Wild Turkey Management:
Accomplishments, Strategies, and Opportunities
Grand Rapids, Michigan

CROP DEPREDATION BY WILDLIFE IN NORTHCENTRAL INDIANA

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Abstract: Perceptions of agricultural producers concerning crop depredation may influence wildlife management decisions. We quantified the amount, type, and temporal pattern of damage to corn (*Zea maize*) and soybeans (*Glycine max*) by wild turkey (*Meleagris gallopavo*), white-tailed deer (*Odocoileus virginianus*), raccoons (*Procyon lotor*), and other vertebrates in the agricultural region of northcentral Indiana. Using stratified random sampling, we conducted depredation surveys of 160 fields (100 corn and 60 soybean) ranging in size from 1 to 125 ha from May through October in 2003 and 2004. We recorded 582,515 depredation events (73,100 to corn and 509,415 to soybeans). We defined a "depredation event" as any damage to a single plant caused by wildlife. Raccoons and white-tailed deer were responsible for >97% of the damage to corn (87% and 10%, respectively), whereas white-tailed deer (61%) and groundhogs (*Marmota monax*; 38%) were responsible for nearly all damage to soybean plants. Small rodents, birds, canids, and all other vertebrates had very little effect on corn and soybean production in our study area. Although turkeys were relatively common on the study area and turkey sign was evident in several fields, no depredation events were attributed to wild turkey. We assessed landowner perceptions concerning crop depredation by wildlife with mail and telephone surveys. Seventy-eight percent of landowners reported having ≥1 crop type damaged by wildlife within the previous 12 months; however, their perceptions regarding the species responsible for monetary losses to corn and soybeans did not correspond closely with our field survey data.

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Key words: corn, crop, damage, depredation, Indiana, perceptions, raccoon, soybeans, white-tailed deer, wild turkey.

Agricultural damage by wildlife species in the U.S. is substantial, widespread, and is a serious concern to many agricultural producers. Conover (2002) estimated wildlife-related, economic losses to agricultural producers (farmers and ranchers) currently exceed 4.5 billion dollars annually in the U.S. Results of nationwide surveys conducted in 1993 and 1994 indicated 80% of farmers and ranchers suffered wildlife

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damage in the prior year, and 53% suffered damage exceeding their tolerance (Conover 1998).

Data from agriculture and wildlife professionals indicate wildlife damage to field crops has increased significantly in recent years. Based on producer estimates, wildlife-caused losses to field crops increased from $237 million in 1989 to $316 million in 1994 (Wywialowski 1994, 1997). From 1957 to 1987, the percentage of wildlife agencies reporting damage to crops by deer increased from 83% to 100% and raccoon damage increased from 10% to 94% (McDowell and Pillsbury 1959, Conover and Decker 1991).

Crop damage by deer and raccoons is probably the most recognized and widespread (Conover and Decker 1991; Craven and Hygnstrom 1994; Wywialowski 1994, 1997; Conover 1998, 2002). While no estimates exist of nationwide annual crop losses due to deer, information is available for some states. Estimates of crop damage in a non-hunted setting (Gettysburg National Military Park and the Eisenhower National Historic Site) in Pennsylvania from 1986 and 1987 indicated white-tailed deer reduced yields of field corn an average of 20% (19 bushels/ha) (Vecellio et al. 1994). In the 10 top corn-producing states, deer-specific losses averaged 0.87 bushels/ha, representing 0.23% of the 10-state harvest of corn for grain in 1993 (Wywialowski 1996). Crop damage by raccoons also has become a serious concern of agricultural producers, with 25% of producers reporting raccoon damage (second only to deer) (Conover 1998, 2002).

Several other wildlife species are commonly responsible or perceived to be responsible for substantial damage to field crops. Groundhogs often damage soybean plants around their burrows (Loven 2000). In some parts of North America, blackbirds (Icteridae) cause extensive damage to agricultural crops, especially sunflowers (*Helianthus* spp.) (Conover 2002). Although generally rare, cases of crop depredation by wild turkeys also have been reported (Gabrey et al. 1993, Paisley et al. 1995, Payer and Craven 1995, Swanson et al. 2001).

The restoration of wild turkeys in North America is generally considered one of the greatest wildlife management successes. Agricultural landscapes once thought to contain insufficient habitat for wild turkey have proven productive (Dickson 1992). However, with the increased presence of wild turkey in agricultural regions, the number of perceived conflicts between wild turkey and agricultural producers over crop damage has increased (Payer and Craven 1995). Although wild turkey may potentially damage agricultural crops, research has shown most cases of turkey depredation result in minimal damage or are actually caused by other wildlife species (Gabrey et al. 1993, Paisley et al. 1996, Swanson et al. 2001, Tefft et al. 2005). The misidentification of crop damage by wild turkey most likely stems from their diurnal nature and coincidental presence in fields already damaged.

While most landowners hold a generally favorable view of wildlife on agricultural lands (Pomeratz et al. 1986, Siemer and Decker 1991), many agricultural producers complain of excessive and intolerable wildlife damage to their crops (Brown et al. 1978, Brown and Decker 1979). Agriculture and wildlife professionals in the U.S. also view wildlife damage as a widespread problem (Conover and Decker 1991). Because of the potential economic losses to agricultural producers, the priorities of wildlife agencies in agricultural regions often are influenced by the perceptions of agricultural producers toward crop damage. An improved understanding of factors underlying crop depredation and the development of strategies to reduce crop losses by wildlife would not only decrease negative agricultural impacts, but also improve public perceptions about wildlife.

In August 2002 we began a study to quantify the amount and type of crop damage caused by vertebrate wildlife species in crop fields (corn and soybean) in northcentral Indiana. Our long term objective is to develop spatially explicit models to predict probabilities of species-specific crop depredation in corn and soybean fields with respect to landscape features. In this paper, we document the amount of crop damage, the species responsible, timing of depredation, and preliminary results of a survey to evaluate attitudes of producers regarding wildlife depredation to corn and soybeans.

STUDY AREA

We selected a 1165-km^2 study area within the Upper Wabash River Basin (UWB) of northcentral Indiana encompassing portions of Grant, Huntington, Miami, and Wabash counties. Agriculture was the dominant land use type (88%), primarily row crops of corn and soybeans interspersed with small fields of hay and small grains. Agricultural field size averaged 17 ha (range = 1–130 ha) and >75% of fields were 24 ha or less in size. Woodlands occurred primarily as interspersed woodlots (mostly <16 ha) or as forested corridors along the rivers. Elevation averaged 243 m above sea level and topography was flat with gently rolling river drainages.

METHODS

Field Sampling

We constructed a Geographic Information System to categorize land use and classify individual agricultural fields by size and crop type. We assigned a sample of fields representing the distribution of field sizes in the study area to 1 of 3 categories: <12 ha, 12–24 ha, or >24 ha. We surveyed 82 fields (n = 53 corn fields; n = 29 bean fields) in 2003 and 78 fields (n = 47 corn fields; n = 31 bean fields) in 2004 for evidence of wildlife crop depredation.

After plant emergence, we established edge and interior transects in each field using hand-held Global Positioning Satellite (GPS) receivers and survey flags. All transects ran parallel with the fields' row plantings and transects continued through the end cross rows to the ends of the fields. We established 2-edge transects within 15 m of the edges of each field; transects followed curvatures of field edges. We spaced interior

field transects (2 for <12 ha, 4 for 12–24 ha, and 6 for >24 ha fields) equidistantly within the remainder of the fields. Most fields had 4 definable edges, of which we surveyed only the 2 edges that ran parallel to the entire field row planting orientation (e.g., north-south orientation, east-west orientation). Some irregularly shaped fields had more than 4 edges. For fields with >4 edges, we surveyed the 2 major edges that ran parallel to entire field planting orientation and any other edge of the same orientation that was greater than one-quarter the length of the field in the direction being surveyed. Wildlife biologists (Indiana Department of Natural Resources and Purdue University Wildlife Extension), experienced in assessing various types of crop damage, trained our technicians on techniques to determine wildlife species responsible for damage and the age of corn and soybean plants.

Technicians walked field transects and surveyed each field approximately once per month from plant emergence until harvest. Survey crews of 2 technicians walked in tandem along transects and documented all plants that exhibited any sign of wildlife-caused damaged visible from transects (i.e., variable-width transects). At each plant damage location, crews recorded the number of plants damaged, wildlife species responsible, amount of leaf area damaged, amount of seed damage, height of damage, growth stage of plant at the time of damage, and remaining yield. At locations where ≤20 plants were damaged we collected data for each damaged plant, and in areas where >20 plants were damaged we collected data on 20 randomly-selected damaged plants. All documented damage was marked clearly with paint to avoid recounting during subsequent surveys. In addition to collecting plant damage characteristics, we recorded UTM coordinates using hand-held GPS units at the epicenter of each location where we collected damage information. We defined a "depredation event" as any previously unrecorded damage to a single plant caused by wildlife.

Crop Producer Surveys

In December 2003 we mailed a survey to producers who grew a total of 20–320 ha of corn and soybeans according to Indiana National Agricultural Statistics Service records. We mailed surveys to all producers meeting this criteria (n = 848) in 4 counties within our study area (Grant, Huntington, Miami, Wabash) and a random sample (n = 625) of producers meeting the criteria in the remaining 7 counties located entirely within the UWB (Carroll, Cass, Fulton, Howard, Tippecanoe, Wells, Whitley). The survey included questions regarding the severity of crop depredation on the landowner's property, the wildlife species perceived to be responsible, the landowner's annual economic losses from wildlife crop depredation, and the landowner's general attitudes towards wildlife. We separated responses pertaining to corn and soybean for statistical analyses. To check for non-respondent bias, we conducted a telephone survey of a random sample of non-respondents (n = 154) from 13–26 January 2004. We used a chi-square goodness of fit test to test for differences in responses between mail and telephone surveys (Zar 1996). We weighted responses that differed ($P < 0.05$) between the groups based on the sample size (i.e., n = 388 for mail and n = 1,091 for telephone).

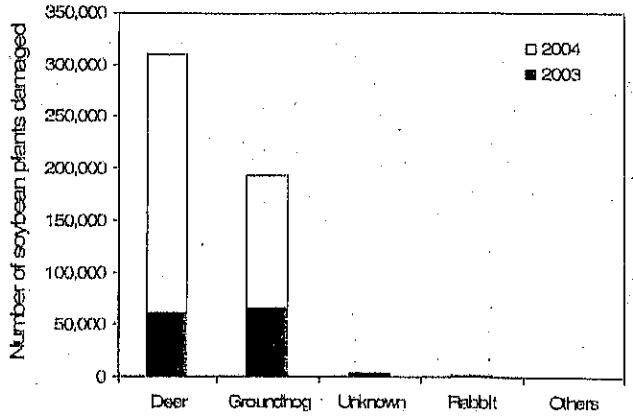

Fig. 1. Number of soybean plants damaged by wildlife species in northcentral Indiana during the 2003 and 2004 growing seasons. We surveyed 29 fields in 2003 and 31 fields in 2004 between May and September of each year.

RESULTS

Field Sampling

We documented a total of 582,515 depredation events in 149 of 160 fields surveyed over the 2 growing seasons. We recorded no wildlife damage in 5 corn fields and 6 soybean fields. Overall, soybean plants were damaged more often than corn plants (509,415 and 73,100, respectively), despite a greater sampling effort in corn (n = 100) than in soybean fields (n = 60).

Our surveys in soybean fields yielded 131,556 depredation events in 2003 and 377,859 depredation events in 2004. The average number of soybean plants damaged per field was 8,490 (SD = 23,708) and the maximum number of plants damaged in a single field was 162,453. White-tailed deer (61%) and groundhogs (38%) were most often responsible for damage to soybean plants. Eastern cottontails (*Sylvilagus floridana*), raccoons, small rodents (e.g., fox squirrel [*Sciurus niger*], thirteen-lined ground squirrel [*Spermophilus tridecemlineatus*], Eastern chipmunk [*Tamias striatus*]), and unidentified species combined were responsible for less than 2% of the total damage to soybean plants (Figure 1). We detected no wild turkey damage to soybeans.

Our surveys in corn fields yielded 24,623 depredation events in 2003 and 48,477 depredation events in 2004. The average number of corn plants damaged per field was 731 (SD = 1,440) and the maximum number of plants damaged in a single field was 8,357. Raccoons and white-tailed deer were responsible for >97% of the damage to corn (87% and 10%, respectively). Small mammals (e.g., eastern cottontail, fox squirrel, thirteen-lined ground squirrel, chipmunk), beaver (*Castor canadensis*), birds, and other wildlife had little effect on field corn in our study area (Figure 2). We detected no wild turkey damage to corn.

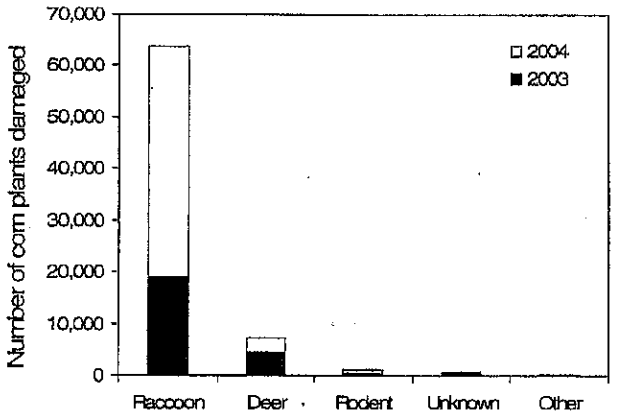

Fig. 2. Number of corn plants damaged by wildlife species in northcentral Indiana during the 2003 and 2004 growing seasons. We surveyed 53 fields in 2003 and 47 fields in 2004 between May and October of each year.

Our 2 years of crop depredation surveys revealed strikingly different temporal patterns of corn depredation by white-tailed deer and raccoons (Figure 3). Deer damaged corn steadily from plant emergence (May) through harvest (Oct). Conversely, raccoons damaged corn only rarely until the beginning of the reproductive stage (early to mid-Jun), but subsequently exhibited substantial depredation through harvest (Oct).

Crop Producer Surveys

Of the 1,500 mail surveys sent to crop producers, 396 (26%) were returned; of these, 388 were usable. For the call-back surveys, 141 of 154 were usable. Seventy-eight percent of producers reported having ≥1 crop type damaged by wildlife within the previous 12 months. Eleven percent reported deer damage to soybeans within the previous 12 months, and less than 2% of producers reported damage to soybeans by raccoons, squirrels, or Canada geese (*Branta canadensis*). Twenty-three percent of producers surveyed reported deer damage to corn, and 12% reported raccoon damage to corn. Less than 3% of producers reported damage to corn by groundhogs, squirrels, or Canada geese (Figure 4).

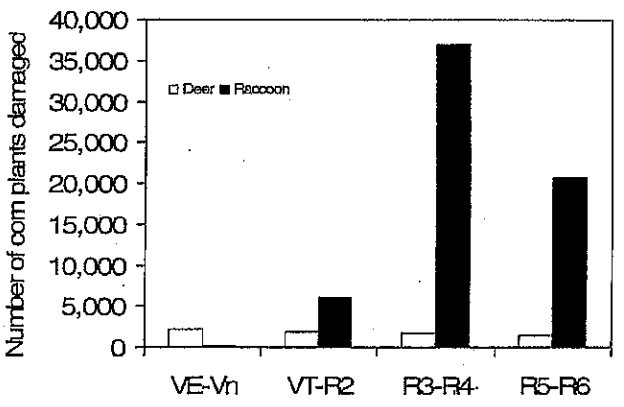

Fig. 3. Number of corn plants in 100 fields surveyed in northcentral Indiana in 2003 and 2004 damaged by wildlife relative to corn plant development. Vegetative stages (VE, V1, V2, . . . , Vn); tassel stage (VT); reproductive stages: silking (R1), blister (R2), milk (R3), dough (R4), dent (R5), and maturity (R6) (Ritchie et al. 1997).

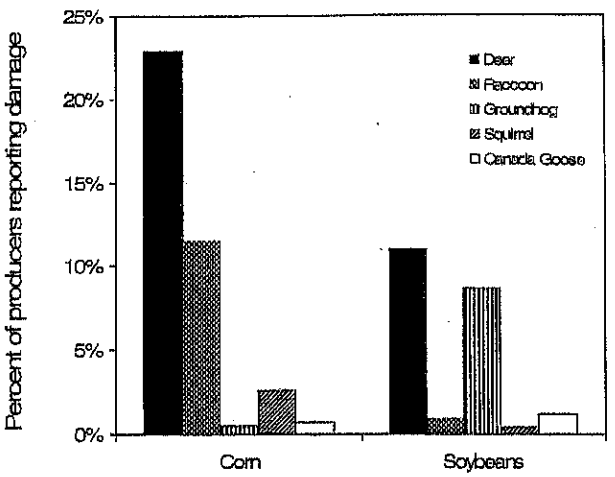

Fig. 4. Percent of agricultural producers (n = 529) reporting corn and soybean damage by wildlife in northcentral Indiana in 2003. The top 5 species for each crop type reported are shown.

Average reported damage by wildlife ranged from \$105-\$585 and \$39-\$479 to corn and soybeans, respectively (Figure 5). Respondents indicated crop value losses in corn of 2.1% for deer and 2.2% for raccoon. In soybeans, crop value losses to deer and groundhogs were 2.8% and 1.7%, respectively. Total reported losses by respondents were highest for deer and raccoon in corn, and deer and groundhog in soybeans (Figure 6).

Regarding crop producers' general attitudes towards wildlife, groundhogs were most disliked and considered a nuisance species by 85% of those surveyed. Raccoons had the second highest nuisance rating at 54%, and deer were considered a nuisance species by 21% of producers surveyed. Wild turkey were considered a nuisance by only 2% of the respondents although a relatively large percentage (16%) were unsure about their feelings towards wild turkey; less than

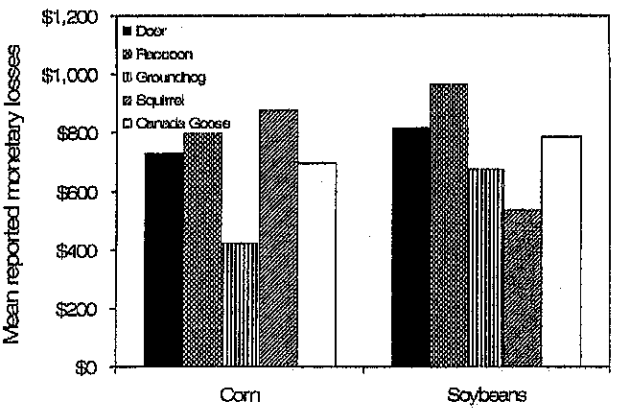

Fig. 5. Mean reported monetary losses attributed to wildlife reported by agricultural producers (n = 529) to corn and soybean by wildlife in northcentral Indiana in 2003. The top 5 species for each crop type reported are shown.

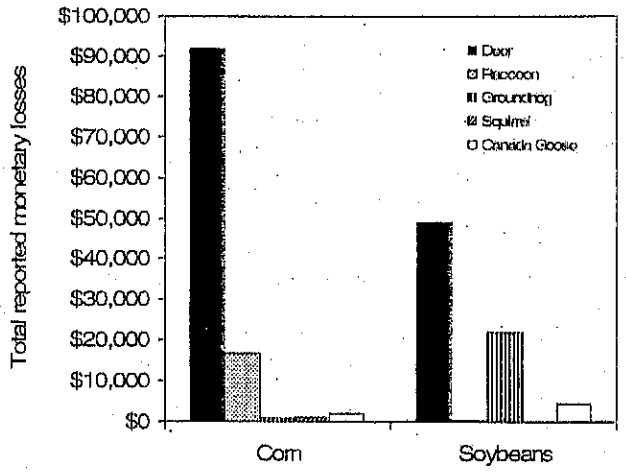

Fig. 6. Total reported monetary losses attributed to wildlife by agricultural producers (n = 529) in northcentral Indiana in 2003. The top 5 species for each crop type reported are shown.

2% of respondents indicated the same for deer, raccoon, or groundhog.

DISCUSSION

Crop depredation by wildlife is a substantial concern to most agricultural producers in northcentral Indiana. Although our field surveys indicated most fields incurred only light to moderate damage, the fields exhibited a high variance in levels of depredation. For example, we found no wildlife damage in 11 of 160 surveyed fields; conversely, we recorded a maximum of 162,453 damaged plants in 1 soybean field and 8,357 damaged plants in 1 corn field. The potential for severe wildlife damage to field crops varies greatly and potentially depends on factors such as animal densities across habitat mosaics and landscape-level habitat features.

Of the 160 crop fields we surveyed, 149 (93%) incurred some degree of wildlife depredation, which corresponded reasonably with landowner perceptions; our survey indicated 78% of agricultural producers reported having ≥1 crop type damaged by wildlife within the previous 12 months. Likewise, Conover (1998) reported 80% of farmers and ranchers nation-wide suffered wildlife damage during the year prior to 1993 or 1994.

Soybeans were damaged most often by deer (61%) and groundhogs (38%). Although most soybean damage by deer was only light browsing (which rarely affects yield adversely; Garrison and Lewis 1987), groundhog damage was more extensive and concentrated (i.e., near the burrow), resulting in reduced plant height or reduced bean production. The potential for groundhog damage to limit soybean harvest yields in the UWB may be substantial, depending on field size and the number of groundhogs present.

Perceptions of crop producers regarding species-specific damage to soybeans were similar to our findings. However, crop producers cited deer as the species most often responsible for damage to corn, when in reality, deer depredation to corn in our study area was minimal compared to raccoon depredation. Raccoon depredation may be more problematic to producers who grow corn in the UWB than in corn-producing regions of the U.S. in general. For example, Kelley et al. (1982) described raccoon depredation to corn fields in Ohio as negligible on a state-wide basis, and in Pennsylvania, Tzilkowski et al. (2002) reported that deer were responsible for most damage to corn.

Throughout the Midwest, raccoon populations have increased over the past 100 years (Lehman 1977), and are currently at or near record population levels in Indiana (Plowman 2003). Increases in raccoon abundance are due primarily to the conversion of native forest and prairie to agriculture (Page et al. 2001) and decreases in fur prices (Gehrt et al. 2002). Differences in depredation levels by raccoons between our study and previous studies (e.g., Kelley et al. 1982, Garrison and Lewis 1987) may be caused by regional differences in raccoon population sizes or the misidentification of raccoon damage as deer damage in previous studies. Annual fluctuations in raccoon population numbers or distributions as well as the availability of alternative food sources may have accounted for the differences observed in damage levels to corn between years in our study area (19,031 plants in 2003; 44,774 plants in 2004).

Crop producers' perceptions regarding monetary losses did not correspond closely to our field data. For example, producers reported deer were responsible for an average of $585 damage within the previous 12 months in all corn fields on their property; whereas only $283 was attributed to raccoon. These reported figures were unlikely to approach reality, given the proportionally high amount of damage our data attributed to raccoon compared to deer. When expressed as a percentage of total damage in corn fields, respondents attributed 82% of damage to deer and 15% to raccoon, which again was contradictory to our field data. However, when asked to describe the damage to corn in terms of percent value of crop lost, the same group attributed a 7.7% loss to raccoon and a 2.3% loss to deer, which was more in line with our field data that indicated more raccoon damage than deer damage in corn fields. Thus, producers we surveyed seem much more adept at expressing damage as a function of percent crop damaged as opposed to actual dollar amounts.

Our surveys of 160 agricultural fields yielded no cases of crop depredation by wild turkey. Turkey sign was evident in several fields and turkeys often were observed in fields we surveyed. Because of their relative conspicuousness, the wild turkey is commonly perceived as a species that damages crops (Payer and Craven 1995, Swanson et al. 2001). Studies of crop use by wild turkey in several midwestern states (Gabrey et al. 1993, Paisley et al. 1995, Payer and Craven 1995, Swanson et al. 2001) documented only trivial damage by wild turkeys to agricultural crops. Our study supports previous research and suggests that the occurrence of crop depredation by wild turkey is very low, even though they often occupy agricultural lands

throughout the year. Future work in the area of crop depredation should consider the beneficial aspects of wild turkey in agricultural landscapes.

Proper identification of species responsible for damage is vitally important so landowners and producers can implement the correct management strategies. Determining the amount and cause of species-specific damage to field crops can be difficult, especially for untrained individuals. Our study demonstrates the need to improve education and training in identifying wildlife damage to agricultural crops. Accurate assessment of wildlife damage by producers is important because those experiencing damage may be less likely to encourage wildlife use of their properties (Conover 1998).

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Lee Humberg (far left) is currently working as a biological science technician for the U.S. Department of the Army at Fort McCoy, Wisconsin. He received his B.S. in Wildlife and M.S. in Wildlife Ecology from Purdue University. Before returning to graduate school to investigate crop depredation and wild turkey ecology, Lee worked for the Pennsylvania Game Commission researching wild turkey ecology and Auburn University assisting in northern bobwhite quail research in longleaf pine ecosystems. His future professional interests include game bird ecology and management, human-wildlife conflicts, and predator-prey interactions. ***Travis L. DeVault*** (far right) is a Research Wildlife Biologist with the National Wildlife Research Center-USDA Wildlife Services in Brewerton, New York. He received a B.A. and M.A. in Biology from Indiana State University and a Ph.D. in Wildlife Science from Purdue University. He then served as a postdoctoral research associate and instructor at Purdue University. His current research interests include ecology and conservation of birds, management of human/wildlife conflicts, and scavenging behaviors of terrestrial vertebrates. ***Brian MacGowan*** (second from right) has been an Extension Wildlife Specialist with the Department of Forestry & Natural Resources, Purdue University since 1999. He earned a B.S. in Natural Resources from Ohio State University and a M.S. in Wildlife Science from Purdue University. His current educational programs and research include forest wildlife management, human-wildlife conflicts, warm season grass management, and the natural history and ecology of native fauna. Brian is a Certified Wildlife Biologist and a member of The Wildlife Society and Association of Natural Resources Extension Professionals. ***James Beasley*** (center) is currently pursuing a Ph.D. in Wildlife Ecology at Purdue University. He received his A.A.S. in Forestry from Paul Smith's College, a B.S. in Wildlife Management from the State University of New York College of Environmental Science and Forestry, and a M.S. in Wildlife Ecology from Purdue University. He is currently studying the effects of forest fragmentation on raccoon populations. His professional interests include carnivore and ungulate ecology, population dynamics, and wildlife management. ***Gene Rhodes*** (second from left) is a full Professor at Purdue University in the Department of Forestry and Natural Resources. He has published 98 peer-reviewed articles and has trained over 20 graduate students and postdocs in the past 10 years. His research focus is in wildlife ecology and genetics, including studies of the genetic consequences of species reintroduction programs, the use of genetic markers in applied wildlife management and conservation programs, the use of genetic markers to elucidate mating systems, movement behavior, and population structure of wildlife species and sustainability of wildlife species in human-dominated landscapes with an emphasis on the resolution of human-wildlife conflicts.