Coyote Predation Management: An Economic Analysis of Increased Antelope Recruitment and Cattle Production in South Central Wyoming

Stephanie A. Shwiff[1] and Rod J. Merrell[2]

[1]*USDA/Wildlife Services, National Wildlife Research Center, 4101 LaPorte Ave., Fort Collins, CO 80521*
[2]*USDA/Wildlife Services, Rawlins, WY 82301*

Keywords: Antelope, Coyote, Cost-Benefits, Economics, Predation Management

Introduction

In 1999, a project was implemented for the protection of antelope fawns in two areas of Carbon County, Wyoming. The project was funded by the Wyoming Animal Damage Management Board (ADMB) for the benefit of two antelope areas that were having trouble rebounding to their normal population levels after the severe winters of 1991 and 1992. While the Wyoming ADMB project's main focus was on enhancing pronghorn antelope fawn recruitment, the benefits of coyote population management could have "spillover" benefits to cow/calf producers in the coyote removal areas.

With the decline of the value of coyote fur in the late 1980s, coyote populations have increased in many areas of Wyoming, including ADMB area 63 and ADMB area 55, the two geographic areas in the study (Merrell and Shwiff, in review). ADMB area 61, another geographic area, was the control site. At the ADMB two predator management sites, there are, on average, 4,095 cows giving birth every spring. Since the decline of the sheep industry in these areas in the mid-1970s, no significant coyote management had been conducted. A study on the relationship of coyotes to mule deer fawn recruitment, done on and around area 63 in 1976-79, estimated the area's coyote population at 1 coyote/20.6 square miles (Springer and Wenger, 1981). Population data from the ADMB project for pre-treatment coyote populations in 1999 were 1 coyote/2.2 square mile, a nine-fold increase (Merrell and Shwiff, in review).

Prior to 1972, coyote populations had been suppressed by the use of broad-based poisons such as 1080, thallium and strychnine. After the ban on poisons, coyote populations continued to be suppressed by people hunting and trapping for fur. Many cow/calf producers who historically had been operating in low-coyote population densities, felt that coyote predation on calves was not at a level to cause concern. Our study suggests that these coyote populations should be a serious economic concern to both the producer and the consumer.

Methods — Study Areas

ADMB area 61 is the geographic control area. It is in west-central Carbon County and generally comprises Wyoming Game and Fish antelope hunt unit 61. Hunt unit 61 differs on the south end from ADMB area 61 because of ongoing predator control for livestock protection south of Mineral X Road (Carbon County Road 63). Area 61 is bordered on the south by Mineral X Road, the west by the Jeffery City/Wammsutter Road (Carbon County Road 23-N), the north by the Bairoil Road (Carbon County Road 22) and the east by Wyoming Highway 289. There are 90,133 ha (348 mi^2) in area 61, including 5,892 ha (22 mi^2) of patented land, 3,528 ha (13 mi^2) of state land and 80,712 ha (311 mi^2) of public land administered by the BLM. The area is predominately used for grazing cattle. There are some mineral uses, especially in the northeast corner of the unit, and one human habitation.

Area 61 was chosen for its similarity to the treatment units in habitat, weather and grazing patterns. There had been almost a total lack of predator control within its boundaries during the previous 10 years due to the lack of lambing and calving in the area. There had been some selective coyote control done in the previous five years along a 24-km stretch of Wyoming Highway 287 for the removal of depredating coyotes on sheep that grazed east of the highway.

ADMB area 55 is the southern treatment unit and corresponds with Wyoming Game and Fish antelope hunt unit 55. It is bordered on the north by Interstate 15, the east by the drainage divide of Atlantic Rim, the south by Muddy Creek and on the west by Wyoming Highway 789. There are a total of 92,982 ha (359 mi^2), including 46,556 ha (179 mi^2) of patented lands, 7,964 ha (30 mi^2) of state lands and 38,462 ha (148 mi^2) of public land administered by the Bureau of Land Management (BLM). Lands within area 55 are predominantly grazing lands used by cattle. Portions of area 55 are oil and gas leases and are currently under use. Three human habitations (seasonal cow camps) exist in the area.

ADMB area 63 is the northern treatment unit. It is the northern portion of Wyoming Game and Fish antelope hunt unit 63. It also encompasses a small portion of antelope hunt unit 68 on the north side of Wyoming Highway 220. It is bordered on the north by the Sweetwater River, on the east by the banks of Pathfinder Reservoir and the North Platte River, on the south by the drainage divide of that portion of the Seminole Mountains located on the west side of the North Platte River and Ferris Mountain, and on the west by Muddy Creek, at Muddy Gap Junction north to the Sweetwater River. There are a total of 95,184 ha (367 mi^2) in area 63, consisting of 14,504 ha (56 mi^2) of patented lands, 8,935 ha (34 mi^2) of state land and 71,744 ha (277 mi^2) of public land administered by the BLM. Lands

within area 63 are used for grazing cattle. There are no mineral leases in operation. There are eight inhabited locations, including six cattle-ranch headquarters and two historical sites.

There are many similarities between the two treatment areas, including size and ecological composition, which is partially why they were chosen as treatment areas. The average budget allocated to coyote removal over the two years in each area is also similar, with area 63 having an average budget that is 7 percent greater than area 55. The average number of coyotes removed in both areas over the two-year period is similar (130 in area 55 and 126.5 in area 63).

Baseline data on coyote abundance was established prior to treatment. Merrell and Shwiff (in review) surveyed many census techniques and after assessing each method the siren-elicited-response method was chosen. This method required minimum personnel, could be accomplished in a short amount of time, and one of the authors (Merrell) had experience in estimating the numbers of individuals involved in a group howl.

Coyotes were removed from area 55 and area 63 each year of treatment primarily by aerial hunting from fixed winged aircraft. Some M-44's were placed in area 63 for livestock protection. During 2002, some denning was used in each treatment area to supplement aerial operations. Aerial operations were conducted beginning in January, 2001 and continued until May, 2001 the first year. Post-treatment coyote populations remaining in the treatment areas were estimated using a formula comprised of the known number of coyotes seen versus estimated population expressed as a percentage, (first year of treatment), extrapolated over to the second year of treatment. We assume that the same amount of effort expended over the same amount of area would result in the same percentage of the coyote population being viewed. Using data supplied by the pilots during aerial operations, we were able to estimate the coyote population each year after treatment had begun.

Economic Analysis

The economic analysis for pronghorn antelope indicated that coyote management for the protection of antelope increased recruitment and led to a positive net benefit for Wyoming (Merrell and Shwiff, in review). For this economic analysis, we applied a benefit-cost model, which attempted to determine the net benefit to Wyoming in monetary terms, based on the gross benefits and costs given coyote predation management on cattle in both treatment areas and cattle and antelope in one of the treatment areas. The benefit-cost analysis (BCA) follows the framework outlined in Engeman et al. (2002).

The BCA of coyote management involves estimating the monetary value of the benefits measured in the dollar value of cattle saved by reduced coyote predation versus the costs measured in the amount spent to remove coyotes. The determination of the monetary values of pronghorn antelope was assumed to fall within the civil penalties, which can range from $400 to $10,000 for an illegal take. In particular, the Wyoming Game and Fish Department estimates the economic value of each antelope to the state at $3,000 in 2003 dollars (Wyoming Game and Fish Department, personal correspondence). We used four different antelope values ($400, $1,500, $3,000 and $10,000) to estimate the benefits and costs of coyote management, allowing for an economic sensitivity analysis (Bodenchuk, et al, 2003). The dollar value was considered consistent across time periods and was not adjusted for inflation given the lack of normal market characteristics unique to wildlife species (see Engeman et al., 2002).

The economic value of cattle is also reflected by a range of values. The minimum value of cattle is assumed to be the market value of $425 at the time of the study. This reflects the minimum value because it is assumed that at the very least, the value of a single head of cattle is what it can bring in the market. A range of values is used to calculate the economic contribution of cattle to reflect the idea that economic value of cattle to the state exceeds what each head can bring on the market. This is due to the fact that market values do not always reflect the actual value of each individual head, and dollars generated from the agricultural sector of the economy tend to have a greater multiplier effect in the local economy. Given this, we used a range of values ($425, $600, $800 and $1,000) to estimate the benefits and costs of coyote management.

Estimates of Cattle Saved from Coyote Predation

In years prior to the study years, cattle production was stable in the study areas, showing no increase in subsequent years. Ranchers also reported that there were no changes in husbandry practices, ranching practices (i.e. new fencing, scare devices, and protection animals), or number of head stocked during the study years. Therefore, at the end of the treatment year, the number of additional calves taken to market was attributed to coyote predation management. Table 1 shows the increased number of calves attributed to coyote predation management. Area 55, which has fewer calves than area 63, produced a consistent 32 additional calves in each treatment year, while area 63 also produced an average of 152 additional calves per year.

In this study, the number of cattle saved each year represents the benefits (B) of the coyote predation management program. It is important to note that the increase in calf production could reflect not just decreased calf predation, but also increased calf production because cows were less stressed, were able to forage without harassment and other contributing factors that led to an environment more conducive to calf production. Antelope were also saved from predation in area 63 during the study period. In 2001, 366 antelope were saved from predation while in 2002, 434 were saved (Merrell and Shwiff, in review).

Calculating Benefits, Costs and Benefit-Cost Ratios (BCRs)

The benefits that accrued each year were measured in terms of the number of

Table 1. Number of cattle saved.

Year	Area 55	Area 63
2001	32	150
2002	32	154

cattle saved each year. Benefits were calculated by multiplying the number of cattle saved each year by the value of each individual head. Annual total cost of coyote removal represents the costs (C). In 2001, at area 55 the annual program costs for coyote predation management was $8,899.58, and in 2002, the program costs were $9,537.37. At area 63, program costs were $9,991 in 2001 and $10,079.20 in 2002. In order to compare costs across years, 2001 costs were adjusted for inflation to reflect their actual costs in 2002 dollars. The BCRs are calculated using the standard format of the ratio of benefits to costs (Loomis and Walsh, 1997; Boardman et al., 1996; Nas, 1996; Zerbe and Dively, 1994; and Loomis, 1993). In general, the BCRs for this analysis were calculated from the equation:

$$BCR = \frac{\textit{Total Value of Calves Saved}}{\textit{Coyote Management Costs}}$$

A value of 1.0 is indicative of no net benefit (dollar savings in recruited calves). For example, the basic BCR for the year 2001 is calculated from the equation:

$$BCR^{\$425}_{2001} = \frac{Benefits(B)}{Costs(C)} = \frac{\$13,600}{\$8,899.58} = 1.53$$

In other words, in 2001, the benefit of saving 32 calves at $425 per calf is 1.53 times greater than the annual cost of predation management for that year.

Keep in mind that only 25 percent of the total area involved in the treatment on area 55 is utilized for calf production. The cost figure represents the total costs for predator management over 100 percent of the area, which implies that the BCR is conservative.

The coyote predation management program in area 63 benefited both cattle and pronghorn antelope. Merrell and Shwiff (in review) examined the benefits and costs associated with coyote predation management for antelope. It is important to examine the cumulative benefit-cost ratio when both species are considered together. The benefits (B) are calculated by multiplying the number of antelope saved by the dollar value per antelope and adding that to the value of cattle saved. The net benefits (NB) of coyote removal are determined by the total value of antelope and cattle saved minus the program costs, which is given in the equation:

$$NB^{\$antelope,\#cattle}_{2001} = [(\$antelope * \#\ of\ antelope\ saved) + (\$cattle * \#\ of\ cattle\ saved)] - annual\ program\ costs.$$

Equation (3) can be rewritten as,

$$NB^{\$antelope,\#cattle}_{year} = [(B^{\$antelope}_{year}) + (B^{\$cattle}_{year})] - C_{year}$$

Adding the benefits together in Equation (4) represents the total value (benefit) of antelope and cattle saved.

Calculating the cumulative (antelope plus cattle) benefits and costs that accrue to area 63 as a result of coyote management allows for the calculation of the benefit-cost ratios. The benefit-cost ratios are calculated for each area by Equation (1), except for the numerator changes to total value of cattle and antelope saved:

$$BCR_{year} = \frac{[(B^{\$antelope}_{year}) + (B^{\$cattle}_{year})]}{C_{year}}$$

This equation more accurately describes the benefits and costs that accrue to each area. Under this equation, if the BCR exceeds 1, then the total benefits to that area exceed the costs.

Results and Discussion

Area 55

Data provided by livestock producers indicated that in the two years of coyote removal in the treatment areas, there were an additional 368 calves sent to market, a 5.4-percent increase per year. This increase occurred despite one of the most severe droughts in south-central Wyoming in recent history and no changes in cow/calf management practices or number of head stocked.

Area 55 had a minimum total population of 169 coyotes prior to treatment. There were 108 coyotes removed, or 63.9 percent of the population in 2001. At the beginning of treatment in 2002, there was an estimated minimum population of 163 coyotes and a total of 130 coyotes removed, or 79.7 percent of the minimum estimated population. The cattle population at area 55 in 2002 consisted of 715 cows and 643 calves. The value of calves saved or the benefit of each calf saved is calculated by multiplying the calves saved by the dollar value of a calf. For example, Table 2 illustrates that in 2001, 32 calves were saved at a dollar value of $425, which resulted in $13,600 worth of calves saved. Substituting the appropriate values into Equation (2) yields the benefit-cost ratios in parenthesis in Table 2.

Lower costs in 2001 resulted in higher BCRs for that year in comparison to 2002. All of the BCRs were greater than 1, indicating that at any calf value, the benefits of the program exceed the costs.

Area 63

Area 63 had an estimated minimum total population of 195 coyotes in 2001. During treatment in 2001, 172 coyotes were removed, or 88.2 percent of the estimated population. In 2002, there was an estimated population of 115 coyotes, with 97 being removed, or 84 percent of the population. The cattle production at this site was 3,380 cows and 2,872 calves in 2002. Calculating the value of calves saved and substituting the appropriate values into equation (2) yields the results in Table 3.

A higher number of calves saved in this treatment unit resulted in higher BCRs. At the very minimum, the benefits exceed the costs by at least six times.

Table 2. Value of calves saved by coyote predation management in Area 55 (Benefit-Cost Ratios).

Year	No. of calves saved	Value of Calf $425	$600	$800	$1,000
2001	32	$13, 600 (1.53)	$19,200 (2.16)	$25,600 (2.88)	$32,000 (3.60)
2002	32	$13, 600 (1.43)	$19,200 (2.01)	$25,600 (2.68)	$32,000 (3.36)

Table 3. Value of calves saved by coyote predation management in Area 63 (Benefit-Cost Ratios).

Year	No. of calves saved	Value of Calf $425	$600	$800	$1,000
2001	150	$63,750 (6.38)	$90,000 (9.01)	$120,000 (12.01)	$150,000 (15.01)
2002	154	$65,450 (6.49)	$92,400 (9.17)	$123,200 (12.22)	$154,000 (15.28)

3.3 Cumulative Benefit-Cost Ratio for ADMB 63

Substituting the appropriate values into Equation (3) yields,

$$NB_{2001}^{\$400,\#425} = [(\$400*366) + (\$425*150)] - \$9,991 = \$200,159$$

Completing this process for all of the values of antelope and cattle yields the numbers provided in Table 4. Even at the lowest value for both antelope and cattle, the net benefit to the Wyoming economy is approximately $200,000 for each year. Using the Wyoming Game and Fish value of $3,000 for antelope and the conservative value of $600 for cattle, the cumulative net benefits of this program are $1,178,009 for 2001 and $1,384,321 for 2002. These values represent the additional benefit to the Wyoming economy of this program, through expenditures on the hunting of antelope and the market sale of cattle and additional revenues generated by cattle production.

The BCRs for area 63 lend further support to the success of this program. BCRs greater than 1 indicate that the program benefits exceed the costs. Examining the BCRs that result from the coyote predation management program in area 63 in Table 5, it shows that at the minimum, the benefits are over 20 times the costs in both years.

Using the Wyoming Game and Fish value of $3,000 for antelope and the conservative value of $600 for cattle, the BCRs indicate that in 2001 the benefits were 122 times the costs and in 2002 the benefits were 138 times the costs. These BCRs show the extraordinary success of this program.

Conclusions

Determination of the economics of predator control has been valuable to formulation of management strategies elsewhere (e.g., Engeman et al., 2002). The results of this benefit-cost analysis demonstrate that, from Wyoming's perspective, a coyote predation management for the protection of antelope and cattle is a cost-beneficial program with the potential to increase revenue to Wyoming in the range of $200,000 to $4,000,000. Benefits would most likely continue to accrue for each year thereafter; however, the model used does not predict benefits beyond the short-term horizon.

Using a range of values for antelope and cattle allows for the examination of the program from the most conservative scenarios (lowest animal values) to the maximum potential benefits (highest animal values). This analysis shows that under any value scenario, the efforts of this program result in economic efficiency.

Table 4. Cumulative net benefits for cattle and antelope saved by coyote predation management in Area 63 for the period 2001-2002.

2001

Value of Cattle	Value of Antelope $400	$1,500	$3,000	$10,000
$425	$200,159	$602,759	$1,151,759	$3,713,759
$600	$226,409	$629,009	$1,178,009	$3,740,009
$800	$256,409	$659,009	$1,208,009	$3,770,009
$1,000	$286,409	$689,009	$1,238,009	$3,800,009

2002

Value of Cattle	Value of Antelope $400	$1,500	$3,000	$10,000
$425	$228,971	$706,371	$1,357,371	$4,395,371
$600	$255,921	$733,321	$1,384,321	$4,422,321
$800	$286,721	$764,121	$1,415,121	$4,453,121
$1,000	$317,521	$794,921	$1,445,921	$4,483,921

Table 5. Cumulative Benefit-Cost Ratios (BCRs) for cattle and antelope saved by coyote predation management in Area 63 for the period 2001-2002.

2001

Value of Cattle	Value of Antelope $400	$1,500	$3,000	$10,000
$425	21.66	63.17	119.77	383.89
$600	24.37	65.88	122.47	386.60
$800	27.46	68.97	125.57	389.69
$1,000	30.56	72.06	128.66	392.78

2002

Value of Cattle	Value of Antelope $400	$1,500	$3,000	$10,000
$425	23.72	71.08	135.67	437.08
$600	26.39	73.76	138.34	439.76
$800	29.45	76.81	141.40	442.81
$1,000	32.50	79.87	144.46	445.87

Literature Cited

Boardman, A. E., D. H. Greenberg, A. R. Vining, and D. L. Weimer. 1996. Cost Benefit Analysis: Concepts and Practice, Prentice Hall, Upper Saddle River, New Jersey, 493 pp.

Bodenchuk, M. J., J. R. Mason, and W. C. Pitt, 2003. Economics of predation management in relation to agriculture, wildlife, and human health and safety. In: L. Clark (Ed.) Human Conflicts with Wildlife: Economic Considerations. Proceedings of a Symposium, 1-3 August 2000 at Colorado State University, Fort Collins, CO, USA.

Engeman, R. M., S. A. Shwiff, B. Constantin, M. Stahl, and H. T. Smith, 2002. An economic analysis of predator removal approaches for protecting marine turtle nest at Hobe Sound National Wildlife Refuge. Ecological Economics 42:469-478.

Loomis, J. B., 1993. Integrated Public Lands Management: Principles and Applications to National Forests, Parks, Wildlife Refuges and BLM Lands. Columbia University Press, New York, 474 pp.

Loomis, J. B., and R. G. Walsh. 1997. Recreation Economic Decisions: Comparing Benefits and Costs. 2nd Edition, Venture Publishing, Inc. State College, Pennsylvania, 436pp.

Merrell, R. J and S. A. Shwiff. Observations on coyote predation in relationship to antelope fawn recruitment in south central Wyoming. In review.

Nas, T. F., 1996. Cost-Benefit Analysis: Theory and Application, Sage Publications, Inc., California, 220 pp

Springer, J. T. and C. R. Wenger. 1981. Interactions between and some ecological aspects of coyotes and mule deer in central Wyoming. Wyoming Game and Fish Publication.

Zerbe, R. O., and D. D. Dively. 1994. Benefit-Cost Analysis: In Theory and Practice,HarperCollins College Publishers, New York, NY, 557 pp.