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ARE WILDLIFE-CAUSED LOSSES OF AGRICULTURE INCREASING?

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ABSTRACT: Both the percent of producers reporting and the value of wildlife-caused losses increased from 1989 to 1994. In 1994, 58% of respondents reported wildlife-caused losses of their agricultural commodities, an increase from the 55% of respondents who reported losses in 1989. Based on the median value of producer-estimated loss, wildlife-caused losses cost producers approximately \$591 million in 1994, \$130 million more than in 1989. Losses based on producer estimates have been consistent with field-measured estimates of damage. While these losses represent 1% of the value of agricultural production, losses were not evenly distributed and 23% of producers estimated losses of >\$500, an amount that is psychologically significant if not also economically significant. While catfish losses to wildlife were 4% of the total sale value of catfish in 1996, the losses were equivalent to one-sixth to one-third of the average catfish producers' profit. Producers' ability to predict the location of their crop losses as well as consistent patterns of losses based on field assessments suggests that wildlife managers may be able to develop models of wildlife damage that would allow them to better assist producers in planning agricultural production so that wildlife-caused losses are reduced. Given the increasing populations of many wildlife species and the declining habitat base for supporting those populations, wildlife managers will need to increasingly rely on cooperative relationships with agricultural producers. Management of wildlife damage relative to agricultural needs will increasingly challenge the wildlife profession in the coming years. Wildlife managers must recognize the magnitude and distribution of wildlife-caused damage to agriculture and consider both perceptions and damage in their decisions about wildlife management.

KEY WORDS: agricultural producers, birds, *Canis*, catfish, coyotes, damage, deer, distribution, dollar value, economic value, field crops, fruits, livestock, *Odontocoleus*, vegetables, wildlife

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INTRODUCTION

Managers in the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS, formerly Animal Damage Control) believed they lacked information and understanding about wildlife-caused losses of agriculture. They, therefore, contracted with USDA's National Agricultural Statistics Service (NASS) starting in 1989 to assess the percent of producers who had sustained losses from wildlife, the producers' assessment of which wildlife caused the losses, and their estimate of the value of those losses. Most recently, the dollars spent by producers in loss prevention have been assessed and the effectiveness of the Wildlife Services program in helping producers reduce losses has been enumerated. National estimates of wildlife-caused damage to agricultural products were completed in 1989 (Wywialowski 1994) and 1994 (Wywialowski 1997). For livestock assessments, losses to cattle in 1991 were < 0.1% of the value of production (Agric. Stats. Board 1992), although an estimated 2.87% of beef calves were lost to predators in 1996 (USDA 1997); losses to sheep based on two years data equal 2.5 to 2.7% of the value of production (Agric. Stats. Board 1991; Simpson 1995); and losses of goats based on a five-state assessment were 3.8% of the value of goats produced in those states (Agric. Stats. Board 1995a,b). Losses to field corn were measured in 1993 with the value of loss estimated at >\$100 million nationwide, but averaging 0.7% of the value of production in the top 10 corn-producing states (Wywialowski 1996). Losses were highly variable among the states measured, with a few producers sustaining substantial losses in some fields. Most recently

wildlife-caused losses of catfish were assessed (Wywialowski 1998). Based on cost of production estimates from other sources, an estimated one-sixth to one-third of the average catfish producers' profit went to wildlife. Questions remain on the best means either for producers to minimize their losses, or to redistribute wildlife-derived benefits among producers with regard to wildlife-derived costs.

Except for field measures of wildlife-caused loss to ripening field corn (Wywialowski 1996), all measures of loss are based on producer estimates. While many argue that producers' estimates of losses are biased high, comparisons of field-based measures of wildlife-caused losses with producer-based estimates of wildlife-caused losses indicate that most producers accept minimal losses without reporting them and underestimate any field crop or vegetable, fruit, or nut losses that do occur (see Wywialowski 1994 for an extensive discussion of this issue). The total losses for livestock-poultry producers were similar in 1994 and 1989; these total losses based on producer estimates are consistent with estimates based on field studies and surveys of predation rates, and the number or value of livestock in the United States. Other losses were consistently underestimates based on extrapolation from field-derived measures. Consistent with this idea, the value of field corn documented as lost to wildlife in 1993 as a proportion of the value of all field crops lost to wildlife in 1994 based on producer estimates, was less than the value of field corn as a proportion of the value of all field crops in 1992 (U.S. Bur. of Census 1994), even though the field-measured value is a minimal estimate of actual wildlife-caused losses because many ripening field corn losses that could

not be definitively identified as wildlife-caused by inspection of the corn in the late fall were not included as wildlife-caused losses (Wywiałowski 1996). The producer-based estimate of field crop losses in this survey at 0.7% of the market value of all field crops mirrors the quantified minimal value of ripening field corn lost to wildlife.

METHODS

For the national estimates of wildlife-caused losses to agriculture, initial samples were 20,001 and 16,000 producers. Wywiałowski (1994) provides details on survey methods, as well as means of data analysis and statistical tests used. For most surveys, the sample was stratified randomly by farm size to assure adequate large farm representation as in 1989, or stratified by farm type and randomly selected within farm type to assure adequate sampling of the minor farm types as in 1994. The NASS List Sampling Frame is a computerized and regularly updated list of farm operations within all states from which the samples are selected.

Data were collected from producers using NASS's 11 computer-assisted telephone interview centers. In December, producers were mailed a pre-survey postcard that explained the objectives of the survey and the importance of their participation. Producers were contacted by telephone in January with questions about the preceding year's production and losses. Respondents were asked to consider any wildlife-caused damages to their agricultural resources that resulted in a substantial or significant loss.

Other data collection and analysis procedures for the 1989 and 1994 national surveys follow (Wywiałowski 1994). Data were weighted before analysis for each respondent based on the number of usable responses in each state and the number of farms in each state relative to the total number of farms and total number of usable responses. For the calculation of the percentage of producers in each commodity group due to producer-type subsampling in 1994, weights to correct for overrepresentation of producers of catfish and trout, and other commodities were also used.

Proportions of respondents in commodity groups and proportions of each wildlife group cited to cause losses were compared among regions using the Bonferroni modified least significant difference test with $\alpha = 0.05$. Significant differences between other groups were determined using maximum likelihood ratio chi-square tests (MLR). Differences between 1989 and 1994 were assessed by non-overlap of the 95% confidence intervals for point estimates. Differences in median losses between primary and non-primary farm types were assessed using the Mann-Whitney U test (MWU). All results that follow are statistically significant.

RESULTS and DISCUSSION

All Agricultural Producers

Nationwide, 58% of respondents reported wildlife-caused losses of some commodity, an increase from the 55% who reported losses in 1989. Losses varied among regions (Figure 1). Overall, losses increased from 1989 consistently across most regions (Figure 2), and in most but not all producer groups (Figure 3). In nearly all

groups, the producers who received the majority of their income from a commodity type (referred to as primary farm type), sustained proportionately and monetarily greater losses than those producers who produced some of the commodity but did not consider it their primary source of income (Figure 4). This is predictable based on sociological as well as economic aspects of wildlife-caused losses. The dollar values of losses were calculated as described in (Wywiałowski 1994) using median losses due to the extremely non-normal distribution of losses (Sokal and Rohlf 1981) (Figure 5). In the 1994 survey, 23% of all producers reported losses >\$500 (Figure 6). Based on the median of producers' estimates of their losses, wildlife-caused losses cost producers approximately \$591 million in 1994 (Figure 7), >\$100 million more than in 1989. If all producers estimated their losses accurately (especially those citing very high values) and their losses represented producers nationwide, then wildlife-caused losses based on the mean of producers' estimates may have been as high as \$1.6 billion in 1994, compared to \$1.3 billion in 1989. Much of these results are from Wywiałowski (1997).

Livestock and Poultry Producers

Livestock or poultry (LP) was raised by three-fourths of respondents. Of those who raised livestock or poultry, 21% reported wildlife-caused losses (Figure 8) statistically not different from the 20.4% who reported losses in 1989. Carnivores were cited most frequently by LP producers as causing their losses, of which coyotes (*Canis latrans*) were cited most frequently (11% nationally, $\geq 20\%$ in three western regions). Carnivores were cited as causing losses most frequently in Texas and least in the Great Lakes. The remaining wildlife groups were cited by $\leq 2\%$ of all LP producers.

Losses of livestock and poultry estimated by LP producers who reported a loss had a median value of \$400/farm, similar to the \$450/farm in 1989. Based on these estimates, wildlife caused \$140 million in losses for LP producers in 1994, similar to the \$138 million estimate for 1989 (Figure 7).

Field Crop Producers

Field crops (FC) were raised by 81% of respondents, similar to the 83% in 1989. Half (51%) of FC producers said they lost crops to wildlife (Figure 9), a slight increase from the 48% who reported losses in 1989. Hoofed mammals were cited by 41% of FC producers, an increase from 34% in 1989. Rodents and rabbits were cited by 15%, a decrease from 19% in 1989. Birds were cited by 12%, an increase from 9% in 1989. The other wildlife groups did not differ between years.

Deer were the main hoofed mammal cited for FC losses (40% of FC producers) and were the species responsible for the increased citing of hoofed mammals in 1994. The remaining significant changes are consistent with increasing small furbearer (carnivore/omnivore) populations and the consequent decreases in prey abundance, reducing rodent and rabbit losses.

For the 51% of FC producers who had FC losses, the median estimated loss was \$350/farm, up from \$300/farm in 1989. Based on median producer estimates, wildlife caused approximately \$316 million for FC producers in

1994, an increase from the estimated \$237 million loss in 1989 (Fig. 7).

Figure 1. Regions of the U.S. used for most of the 1989 and 1994 national surveys.

Figure 2. Percent of all respondents with any loss to any wildlife for any commodity by region in 1989 and 1994.

Figure 3. Percent of each producer group with wildlife-caused losses to their commodity type in 1989 and 1994.

Figure 4. Percent of each producer group with wildlife-caused losses to their commodity type by primary and non-primary farm types in 1994.

Figure 5. Percent of all respondents by the sum of all wildlife-caused losses for all commodities per farm in 1994.

Figure 6. Percent of all producers within a dollar value category of wildlife-caused losses for all commodities per farm in 1994.

Figure 7. The median-based sum of wildlife-caused losses by commodity types in 1989 and 1994.

Figure 8. Percent of livestock/poultry producers with wildlife-caused losses of their livestock or poultry by region in 1989 and 1994.

Figure 9. Percent of field crop producers with wildlife-caused losses of their field crops by region in 1989 and 1994.

Producers with Stored Commodities

Nearly half (44%) of respondents stored some whole grain, feed, or seed on their farm; the majority of which were the LP (55%) and FC (43%) farm types. Of respondents with stored commodities, 24% cited losses

(Figure 10), of which rodents (primarily mice and rats) or rabbits were most frequently cited as causing losses of stored commodities. The frequency of producers who reported losses of stored commodities to rodents or rabbits varied from 29% in the West Coast to 11% in the Northern Great Plains; but the \$23 million and \$26 million did not differ between years (Figure 7).

Vegetable, Fruit, or Nut Producers

Of all respondents, 11% raised vegetables, fruits, or nuts (VFN)—a decrease from 19% in 1989, although the reduced proportion of VFN producers is likely due to specifying "commercial" production in the 1995 interview. Regions were larger due to a smaller percentage of VFN producers (Figure 11). Of VFN producers, 59% reported wildlife-caused VFN losses, an increase from 46% in 1989 (Figure 12). Losses of VFN were attributed to a diverse mix of wildlife (Figure 13). The total percent of cited losses as depicted in Figure 13 could exceed 100% because each producer could cite up to five wildlife species that caused losses for each commodity. Rabbits and rodents (primarily squirrels, woodchucks, and gophers) were cited by 28% of VFN producers, up from 20% in 1989. Losses to hoofed mammals (primarily deer) were cited by 25% of VFN producers, up from 17% in 1989. Deer (24%) were the main hoofed mammal cited for VFN losses; and rates were highest in the northeast. Birds were also cited more frequently (21% vs. 17% in 1989), although the proportion of VFN producers who attributed losses to birds did not differ among regions. Omnivores (primarily raccoons) were cited by 10% of VFN producers. Carnivores (primarily coyote) were cited by 5%, up from 2% in 1989. Based on the median estimated loss, wildlife caused \$66 million in losses for VFN producers in 1994, more than the \$46 million estimated loss in 1989 (Figure 7).

Catfish Producers

When comparing all producer types in 1994, producers who raised catfish or trout reported the greatest wildlife-caused losses (Figure 14). These high rates of loss prompted the author to complete a more detailed survey of losses for catfish producers during 1996 (Wywiałowski 1998).

In the 15 states surveyed in 1994, 1,008 catfish producers completed the survey resulting in an 81% response rate for producers. Overall, 69% of catfish producers cited a wildlife-caused loss of their catfish, although losses varied among regions (Figure 15). Producer spent \$5 million in loss-prevention costs, and sustained wildlife-caused losses of \$12 million, for total costs for catfish producers of \$17 million or 4% of the value of catfish sales in 1996. Birds were most frequently cited as a cause of the losses, and double-crested cormorants were most frequently cited (53%), as well as most frequently cited as the primary species causing losses. The next most frequently cited birds were herons (48%), of which 42% cited great blue herons. Other wildlife groups were cited by <20% of producers.

More catfish producers (44%) than other types of agricultural producers were familiar with the federal Wildlife Services (formerly Animal Damage Control or

Figure 10. Percent of all producers who stored feed, seed, or grain on their farm and reported wildlife-caused losses of those stored commodities by region in 1989 and 1994.

Figure 11. Regions of the U.S. used for analysis of vegetable, fruit, and nut producers in 1989 and 1994 national surveys.

Figure 12. Percent of vegetable, fruit, or nut producers with wildlife-caused losses of their vegetables, fruits or nuts by region in 1989 and 1994.

Figure 13. Percent of vegetable, fruit, or nut producers that reported wildlife-caused losses of their vegetables, fruits, or nuts for each wildlife type by region in 1994.

Figure 14. Percent of each producer group that reported wildlife-caused losses of their commodity type for each wildlife type in 1994.

Figure 15. Regions including all U.S. states used for analysis of catfish production and wildlife-caused prevention costs and losses in 1996.

ADC) program. Mississippi contributed the majority of production, but not the majority of losses. The two areas identified in the 1996 survey in which Mississippi statistically differed from all other regions was that a greater proportion of producers in Mississippi used more direct services from Wildlife Services, and producers used roost dispersal more frequently than in other regions. Other unidentified factors may also play a role but Mississippi catfish producers being more likely to have mid- to low-range preventive costs (preventive costs/total sales) (Pearson's $R = -0.0728$, $p = 0.021$), and least likely to sustain losses in the highest proportion (cost of loss/total sales) of wildlife-caused loss categories (Pearson's $R = -1.132$, $p < 0.001$).

MANAGEMENT RECOMMENDATIONS AND CONCLUSIONS

Successive surveys in 1989 and 1995 indicated that the reported value of wildlife-caused losses increased for some agricultural commodities. The author's conclusions are a discussion of some commonly held misconceptions about wildlife-caused losses of agricultural commodities.

Inequitable Distribution of Losses

Managers must understand that although the proportion of the total value of commodities perceived to be lost to wildlife may be small in comparison to their total value (0.5 to 1.3% overall), losses are not uniformly distributed among producers or commodity types. When the distribution of losses is highly skewed, dismissing all losses because they represent a small percentage of the total national product has limited utility. For example, nationwide, the percentage of field corn lost to wildlife may be less than the amount of corn lost in harvesting operations (Wakeley and Mitchell 1981); however, for the 1% of corn fields with $\geq 20\%$ lost to wildlife (Wywiałowski 1996), production costs probably exceed harvested value. Hence, the low overall percentage does not console farmers with high losses. Some producers of commodities susceptible to high wildlife-caused losses, such as catfish, sheep, goats and fruit, may require assistance to maintain viable operations. As economic conditions or wildlife populations change, perceptions of and concerns about losses may also change (Siemer and Decker 1991; Adkins and Irby 1992). Most producers tolerate some wildlife-caused losses; intolerance begins when losses exceed \$500 (Siemer and Decker 1991); 23% of respondents in 1994 fit this criteria.

The estimated value of wildlife-caused loss in 1994 of \$0.6 to 1.6 billion is only 0.4 to 1.1% of the \$162.6 billion of agricultural products sold in 1992 (the last year for which complete data is available, U.S. Bureau of the Census 1994). However, expenses to produce those agricultural commodities were estimated at \$130.8 billion. The average farmer sold \$84,459 of products for which cost of production averaged \$67,928 (80% of sales) leaving an average farm income of \$16,531. For all producers surveyed, the median reported loss was <\$100 with a mean of \$798 (SE=33), which would be 0.6 to 5% of the average farmer's net income. For farmers who reported losses to wildlife, losses averaged 3 to 8% of the average farmer's net income. Losses were greater for catfish producers at 4% of the value of production, but 15

to 30% of the average catfish producer's profit (dependent on the estimated profit) (Keenum and Waldrop 1988). Most of these surveys have only assessed direct wildlife-caused losses; producers may spend substantial sums protecting their commodities from damage. Further, losses are inequitably distributed among commodity types with assessed losses ranging from <1% to >30% of producer profits. The median-based estimate of losses was one-third of the mean-based estimate of losses of \$1.6 billion because a small percent estimated large losses. These high loss estimates may be accurate, however, because wildlife-caused damage is not uniformly distributed among producers (Dolbeer 1980; Besser and Brady 1986; Hothem et al. 1988; Wywiałowski 1996).

Problematic Wildlife Populations are Increasing

With the exceptions of livestock/poultry, stored commodities and other commodities, percent citing losses and value of losses increased from 1989 to 1994. Both the percentage citing losses and the cost of wildlife-caused losses increase from 1989 to 1994 for field crops, and vegetables, fruits, and nuts. Better sampling of VFN producers may have influenced the results, but the author believes the 1994 estimates more accurately reflect actual losses than the 1989 estimates. Deer populations continue to increase in many states, and appear to be responsible for much of the increased losses between 1989 and 1994.

The production of vegetables, fruits, and nuts was greater in 1992 than in 1987 (U.S. Bur. of the Census 1994), and current diet recommendations and trends suggest that consumption and demand for VFN will continue to increase. Hence wildlife-caused losses of VFN will continue to be a growing problem for wildlife-damage managers.

The proportion of all producers who perceived that they sustained wildlife-caused losses was higher in 1994 than in 1989. The higher estimated losses may result from higher wildlife populations (particularly deer), higher perceptions of damage, and improved sampling of rare producer types.

Effectiveness of Wildlife Services in Reducing Losses

Given the growing numbers of catfish (Tyson et al. 1998), preventive techniques have probably been useful in preventing losses from reaching even higher levels. The 4% value of loss in the top 15 catfish producing states in 1996 mirrors the 4% value reported loss in Mississippi in 1989 (Stickley and Andrews 1989). Cormorant flocks were estimated to consume \$13.45/catfish/hour of foraging (Stickley et al. 1992). Hence the large flocks observed can rapidly consume substantial amounts of fish that translate into economic losses for producers. Keenum and Waldrop (1988) found cost of production of catfish to be \$0.60 to 0.68 for the smallest to the largest farms. The average sale price of catfish in 1988 was \$0.764/pound (NASS 1994); this would give a profit range of 11 to 22%. Hence, the 4% cost of wildlife may range from one-sixth to one-third of farm profits.

The amount of farm-raised catfish processed has increased from 2.6 million kg in 1970 to 206.6 million kg in 1993 (USDA 1994). The 1996 estimated market value of catfish was \$424 million (USDA, NASS 1997).

Mississippi catfish producers have had greater support from WS, APHIS, as well as Cooperative Extension and assistance from Mississippi State University; and their efforts better prevented wildlife-caused losses at less cost than catfish producers in other states. This implies that Mississippi producers were probably better informed in their loss prevention strategies, and spent what was necessary to employ those strategies.

Overall, catfish producers were most likely to contact a WS specialist. The greater proportion catfish producers requesting assistance may be motivated by both actual and perceived losses that are greater than wildlife-caused losses sustained by producers of other commodities. Most of the birds cited to cause losses are diurnal, and the open and expansive catfish ponds result in highly visible losses. Alternatively, mammalian wildlife consumers are more likely to be nocturnal or crepuscular, and the only evidence of depredations are missing commodities. The wildlife-caused losses of catfish may be more difficult to resolve because the depredating species are more frequently migratory birds than resident mammals (Hoy et al. 1989; Stickley and Andrews 1989; Wywialowski 1998). A U.S. Fish and Wildlife Service blanket depredation order should become a final rule in 1998. Hence, aquacultural producers may request WS assistance more frequently both because their loss rates are greater and because the complexity in resolving their problems is greater than for other producers of most other commodities.

New and Innovative Means to Resolve Problems

Only direct wildlife-caused losses were estimated in the earliest surveys, although indirect costs of protecting crops or livestock can be substantial (Pearson and Caroline 1981; Stickley and Andrews 1989; Andelt 1992). Sheep and lamb producers estimated that they spent \$1.77 and \$0.50/breeding animal on non-lethal and lethal means, respectively, to protect their flocks from wildlife-caused losses in 1994 (Simpson 1995), and 65.5% of sheep producers used some predator management practices in 1994 (USDA 1996). Overall, catfish producers spent \$5.4 million protecting their operations from wildlife-caused losses.

The economic benefits to farmers of incorporating wildlife-derived benefits into operations have been demonstrated (Rasker et al. 1991; Butler and Workman 1993). Such wildlife-derived benefits may be most equitably allocated for resident wildlife within predominantly private lands. Equitable distribution of benefits and costs of wildlife becomes more complicated with seasonally migratory resident wildlife in a mosaic of public and private lands (Arha 1996). Frustrations of producers may be greatest when depredating wildlife are migratory birds as demonstrated by high proportions of producers with losses and high dollar-value losses as expressed by aquacultural producers in this survey. Management that benefits both wildlife and the private landowner becomes more complex with migratory wildlife because the economic benefits of migratory wildlife are unlikely to be distributed to the same people as the costs of sustaining wildlife (Heinrich and Craven 1992). Some means of reallocation between "gainers" and "losers" is both appropriate and socially desirable. Public assistance

to alleviate losses is one form of redistributing the benefits and costs of our publicly-owned wildlife resource. Other creative methods to either prevent losses or correct distributional inequities should be sought by the wildlife profession to promote greater harmony between agriculturalists and wildlife enthusiasts.

Some may still argue that this study merely reflects agriculturalists' perceptions of loss and does not accurately reflect the real losses. The author contends that data from verified loss studies supports these estimates as consistent with actual losses. Further, if a problem is perceived to exist, a problem exists. If the perception does not reflect reality, the appropriate resolution of the problem may lie in sharing information rather than actual damage reduction, but resolution of the problem is still imperative for wildlife managers (Craven et al. 1992). For individuals with either perceived or real substantial losses, wildlife managers should take actions to lessen their net losses (Heinrich and Craven 1992) or provide information to producers to alleviate their concerns about losses (Craven et al. 1992).

Agricultural producers frequently provide habitat for publicly-owned wildlife. The dependencies between agriculture and environmental enhancements that benefit wildlife have become increasingly apparent in public debate over the farm bills. Support from agriculturalists will be enhanced if their needs and interests are considered in conjunction with wildlife and environmental concerns. Wildlife managers may receive more support for their decisions if they acknowledge the losses that agricultural producers perceive to be caused by wildlife and take appropriate actions to alleviate both real and perceived losses.

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