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Original Article

Spillover Benefits of Wildlife Management to Support Pheasant Populations

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ABSTRACT Ring-necked pheasant (*Phasianus colchicus*) and other upland game populations in Wyoming, USA, have been declining due to changes in agricultural practices, urban development, and predation. Raccoons (*Procyon lotor*) have been implicated as one of the main predators of pheasant nests. Management of raccoons to support pheasant populations has the direct benefit of increasing pheasant populations and additional spillover benefits to corn producers in the region may occur. We conducted a field study in southeastern Wyoming from July to October 2009 to estimate the increase in corn yield associated with raccoon trapping. Although the primary purpose of the raccoon trapping was the support of upland game bird populations, the added benefit of increased revenue for corn producers is an important consideration. We tracked corn damage in 10 study plots over 6 weeks and estimated that trapping raccoons yields a revenue increase of US$10.75/ha. This type of spillover benefit is rarely considered when raccoon management decisions are made but is significant and should be included in any explicit or implicit benefit–cost analysis of the management action. Published 2013. This article is a U.S. Government work and is in the public domain in the USA.

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In southeastern Wyoming, USA, a major goal of the Animal Damage Management Board is to support ring-necked pheasant (*Phasianus colchicus*) and other upland game bird populations. License fees for pheasant hunting are an important revenue source for many state wildlife agencies, and pheasant populations have been declining throughout the western United States due to changes in agricultural practices, urban development, and predation. One method used by the Animal Damage Management Board to support upland game bird populations is the control of small predators, such as raccoons (*Procyon lotor*), because raccoons feed on eggs and juvenile birds (Ough 1979, Greenwood 1982). In Goshen County, the Predator Management District designated 5 areas in which to focus predator control. U.S. Department of Agriculture Wildlife Services cooperated with 60 landowners in these areas to manage raccoon populations. Although numerous studies have quantified the impact of predator control on wild bird populations (e.g., Côté and Sutherland 1997, Bolton et al. 2007, Kauhala et al. 2008), there are additional, spillover benefits from raccoon control that have not been previously quantified. These spillover benefits, also referred to as secondary, indirect, or incidental benefits, depend on the quantity and variety of species affected by raccoons (Boardman et al. 1996, Shwiff and Bodenchuk 2004). For example, when control occurs near land used for corn production, the primary benefit is that raccoon-caused damage to the pheasant population is mitigated, but the spillover benefits of a decrease in raccoon-caused damage to corn are an unintentional side effect.

Raccoons are known to damage sweet and field corn; however, estimates of raccoon damage to corn are rare. In Indiana, USA, raccoons were responsible for 87% of corn damage by wildlife (MacGowan et al. 2006). Tzilkowski et al. (2002) estimated that damage to corn in Pennsylvania, USA, by wildlife was >US$28 million, with raccoons responsible for about US$1.4 million of the damage. Wildlife damage to agricultural crops is a major concern for producers and government agencies tasked with managing offending wildlife species. Providing new information on the amount, type, and distribution of wildlife-caused damage is a crucial part of making the appropriate wildlife management decisions. Thus, the purpose of this study was to quantify the spillover benefits of raccoon control that accrue to corn producers.

STUDY AREA

We conducted a field study in Goshen County, in southeastern Wyoming (42.08°N, 104.32°W). Elevation

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was approximately 1,250 m, average rainfall was about 36 cm annually, and snowfall averaged 89 cm annually. Goshen was an important agricultural county in Wyoming. In 2007, 115,829 ha in the county were cropland and 11,382 ha (9.8%) were planted with corn (NASS 2011*a*).

METHODS

We chose 10 study plots: 5 that were adjacent to current raccoon trapping operations and 5 not near trapping operations. All trapping operations adjacent to the plots selected were ongoing for ≥1 year prior to the field study. Results should be interpreted in light of this length of time, given that trapping success is likely a function of time. The 10 plots were then grouped into 5 pairs, such that each pair consisted of 1 plot adjacent to a trapping operation and 1 plot not adjacent to a trapping operation. Plots were paired with similar plots on the basis of type of corn grown, distance from the edge of the field to trees or shrubbery providing raccoon habitat or cover, and distance to water. Although there is no test for the validity of the pairings, Table 1 summarizes the pairings and data used to make those pairings. It should be noted that we did not estimate raccoon densities before or after trapping, but the positive yield loss estimates for all fields implies that raccoons were present at all fields. The lack of data on raccoon density prevented us from estimating the relationship between density and damage but did not prevent us from testing for relationship between trapping and damage.

We conducted damage assessment once per week for 6 weeks near the end of the corn growing season (Jul–Oct 2009) because raccoons tend to consume ripening or ripened corn (MacGowan et al. 2006). Study design elements were based on previous studies of wildlife damage to corn (e.g., Wywialowski 1996, Tzilkowski et al. 2002, MacGowan et al. 2006). Every tenth row was included in the sample, and the sample was limited to 20 stalks deep because raccoons typically consume corn close to the edge of the field. We recorded raccoon-caused damage from each week and included the number of newly damaged or missing ears and newly broken or stripped stalks. We marked damage with paint to avoid double-counting.

To estimate yield loss, we assumed that only the outer 20 stalks of the field were susceptible to damage and that no damage occurred in the interior. We then used sampling data to estimate the number of damaged stalks in the perimeter of the field. The percentage yield loss was calculated by dividing the estimated number of damaged stalks by the estimated total number of stalks in the entire field. We did not calculate total yield based on sample data; we only calculated percent yield loss based on sample data. For simplicity and to ease extrapolation, when we monetized yield loss we assumed overall yield was equal to the average corn yield in Wyoming.

We analyzed data to determine the difference between the mean levels of damage in the fields adjacent to trapping operations and those not adjacent. For spillover benefits to accrue to corn farmers, the mean level of damage in corn fields adjacent to trapping operations should be less than the mean level of damage in corn fields not adjacent to trapping operations. We evaluated differences in damage levels using a 1-tailed paired t-test. We chose a 1-tailed test due to the unlikelihood of raccoon removal leading to more damage by raccoons.

Price and production data from the U.S. Department of Agriculture National Agriculture Statistics Service (NASS) was used to quantify the spillover benefits of trapping that accrue to corn production. In Wyoming from 2006 to 2008, the average corn yield was 8.327 metric tons/ha, assuming that one bushel weighs 0.0254012 metric tons (NASS 2011*a*, CME Group). The average price received over the same time period was US$127.95/metric ton (NASS 2011*b*). The spillover benefits associated with raccoon trapping can be monetized by estimating to what extent trapping reduces yield loss and adjusting expected final yields based on this estimate.

RESULTS

In 4 out the 5 pairs of fields, trapping-adjacent fields received less damage than non-adjacent fields (Table 1). In the fields adjacent and not adjacent to trapping operations, the mean yield loss to raccoons was 0.07% (SD = 1.57) and 1.07% (SD = 0.08), respectively, and the average difference in yield loss among the 5 pairs was 1.0% point (SD = 1.50;

Table 1. Study plot characteristics and calculated crop yield losses to raccoon in Goshen County, Wyoming, USA, from crop damage assessment data collected once per week, July–October 2009.

Plot[a]	Trapped[b]	Distance to cover (m)	Distance to water (m)	Size (ha)	Yield loss (%)
A1	N	9	18	1.27	4.14
B1	Y	27	18	2.76	0.23
A2	N	91	73	6.69	0.221
B2	Y	64	46	17.79	0.037
A3	N	18	594	6.77	0.023
B3	Y	18	777	3.31	0.043
A4	N	805	137	5.18	0.963
B4	Y	483	160	7.19	0.044
A5	N	2,414	1,609	21.33	0.0013
B5	Y	1,609	2,012	4.52	0.00

[a] Plots with same number were paired based on similarity of corn type, distance from edge field to raccoon habitat, and distance to water.
[b] Indicates whether ongoing raccoon trapping had been (Y) or had not been (N) conducted on the plot during the year preceding the study.

$P = 0.126$). Although the difference in means would not be considered statistically significant in the classical sense (5% or 10% level of significance), it does indicate a strong probability that trapping was responsible for the different levels of damage. The field study results imply that average yield without damage would be 8.416 metric tons (0% yield loss), damage in a field not adjacent to trapping operations would reduce the yield to 8.326 metric tons (1.07% yield loss), and damage in an field adjacent to a trapping operation would reduce yield to 8.410 metric tons (0.07% yield loss). Thus, trapping saves an average of 0.084 metric tons of corn/acre. At a price of US$127.95/metric ton, the crop savings is valued at US$10.75/ha.

DISCUSSION

Spillover effects, either negative or positive, are rarely factored into decisions about wildlife management. Often even the direct impacts of wildlife damage management actions are difficult to quantify, which limits the scope of economic analyses involving wildlife. This study highlights a method to capture a specific spillover benefit of wildlife management. The spillover benefits of any proposed wildlife management action are often small, but in cases in which the direct benefits of a proposed action are marginal, it is possible that consideration of the spillover effects make it worthwhile to initiate the management action.

The results of this analysis show there are revenue gains associated with trapping raccoons near corn fields. Despite this conclusion, anecdotal evidence suggests that few farmers trap raccoons to prevent corn damage, which implies that the expected revenue gains rarely outweigh the costs they would incur from trapping. In part, this may be because the perimeter of fields is often relatively less productive, which minimizes the crop savings due to trapping. However, the purpose of the raccoon trapping in this study was not primarily to prevent corn damage. Rather, it was to promote pheasant and other upland game bird populations. Viewed from this standpoint, the revenue gains associated with increased corn yields are an important spillover benefit of the trapping operation. A full benefit–cost analysis of raccoon trapping is beyond the scope of this study, but the decision about whether and where to trap for raccoons to promote game bird populations should consider the potential revenue gains by corn farmers.

MANAGEMENT IMPLICATIONS

Selecting trapping locations should be based on raccoon foraging and movement and on the proximity to corn fields to maximize trapping benefits to corn farmers. Fields that are close to suitable raccoon habitat and water sources appear to increase the revenue gains experienced by corn farmers when trapping is conducted nearby. Consideration should also be given to the type of corn grown. Irrigated corn may be more valuable than dry-land corn, which implies a larger benefit to trapping near irrigated fields. Additionally, sweet corn is considerably more valuable than field corn and is especially attractive to raccoons, thus, proximity of trapping operations to sweet corn should be considered.

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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, USA.

Bolton, M., G. Tyler, K. Smith, and R. Bamford. 2007. The impact of predator control on lapwing *Vanellus vanellus* breeding success on wet grassland nature reserves. Journal of Applied Ecology 44:534–544.

CME Group. Undated. Commodity metric conversion guide. http://www.cmegroup.com/trading/agricultural/files/AC-225_MetricGuide.pdf Accessed 23 Nov 2012.

Côté, I. M., and W. J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology 11:395–405.

Greenwood, R. J. 1982. Nocturnal activity and foraging of prairie raccoons (*Procyon lotor*) in North Dakota. American Midland Naturalist 107:238–243.

Kauhala, K., P. Helle, and E. Helle. 2008. Predator control and the density and reproductive success of grouse populations in Finland. Ecography 23:161–168.

MacGowan, B. J., L. A. Humbug, J. C. Beasley, T. L. Devault, M. I. Retamosa, and O. E. Rhodes, Jr. 2006. Corn and soybean depredation by wildlife. Purdue University, Extension FNR-265-W, Purdue, Indiana, USA.

National Agricultural Statistics Service [NASS]. 2011*a*. Quick stats 1.0. http://www.nass.usda.gov/Data_and_Statistics/index.asp. Accessed 15 Nov 2009.

National Agricultural Statistics Service [NASS]. 2011*b*. Agricultural statistics annual. http://www.nass.usda.gov/Publications/Ag_Statistics/2009/index.asp. Accessed 15 Jan 2011.

Ough, W. D. 1979. Influence of probability and magnitude of reward upon raccoon foraging behavior. Thesis, University of Nebraska, Lincoln, USA.

Shwiff, S. A., and M. J. Bodenchuk. 2004. Coyote predation management: an economic analysis of increased antelope recruitment and cattle production in South Central Wyoming. Sheep & Goat Research Journal 19:32–36.

Tzilkowski, W. M., M. C. Brittingham, and M. J. Lovallo. 2002. Wildlife damage to corn in Pennsylvania: farmer and on-the-ground estimates. Journal of Wildlife Management 66:678–682.

Wywialowski, A. P. 1996. Wildlife damage to field corn in 1993. Wildlife Society Bulletin 24:264–271.

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