003 through 2006, ranchers report killing a total of 107 predators over a three year time period (on average 3 predators killed each year per rancher), compared to a reported 222 predators killed by the USDA WS for the years 1996 through 1999 (on average 4 predators killed each year per rancher) (Table 1).

Reported Sheep Losses:

Mann-Whitney analysis indicated that sheep and lamb losses under the USDA WS program (1995-2001) were significantly higher than losses reported by survey respondents participating in the Marin Program (2001-2007) ($U=52.0$; $P=0.022$). Mean annual sheep and lamb loss per rancher under the USDA WS program was 24.2 (± 13.5) animals (mean \pm sd). Under the Marin Program the mean annual sheep and lamb loss per rancher was 8.5 (± 3.4) animals. The mean annual sheep and lamb losses for all ranchers under the USDA WS program was 506.7 (± 285.8) animals; under the Marin Program the mean annual sheep and lamb losses for all participating ranchers was 141.7 (± 53.0) animals. The trend indicates that sheep and lamb losses have generally decreased under the Marin Program (Figure 7).

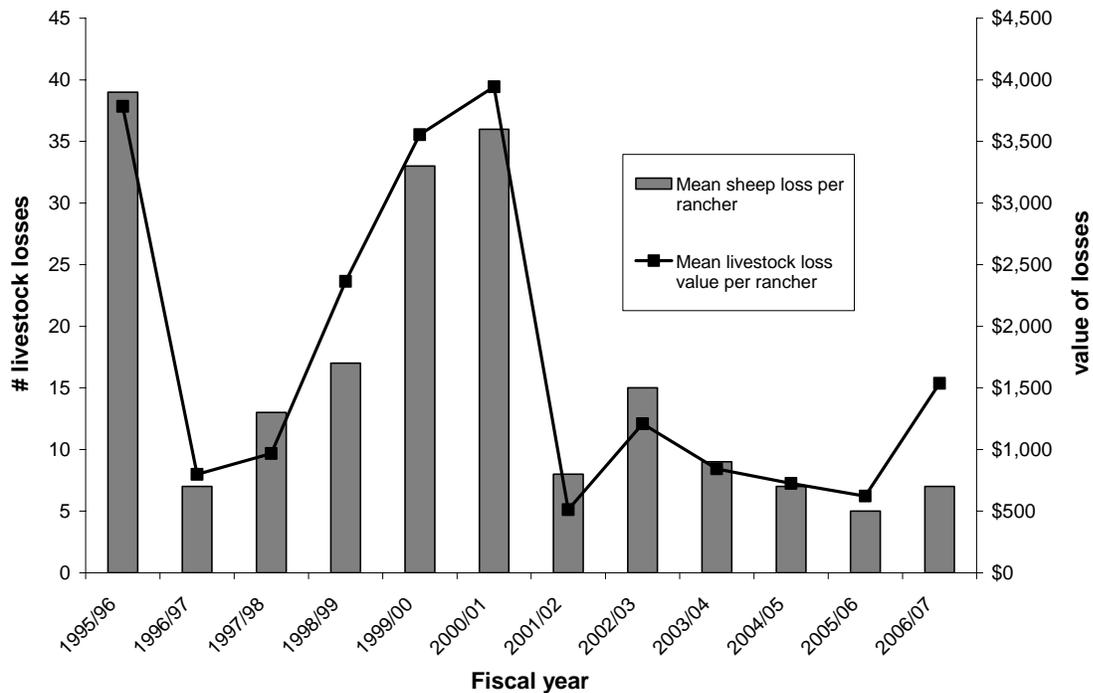


Figure 7. Comparison of numerical and cost values of sheep and lamb losses resulting from predation under two different livestock protection programs in Marin County, California. Fiscal years 1995/96 through 2000/01 reflect years when the U.S. Department of Agriculture’s Wildlife Services program operated in the county. Fiscal years 2000/01 through fiscal years 2001/02 was a transition period during which USDA WS continued to operate in the county in a limited capacity while the Marin County Department of Agriculture developed the Marin County Strategic Plan for Protection of Livestock and Wildlife.

Of the twelve survey respondents, 9 (75%) indicated they had experienced the same (5) or fewer (4) livestock losses due to predation since participation in the Marin Program. Under the comments section, one rancher wrote “Now down to zero losses from predation- hooray!” Three (25%) survey respondents said they had experienced greater losses over the last four years and all three indicated that increased losses were due to increasing coyote populations (real or perceived).

Number of Species of Predators Killed:

The number of species of predators killed on participating rancher’s lands has decreased from 10 to 4 since implementation of the Marin Program. For the fiscal years 1995 through 2000, USDA Wildlife Services killed 10 different species as part of its livestock protection program in Marin County: badger, bobcat, coyote, gray fox, opossum, feral pig (*Sus scrofa*), raccoon, red fox, feral

dog, and striped skunk (Table 1). In comparison, since inception of the Marin Program, participating ranchers indicated they have killed coyotes, foxes, bobcats, and badgers (though only one survey respondent indicated that he had killed one badger) to protect livestock. Under the Marin Program, coyotes were by far the most targeted species followed by fox and bobcat.

Eight of the 12 (67%) survey respondents said they are most tolerant of badgers, selecting “this predator causes few problems” as the reason for their high tolerance level of this species. The coyote was identified by all 12 survey respondents as the species for which there was the least tolerance with “causation of the most livestock problems” as the primary reason cited for their low tolerance level.

Use of Non-Lethal Predation Deterrents:

Of the twelve survey respondents, 9 (75%) indicated their use of non-lethal predation deterrent techniques had either increased greatly ($n=4$) or increased moderately ($n=5$) since participating in the cost-share program, whereas only 3 (25%) ranchers said their use of non-lethal predation deterrent techniques had remained the same. No ranchers said their use of non-lethal predation deterrent techniques had decreased since participating in the Marin cost-share program.

Program Costs:

In Marin County, the USDA WS program was funded by both federal and county tax dollars, which paid for a USDA trapper’s salary and equipment. The federal agency provided funding to the county as an incentive to contract with the agency, as it does with other counties and entities with whom it contracts. Shared costs varied annually between the county and USDA WS (Figure 8); however, the county generally paid a higher percentage of the total than the federal agency with the exception of fiscal years 1999/2000 and 2000/2001 when costs were evenly divided. Costs significantly increased for the program in 1998 when a full-time USDA WS trapper was hired (instead of part-time as in previous years), in part to help administer the new Compound 1080 Livestock Protection Collars that were being piloted tested in Marin and two other northern California counties at the time. In fiscal year 1998/1999, the county incurred a greater share of the costs for the full-time USDA WS trapper and then in 1999/2000 the costs were evenly split between the county and USDA WS. According to the Marin County Agricultural Commissioner,

2000/2001 was a transition year during which his department focused on developing the Marin non-lethal Program. During this year, USDA WS still operated in the county on a limited basis as part of its phase-out agreement with Marin County.

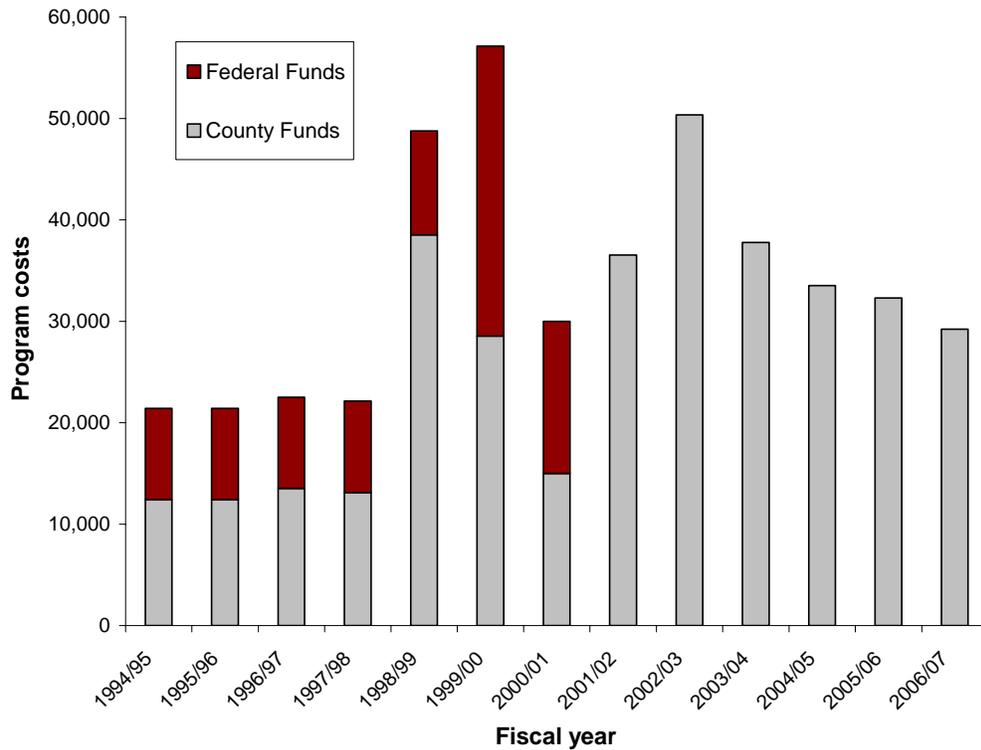


Figure 8. Annual costs for the USDA Wildlife Services program (1994 through 2001) and the Marin County Strategic Plan for Protection of Livestock and Wildlife (2001 through 2007). Fiscal years 2000/01 through fiscal years 2001/02 was a transition period during which USDA WS continued to operate in the county in a limited capacity while the Marin County Department of Agriculture developed the Marin County Strategic Plan for Protection of Livestock and Wildlife.

Program costs for the Marin Program were higher in the first few years of implementation when compared to subsequent years. There was a slight spike in costs in fiscal year 2002/2003, which, according to the Marin County Agricultural Commissioner, reflected additional expenditures of unused funds encumbered from the previous year. In fiscal year 2001/2002, the Marin County Board of Supervisors budgeted \$50,000 for the Marin Program, but only \$36,536 was spent. The remaining \$13,464 was allocated to the following fiscal year and used for additional cost-share and compensation payments for participating ranchers. Since 2003, program costs have continued to decrease. According to the Marin County Agricultural Commissioner, costs have

continued to decrease because many participating ranchers have been able to implement predator-proof fencing and guard animals funded through the program and are therefore experiencing fewer sheep losses as a result. Program costs for both the cost-share and compensation program had decreased to \$29, 223 in fiscal year 2006/2007.

Preference of Predator Control Methods:

Ten (83%) of the 12 survey respondents said they were able to use their preferred method for reducing predator losses and these methods included guard dogs (4), fencing (3), and shooting (3). Of the two (17%) who said they were not able to use their preferred predator control method, one said “eliminating them [coyotes] is not possible” and the other said his preferred method — the M-44 sodium cyanide device — was banned by California voters in 1998.

Tolerance for Predators:

Only four ranchers responded to the survey question about whether the Marin Program changed their level of tolerance for predators. The format and response device for this series of four questions was different than the rest of the survey and I believe confused ranchers as indicated by three ranchers with whom I conducted follow-up interviews (Appendix 3).

Personal Interviews

In person ($n=4$) and phone ($n=6$) interviews with participating ranchers provided additional insights about the Marin Program, the challenges ranchers face, and the ways they think the program can be improved. Selection for interviewees was based on a willingness to be interviewed as expressed by ranchers on the written survey response. Of the 10 ranchers interviewed by phone or in person, eight indicated that the coyote was the primary (and in some years sole) predator that caused conflicts. Those ranchers who had cattle in addition to sheep indicated that coyotes seldom came into conflict with their cattle; conflicts were almost exclusively between coyotes and sheep, particularly lambs, especially if unprotected during the first few critical weeks after birth. Four ranchers indicated that while they were skeptical of the program at first, they began to feel differently when they saw their sheep losses decrease after implementing novel and/or improved predation deterrent methods. Four ranchers said they had

“concerns” and/or “issues” with the previous USDA Wildlife Services trapper and three complained that snares were sometimes not checked in a timely fashion and/or that responsiveness to requests for assistance was sometimes lacking. Noteworthy statements obtained through personal interviews and from the “additional comments” component of the formal survey include the following:

- “It’s [the Marin Program] way better than what we had before.”
- “Every little bit helps.”
- “The county program is helping.”
- “It’s better than nothing.”
- “It [the Marin Program] works and is run well.”
- “I’ve had almost no losses this last year.”
- “Help is OK. Won’t make or break the business...pays for animals lost up to 5% of herd volume. OK in light damage years; insufficient if a serious problem occurs.”
- “It’s an ‘atta-boy’ program that pats us on the back but doesn’t change the larger forces we’re facing like cheap imports.”
- “A guard dog is going to help me a lot more in the long run than someone continually putting snares and poisons out on my land.”
- “Herding the sheep into corrals at nite [sic] helps a lot.”
- “Deterrents are working.”
- “Now able to bring sheep in close- especially at night.”
- “Knowing that the support is there is nice...we’re not going back to poisoning.”
- “The cost share program is great for fencing as costs are going up.”
- “Helps with dog care and fencing (It’s awkward taking government money).”
- “With under 200 ewes the amount of money is not worth what was given up (a trapper). \$500 is not very much money if you need to construct some things....if you have valuable livestock that are worth far more than market (meat) value, there is no different price.”
- “Had some cost share for electric fencing. Appreciative of that. Cannot stand the thought of my animals being physically and otherwise abused!!”

- “I’m hoping I don’t have to tap into the compensation program this year!”
- Regarding the compensation program: “It doesn’t get rid of the predator but it helps financially with the loss.”
- Regarding the compensation program: “We lose a lot more to predators than we get credit for.”
- Regarding the compensation program: “Only pay for a percentage of losses- not paying for damage to ewes with a lost lamb.”
- “Poison won’t work here.”
- “1080 was our best tool with coyotes.”
- “We tried poison collars on a sacrificial band of sheep but there was no action and it wasn’t effective.”
- “Coyote getters were the best” [referring to M-44 sodium cyanide devices].
- “USDA trappers sympathetic but not very effective.”
- Regarding snaring conducted by USDA WS: “too much by-catch; livestock damage also.”

Four ranchers said making a living from sheep ranching was becoming increasingly difficult, and two ranchers cited cheaper imports from New Zealand and Australia as a causative factor. Several ranchers said they had seen fellow sheep ranchers go out of business over the last decade and largely attributed this to cheap imports and consumer demand. Three ranchers said that while predation was not the most significant difficulty they face as ranchers, it could “put them over the edge” as one rancher stated when compounded by other economic factors. One rancher indicated that he was ready to shift over entirely to cattle ranching because “the coyotes don’t eat my cows.” Two ranchers said in order to “make it” as a sheep rancher and stay in business, ranchers had to start looking at “niche” marketing, including shifting production to organic and/or grass-fed animals. Several ranchers indicated they had started to diversify or were considering doing so by incorporating cattle into their sheep ranching operations, shifting a segment of their production to organic or grass fed livestock and/or selling wool and other livestock related products. A common theme echoed by several ranchers was that traditional sheep ranching is a “dying industry” and at least two ranchers indicated that their children would likely not continue in the sheep ranching business.

Areas for Improvement and Future Goals of Program

In both the written survey and in personal interviews with participating ranchers and with Marin County Agricultural Commissioner, Stacy Carlsen, I asked questions about how the Marin Program could be improved. Rancher feedback included the following comments:

- “I’d like to see more money for fencing...making your perimeter fence bullet proof is the aim.”
- “The county should provide more money through the cost-share program for those who need it most so we can get more guard dogs.”
- “I’d like to see the compensation program streamlined through one county; it’s a waste of time and money to have us call one county about losses and then send our livestock loss cards to Sonoma.”
- “Duplication of effort- dual reporting to Marin and Sonoma counties seems silly. Staff in Marin helpful, flexible.”
- “Program must pay producers 2x a year- currently we are 20 months behind on the indemnification program because of some computer glitch I guess- probably not enough people to administer program.”
- “Phone calls/paper work- don’t like doing them.”
- “Some cattle ranchers have terrible fencing and let the coyotes get in to our sheep pastures...the county should help them improve their fences which would help us all.”

When asked about possible future program improvements, two ranchers said they appreciated the past educational forums and trainings on livestock predation deterrents and would like to see more of these offered by the county. Another rancher indicated that while he had complaints at the beginning of the program that the paperwork was cumbersome, he felt the county had streamlined the process but that there was “still room for improvement.” Stacy Carlsen, Marin County Agricultural Commissioner, said that his office had streamlined the program to the point where significantly less staff time is spent on program administration but that “improvements can still be made.” He said his future goals for the program include the following:

- To provide more site-specific assessments of those ranches that experience consistently heavier livestock losses to determine if there are improvements that could be made to reduce losses;
- To look at using any unused program funds to help select ranchers who are experiencing higher losses to build lambing sheds and night pasture-corrals, and to patch fencing;
- To look at “hot spot” areas where cattle fencing is providing access points for coyotes and providing funding to “predator proof” these fences;
- To look at providing shepherding as a possible additional method for reducing livestock losses through the county cost-share program;
- To increase educational outreach forums for county ranchers;
- To explore niche marketing opportunities for county ranchers and provide the information and tools necessary to make such opportunities more readily available to ranchers;
- To continue to seek additional funding for both the cost-share and compensation programs;
- Assess quantitatively how many staff hours are spent on administering the program.

Expressing pride and praise for the program Carlsen stated in Bay Nature magazine (Agocs 2007:2), “For the first couple of years we couldn’t tell if the [loss] reductions were a trend or a blip. Now, we can say there’s a pattern...In a few years we’ll be a model without anyone questioning our success.” Echoing this sentiment, Anita Sauber, field administrator of the program through the County Department of Agriculture, stated to the Point Reyes Light newspaper (Charles 2007:8), “I know the program has made a difference for the sheep producers out there. In addition to the cost sharing, they are also just being recognized in a way that they weren’t before.”

DISCUSSION

While this study was limited to 12 of 18 (67%) sheep ranchers who participate in the Marin Program, the responses provided enough quantitative and qualitative data to assess specific aspects of the program’s effectiveness and rancher’s perceptions of its strengths and weaknesses.

Moreover, because the majority of commercial sheep ranchers participated in the survey, the results provide substantive information about the Program's impact on those who continue to make a substantial portion of their livelihoods from sheep ranching in Marin County.

Because predation is not a significant issue for most cattle ranchers in Marin County who produce beef and dairy cows exclusively (no sheep), most have chosen not to participate in the Marin Program (Anita Sauber, Marin County Department of Agriculture, pers. commun.).

Although a variety of carnivores exist in Marin County, including mountain lions, bobcats, gray and red foxes, raccoons, and badgers, the coyote is the primary predator of livestock (Hall 2000; Carlsen 2005; UCCE 2005; Agocs 2007; Charles 2007).

While almost all of Marin's commercial sheep ranchers ("commercial" is defined by the Marin County Department of Agriculture as 200 head or more and those who make a significant portion of their income from sheep ranching) participate in the Marin Program according to the Marin County Agricultural Commissioner, some of the smaller, hobbyist sheep operators have opted not to participate. Reasons for non-participation may involve multiple factors, the most significant of which may be that the majority of these ranchers do not raise sheep as a primary commercial enterprise (Stacy Carlsen, Marin County Agricultural Commissioner, pers. commun.). Others with smaller operations may graze their sheep on leased land and therefore have less incentive to invest resources and labor into fence improvements and other structural predator deterrents (Larson 2006). However, according to the Marin County Agricultural Commissioner's office an increasing number of smaller hobbyist operators are participating in the program in recent years (Stacy Carlsen, Marin County Agricultural Commissioner, pers. commun.).

Of the 18 sheep ranchers who participate in the cost-share program, 15 also receive funds for livestock losses through the county-funded indemnification program. The discrepancy between the number of participants in the cost-share program (18) and the indemnification program (15) is that two ranchers have not qualified to receive compensation because they have not implemented at least two non-lethal predator deterrent methods in addition to adequate fencing, as required by the County Agricultural Commissioner's office, and one sheep rancher has

reported no predator losses since participating in the cost-share program and has therefore has had no reason to claim compensation (Stacy Carlsen, Marin Co. Agricultural Commissioner, pers. commun.).

This study showed that after five years of implementation, the Marin Program:

- has support from a majority of participating ranchers although several ranchers tempered their support with comments about areas they viewed as weaknesses within the program and areas that could be improved;
- is preferred over the USDA Wildlife Service’s traditional predator management program by a majority of participating ranchers;
- has helped to reduce livestock losses,
- has resulted in increased use of non-lethal predation deterrent methods by a majority of participating ranchers;
- has likely reduced the total number of predators killed to protect livestock;
- has reduced the spectrum of species of predators killed to protect livestock.

Qualitative interviews provided additional insights into rancher’s concerns about the future of sheep ranching in a competitive global economy and the ways livestock predation factors into these concerns.

While a number of ranchers expressed skepticism about the program at first, they joined after their peers did and when they saw its tangible benefits. One of the most skeptical ranchers stated that after joining the program and acquiring a guard dog, he “realized a guard dog is going to help me a lot more in the long run than someone continually putting snares and poisons out on my land.” Although this sentiment was not shared by all participating ranchers, it anecdotally reflects a shift of attitude toward something initially viewed with distrust and uncertainty.

This study also showed that for a majority of survey respondents, the coyote is the primary — and in some years sole — species that causes conflicts with sheep. This differs sharply from data from the USDA Wildlife Services program wherein at least 10 different species were targeted on Marin County ranches during WS’s tenure in the county (Table 1). In 1999, USDA WS killed

more badgers county-wide than any other species, including coyotes despite 8 of 12 survey respondents saying they were most tolerant of badgers because “this predator causes few problems”. Coyotes may be displacing some of the other predators that were targeted by USDA WS, such as foxes and bobcats. It may also be as one rancher noted, “[USDA WS] took care of whatever animal *might* be a problem down the line- not just the one causing problems now.” Four respondents said sheep and lamb predation by coyotes had increased on their ranches over the last decade and that they believed this was due to an increase in the coyote population.

Two ranchers indicated in the “additional comments” section of the survey that ranchers looked to one particular rancher to remove “problem coyotes” although it is unknown how many coyotes this rancher removes each year from Marin ranches. One of these respondents also noted that this rancher was a “skilled marksman” who “recognized that not all coyotes are livestock killers” and thus selectively targets only those coyotes deemed “a problem”. Comparatively, according to the County Agricultural Commissioner and some Marin County sheep ranchers, under certain USDA WS trappers, predator control was often non-selective with an emphasis on snares, M-44s, and leghold traps (Stacy Carlsen, Marin Co. Agricultural Commissioner, pers. commun.; three anonymous Marin County sheep ranchers, pers. commun.). Such an assertion is corroborated by other studies documenting non-selectivity in these devices when set to target predators (Gipson 1975; Sacks et al. 1999; Connor et al. 2002). These same ranchers expressed concern that snares were not checked daily (as California law requires) and expressed dissatisfaction with indiscriminate trapping and deaths of non-target animals. At least 19 non-target animals were killed by USDA WS in neck snares, leghold traps, and M-44s set for other species from 1996 through 1999 (USDA Wildlife Services Marin County Operational Quarterly Summaries 1996-1999). Although the number of non-target wildlife killed by USDA WS appears low, the agency defines non-target as any species not explicitly listed on the contract with a land-owner. Because a USDA WS trapper can list any number of species on the contract, regardless of what has caused damage, actual non-target kills are likely to be far higher.

According to Carlsen, USDA WS placed emphasis on lethal predator control, and such an emphasis was sometimes in conflict with non-lethal predation deterrent methods: “[USDA WS personnel] also did not recommend guard dogs because of the conflicts of using snares. 100% of

the ranchers swear by guard dogs and USDA had research to support this several years ago. However, this conflicted with a sole lethal program position.” Carlsen explains that under the Marin Program, the “program elements shifted from trapping, no emphasis on exclusion, and no interest in guard animal husbandry or scare devices [under the USDA WS program] to an integrated program with changing activities [under the Marin Program],” (Stacy Carlsen, Marin Co. Agricultural Commissioner, pers. commun.).

While my data and statistical analysis indicate the number of predators killed under the Marin Program has decreased when compared to the number of predators killed under the USDA WS program over an equivalent time, variability in data collection and recording between the two programs must be acknowledged. For the years 2003 through 2006, ranchers participating in the Marin Program report killing a total of 107 predators over three years, compared to a reported 222 predators killed during the previous three years (for the years 1996 through 1999) of the USDA WS program (USDA Wildlife Services Marin County Quarterly Reports). However, USDA WS only collects data on how many predators federal trappers kill; their reports do not include information about predators killed by individual ranchers. Data that I collected for the years 2003 through 2006 included only those predators killed on participating rancher’s property as reported by survey respondents. While the data do not allow for direct comparisons, the available data suggest fewer predators have been killed under the Marin Program. Because of the variability in data collection and reporting, however, it is difficult to make definitive conclusions about the total number of predators killed under each program.

Nine of 12 survey respondents (75%) indicated their use of non-lethal predation deterrent techniques had increased since participating in the cost-share program. The most common non-lethal predation deterrent techniques employed by ranchers under the cost-share program have been fencing (including electric, patch, and cross), guard animals (dogs and llamas), and protective pasture corrals. From 2002 through 2006, more than 160,000 linear feet (>30 miles) of fencing had been installed by ranchers under the cost-share program (Anita Sauber, Marin County Department of Agriculture, pers. commun.). Ranchers who have guard animals can receive \$250 for “guard animal maintenance,” which includes assistance for vet bills and food (if ranchers accept this assistance, it is included in their \$2,000 cost-share cap, not additional). The

most common types of guard dogs used by Marin ranchers are Great Pyrenees and Akbash. Participating ranchers employ the use of 30 guard dogs and approximately 20 llamas (Anita Sauber, Marin County Department of Agriculture, pers. commun.).

Regarding program costs, in the last two years when the USDA WS program was fully functioning in the county with a full-time USDA WS trapper (fiscal years 1998-1999 and 1999-2000), overall program costs averaged approximately \$55,000 annually (including federal and county funds) compared to approximately \$30,000 annually (fiscal years 2005-2006 and 2006-2007) for the last two years of the Marin cost-share and compensation programs (Figure 8). Marin County now fully funds the non-lethal program whereas under the USDA WS program, costs were shared by the county and the federal government. Overall, the data suggest that program costs are decreasing under the Marin Program and are lower than for the fully implemented USDA WS program. According to the Marin County Agricultural Commissioner, overall costs for the Marin Program are significantly less than the federal USDA WS program when all administrative costs are factored: “Their [USDA WS] program would be around \$150,000 a year in time and effort to retain it” (Stacy Carlsen, Marin County Agricultural Commissioner, pers. commun.). (See sections, “Importance and Projected Implications” and “Additional Research Needs,” for discussion of USDA WS’ cost-benefit analysis of their California program).

Challenging the Status Quo

Marin County’s Livestock and Wildlife Protection Program challenges the institution of top-down predator management as traditionally carried out by the U.S. federal government. As possibly the first county to have voted to cease contracting with the USDA Wildlife Services because of controversy over the agency’s methods, Marin County sent a strong and clear message to the federal government: if you won’t agree to our community’s guidelines that call for employing non-lethal methods before lethal then we will develop a locally administered program using humane and best management practices without federal intervention. In deciding to stop contracting with the USDA WS, Marin County supervisors also knowingly chose to forego the federal agency’s cooperative funding program for predator control services — a

significant incentive for counties to maintain these contracts with the agency even in the face of public controversy. The USDA's decision not to work within the guidelines requested by the local governing board also sent a strong and clear message to local governments: we want our full tool kit and want cooperating entities to abide by our institutional framework. This sentiment was acknowledged by Marin County Agricultural Commissioner, Stacy Carlsen, when he said the USDA WS was fearful it would "set a precedent that other counties might follow nationwide" if the agency agreed to abide by Marin's guidelines (Stacy Carlsen, Marin Co. Agricultural Commissioner, pers. commun.). That the USDA WS commissioned a statewide cost-benefit analysis in California (Shwiff et al. 2005) comparing its statewide predator management program to Marin's relatively small community-based alternative program speaks to the agency's concerns about losing centralized control and authority and its struggle to maintain continued legitimacy and support against the backdrop of changing public attitudes toward wildlife and wildlife management.

Governance & Public Participation within Wildlife Management

Marin's Program and the process by which it was developed, the controversies between various stakeholder groups that precipitated its implementation, the initial distrust that ranchers felt about the program, the distrust that animal advocacy and conservation groups felt about the USDA Wildlife Services program, reflect a larger systemic schism within the institutional wildlife management framework. As described by Clark et al. (2005:237) this schism has a long and deep history in the U.S. that has resulted in a "wildlife bureaucracy [that] divides rather than unites the community." Such bureaucracies tend to operate in ways that ensure agency control and power while largely excluding the public from meaningful participation (Clark et al. 2005; Robinson 2005; Povilitis et al. 2006; Livingston 2007). Patterson et al. (2003) suggest that a "Progressivist" political philosophy that emphasizes science and technical expertise over democratic participatory processes in wildlife management underlies the institutional decision making philosophy of state and federal wildlife management agencies. Under this framework, decisions are left to the experts and scientists and the public is denied meaningful input into the wildlife management policy process. As a result, these institutions often fail to change strategies and policies to reflect new and more holistic ecosystem approaches to wildlife conservation that

incorporate adaptive management practices and democratic participatory planning processes (Patterson et al. 2003; Clark et al. 2005; Povilitis et al. 2006). They also tend to shun discussion or consideration of ethics, public attitudes, and values by deeming such concerns as unscientific and contrary to conventional wildlife management. The current problems with livestock-predator/human-wildlife conflicts reflect this bureaucratic institutional system that has been criticized as being unaccountable to the public, lacking transparency in its processes, policies and practices (Robinson 2005, Povilitis et al. 2006; Livingston 2007), and failing to incorporate shifting public values toward wildlife in an increasingly urbanized landscape (Patterson et al. 2003).

What is the solution to this entrenched systemic problem? Clark et al. (2005:237) caution that “Expanding confused bureaucracies is not the answer, although this is what we often do...To improve wildlife conservation, especially large carnivore management, bureaucracies must be reformed.” A first step toward wildlife management agency reform is to create models and processes that promote integration and inclusion -- where people feel heard, where they feel their values are considered, and where they feel they can have a meaningful say in the development and outcome of the management approach. Such collaborative, community-based models are aimed at fostering participation by all relevant stakeholders in a democratic and participatory based process aimed at finding solutions that benefit the common good through negotiation and compromise.

Patterson et al. (2003) suggest that this new post-Progressive Era model will require a fundamental change in decision making philosophies that shift the emphasis away from regulation and science toward political processes that focus on the social context of wildlife management aimed at building trust, fostering relationships, and facilitating open and respectful communication. As described by Treves et al. (2006:11), “co-managers must combine technical expertise with local knowledge and embrace transparent and democratic processes of participatory planning, with the sacrifices this entails.” Clark et al. (2005) contend that such civic-minded processes will also help foster mutual understanding and common ground and counter the dominant wildlife management paradigm in the U.S. that tends to promote divisiveness instead of cooperative problem-solving (Clark et al. 2005).

However, not all social scientists agree with this perspective. Peterson et al. (2005) argue that consensus-based approaches to environmental decision making may have potentially dangerous implications for conservation. The authors contend that environmental decision making rooted in consensus theory legitimizes current power relationships rooted in unsustainable social constructions of reality. Conversely, they posit that public participation processes rooted in argumentation- where the status quo can be challenged at its root source if necessary- has more potential for fostering systemic change than a consensus-based process. However, the authors suggest that there is a place for consensus building and that argument- and consensus-based processes can coexist. Moreover, not all community based collaborative processes are consensus-driven. For example, the Marin Program was a community based process aimed at fostering involvement from multiple stakeholders with an independent facilitator, but was not necessarily aimed at consensus, nor did it shun argumentation.

In addition to new modes of civic processes that foster inclusion, integration, and public empowerment, practical on-the-ground carnivore coexistence model programs are needed that promote wildlife conservation and cooperative community-based problem-solving. Clark et al. (2005) call these “practice-based improvements,” the application of which use actual experience and adaptive management practices to address site-specific conflict areas rather than theoretical principles as the basis for making improvements. Musiani and Paquet (2004) argue that such efforts should focus on rural areas where human-predator conflicts are more likely to occur.

‘Practice-Based Improvement’ Models for Resolving Human-Wildlife Conflicts

Globally, an increasing number of “practiced-based improvement” models provide examples of practices that foster large carnivore conservation, promote coexistence between humans and carnivores, and integrate animal welfare concerns. For example in Bulgaria, non-governmental organizations have implemented a program aimed at reducing conflicts between livestock and wolves using non-lethal methods and building tolerance for the presence of wolves by supplying shepherds with Karakatchan guarding dogs (Tsingarska 1997; Rigg 2001). They have also conducted a broad public awareness campaign that includes outreach to livestock producers,

students, and the general public (Tsingarska 1997). In Sweden, a government-run program provides livestock producers with financial support to implement electric fencing and other non-lethal predation deterrents (Swenson and Andrén 2005); livestock producers are compensated for the presence of carnivores on their property at pre-determined rates, fostering better animal husbandry and carnivore conservation (Linnell et al. 1996). To date, the program has been successful in reducing losses and building tolerance for the presence of wolves and other large carnivores (Swenson and Andrén 2005; Linnell et al. 1996).

In Ethiopia, the Ethiopian Wolf Conservation Program employs people from the local communities to protect the wolf, conducts outreach to livestock producers to improve husbandry practices, vaccinates domestic dogs to help prevent the spread of canid diseases, and has an extensive educational program aimed at building local understanding of the important role that the wolf plays in the Bale mountain ecosystem (Sillero-Zubiri and Laurenson 2001). In an effort to protect imperiled snow leopards within Hemis National Park, India, conservationists are working with local villagers to predator-proof nighttime livestock pens and enhance household incomes in environmentally sensitive and culturally compatible ways (Jackson and Wangchuk 2004). The researchers report that this highly participatory strategy has led to a sense of project ownership by local stakeholders, communal empowerment, self-reliance, and a willingness to co-exist with snow leopards.

Isolated models of proactive carnivore coexistence programs that integrate ethics and ecological concerns are beginning to appear in the U.S. as well. In addition to the Marin Program, a national “Predator Friendly” program administered by the non-profit organization Keystone Conservation certifies woolgrowers and other agricultural producers who commit to a strict set of criteria to qualify for Predator Friendly status. The program, begun in 1991 in Montana, requires that participating ranchers only employ non-lethal livestock predation deterrents. In turn, Keystone Conservation provides various marketing incentives for ranchers to join the program. Keystone Conservation also started a program called “Range Riders” which provides range riders to protect cattle on open range lands in areas where cattle and wolves have come into conflict. Patrolling wolf and cattle country on horseback, the range riders seek to reduce livestock predation by providing a human presence near cattle and harassing encroaching wolves. The

program, developed as a partnership involving government, ranching, and conservation interests, is promoted as a proactive way to reduce conflicts and protect gray wolves that have repopulated the area since their reintroduction to the Rocky Mountain states in 1995. Similarly, the non-profit organization Defenders of Wildlife has developed a Proactive Carnivore Conservation Fund designed “to prevent conflict between imperiled predators and humans by supporting the use of preventative measures, including non-lethal deterrents and best management practices” (DOW 2007). The program is an outgrowth of the organization’s wolf and grizzly bear depredation compensation programs, which offer payments to livestock owners for livestock losses caused by wolves or grizzly bears. All of these models integrate new scientific thought about the ecological importance of predators to healthy ecosystems while focusing on resolving conflicts between ranchers and large predators.

It is worth noting that the impetus behind all of the U.S. based programs discussed above, including the Marin Program, originated with non-governmental organizations. While program partners may include government agencies, ranchers, and other interest groups, the momentum behind the programs started with non-governmental organizations whose missions encompass predator protection and conservation. This important point implies that change in the area of wildlife management in the United States often results from a segment of the populace agitating for an alternative to the dominant paradigm. In this case the dominant paradigm is traditional predator management as carried out by the U.S. federal wildlife agencies. The agitators are non-governmental organizations representing a significant, principled, segment of society, which is discontented with the current paradigm of wildlife management (Jones 1997; Minnis 1998; Pacelle 1998; Cockrell 1999). Some of these organizations boast memberships in the millions and claim to represent the views of a growing urban, educated populace that is increasingly concerned with animal welfare (Pacelle 1998; Cockrell 1999). These organizations may seek change through traditional policy processes including legislation, litigation, and administrative rulemaking; others seek change through direct democratic processes like public ballot initiatives.

The programs described above provide examples of non-profit organizations seeking change in the ways predators are managed by supporting “practice-based improvements” as defined by Clark et al. (2005). Such efforts and developing partnerships between non-profit organizations,

government agencies, and ranching interests provide alternative models for reducing conflicts between animals (predators and livestock) and between people (ranchers and conservationists). However, such programs likely cover and assist less than one tenth of one percent of all livestock producers in the U.S. They are the exception rather than the rule. Rather than being embraced by traditional wildlife management agencies as innovative prototypes offering new approaches to human wildlife conflicts, they are often viewed as a threat to the status quo (Patterson et al. 2003; Clark et al. 2005). Their very existence challenges the conventional predator management paradigm and the deeply imbedded values that buttress and sustain it (Robinson 2005).

Marin's Strategic Plan for Protection of Livestock and Wildlife provides another "practice-based improvement" alternative, offering an adaptive management model that may spark incremental change in other jurisdictions that are discontented with the conventional North American model of predator control.

CONCLUSION

Program Implications and Applications

Marin's Strategic Plan for Protection of Livestock and Wildlife sets a precedent for meeting a wider compass of community needs and values where both agriculture and protection of wildlife are deemed important by the community. This study showed the Marin Program has support from a majority of participating ranchers; is preferred over the USDA Wildlife Service's traditional predator management program by a majority of participating ranchers; has helped to reduce livestock losses; has resulted in an increase in the use of non-lethal predation deterrent methods by a majority of participating ranchers; has likely reduced the total number of predators killed to protect livestock; and has reduced the spectrum of species of predators killed to protect livestock in the county.

While the Marin County Board of Supervisors initially funded the program as a five-year pilot project in 2000, beginning in 2005 they approved funding on an annual basis and now recognize the program as an established county program.

As the Marin Strategic Plan for Protection of Livestock demonstrates, developing a locally-run program aimed at reducing conflicts between ranchers and wildlife requires active participation on the part of all stakeholders, demands strong leadership, exacts a long-term commitment on the part of the local government to support such a program, and presupposes a willingness amongst all involved to listen, to engage in respectful debate, and to compromise where such compromise meets the greater good of the community.

While the Marin Program may work for Marin County, this model may not be directly applicable or feasible in all other communities. Because fewer than 20 sheep ranchers participate in the Marin Program, the county is able to provide both a cost share and livestock loss compensation program for these ranchers. Replicating this exact program in other jurisdictions may not be financially feasible, for instance, in a county with hundreds of livestock producers. Moreover, as Manfredo and Dayer (2004) point out, variability in societal conditions, cultures, values, attitudes, and norms may make direct replication of any given wildlife management model challenging. However, components of Marin's program may provide a model for other communities to emulate. Cost-sharing can be done in different ways; and while Marin caps its cost share and compensation programs at a certain dollar amount depending on livestock operation size, this cap can be adapted within other communities to meet their individual needs and constraints. In addition, alternative forms of revenue can be sought and generated that reduce the reliance on county funding.

Since its adoption and implementation in Marin County, the Marin Strategic Plan for Protection of Livestock and Wildlife has been continually streamlined and adapted to meet the needs of Marin County ranchers and of the community (Stacy Carlsen, Marin County Agricultural Commissioner, pers. commun.). This is the essence of adaptive management which incorporates flexibility, evaluation, learning, human dimensions, and a collaborative governance approach. The very nature of a new program like Marin's demands an adaptive management approach to ensure continued evaluation of strengths and weaknesses and identification of areas for improvement. Such collaborative and participatory governance processes are fundamental to the success of a program like Marin's and essential for other communities which consider emulating locally-controlled alternative human-wildlife coexistence models.

Additional Research Needs

Although beyond the scope of this analysis, it would be helpful to assess why some sheep ranchers consistently experience greater losses from coyote predation than others in Marin County. It is not clear from the available data to what extent livestock husbandry practices, predator deterrents, geography, livestock breeds, or other factors affect predation rates in these areas. Such information could help determine the changes needed to reduce predation on these ranches.

Because of variability in data collection, monitoring, and reporting, it is difficult to accurately assess differences in the numbers of predators killed under both programs. It would be useful to discern if more or less or the same number of predators are being killed countywide by livestock producers (including by those who do not currently participate in the Marin Program) compared to the total number of predators killed when the USDA WS operated in the county. An accurate assessment would include predators killed by individual ranchers and by USDA WS.

I did not assess level of education of participating and non-participating ranchers in my survey. It would be useful to look at whether education has influenced participation in the Marin Program and responses to survey questionnaires. Hall (2000) found that level of education significantly affected both tolerance of and appreciation for the presence of coyotes in Marin County. He also found that a disproportionate number of survey respondents had a high level of education (college or graduate degree).

Few studies have looked at how proactive measures to reduce livestock depredation by carnivores affect human tolerance towards carnivores (Karlsson and Sjoström in press). It would be valuable to assess if and how the Marin Program has affected tolerance for coyotes and other wildlife in Marin amongst both ranchers and the general public and whether Marin residents support the program and the use of county funds to subsidize it.

It was beyond the scope of my study to assess the Marin Program from a policy process perspective. Such an analysis would be useful in providing more information about the specific

processes that took place in the development of the Marin Program including:

- how decisions were made regarding who would have a seat at the table in the roundtable discussions that led to the establishment of the Marin Program;
- whether this process was inclusive, participatory, and democratic;
- how the common interest was defined amongst all participating stakeholders and what processes went into define and seek this;
- what kind of ongoing involvement these stakeholders — and others outside of this group within the greater community — have had in the ongoing implementation and evaluation of the program;
- what types of evaluation and assessment tools and processes have been incorporated to monitor program effectiveness and identify areas for improvement of such tools within the community.

While it is clear that coyotes continue to expand their range into the Bay Area (Hall 2000; Sacks et al. 2006), little is known about their populations, behavior, and overall ecology in the region. Such information would be useful in assessing and addressing coyote-human conflicts and identifying potential hot spot areas that need more attention.

The cost-benefit analysis commissioned by the USDA WS in 2005 “To compare benefits and costs of livestock protection afforded by USDA WS program activities versus a predation-compensation program recently begun in Marin County” (Shwiff et al. 2005: preface, p. iv) warrants an independent assessment. The analysis is rife with unscientific assumptions. For example, the “replacement value” assumption used in the analysis assumes that costs of replacing USDA WS would continually increase based on an assumed projection of increased livestock losses. By assuming a priori that costs will continually increase for counties operating without USDA WS (and even with an alternative program in place like Marin’s), the authors have prejudged the outcome so their results support a conclusion that the USDA WS program is more cost effective. The assumption is tantamount to saying USDA WS is the best at wildlife damage reduction hence all other alternatives must include a forecast of increased livestock losses and associated costs. The authors provide no evidence to support this assumption. The

500+ page economic assessment is clearly biased by the agencies' own interests and lacks scientific objectivity. Because of the potential political ramifications of this cost-benefit analysis, an in-depth critique of this document and the economic models upon which it is based is warranted, but beyond the scope of this study.

Concluding Comments

As a resident of Marin County and a participant in the initial roundtable discussions and debate over the use of Compound 1080 that ultimately led to the development and implementation of the Marin Strategic Plan for Protection of Livestock and Wildlife and a statewide ban on Compound 1080 and other lethal wildlife control methods, I bring my own set of values, beliefs and attitudes to this study. I believe my decade-long involvement in this program provides me a better understanding of the social context of human-wildlife conflicts at a local level from direct experience and a clearer perception about how such conflicts influence management decisions and actions. It has become apparent to me that finding effective solutions to human wildlife conflicts necessitates involvement of all stakeholders in a transparent participatory planning process that fosters trust, open dialogue, and respect amongst all stakeholders. Such an open and transparent process did not always exist in Marin, particularly prior to the county's adoption of the Marin Program when divisiveness and distrust amongst stakeholders threatened to derail the process of finding a compromise solution to an issue imbued with value-laden cultural mores. Many of the ranchers who invited me into their homes to interview them for this study knew me as the agitator who ten years earlier was pushing for a ban on Compound 1080. Yet they trusted my intentions in conducting this survey and shared their personal insights and feelings about the program as well as their hopes and uncertainties about their continued future in sheep ranching.

My greatest lesson in this process has been recognizing that the challenge in finding solutions to human-wildlife conflicts lies in managing people — much more so than wildlife. The social context of the policy process requires that participants recognize and acknowledge their own values, attitudes, and beliefs that they each bring to the table. Only when we self-reflect and recognize our own potential biases and points of view can we truly make the necessary steps

toward finding common interest solutions that benefit a greater community of life- encompassing the biotic and abiotic, the human and non-human.

It is my hope that this analysis and the dialogue it generated with the Marin County Department of Agriculture and the ranching community will help in assessing where the Strategic Plan for Protection of Livestock and Wildlife Program can be improved while providing valuable insights about how a community can move from a place of gridlock around an issue imbued with deep-seated pre-existing values and judgments to finding innovative alternatives that are humane, practical, and effective.

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PERSONAL COMMUNICATIONS

Carlsen, Stacy, Marin County Agricultural Commissioner

Meetings: June 16, 2006
June 28, 2006.
January 3, 2007
July 17, 2007
December 17, 2007
December 19, 2007

Sauber, Anita, Marin County Department of Agriculture

Meeting: June 16, 2006

**APPENDIX 1:
MARIN COUNTY STRATEGIC PLAN FOR PROTECTION OF
LIVESTOCK AND WILDLIFE**



MARIN COUNTY DEPARTMENT OF AGRICULTURE • WEIGHTS AND MEASURES

STACY K. CARLSEN
COMMISSIONER/DIRECTOR
Fred W. Crowder
DEPUTY COMMISSIONER/DIRECTOR

February 21, 2002

To: Marin County Livestock Producers

From: Stacy Carlsen
Marin County Agricultural Commissioner

Topic: Predator Management Program Update

Dear Rancher:

Last year the Marin County Board of Supervisors approved and adopted a five-year action plan to develop, implement, and evaluate a sustainable/wildlife protection with non-lethal components. This plan outlines a proposal for cost sharing the implementation and application of non-lethal predator control methods.

County Cost-Share Program Overview - Initially, it was proposed that the cost-share funds be administered by a third party such as the Woolgrowers Association. However, after meeting with Marin County sheep ranchers, the decision was made for the Marin County Agricultural Commissioner's office to provide for fund administration and allocation. These funds are to be made available to all ranching operations with predator issues, including dairy, steers, etc.

How the Cost-Share Program works – The current allocation plan includes a reimbursement claim for non-lethal control, including qualification for indemnification, have been developed cooperatively between the Agricultural Commissioner's office, the Ranchers and the Farm Advisors office. The Reimbursement claim form is designed to document a rancher's non-lethal predator program and the associated costs so available funds can be distributed.

Projects that would be eligible for cost-share reimbursement are any material or property improvements that deter depredation, such as fencing, barriers, and lambing sheds. Also reimbursable are animal management strategies such as shepherding, penning, guard animals, noisemakers, and any other non-lethal predator protection/mitigation measures or animal husbandry practices.

There are currently 29 commercial sheep ranchers in Marin constituting approximately 7,500 head. Ranchers with **greater than 200 head** are eligible to submit a claim to receive up to **\$2,000** annually. Ranchers with **fewer than 200 head** would be eligible to receive up to **\$500**. Operations with less than 25 head are not considered commercial and are therefore not eligible for participation in this program.

Reimbursement Criteria for Non-Lethal Control – To submit a claim, ranchers must complete the claim form documenting the specific activity and the costs for which cost share funds are being requested. The four main categories that are reimbursable under this program are protection/guard animals, fencing, scare devices, and shepherding/husbandry.

To process a claim, ranchers should contact the Agricultural Commissioner's office and set up an on-site review. This review will be made at the ranching location by either the Agricultural Commissioner's staff or the Cooperative Extension's Livestock and Range Management Advisor.

Once the claim has been reviewed and the site and criteria verified, the County Inspector and/or the Livestock Advisor sign the claim along with any notes and comments, and submit it to the Agricultural Commissioner for review. Once approved, an invoice for the amount of the claim will be submitted to the Treasurers office and a check in the name of the respective rancher will be issued.

Eligibility for Indemnification – A ranch must have in place an effective non-lethal program to manage livestock depredation. Indemnification claims are for commercial livestock operations and does not apply to show animals or special breeding stock. As with the cost share/ reimbursement funds, ranchers will contact the Agricultural Commissioner's office to set up an on-site ranch review to verify and document that the ranch has in place the elements of an effective non-lethal program. This review will be made by either the Agricultural Commissioner's staff or the Livestock Advisor. Once the ranch is determined to be eligible for indemnification, **losses covered are those suffered from that date on.**

Important: To be reimbursed for predator losses a rancher must do two things:

1. Immediately notify the Agriculture Commissioner's office with the date, numbers lost, and location of loss.
2. Fill out the Marin County Monthly Predator Survey Report Card (green color form). This must be filled out, signed and mailed on a monthly basis to the Livestock Advisor.

The County Inspector and/or the Livestock Advisor may make an on-site verification of the submitted losses and review the site to determine ways to deter further depredation.

Indemnification payments will be made starting in June after the lamb season and after all claim forms have been submitted for the fiscal year. At that time, individual ranch losses will be tallied; the ranch will be notified of the reported losses based on the number of losses reported by the ranch. The rancher will review and verify the number reported losses on record for their operation, and then sign and return an affidavit attesting to the accuracy of the losses claimed for that year.

If sufficient funds are available to cover all claims calculated at that year's market value, claims will be reimbursed at the market value of the loss. If the market value exceeds the available funds, payments will be prorated.

At the end of each fiscal year (July through June), an exit interview will be conducted with each participant to review and evaluate the operations predator management program.

A copy of the **Reimbursement Claim for Non-lethal Control** is included with this letter. If you would like to participate in this program, fill this form out and call **Anita Sauber** at the Marin Agricultural Commissioners office at **(415) 499-6700** or **Stephanie Larson** at the U.C. Coop. Extension office at **(707) 565-2621**. Please feel free to call if you have any questions regarding this program.

Sincerely,
Stacy K. Carlsen
Agricultural Commissioner/Director of Weights and Measures

**APPENDIX 2:
MARIN COUNTY PROGRAM REIMBURSEMENT CLAIM FORM**



MARIN COUNTY DEPARTMENT OF AGRICULTURE • WEIGHTS AND MEASURES
STACY K. CARLSEN
 COMMISSIONER/DIRECTOR
 DEPUTY COMMISSIONER/DIRECTOR

Reimbursement Claim for Non-lethal Control

The Marin County Board of Supervisors recently approved and adopted a five-year action plan to develop, implement, and evaluate a sustainable/wildlife protection program. The plan provides funding for the use and implementation of non-lethal methods.

The following is a list of recognized non-lethal methods that could qualify a rancher for the non-lethal reimbursement money and potentially for indemnification due to predator loss. There are four main categories: Protection animals, Fencing, Scare Devices, and Husbandry and Shepherding. Please fill out the following information:

Date: _____
Name: _____
Mailing address: _____
Location address: _____
Telephone: _____
Number of livestock (adults head count) _____ **Acreage:** _____

Reimbursement Tier for cost share funds:

25 to 199 adult head = up to \$500.00
200 adult head and up = up to \$2,000.00

I. Protection Animals

Animals used to protect livestock: guard dogs, llamas, donkeys, etc.

Type of Animal	Name	Id or Markings	Animal Cost	Yearly upkeep (Vet, food, etc.)

Date(s) of implementation: _____
 Total costs: _____

 Remarks: _____

Fencing

NEW FENCING – electric, woven wire, barb wire, cross fencing, other.

Type of new fencing: _____

Cost of materials: _____

Receipts submitted yes no: _____

Number of linear fence feet: _____

Labor/number of hours to install _____

Remarks: _____

EXISTING FENCES/PATCH FENCING

Type of fencing: _____

Cost of materials: _____

Number of feet improved: _____

Labor/number of hours to install: _____

Date(s) of implementation: _____

Total costs: _____

Remarks: _____

III Scare Tactics

Horns, lights, radios, bells, noisemakers, behavioral disrupters, etc.

Name/type of scare tactic	Where it's used	Upkeep cost(s)

Date(s) of implementation: _____

Total costs: _____

Remarks: _____

IV Husbandry and Shepherding

Rotating pastures, night pastures (bring animals to a protected area), barn/protective-housing improvements, shed lambing, shed herding/herders.

Describe type of husbandry/shepherding: _____

Number of labor hours on a weekly, monthly, and year: _____

Date(s) of implementation: _____

Total costs: _____

Remarks: _____

I declare under penalty of perjury under the laws of the State of California that the above statements are true and correct of my own knowledge, or, if based upon information and belief, I believe them to be true.

Applicant signature _____ **Date** _____

V. Summary

To be filled out by Marin County Department of Agriculture/U.C. Cooperative Extension.

Estimate total spent on non-lethal methods (from October 31, 2000 to present): _____

Total cost share funds eligible through non-lethal program: _____

Rancher meets the criteria for indemnification: ___ Yes ___ No

Comments: _____

Inspector signature: _____ Date: _____

Rangeland Advisor signature: _____ Date: _____

Notes/Comments _____

APPENDIX 3:
RANCHER SURVEY

Marin County Livestock Protection Cost-Share and Livestock Loss Compensation Programs



Rancher Survey
2006

Prescott College Master of Arts Program

How to share your opinions:

- Λ It is important that this questionnaire be completed by the person to whom it was addressed.
- Λ Please read the questions carefully and make your responses dark and legible.
- Λ Feel free to write any comments or explanations on this survey.
- Λ Your responses to this survey are confidential and will not be associated with your name.
- Λ Please mail your completed form in the enclosed pre-paid, pre-addressed envelope.

Thank you very much for your help!

Marin County Livestock Protection Cost-Share and Livestock Loss Compensation Programs Rancher Survey 2006

1. How long have you been raising livestock as an economic activity?
 ____ Years (please fill in)

2. Is livestock production your principal occupation?
 ____ Yes
 ____ No

3. Did your parents raise livestock as an economic activity?
 ____ Yes
 ____ No

4. What livestock do you raise and how many of each did you own in March of 2006 (check all that apply)?

____ Sheep (# adult head ____; # lambs ____)
 ____ Beef cows (# adult head ____; # calves ____)
 ____ Dairy cows (# adult head ____; # calves ____)
 ____ Other (list species _____ and # adult head ____; # young ____)

5. Of the area where you graze livestock, how many acres do you own ____ and/or lease ____?

6. Please indicate the **ESTIMATED TOTAL** number of head of livestock you've raised **during the following time periods:**

1995-1998 sheep ____ lambs ____ cows ____ calves ____ other ____

1999-2002 sheep ____ lambs ____ cows ____ calves ____ other ____

2003-2006 sheep ____ lambs ____ cows ____ calves ____ other ____

7. 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?:

1995-1998:	1999-2002	2003-2006
1. (most common) _____	1. (most common) _____	1. (most common) _____
2. _____	2. _____	2. _____
3. (least common) _____	3. least common) _____	3. least common) _____

8. Please indicate the **ESTIMATED TOTAL** number of sheep, lambs, cows, calves or other livestock you have lost **due to predation (do not include scavenging or losses for other reasons) during the following time periods:**

1995-1998 sheep _____ lambs _____ cows _____ calves _____ other _____

1999-2002 sheep _____ lambs _____ cows _____ calves _____ other _____

2003-2006 sheep _____ lambs _____ cows _____ calves _____ other _____

9. Please list the predator animal(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:**

10. Please list the **ESTIMATED TOTAL** number of predators that have been lethally removed to protect your livestock (whether by you, Wildlife Services, or someone you know) **during the following time periods:**

1995-1998 #badgers _____ #bobcat _____ #coyotes _____ #foxes _____
#other (pl. specify species and total removed) _____

1999-2002 #badgers _____ #bobcat _____ #coyotes _____ #foxes _____
#other (pl. specify species and total removed) _____

2003-2006 #badgers _____ #bobcat _____ #coyotes _____ #foxes _____
#other (pl. specify species and total removed) _____

11. Have you received financial assistance for implementing predation deterrent techniques (fencing, scare devices, increased lighting, etc.) and/or for livestock guard animals from the **cost-share component** of Marin County's livestock protection program?

No

Yes (if yes, please check each year that you participated)

2001 _____

2002 _____

2003 _____

2004 _____

2005 _____

2006 _____

12. For which **predation deterrent techniques** have you received financial assistance from the county through the cost-share program? (Please check all that apply)

- Livestock guard dogs
 - Livestock guard llamas
 - Guard animal maintenance (food and vet bills)
 - Electric fencing
 - Other improved fencing (e.g. patch, cross, etc.)
 - Scare devices (e.g. radios, flashing lights, alarms, scare crows)
 - Increased lighting
 - Lambing shed
 - Protective pasture corrals
 - Other, please specify: _____
- _____
- _____

13. Since participation in the county cost-share program have you experienced fewer, greater, or approximately the same losses of livestock **to predators**?

- Fewer
- Greater
- Same

Additional comments:

14. Since installing deterrents or using guard animals, has the **nature** of predator problems changed on your ranch?

- No
- Yes; please explain _____

15. Since installing deterrents or using guard animals, has the **timing** of predator problems changed?

- No
- Yes; please explain _____

(CONTINUED ON NEXT PAGE)

16. What predator defense techniques were used on your ranching operation (by you, USDA Wildlife Services, or someone you know) **PRIOR to implementation of the county cost-share program (before 2000)**? (Please check all that apply and please note that all methods listed below are legal under California law):

- Livestock guard dogs
- Livestock guard llamas
- Electric fencing
- Other fencing (e.g. patch, etc.)
- Scare devices (e.g. radios, flashing lights, alarms, scare crows)
- Increased lighting
- Lambing shed
- Pasture protective corrals
- Snares
- Shooting
- None
- Other, please specify: _____

17. Since participating in the cost-share program, has **your use of non-lethal predation deterrent techniques** (e.g. livestock guard dogs, llamas, fencing, scare devices, etc.)

- Increased Greatly
- Increased Moderately
- Remained the same
- Decreased Moderately
- Decreased Greatly

18. If you've used any of the predation deterrent techniques listed below, 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 listed below are legal under California law):

Method	Highly satisfied	Somewhat satisfied	No opinion	Somewhat dissatisfied	Highly dissatisfied
Livestock guard dogs					
Llamas					
Electric fencing					
Other fencing					
Scare devices*					
Increased lighting					
Lambing sheds					
Protective pasture corrals					
Snares					
Shooting					

(*scare devices = radios, flashing lights, alarms, scare crows, etc.)

20. **Looking back on all of your experiences**, what is your preferred method of preventing predation on your livestock? _____

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

Yes

No (if no, why not?): _____

22. Please indicate your level of satisfaction with the amount of financial assistance you received through the **cost-share program**?

Highly satisfied

Somewhat satisfied

No opinion

Somewhat dissatisfied

Highly dissatisfied

Please explain your answer in the space provided _____

In this section you'll be asked a series of questions pertaining to the Marin County COMPENSATION PROGRAM. Please note that these questions DO NOT pertain to the Marin County cost-share program.

23. Have you received **compensation for livestock** that were killed by coyotes or other predators through the Marin indemnification/compensation program?

No

Yes (if yes, please check each year that you participated):

2002 _____

2003 _____

2004 _____

2005 _____

2006 _____

24. Please indicate your level of satisfaction with the **amount of compensation you've received overall**.

Highly satisfied

Somewhat satisfied

No opinion

Somewhat dissatisfied

Highly dissatisfied

Please explain your answer in the space provided _____

25. Please indicate your level of satisfaction with **the way the compensation program is run overall.**

- Highly satisfied
- Somewhat satisfied
- No opinion
- Somewhat dissatisfied
- Highly dissatisfied

Please explain your answer in the space provided _____

26. Of which predator are you **most** tolerant (check one)?

- badger
- bobcat
- coyote
- fox
- golden eagle
- mountain lion
- raven

27. Check the reason that applies best for why you are most tolerant of this predator:

- This predator causes few problems
- This predator is most appealing to me and my family
- This predator helps control vermin or other predators
- Other reason (please explain) _____

28. Of which predator are you **least** tolerant (check one)?

- badger
- bobcat
- coyote
- fox
- golden eagle
- mountain lion
- raven

29. Check the reason that applies best for why you are least tolerant of this predator:

- This predator causes the most livestock problems
- This predator is the least appealing to me and my family
- This predator is a threat to human health and safety
- This predator is a threat to dogs and cats
- Other reason (please explain) _____

30. 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

31. If you have experience with the USDA Wildlife Services livestock protection program, what do you believe are its strengths and weaknesses? (if not, skip to 32)

32. Please indicate the extent to which you agree or disagree with the following statements about Marin County's cost-share and livestock loss compensation programs

(CIRCLE THE LETTER THAT BEST DESCRIBES YOUR FEELING)

	<u>Strongly Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Strongly Disagree</u>
Marin County's compensation program for livestock losses is a good way to reduce conflicts between predators and ranchers.	A	a	n	d	D
Marin County's compensation program for livestock losses has increased my tolerance for the current population level of predators.	A	a	n	d	D
Marin County's cost-share program is a good way to reduce conflicts between predators and ranchers.	A	a	n	d	D
Marin County's cost-share program that provides assistance with depredation deterrents has increased my tolerance for the current population level of predators.	A	a	n	d	D

33. On a scale from 1-10, rate your level of overall satisfaction with Marin County's cost-share and compensation program (with 10 the highest rating) _____

34. On a scale from 1-10, rate your level of overall satisfaction with the previous USDA Wildlife Services program (with 10 the highest rating) _____

35. Please express any additional comments you'd like to provide about Marin County's cost-share and/or compensation programs (feel free to provide additional comments on the back):

If you would be willing 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:

PLEASE SEND COMPLETED SURVEY TO:

**Camilla Fox
P.O. Box 5007
Larkspur, CA 94977**

If you have any questions, please feel free to call Camilla Fox at 415-945-3232 or Anita Sauber in the Marin County Agricultural Commissioner's office at 415-499-6700.

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

APPENDIX 4: COVER LETTER



Prescott College

Dear Marin County Rancher:

November 1, 2006

In cooperation with the Marin County Agricultural Commissioner's office, I am conducting a study to assess the effectiveness of the Marin County Livestock Protection Cost-Share and Livestock Loss Compensation Programs. I am a Marin County resident and graduate student at Prescott College with an interest in supporting and improving sustainable agricultural practices. Because you are a participant in this program, **your opinions are vital to helping better understand and improve this program** and that's why I hope you will take the time to fill out the questionnaire in this envelope and send it back to me in the enclosed postage-paid self addressed envelope.

Background of Marin County Livestock Protection Cost-Share and Livestock loss Compensation Programs: In 2000, the Marin County Board of Supervisors adopted the Strategic Plan for Livestock and Wildlife Protection, which provides financial assistance to Marin County ranchers to help reduce depredation. In 2002, a compensation program was added to the program that offers qualified ranchers compensation at market value for verified livestock losses to predators.

Why should you take some of your valuable time to do this?: Marin County has expressed a commitment to sustainable agricultural practices and we want to assess whether these livestock protection programs are helping the long-term viability of ranching in our county. Please help us by completing this survey, as your feedback is important for improving the Marin County program.

Your response will provide vital information for assessing the effectiveness of this program and improving the program in the future.. Because you are one of a handful of participants in this program, *your response is essential to ensuring the success of this analysis.* We need to hear from every participant in order to ensure that the assessment reflects the experiences of everyone participating in the program. Therefore, your thorough and thoughtful response to the questionnaire is respectfully requested.

Other questions you might have:

How did I get your name? The Marin County Agricultural Commissioner's office provided your name as a participant in the Marin County Livestock Protection Cost-Share and Livestock loss Compensation programs. Your identity will be kept completely confidential. The questionnaire has an identification number for mailing purposes only so that I can check your name off when your questionnaire is returned. If you have concerns about this survey, please call Stacy Carlsen or Anita Sauber at the Marin County Agricultural Commissioner's office at 415-499-6700.

Please do not hesitate to contact me with any comments or questions. You can write to me (address: P.O. Box 5007, Larkspur, CA 94977), telephone (415-945-3232) or email (chfox@earthlink.net). All participants will receive a copy of the summary report on the study after we have analyzed the data.

Thank you very much for your cooperation and for voicing your opinion about the Marin County Livestock Protection Cost-Share and Livestock loss Compensation programs.

Sincerely,

Camilla Fox
Graduate Student
Larkspur, CA/ Phone: 415-945-3232/ Email: chfox@earthlink.net

**APPENDIX 5:
COVER LETTER FROM STACY CARLSEN,
MARIN COUNTY AGRICULTURAL COMMISSIONER**



DEPARTMENT OF AGRICULTURE • WEIGHTS AND MEASURES

October 18, 2006

STACY K. CARLSEN
COMMISSIONER/DIRECTOR
FRED W. CROWDLER
DEPUTY COMMISSIONER/DIRECTOR

Dear Rancher,

As a participant in the Marin County Livestock Protection Cost-Share & Livestock Loss Compensation Programs you are receiving this survey that is being conducted by Marin County resident Camilla Fox as part of her graduate research project. The Marin County Agricultural Commissioner's office fully supports this project and strongly encourages you to participate by filling out the enclosed questionnaire.

This survey will help the Department of Agriculture to assess the effectiveness of the program and identify areas needing improvement. Our goal is to ensure that the program continues to offer Marin county ranchers effective support over the long-term so that sustainable agricultural practices persist in our county. Your participation in this survey will also help to ensure continued funding for these programs.

Because so few ranchers participate in the program, it is vital that each and every one of you respond to this survey to ensure scientifically valid results. If you have any questions about the survey, please do not hesitate to contact either Camilla directly at 415-945-3232 or Anita Sauber in our office at 415-499-6700.

Thank you in advance for your time and for helping to maintain the success of the program.

Sincere regards,

Stacy Carlson
Marin County Agricultural Commissioner