Black Bear Damage to Agricultural Crops in Coastal North Carolina

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Abstract: Damage to agricultural crops by black bears (*Ursus americanus*) is a widespread problem in coastal North Carolina. We examined extent and duration of damage to 1,802 ha of corn crops using aerial surveys conducted during summer 1993. Additionally, we obtained 1993 crop damage estimates and attitudes towards bears using a mail survey of farm operators on the Neuse-Pamlico peninsula in 1994. Greatest corn damage occurred in middle to late July during early stages of kernel ripeness. Aerial survey results showed that bears damaged approximately 0.6% of the corn crop compared to 1.2% estimated by farm operators. Most farm operators (77.8%) enjoyed seeing bears on their farms, but 45.4% worried about crop damage. Farm operators who had received crop damage were more likely to view bears as nuisances. Corn was the major crop damaged with estimated losses exceeding $27,000. Management efforts should focus on alleviating bear/farmer conflicts through education and population manipulation which could keep bear numbers at a socially acceptable level without negatively impacting populations.

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Black bear populations in coastal North Carolina have expanded in recent years (Warburton et al. 1993) and, consequently, damage complaints from farmers have increased. Animal damage to agricultural crops is a major concern to agricultural and wildlife agencies in the United States (Conover and Decker 1991). Damage done to crops by bears has been examined in several locales including Virginia (Davenport 1955, Vaughan et al. 1989), Minnesota (Garshelis 1989), New Hampshire (Calvert et al. 1992), Wisconsin (Hyngstrom and Hauge 1989, Stowell and Willging 1992), and Louisiana (Irvine et al. 1983). Crops damaged by bears include corn, wheat, oats, soybeans, watermelons, sugarcane, peanuts, and sorghum (Warburton and Maddrey 1994).

Extent of damage to crops caused by bears is important to farmers and

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wildlife managers. Agriculture is the largest industry in coastal North Carolina with corn, winter wheat, and soybeans predominant (N.C. Agric. Stat. 1994). Bear range in coastal North Carolina overlaps most of the large agricultural areas making conflicts between bears and farmers inevitable. Increasing complaints and lack of adequate data on crop damage caused by bears were the impetus for this study. Wildlife managers need to quantify actual crop damage before decisions are made regarding hunting regulations and before they can talk intelligently to farmers about problem situations. In the past, wildlife managers have relied on perceived damage estimates from farmers in making management decisions because no actual damage figures were available. Our objectives were to quantify and characterize corn damage from bear depredation using aerial surveys and to estimate perceived crop damage and farmer attitudes concerning bears through a mail survey.

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Methods

Study Area

The 150,000-ha Neuse-Pamlico peninsula (NPP) is located in central eastern North Carolina and encompasses portions of Beaufort and Craven counties and all of Pamlico County. It is bounded on the north by the Pamlico River and on the south by the Neuse River. Pamlico Sound forms the eastern boundary. The landscape is rural with agriculture and forestry being the predominant land uses. Agricultural lands on the NPP comprise about 40,000 ha with principal crops being corn, soybeans, winter wheat, potatoes, tobacco, and cotton.

The 29,617-ha Gum Swamp study (Fig. 1) area is located on the northeastern end of the NPP and is a mixture of hardwood swamps, pine plantations, pocosins, and large agricultural areas. Woodlands account for approximately 72% of the total acreage. Most agricultural fields are found along the southern and northern boundaries and border highways; the exception being the 1,000-ha Parker Farm which is situated in the interior of the large woodland area. Farm fields are large and contiguous with predominant crops being corn, winter wheat, soybeans, and potatoes. Human density is low with most houses located along major highways or in the towns of Bayboro and Aurora.

Data Collection

Weekly aerial flights of all corn fields in the Gum Swamp area were conducted during summer 1993. This area of the NPP was selected due to its past history of severe corn and wheat damage, farmer complaints, and a high bear

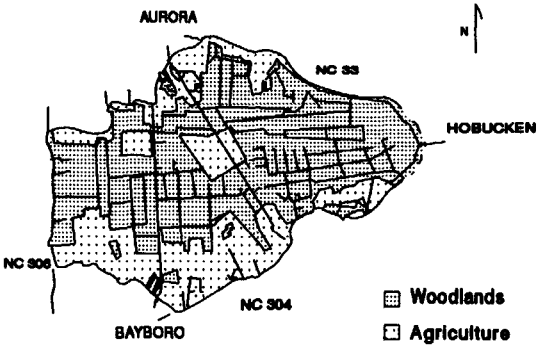

Figure 1. Juxtaposition of agricultural fields and woodlands in the Gum Swamp study area.

density (Martorello et al. 1995). Aerial photos of the study area were obtained from the local Agricultural Stabilization and Conservation Service (ASCS) offices, and maps were made of all 707 corn fields with surrounding vegetation and other crops noted. Fields in the Gum Swamp area average 2.6 ha; however, fields are generally separated from one another only by small drainage ditches. The result is large contiguous expanses of farm fields covering several hundred, and in some instances, several thousand hectares. Surveys were flown once per week from 15 July 1993 until corn was harvested in mid-September. The only exception was the first week in September when military flight scheduling in the restricted air space over the study area did not allow other air flights.

Initially, crop depredation analysis was to consist of aerial surveys of wheat, corn, and soybean damage. Corn damage caused by bears is readily discernible from the ground or air due to the characteristic stalk trampling. Bear damage to wheat, however, is hard to distinguish from deer (*Odocoileus virginianus*) or wind damage because wheat stalks are easily broken or crushed. Soybeans are usually stripped from the stalks without trampling damage. For these reasons, wheat and soybeans were not surveyed for the purposes of this study.

Aerial flights were initiated once damage was seen from the ground. On the initial flight, 35mm still photos were taken of each damaged area and the area was drawn in on the corresponding field map. Due to the large number of photos taken on this first flight, a hand-held video camera was used on subsequent flights. Small areas of damage in isolated fields were drawn on the field maps from the air. Large fields with multiple damaged areas were usually filmed 2–3 times from different angles at approximately 100m altitude. Ground checks were used to verify areas wherein damaging species could not be determined from the air. After playback on a video-cassette recorder, damaged areas were drawn on each field map. The single-frame playback mode was used to maximize accuracy. Total stalk damage in hectares for each field in the study area was computed weekly and for the entire crop season.

A mail survey of bear crop damage and farmer attitudes on the NPP was developed for farm operators. The list of farm operators was provided by the ASCS from Beaufort, Craven, and Pamlico counties. The survey consisted of

21 multiple choice questions concerning attitudes toward bears and crop damage caused by bears. It was patterned after similar mail surveys done by Wigley and Garner (1986), Craven (1989), Wigley et al. (1989), and Clark et al. (1991). The last 5 survey questions were optional and addressed personal information such as age, sex, race, educational background, and income. A farm operator was defined by ASCS as anyone who participated in a federal crop program or received crop subsidy payments. This list of farm operators included many individuals who were not actually farmers.

Beginning in April 1994, a cover letter and questionnaire were mailed to 256 farm operators. A second cover letter and questionnaire were sent to nonrespondents after approximately 3 weeks. A final reminder and closing date postcard was sent 1 month later. Chi-square analysis was performed to determine relationships between levels of bear damage and farm operator attitudes. Statistical significance was indicated at $P \leq 0.05$.

Results

Aerial Surveys

Nine survey flights were conducted to map corn damage in 1,802 ha of corn fields in the Gum Swamp study area. New corn acreage damage was highest (28.8% of total) on the second flight and declined gradually thereafter (Fig. 2). The last flight occurred 15 September 1993. Twenty-four percent of the study area corn fields (N = 176, 679 ha) contained bear-damaged areas. Total corn damage amounted to 10.4 ha, representing 0.6% of the total corn crop acreage surveyed. Field/woods juxtaposition affected amount of damage received. Fields which were isolated or jutted into woodland areas typically received more damage. The isolated Parker Farm tract received the greatest damage with 3.8 ha damaged out of 253.6 ha of corn (1.4%). Damage to individual corn fields ranged from 0%–20%. Eighty percent of the damage was located within 50 m of the woodland edge. Groups of corn fields not adjacent to woodlands generally received very little or no damage. However, in one instance, bears damaged a field separated by 300 m of soybean fields from the woods' edge.

Farm Operator Mail Survey

NPP farm operators returned 113 of 256 (44%) surveys. First mailings produced 91 (81%) of the returns. Second mailings produced the remaining 22 returns. No returns resulted from the third mailing.

Half of the respondents reported they had bear damage to crops in 1993. Deer were listed as the major cause of crop depredation by 86% of respondents; bears were listed by 16%, birds by 6%, and raccoon (*Procyon lotor*) by 4%. Beavers (*Castor canadensis*) were the only other animal implicated. Farmer estimates of crop damage indicated that corn was the major crop damaged in terms of number of farms receiving damage, area damaged, percent of area damaged,

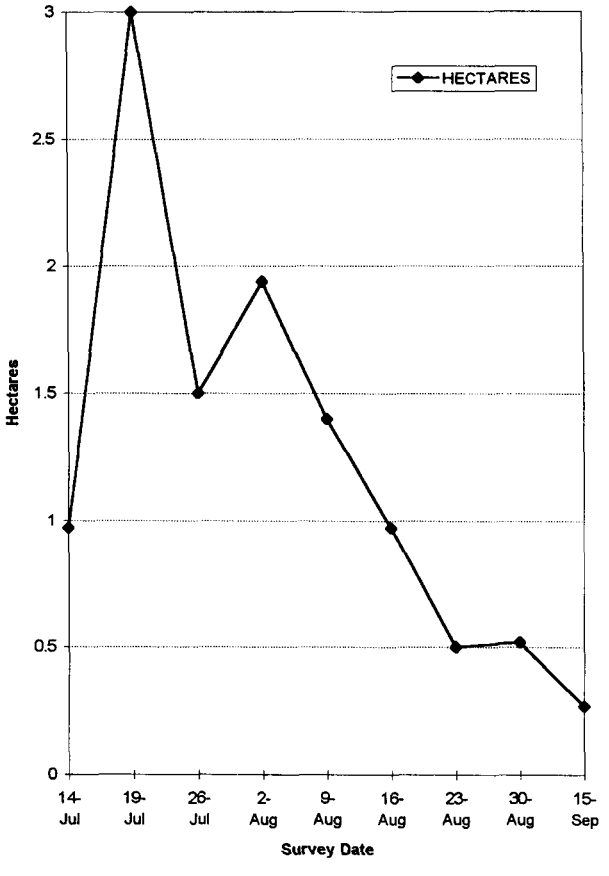

Figure 2. Weekly corn damage caused by black bears on the Gum Swamp study area, Neuse-Pamlico peninsula, North Carolina in 1993.

Table 1. Black bear crop damage reported by farm operators on the Neuse-Pamlico peninsula, North Carolina, 1993.

Crop	Total hectares	Total damage	% Damage	Total *N* farms	% Farms w/damage	Est. total $ loss	Est. $ loss/ha
Wheat	5,260	60.9	1.2	55	23	$14,250	$235
Corn	7,500	92.5	1.2	79	35	$27,825	$301
Soybeans	11,945	32.8	0.3	100	11	$8,075	$251
Total	24,705	186.2	0.8	109	69	$50,150	$269

and monetary losses (Table 1). Monetary losses incurred by individual farm operators varied from $25–$6,950 and averaged $1,288.

Bear damage to crops was considered intolerable by only 10% of those farm operators who had incurred damage. Damage was considered moderate by 41% and light by 40%. Forty-three respondents (70%) felt that crop damage had increased on their farm within the past 5 years. Asked about causes of

increased bear damage, "more bears" (40%) was the predominant answer. Thirty-two percent of farm operators responded that they enjoyed seeing bears on their farm and were unconcerned about crop damage. An additional 45% said they enjoyed seeing them but worried about crop damage. Only 12% considered bears a nuisance. Attitudes were different between farm operators who had sustained damage and those who had not. Only 6 of 46 (13%) farm operators reporting bear damage enjoyed seeing bears on their farms without worrying about crop damage compared to 29 of 63 (47%) farm operators with no damage ($X^2 = 18.25$, 1 df, $P < 0.001$). A larger percentage of these farm operators also enjoyed seeing bears but worried about crop damage (61% to 34%) ($X^2 = 7.13$, 1 df, $P < 0.001$) and considered bears nuisances (22% to 5%) ($X^2 = 9.54$, 1 df, $P = 0.002$).

Most farm operators felt that bear activity on their farm was stable (32%) or had increased (56%) in the last 5 years. Farm operators with damage felt more strongly (83%) than those with no damage (37%) that bears had increased ($X^2 = 17.08$, 1 df, $P < 0.001$). Farm operators sustaining crop damage also were much more likely to think bear populations were too high near their farms (50%) than those with no damage (7%) ($X^2 = 31.35$, 1 df, $P < 0.001$). Farm operators with no damage were more likely to think populations were too low (27%) compared to only 7% of farm operators with damage ($X^2 = 10.6$, 1 df, $P = 0.001$). Thirty-one percent of farm operators with damage felt that population levels were about right compared to 44% of farm operators without damage. Interestingly, 21% of farm operators with damage had no opinion of local bear population levels.

Few farm operators sustaining crop damage had tried to prevent it (18%). Of those which had, shooting was the preferred method (42%). Using scare devices (24%) was the only other method tried by more than 2 respondents. Fencing, chemicals, and lure crops also were listed. When asked about deterrent effectiveness, 52% thought they had helped reduce damage. Farm operators believed longer hunting seasons (33%) and compensation for crop losses (27%) were the best solutions to alleviate crop damage. Relocation (13%) and special permit seasons (5%) received lesser consideration.

The personal characteristics section of the survey showed that a NPP farm operator was most likely to be a ≥46 year old (66%, $N = 103$) white (100%, $N = 106$) male (100%, $N = 105$) with a high school education (51%, $N = 103$) who received 76%–100% of his income from farming (52%, $N = 103$). No significant differences ($P \geq 0.05$) were noted between responses from different age, education, or income groups.

Discussion

Aerial Survey

Aerial photography has been used extensively to conduct wildlife and agricultural habitat surveys (Sidle and Ziewitz 1990). Aerial videography of bear

corn damage was attempted in Massachusetts (J. McDonald, Jr. pers. commun.), but their corn fields were generally small and scattered compared to the extensive contiguous fields of coastal North Carolina. Aerial surveys have also been used in Minnesota to locate damage in corn and oats crops (D. Garshelis, pers. commun.). Corn damage is characterized by trampled stalks pulled into a central feeding area. Damaged areas, which may be up to 1 hectare, are easily seen from the air and are easily distinguished from bare spots in the field and damage caused by deer or raccoons. Bears also will strip ears from stalks and carry them out of the field to eat in the woods. Because ear stripping damage is impossible to detect from the air, aerial surveys should be considered a minimum estimate of actual damage.

Our study showed that bears switched readily to corn fields that were just ripening: fields that had substantial damage one week had no new damage the next week. The aerial surveys showed that most of the damage (68%) occurred between 15 July and 2 August, indicating that bears preferred corn during the early stages of ripening.

Although bear damage accounted for only 0.6% of the total corn acreage, it was not an insignificant loss to farm operators who had sustained large amounts of damage. Fields which were isolated or surrounded by large timbered tracts, such as the Parker Farm area, received a disproportionate amount of damage. Farm operators in these areas would be more likely to view bear damage as being a significant economic loss.

Mail Survey

Returns from farm operators were lower than expected considering the widespread media attention this study had received in the region. The primary cause was the definition of "farm operator" used by the local ASCS offices. Consultation with several area farmers indicated that many names listed as farm operators did not farm but had farm subsidy payments listed in their names. These persons usually worked elsewhere and leased the farming operation to an actual farmer. Therefore, number of farm operators was much larger than actual number of farmers. This inflated list led to a decreased percentage of respondents and also precluded any attempt to extrapolate figures for nonrespondents. Only 2 responses were received from persons saying they did not farm.

Overall, farmers characterized bears as welcome visitors. Coastal plain bear populations have increased greatly in recent years (Warburton et al. 1993) and that view was shared by most area farmers. Most respondents still did not believe that bears were reaching levels that were too high and a few farmers still believed the population to be too low. As would be expected, farmers who had crops damaged were more likely to feel bears were nuisances and that populations were too high. Clark et al. (1991) found that landowners in Arkansas who had sustained bear damage also were more likely to view bears negatively than those who had not.

Corn was listed as the major crop damaged by bears. The 1.2% crop loss estimate given by farmers was comparable to the 0.6% figure from the aerial survey. Damage to corn by bears is highly visible and unmistakable (Davenport 1955) and this characteristic may have inflated its damage ranking in the mail survey. Winter wheat is eaten by bears for a longer period of time than is corn, and is a source of food in early spring when few natural foods are available (Maddrey 1995). Bear damage to wheat is not discernible, however, until the stalks are drying and easily broken. Deer also feed extensively in wheat and bed in the fields mashing the stalks, thus making identification of the damaging species difficult. For these reasons, wheat damage caused by bears is hard to quantify and any damage estimate would be suspect. Damage to soybeans is probably underestimated by area farmers because bear feeding activity causes very little stalk damage and is a relatively new documented phenomenon. Differentiation of bear damage to soybeans from damage caused by other species would be difficult.

Farmers felt that increased bear population levels were the main reason for increased crop damage, as opposed to loss of natural habitat. Loss or absence of natural foods was named by only 30% of respondents. In Minnesota, Rogers (1987) and Garshelis (1989) felt that natural food availability was directly related to numbers of nuisance complaints on a yearly basis. Bears on the NPP, however, include crops as part of their normal diet: Maddrey (1995) found that wheat comprised >50% of the NPP bear diet during May and June and that almost 60% of the July–August diet was composed of corn. Because bears on the NPP include crops as part of their normal diet, the number of nuisance complaints is probably better correlated with the tolerance level of the farmers than with local natural food abundance. Soybeans may be an exception because they are eaten by bears during late fall when oak acorns (*Quercus* spp.) and black gum (*Nyssa sylvatica*) berries are available. Maddrey (1995) found that a small black gum berry crop in 1993 correlated with higher incidence of soybean use by bears.

Although damage to crops by bears is widespread, few farmers attempted to prevent damage. Shooting was the primary method listed by farmers who had taken steps to alleviate damage problems, although farmers indicated they are usually reluctant to shoot bears for crop depredation. "Longer hunting seasons" and "compensation for losses" were the top choices for alleviating crop depredation. Longer hunting seasons are a much more viable option in North Carolina than crop compensation. Five states currently compensate landowners for bear damage and the costs can run as high as $2 million per year (Warburton and Maddrey 1994). Extent of agricultural damage done by bears in coastal North Carolina could easily cost several hundred thousand dollars per year. Because the state wildlife agency has jurisdiction over the bear resource, many farmers felt it should be responsible for making reparations for losses. Compensation, however, does not address or correct the problem of depredation (Robinson 1992). Lack of an adequate deterrent for bears damaging large scale ag-

ricultural interests is a major problem (Warburton and Maddrey 1994). Some of the larger agricultural tracts such as the Parker Farm may have more than 50 bears causing damage in a single season. Over 70 bears were either captured by project personnel or harvested by hunters within 2,500 m of the Parker Farm during the course of this study (Maddrey 1995, Martorello pers. commun.). Deterrents such as propane cannons, electric fences, shooting, and chasing with bear dogs may work on smaller farms where a single bear is doing damage, but none of these deterrents have been effective in larger fields. Relocation of nuisance bears is used to alleviate problem situations in many states (Warburton and Maddrey 1994), but this practice is rarely used in eastern North Carolina. Most coastal bear range abuts agricultural lands in North Carolina; therefore, relocating bears would only move the problem to another area. In addition, the cost involved in trapping and relocating nuisance bears would be exorbitant and would probably exceed the dollar loss incurred by the farmer. Finally, NCWRC policy on bear depredation complaints states that bears should not be moved unless human welfare or safety of the life of the bear is threatened (NCWRC unpubl. rep.). Planting lure crops has been suggested for alleviation of bear/crop damage (Stowell and Willging 1992); however, finding a crop that bears relish more than corn would be a problem.

The low bear population level in this area a few years ago coupled with historically low reported damage rates played a large role in how farmers felt about bears and how much crop loss they were willing to withstand. If farmers continue to absorb crop losses over a number of years, attitudes will probably become less tolerant. The bear population must be managed at a socially acceptable level wherein crop losses are kept to a tolerable level. This cultural carrying capacity for bear populations will be dependent on numerous factors, including bear density, agricultural practices, and human density. The tolerance level, and thus the cultural carrying capacity, may be raised through education, hunting leases, or compensation of crop losses by user groups. Heavy crop losses and high numbers of complaints may lower the tolerance level in some areas. Hunting seasons must allow an adequate harvest to maintain populations below the cultural carrying capacity to keep depredation at a low level. Due to the juxtaposition of humans and black bears in coastal North Carolina, future management decisions must consider human enterprises if bears and humans are to live in harmony.

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