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Corn and Soybean Crop Depredation by Wildlife

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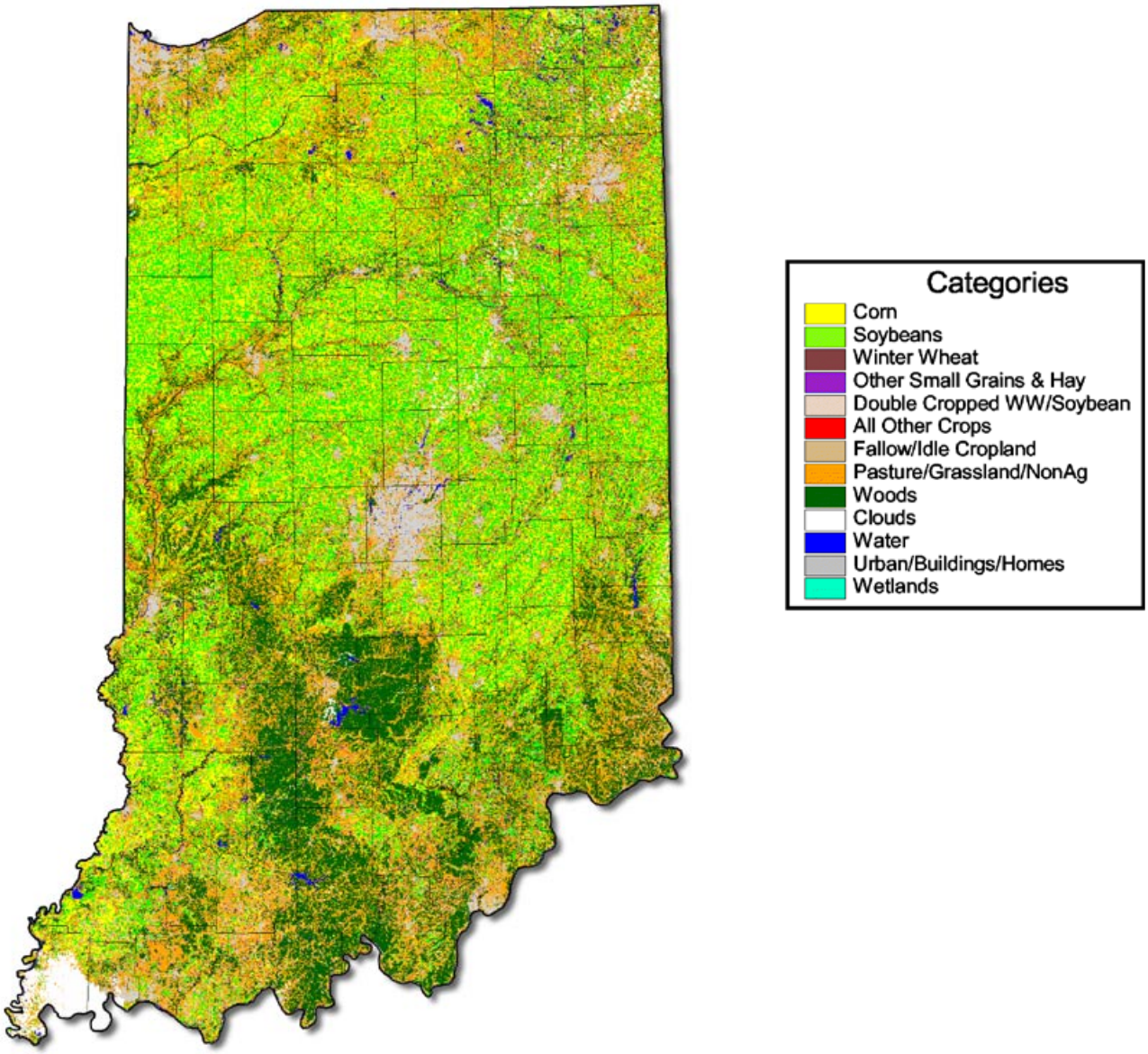

Figure 1. About two-thirds of the land area in Indiana is agriculture, most of which is corn and soybeans. (Source: U.S. Department of Agriculture, National Agricultural Statistics Service)

Introduction

The industry of agriculture is the dominant land use throughout the Indiana landscape, with over 65 percent of Indiana's land area in farmland (USDA National Agricultural Statistics Service 2002) (Figure 1). In both 2004 and 2005, producers in Indiana harvested approximately 900 million bushels of corn and 275 million bushels of soybeans (USDA National Agricultural Statistics Service 2006).

Healthy wildlife populations utilize these agricultural lands and are important to Hoosiers, as is demonstrated by the $1.5 billion spent annually on wildlife-related activities in the state (U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau).

Unfortunately, the competing needs of agriculture and wildlife utilizing the same lands often result in conflict, and despite the high demand for recreational and aesthetic opportunities associated with wildlife, many species are viewed negatively by producers because of crop damage issues.

Wildlife damage to field crops is a widespread concern in the United States, especially in midwestern states, and the assessment and control of wildlife damage to crops has become an important component of wildlife management. Conover (2002) estimated that wildlife-related economic losses to agricultural producers (farmers and ranchers) in the United States exceed $4.5 billion annually. Results of nationwide surveys conducted in 1993 and 1994 indicated that 80 percent of farmers and ranchers suffered wildlife

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

White-tailed deer *(Odocoileus virginianus)* also are thought to be the most common wildlife species that routinely damages agricultural crops (Craven and Hygnstrom 1994, Wywialowski 1994, Conover 1998). Agricultural crops, especially corn and soybeans, comprise a major portion of deer diets in midwestern agricultural regions. Past research has documented damage caused by deer to field corn (Sperow 1985, Vecellio et al. 1994, Wywialowski 1996, and Tzilkowski et al. 2002) and soybeans (de Calesta and Schwendeman 1978, Tanner and Dimmick 1984).

Raccoons *(Procyon lotor)* can inflict significant damage to corn. Over the past few decades, raccoon populations have increased throughout much of the Midwest (Gehrt et al. 2002, Plowman 2003), and likely are at or near record population levels in Indiana.

When available, corn is a primary food source for raccoons and can constitute over 65 percent of the total volume consumed by raccoons during the fall (Rivest and Bergeron 1981). The number of wildlife agencies reporting damage by raccoons increased from 10 percent in 1957 to 94 percent in 1987 (Conover and Decker 1991). Raccoons thrive in areas fragmented by agriculture where they reach their highest abundance because of the increased foraging opportunities and efficiencies associated with the interspersion of agriculture and woodlots.

Given the economic and social importance of both agriculture and wildlife-related activities in Indiana, balancing the needs of crop producers and wildlife populations is critical to the sustainability of both. In cooperation with the Indiana Department of Natural Resources and the National Wild Turkey Federation, the Purdue University Department of Forestry and Natural Resources conducted a research project to estimate the extent and timing of corn and soybean damage caused by wildlife in Indiana. Researchers and technicians spent thousands of hours surveying 160 corn and soybean fields in portions of the Upper Wabash River Basin (Figure 2) in northern Indiana. Crop producers in the area also were asked to estimate the amount of wildlife crop depredation on their properties and subsequent economic losses, to identify the wildlife species perceived to be responsible, and to relate their general attitudes toward wildlife. In addition, over 300 hours were spent observing the

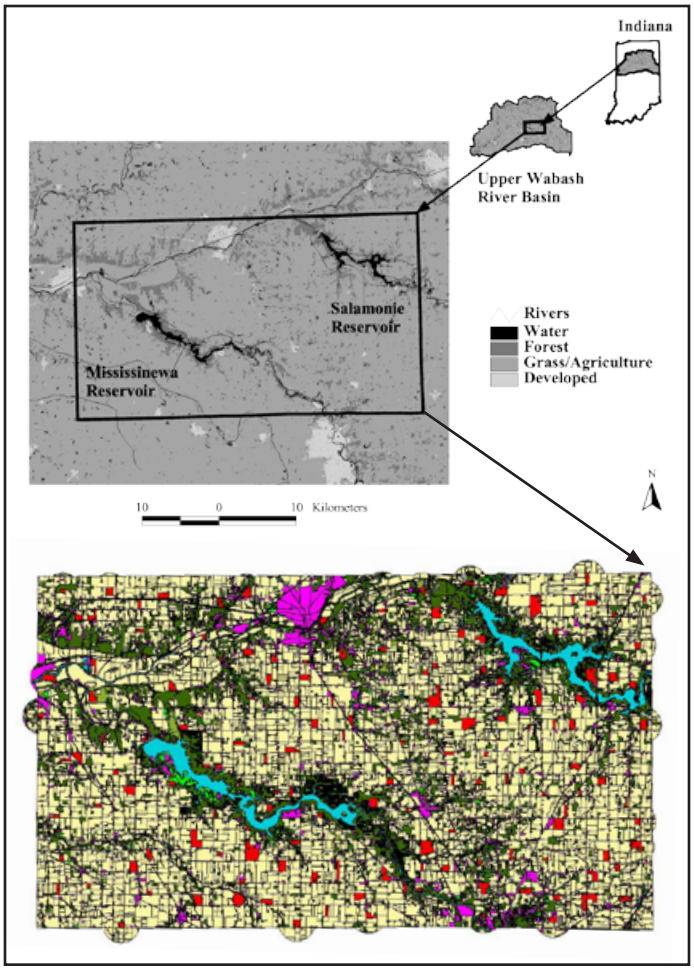

Figure 2. The study encompassed an approximately 450-mi^2 area in the Upper Wabash River Valley (top). Fields sampled are highlighted in red (bottom).

Figure 3. In addition to surveying wildlife damage to 160 corn and soybean fields over two years, researchers spent over 300 hours observing wildlife feeding behavior in corn and soybean fields from blinds.

feeding behavior of wildlife in crop fields (Figure 3). Researchers trapped wild turkey *(Meleagris gallopavo)*, raccoons, and white-tailed deer (Figure 4) and recorded their movements using radio telemetry. This publication summarizes the key findings of those projects.

Figure 4. A total of 92 wild turkeys, 83 raccoons, and 20 white-tailed deer were captured during the study. Each animal was fitted with a radio transmitter and tracked throughout the study period to assess daily and seasonal habitat use and movements.

What Do Indiana Farmers Think?

Understanding producers' attitudes and perceptions regarding wildlife and crop damage caused by wildlife is a critical element in finding a solution to this complex issue. Farmers are a key stakeholder group in this process, and what they think is important. Moreover, understanding negative misconceptions held by farmers toward wildlife is important because such misconceptions can affect their willingness to manage their lands for wildlife (Conover 1998); and because of that, 1,500 producers within portions of the Upper Wabash River Basin were mailed a survey with questions regarding the severity of crop depredation on their property, the wildlife species perceived to be responsible, their estimated annual economic losses from wildlife crop depredation, and their general attitudes toward wildlife.

Seventy-eight percent of producers who responded reported having ≥1 crop type damaged by wildlife within the previous 12 months. Eleven percent and 9 percent reported deer and groundhog *(Marmota monax)* damage, respectively, to soybeans within the previous 12 months, and less than 2 percent of producers reported damage to soybeans by raccoons, squirrels *(Sciurus* spp., *Spermophilus tridecemlineatus)*, or Canada geese *(Branta canadensis)*. Twenty three percent of producers reported deer damage to corn, and 12 percent reported raccoon damage to corn. Less than 3 percent of producers reported damage to corn by groundhogs, squirrels, or Canada Geese.

Average reported monetary losses to various species of wildlife ranged from $105-$585 for corn and $39-$479 for soybeans. Farmers indicated losses of 2 percent of total crop value for deer and raccoon. In soybeans, crop value losses to deer and groundhogs were 2.8 percent and 1.7 percent, respectively. Total reported losses by respondents were highest for deer and raccoon in corn, and deer and groundhog in soybeans (Figure 5). The extent of monetary losses reported by individual farmers appeared to be related to a farmer's tolerance for wildlife damage; however, such reported losses and tolerance levels varied greatly. For some, relatively little perceived damage ($50-$100) exceeded their tolerance, but for others, relatively substantial perceived damage (>$500) did not.

Regarding farmers' general attitudes toward wildlife, groundhog was most disliked and considered a nuisance by 85 percent of those surveyed. Raccoon had the

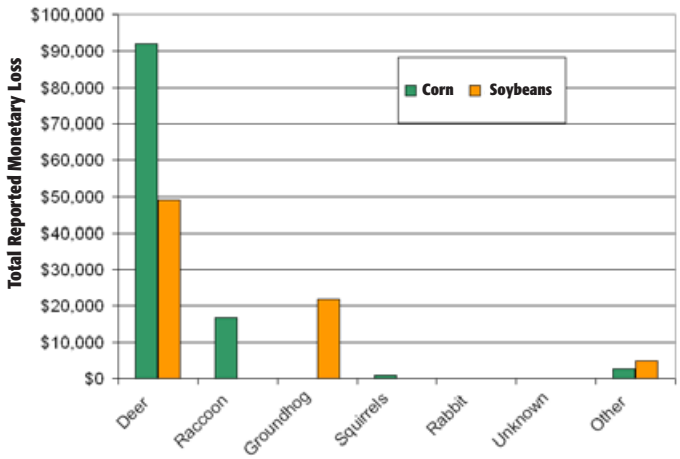

Figure 5. Total monetary loss due to wildlife damage reported by crop producers in northcentral Indiana.

second highest nuisance rating at 54 percent, and deer was considered a nuisance species by 21 percent of producers surveyed. Wild turkey was considered a nuisance by only 2 percent of the respondents, although a relatively large percentage (16 percent) were unsure about their feelings toward wild turkey. Less than 2 percent of respondents indicated unsure feelings for deer, raccoon, or groundhog.

Amount and Timing of Wildlife Damage

We sampled corn and soybean fields that were representative of the distribution of field sizes in the study area. Technicians walked field transects (along the field edges and interior) and surveyed each field approximately once per month from plant emergence until harvest (Figure 6). Survey crews documented all plants that exhibited any sign of wildlife-caused damage visible from transects. Where depredation events (any previously unrecorded damage to a single plant caused by wildlife) were documented, 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. All documented damage was marked clearly with paint to avoid recounting during subsequent surveys.

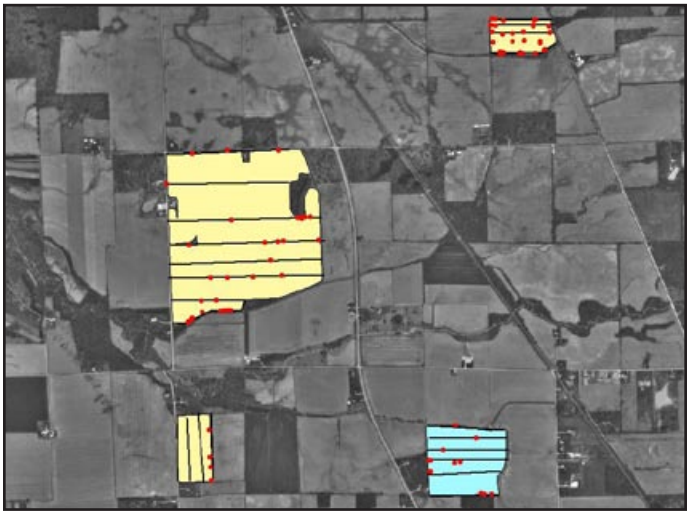

Figure 6. Technicians regularly surveyed fields along transects (black lines) for wildlife damage and recorded the location of damage (red circles) within the cornfields (yellow) and soybean fields (blue), number of plants damaged, wildlife species responsible, amount of leaf area damaged, amount of seed damage, height of damage, and growth stage of plant at the time of damage.

Researchers documented a total of 582,515 depredation events in 149 of 160 corn and soybean fields (93 percent) surveyed over the growing seasons of 2003 and 2004. No wildlife damage was observed in five corn fields and six soybean fields. 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 soybean field was 162,453. White-tailed deer (61 percent) and groundhogs (38 percent) were most often responsible for damage to soybean plants. Eastern cottontail *(Sylvilagus floridana)*, raccoon, small rodents (e.g. fox squirrel *[Sciurus niger]*, 13-lined ground squirrel *[Spermophilus tridecemlineatus]*, chipmunk *[Tamias striatus])*, and unidentified species combined were responsible for less than 2 percent of the total damage to soybean plants (Figure 7). We detected no measurable wild turkey damage to soybeans. Damage to soybeans remained relatively constant throughout the growing season as long as plants were green and succulent.

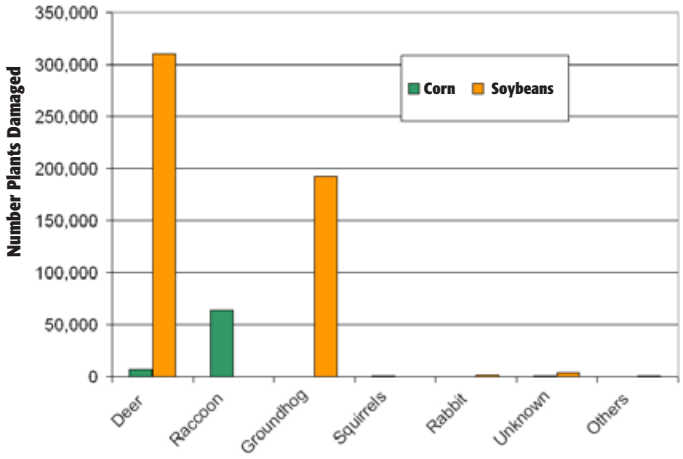

Figure 7. Number of corn and soybean plants damaged by wildlife species in northcentral Indiana.

Our depredation 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 were responsible for 87 percent of the observed damage to corn, an amount more than eight times greater than damage caused by deer. Small mammals (e.g. eastern cottontail, fox squirrel, 13-lined ground squirrel, and chipmunk), beaver *(Castor canadensis)*, birds, and other wildlife had little effect on field corn yield in our study area (Figure 7). We detected no damage to corn by wild turkey. Deer damaged corn steadily from plant emergence through harvest (October) (Figure 8). Conversely, raccoons rarely damaged corn until the beginning of the corn reproductive stages (early to mid-June); raccoons subsequently caused substantial amounts of damage until harvest (October) (Figure 8).

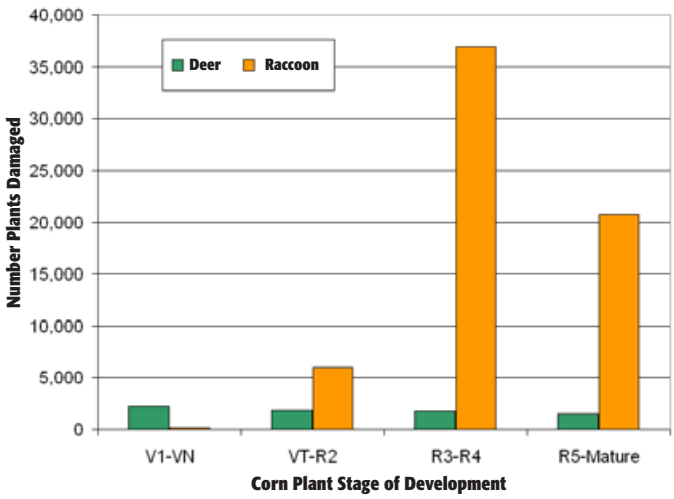

Figure 8. Intensity of raccoon and deer depredation to corn by plant developmental growth stage. The vegetative stage of corn growth (V_) begins with the emergence of the first collared leaf (VE), generally in early May, and ends at tassel (VT) when the last branch of the tassel becomes visible (usually early June). The reproductive stage (R_) begins with the emergence of silk (R1) (usually early to mid-June) and continues until plant maturity (R6) (early September).

Edge and Landscape Effects

Not all fields are created equal with regard to their potential for wildlife damage, as crop depredation can be influenced by local and landscape characteristics (Table 1). Landscape characteristics for a given crop field include the habitat features surrounding it (i.e., landscape composition) and the arrangement of those features (i.e., landscape configuration). For example, the amount of wooded area in the vicinity of a crop field can be an important contributor to the intensity of damage caused by deer and raccoon (Figure 9). The distribution and density of deer often varies with the abundance of riparian or other woody cover (Smith 1987, Dusek et al. 1989). Raccoons, however, select hardwood habitats when available, possibly due to the foraging and denning opportunities that hardwood trees provide, as well as the availability of water in these areas (Chamberlain et al. 2003). Thus, corn fields adjacent to forest patches may be particularly susceptible to damage by raccoons.

Table 1. Variables of influence for wildlife damage to corn and soybean fields in northcentral Indiana. Landscape variables were calculated for a 530-ha area centered upon crop fields and defined according to the largest reported seasonal home range size for deer and raccoons in the study. Negative and positive signs denote negative and positive relationships between each habitat predictor and the rate of crop damage, respectively. For example, larger fields tended to have lower rates of crop damage.

Local habitat variables	Landscape habitat variables
Area of the field (-)	Amount of wooded area (+)
Proportion of the perimeter of the field adjacent to wooded area (+)	Amount of forest edge (+)
	Mean forest patch size (+)

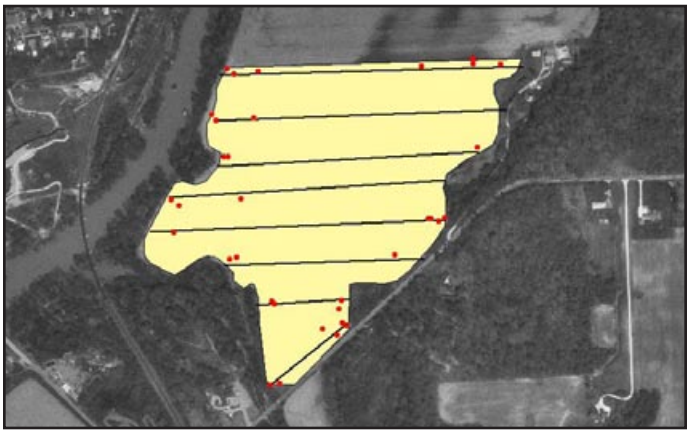

Figure 9. The amount of wooded area and the degree of fragmentation (i.e., amount of wooded edge) was positively related to the amount of damage to a field. Moreover, smaller fields with a high proportion of their perimeter adjacent to woodland had more damage. Locations in the field where damage occurred (indicated by red dots) are nearly all adjacent to wooded field edges.

Fragmentation (i.e., the patchy arrangement) of wooded habitats may contribute to the frequency of crop damage by deer and raccoons. Both of these species thrive in edge habitats–areas where one habitat type intersects another. Dividing large wooded areas into several smaller fragments creates more edge habitat relative to core woodland areas (Figure 10), and can contribute to increased rates of crop depredation by deer and raccoons.

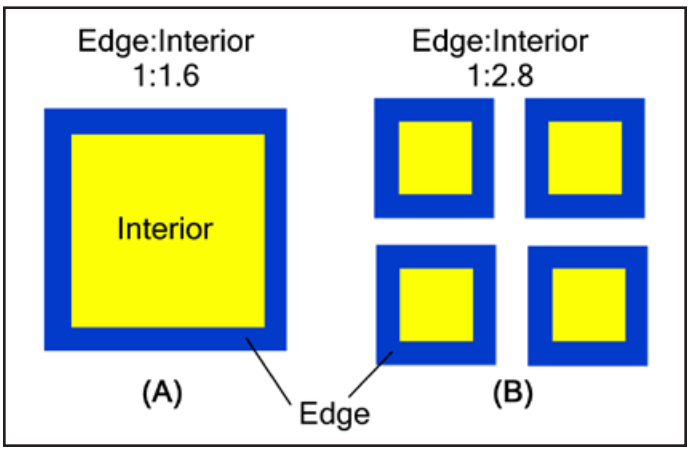

Figure 10. Fragmentation divides large blocks of forest into separate smaller blocks. Dividing a forest block into fourths increases the amount of edge habitat and decreases the amount of core or interior forest. The amount of damage to corn caused by deer and raccoon were positively related to the amount of fragmentation in the landscape.

What Is the Influence of Wildlife Damage on Yield?

Determining the actual impact of wildlife damage to crop yield depends on the stage of plant development, location of damage in the field, amount of damage, and the location of damage on the plant(s). Damage during critical reproductive stages generally will result in the most adverse results to yield–stages 4.5 to 5.5 for soybeans and the tassel (VT) and silk (R1) stages for corn. Any damage that knocks down corn plants later in development will result in losses up to 100 percent for each damaged plant. Downed corn that is not consumed will either rot or be eaten by other wildlife, and is unharvestable by a combine. Raccoon damage to corn during the milk (R3) through mature (R6) stages usually results in a total loss of yield for each plant damaged (Figure 11).

In almost all of the fields surveyed, most wildlife damage resulted in relatively low yield losses (<$100). For the most heavily damaged fields we surveyed,

Figure 11. In the UWB, rate of damage to corn by raccoon was higher than that of deer. Discussions with some landowners revealed they mistook damage by raccoon for damage by deer. Typical raccoon damage is depicted. Raccoons typically either stand on their hind legs and feed on the ears while on the stalk, or climb the stalk to reach the ear. In either case, the corn stalk usually breaks. The result is a varying amount of corn stalks on the ground and lying in various directions.

yield losses were less than $500 based on the number of damaged plants, assuming 100 percent loss for each damaged plant. A total loss of approximately 1.4 acres of corn, or 32,000 plants, would equal $500 in damage. Similarly, over 1.8 acres of soybeans would have to be completely damaged at $5.50/bu with a yield of 49 bushels/acre (2005 statewide averages for Indiana [USDA-NASS 2006]) to reach $500 in damage. However, light to moderate browsing of soybeans by white-tailed deer usually results in no yield loss (Garrison and Lewis 1987). Five hundred dollars is the minimum amount of damage required to obtain a Deer Control Permit; thus, a substantial amount of damage to either corn or soybeans is required to reach that threshold.

Perception vs. Reality

Several key points emerge in a comparison between landowner perceptions regarding crop damage and actual field data. Field crews found wildlife damage in 93 percent of the fields they sampled. Only 73 percent of landowners reported wildlife damage to either corn or soybeans within the past year; thus, minor damage may be overlooked by landowners. Landowners underestimated the number of damaged fields, but

overestimated the value lost due to damage, especially in terms of dollars lost rather than percent of total crop lost. However, regardless of the amount of damage, whether real or perceived, landowners varied on the level of damage that was tolerable to them. For some, no damage was tolerable. It is important for wildlife biologists and educators to acknowledge individual differences in tolerance levels when working with agricultural producers. What is tolerable damage to one individual may not be tolerable to another, and thus, should not be dismissed as insignificant.

Crop producers correctly identified the wildlife species that caused the most damage for each crop type–raccoon and deer for corn, and deer and groundhog for soybeans. However, they believed that deer caused the most damage to corn, whereas field surveys indicated that raccoons were responsible for the vast majority of the damage (Figures 6, 11). Even so, only about one in five farmers considered deer a nuisance (2.5 times more landowners thought raccoons were a nuisance, and four times more thought groundhogs were a nuisance). Raccoon depredation is apparently more problematic to corn producers in the UWB than in other less fragmented corn-producing regions of the United States in general. For example, raccoon depredation in cornfields was negligible statewide in Ohio (Kelley et al. 1982), and white-tailed deer were responsible for the most damage in Pennsylvania (Tzilkowski et al. 2002).

Understandably, negative feelings by farmers toward deer and raccoons were related to the amount of perceived damage. This fact reinforces the importance of proper identification of wildlife damage. Misidentification of wildlife damage to crops can lead to negative feelings, which in turn may lead to unnecessary and unwarranted management objectives for some wildlife species. For more information on the identification of wildlife damage in crop fields, see FNR-267, Identification of Wildlife Crop Depredation; www.purdue.edu/cropdamage.

Surveys of 160 agricultural fields yielded no cases of measurable crop depredation by wild turkey. Turkey sign was evident in several fields and turkeys were observed often in fields we surveyed. We suspect that turkeys are perceived to damage crops because they are easily observed compared to other species in the UWB landscape. Due to their size, flocking behavior, and daytime activity, wild turkeys often are seen foraging in crop fields; however, they are usually foraging on waste grain and insects rather than

Figure 12. Wild turkeys often are linked incorrectly to crop damage, probably because of their high visibility compared to other species. Landowners surveyed were unsure about turkeys as a nuisance more than any other species.

Figure 13. Wild turkeys were observed feeding on newly emerged soybeans in a couple fields (not included in the 160 fields systematically surveyed for wildlife damage). Estimated annual damage caused by wild turkey in Indiana is ≤$10,000 (Tefft et al. 2005). Overall wildlife damage to harvestable field corn in Indiana was estimated at $1.8 billion in 1993 (Wywialowski 1996).

damaging crops (Figure 12). Studies of crop use by wild turkey in several midwestern states documented only trivial damage by wild turkeys to agricultural crops (Gabrey et al. 1993, Payer and Craven 1995, Paisley et al. 1995, Swanson et al. 2001, Tefft et al. 2005). 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. Anecdotal evidence of wild turkeys feeding on newly emerged soybeans was observed in a couple fields outside of the 160 surveyed for wildlife damage (Figure 13). However, this observation does not necessarily translate to measurable damage. For example, light damage to soybeans by white-tailed rarely affects yield adversely (Garrison and Lewis 1987).

Management Implications

Crop depredation by wildlife is a substantial concern to agricultural producers in northcentral Indiana. Although our field surveys indicated that most fields incurred only light to moderate damage, 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 one soybean field and 8,357 damaged plants in one corn field. The potential for severe wildlife damage to field crops varies greatly and depends on several factors including animal densities across habitat mosaics, field characteristics (size and proportion of edges adjacent to woodlands), and landscape-level habitat features (e.g., percent woodland).

We recorded a high level of raccoon damage to corn relative to previous research; raccoons were the source of 87 percent of observed depredation events (Figure 14). A relatively high population of raccoons in the study area is the most likely reason behind our observations. Throughout much of 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). One reason for the increase in raccoon abundance may be the conversion of native forest and prairie to agriculture (Page et al. 2001). Declines in trapping effort due to decreases in pelt prices over the last 15-20 years also are a likely contributing factor (Gehrt et al. 2002). Differences in depredation levels by raccoons between our study and previous studies (e.g. Kelley et al. 1982) may have been caused by regional differences in raccoon population numbers or the misidentification of raccoon damage as deer damage in previous studies. Based on visual observations of several fields using night vision, we are confident that we correctly identified wildlife damage. Preliminary research suggests that the density of local raccoon populations is positively related to the amount of damage to field corn caused by raccoons. Densities of raccoons were very high in our study area ($\bar{X}$ = 0.6 raccoons/acre of forest; J. C. Beasley, unpublished data). For example, six individual raccoons were captured and marked in a single 10-acre woodland. Although this research is ongoing, it strongly supports the premise that local population control should decrease crop damage, at least in the short term. The immigration rate of new raccoons into an area likely is dependent upon the landscape configuration and surrounding raccoon population characteristics (e.g., density, sex ratio), which should dictate the length of time control efforts would be effective.

Proper identification of the species responsible for crop damage is vitally important so that landowners can implement proper management strategies. Furthermore, accurate assessments of wildlife damage by farmers are important because those experiencing damage may be less likely to manage for wildlife on their property (Conover 1998). Rules governing lethal control differ for deer, raccoon and groundhogs. For groundhogs, there are no limits on control in Indiana. Raccoons causing damage outside of regulated seasons can be removed in Indiana (trapped and relocated, or killed in a lawful manner) without a permit, although a conservation officer must be notified within 72 hours (312 IAC 9-3-15). Control of deer outside of the established hunting season requires a Deer Control Permit issued by the Indiana Department of Natural Resources through a District Wildlife Biologist; a minimum of $500 damage is required. Ultimately, the proper identification of the species causing damage to agricultural crops will dictate the proper management actions and the tools available to landowners to reduce such damage if they so chose.

Figure 14. Raccoon damage to corn often results in shredded husks and muddied, masticated cobs with many torn seed coats remaining.

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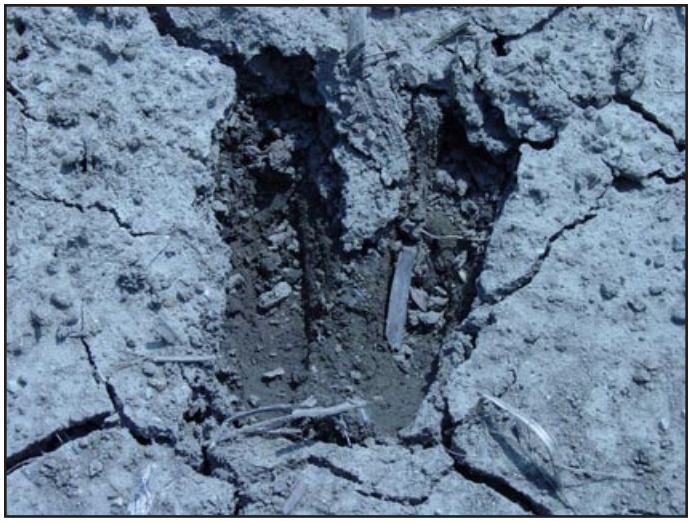

Deer track

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Raccoon track

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