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WATERBIRD BEHAVIORAL RESPONSES TO HUMAN DISTURBANCES

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Recreationists in natural areas can affect wildlife by disrupting foraging and social behavior (Burger 1981, 1986; Skagen et al. 1991), feeding animals (Edington and Edington 1986: 41), disrupting parent-offspring bonds (Oldfield 1988) and pair bonds (Tindle 1979), and increasing nest predation by attracting predators to nest sites or young (Strang 1980, Safina and Burger 1983, Piatt et al. 1990). Increasing human use of natural areas also can decrease wildlife densities (Werschkul et al. 1976, Erwin 1980, Madsen 1985) and length of foraging sessions (Kaiser and Fritzell 1984). Although many studies have identified wildlife responses to human disturbance, the various ways that humans disturb wildlife and wildlife responses to such disturbance have not been determined. Therefore, my objectives were to determine how foraging waterbirds responded to specific human actions, and to characterize human behaviors, with emphasis on identifying their potential for wildlife disturbance.

METHODS

Study Area

My study was conducted on the J. N. "Ding" Darling National Wildlife Refuge (DDNWR), a 2,030-ha refuge on Sanibel Island. Sanibel is a 20-km-long, subtropical barrier island located off the southern gulf coast of Florida. Tidal mud flats and scattered islands of mangroves (*Rhizophora mangle, Avicennia germinans, Laguncularia racemosa, Conocarpus erecta*) provide habitat for waterbirds (Curry-Lindahl 1978, Murdich 1978:8, Pannier 1979). An earthen dike with control structures surrounds approximately 3 km^2 of mangrove swamp. This allows control of the salinity and hydroperiod in 2 impoundments (Provost 1969, Erwin 1986). An additional 11 km^2 of habitat exists outside impoundments. The dominant aquatic vegetation is turtlegrass (*Thalassia testudium*), Gulf manateegrass (*Cymodocea filiformis*), and common wigeonweed (*Ruppia maritima*).

Visitation at DDNWR is high, with most visitors from outside of Florida. During my study, DDNWR hosted approximately 538,000 visitors/year, peaking from November through April. Nearly all refuge visitors were confined to an 8-km wildlife observation dike that serves as a 1-way drive through high-quality foraging areas.

Experimental Disturbances

I experimentally disturbed waterbirds of 31 species between 1 June 1987 and 30 May 1988. At dawn, when other human interference was minimal, I observed birds on 3 randomly chosen days during each of 13 consecutive 28-day sample periods. No experimental disturbances were made in the presence of visitors. Species not found within 50 m of the dike were ignored because I could not determine their behavioral response to imposed disturbances.

I subjected individual birds to 1 of 5 human behaviors, selected at random (Table 1). When I encountered a flock, I recorded the response of a single bird. Bird responses were classified as 1 of 5 behaviors (Table 1). I wore neutral-colored clothing when administering all treatments.

For treatment category 4, rate of approach was approximately 0.12 m/second. Noise in category 5 came from a 1-minute repeating tape of human voices, replayed at the same loudness in each trial. Chi-square contingency table analysis (Ott 1984:203) was used to test the null hypothesis that frequencies of bird responses were independent of disturbance treatments ($\alpha = 0.05$).

Unobtrusive Observation of Refuge Visitors

Using unobtrusive observation techniques (Mullins et al. 1983), 10 volunteers and I monitored visitors ≥ 2 times/month for each day of the week from November 1987–April 1988 (2 randomly chosen Mondays, Tuesdays, etc.), and at least once/month from June–October 1987 and in May 1988. Sampling was more frequent from November–April because of higher human visitation during that time. Observations began when a randomly chosen group of people entered the refuge. A "group" was defined as ≥ 1 individual visiting DDNWR together. An observer followed the group in

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Table 1. Experimental disturbance treatments and behavioral response categories for waterbirds, J. N. "Ding" Darling National Wildlife Refuge, Florida, 1987–1988.

Human disturbance (treatments)	Possible bird responses
1. Drive by bird, do not stop vehicle.	1. No observable response.
2. Stop vehicle within sight of bird, do not get out.	2. Bird looked up, aware of human presence.
3. Stop vehicle within sight of bird, get out and look at bird, do not approach.	3. Bird gave alarm call, but did not flee or move away.
4. Stop vehicle within sight of bird, get out, slowly approach while looking at bird.	4. Bird slowly moved away from source of disturbance.
5. Stop vehicle within sight of bird, do not get out, play noise tape.	5. Bird quickly fled, usually leaving the vicinity.

an unmarked passenger car at an inconspicuous distance for the duration of the group's visit. Most groups traveled around the refuge by car, bus, bicycle, or moped. I standardized collection of observational data among assistants by individual training, a field manual of standard operating procedures, and in-field evaluations of team members. In addition, monthly meetings were held to answer questions and discuss data collection.

A group's purpose for visiting the refuge was inferred from the primary activities of the members (e.g., nature observation, photography, fishing, crabbing, shell collecting, boating, fitness, or driving). Photographers were defined as having a 35-mm camera or more sophisticated equipment and spending ≥50% of their time photographing wildlife. "Drive-through" visitors drove quickly through the refuge and rarely or never stopped. Group composition (lone individuals, couples, peers, families, and organized groups [i.e., Mullins et al. 1983]) was noted because Vaske et al. (1983) found that it influenced human–wildlife interactions.

Proportions were calculated for categorical data, and 95% confidence intervals (Ott 1984:185) were calculated for all proportions. I tested the null hypotheses that group type and purpose for visiting the refuge did not influence the mean number of stops and number of times a party got out of its vehicle using analyses of variance (Ott 1984:616 [$\alpha = 0.05$]). In cases where the F-statistic was significant, I used the Fisher's protected least significant difference test (Ott 1984:356) to determine which means differed from each other.

RESULTS

Behavioral Response to Experimental Disturbance

Fifteen species of waterbirds were sampled in sufficient numbers (≥40 individuals) for analysis. The responses of 11 species (73%) were dependent ($P \leq 0.03$) on type of disturbance (Figs. 1–3). As intensity of disturbance increased, avoidance response by the birds tended to increase.

Brown pelicans (*Pelecanus occidentalis*, $\chi^2 = 23.90$, 12 df, $P = 0.02$), double-crested cormorants (*Phalacrocorax auritus*, $\chi^2 = 28.89$, 12 df, $P = 0.00$), and anhingas (*Anhinga anhinga*, $\chi^2 = 53.83$, 16 df, $P = 0.00$) exposed to human disturbance often became attentive but seldom moved away, except when approached by a person on foot (Fig. 1A–C). Some brown pelicans only responded to human approach. Although less disruptive than approach on foot, noise caused avoidance behavior by pelicans and cormorants.

Behavior of great blue herons (*Ardea herodias*, $\chi^2 = 25.03$, 12 df, $P = 0.01$), little blue herons (*Egretta caerulea*, $\chi^2 = 29.08$, 16 df, $P = 0.02$), tricolored herons (*Egretta tricolor*, $\chi^2 = 47.63$, 16 df, $P = 0.00$), and white ibis (*Eudocimus albus*, $\chi^2 = 28.13$, 12 df, $P = 0.01$) ranged from relatively minor disturbance in drive-by trials to strong avoidance for approach trials (Fig. 2A–D). Sixty to 80% of birds tested either slowly moved away or fled from observer approach.

Pied-billed grebes (*Podilymbus podiceps*, $\chi^2 = 67.57$, 12 df, $P = 0.00$) and mottled ducks (*Anas fulvigula*, $\chi^2 = 46.10$, 12 df, $P = 0.00$) were sensitive to approach on foot, moving away slowly or fleeing in >95% of the trials (Fig. 3A, B), and almost always responded to disturbances. These species, common moor-

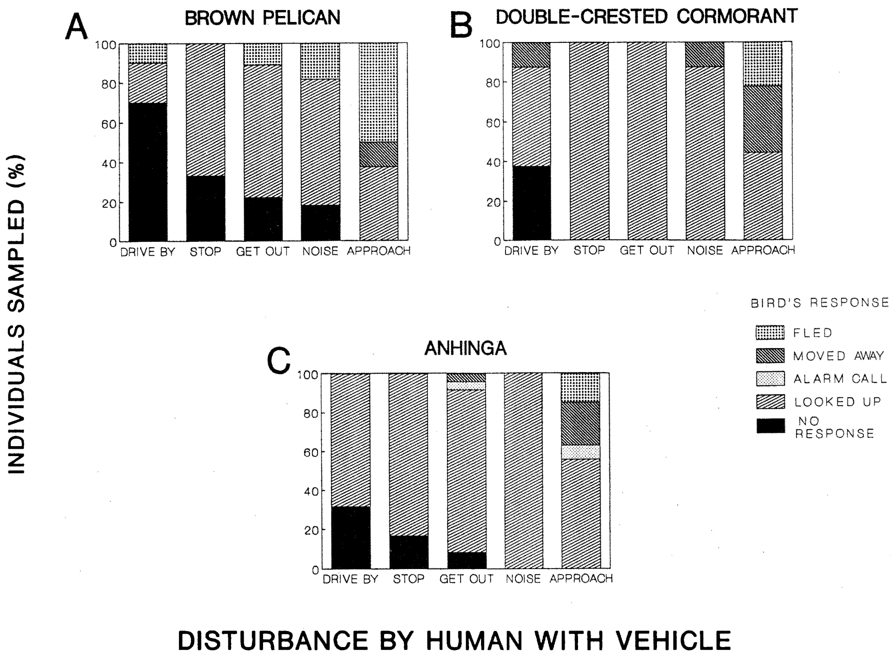

Fig. 1. Behavior profiles (%) of waterbird species that showed dependence ($P < 0.05$, χ^2 test) on experimental disturbances by becoming attentive, but seldom moving away. J. N. "Ding" Darling National Wildlife Refuge, Florida, June 1987–May 1988.

hens (*Gallinula chloropus*, $\chi^2 = 49.29$, 16 df, $P = 0.00$), and blue-winged teal (*Anas discors*, $\chi^2 = 22.48$, 12 df, $P = 0.03$ [Fig. 3C, D]) usually slowly swam away from disturbance. This behavior contrasted with that of herons and ibis, which in general quickly flew away when disturbed.

Great egrets (*Casmerodius albus*, $\chi^2 = 11.95$, 12 df, $P = 0.45$), snowy egrets (*Egretta thula*, $\chi^2 = 16.03$, 12 df, $P = 0.19$), green-backed herons (*Butorides striatus*, $\chi^2 = 26.66$, 16 df, $P = 0.05$), and yellow-crowned night-herons (*Nycticorax violaceus*, $\chi^2 = 18.99$, 12 df, $P = 0.09$) did not respond to disturbance. Noise seemed less disruptive to snowy egrets than other treatments, except drive-by. Stopping a vehicle caused flight in 40–50% of the great egrets, green-backed herons, and yellow-crowned night-herons. These individuals contrasted with another 40–50% of the individuals tested that would not flee until I left my vehicle and approached closely on foot.

Visitor Activities

Behavior of Refuge Visitors.—We observed 622 visitor groups (1,673 individuals). Purpose of visit influenced ($\chi^2 = 39.51$, 4 df, $P = 0.00$) behavior of visitors. Photographers were more likely to approach birds than other group types except fitness groups (Fig. 4A). Even slow approach by photographers disrupted waterbirds. Group composition was not associated with tendency to approach birds ($\chi^2 = 3.66$, 4 df, $P = 0.45$).

Groups' purposes for visiting the refuge also

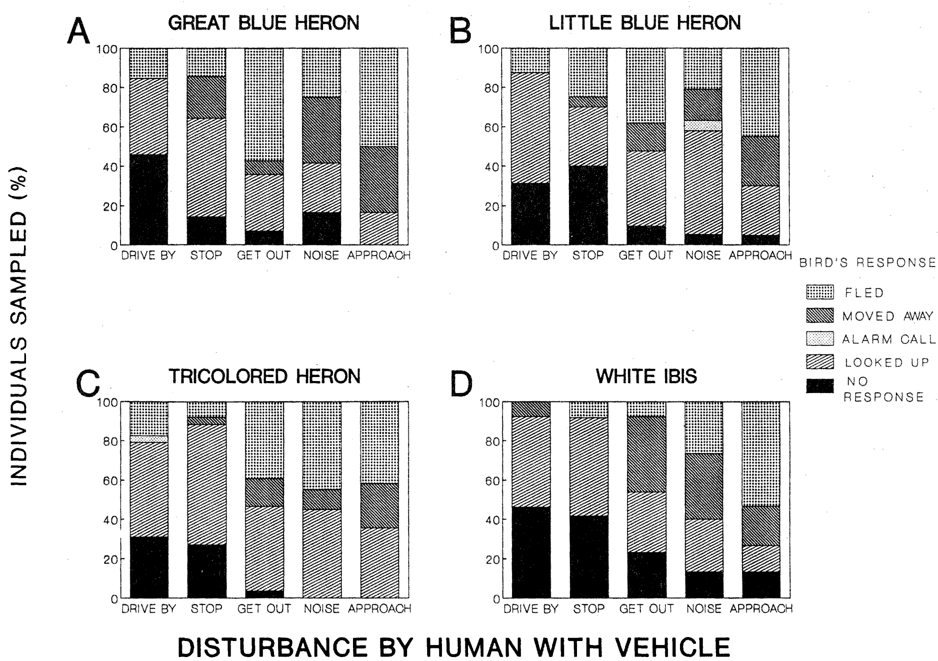

Fig. 2. Behavior profiles (%) of waterbird species that showed dependence ($P < 0.05$, χ^2 test) on experimental disturbances by remaining relatively undisturbed in drive-by trials but flying away from approach trials. J. N. "Ding" Darling National Wildlife Refuge, Florida, June 1987–May 1988.

affected the number of times group members stopped their vehicles ($F = 15.72$; 4,617 df; $P = 0.00$) or left their vehicles ($F = 30.05$; 4,617 df; $P = 0.00$ [Fig. 4B, C]). Photographers were more likely to stop ($\bar{x} = 12.0$ times, SE = 0.6, $n = 103$) and leave their vehicles ($\bar{x} = 5.7$ times, SE = 0.3, $n = 103$) than groups with other purposes for visiting the refuge. Although nature observers also frequently stopped ($\bar{x} = 10.3$, SE = 0.3, $n = 472$), they were less likely to leave their vehicles ($\bar{x} = 3.0$, SE = 0.1, $n = 472$) than photographers. Group composition did not affect stopping ($F = 0.20$; 4,614 df; $P = 0.94$) or out-of-car ($F = 1.39$; 4,614 df; $P = 0.24$) frequency.

Observed Disturbance of Wildlife.—We observed 61 visitor groups (10%) disturb 89 waterbirds. With 168,112 visitor groups/year during 1987–1988, an estimated 18,395–29,679 (95% CI) disturbances occurred that caused waterbirds to flee. Most birds that fled were herons, egrets, pelicans, cormorants, grebes, and anhingas foraging or perching within 50 m of the dike. Mottled ducks and blue-winged teal near the dike also were frequently disturbed to flight.

Purpose of visit affected whether groups disturbed wildlife ($\chi^2 = 10.73$, 3 df, $P = 0.02$). Photographers disturbed waterbirds (18%) more than people observing nature (9%, $P = 0.02$) and fishing or crabbing (0%, $P = 0.00$). Fitness visitors frequently disturbed wildlife (20%), but the number of these groups observed was too small (5) to allow inferences to be drawn.

Recreationists who went into the visitors' center were equally likely ($P = 0.25$) to disturb waterbirds (9%) as those who did not (11%).

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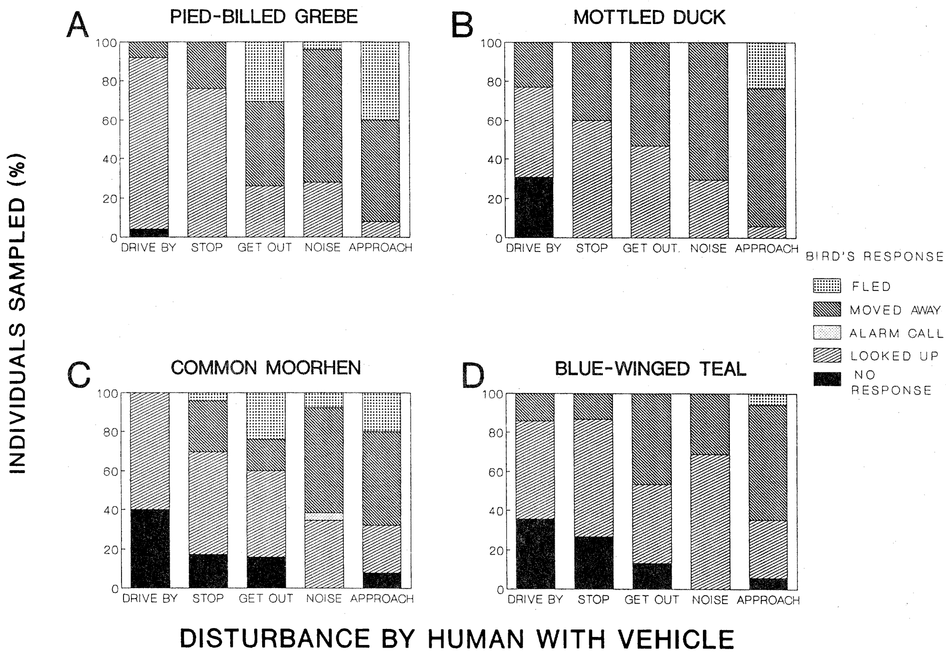

Fig. 3. Behavior profiles (%) of waterbird species that showed dependence ($P < 0.05$, χ^2 test) on experimental disturbances by remaining relatively undisturbed in drive-by trials but swimming away from approach trials. J. N. "Ding" Darling National Wildlife Refuge, Florida, June 1987–May 1988.

However, visitors who spoke to roving refuge volunteers were less likely ($P = 0.00$) to disturb wildlife (3%) than other recreationists except for those who were fishing (0%) and crabbing (0%).

DISCUSSION

Sensitivity of Species

Sanibel's mangrove flats provide feeding habitat for nearly 50 species of waterbirds. Wading birds and dabbling ducks are attracted to the mud flats that are exposed during low tides and rarely are under >1 m of water. At the refuge, diving birds are attracted to the deeper "borrow" ditches along the dike where they feed on fish trapped when the mud flats drain during low tide. Thus, tidal cycles dictate foraging schedules for many waders and shorebirds that feed only during low tides, whereas time of day and weather have less influence (Chapman 1984:33). Birds must feed heavily during brief periods, when disturbance could result in lost feeding opportunities.

Brown pelicans, double-crested cormorants, and anhingas feeding on fish or perching near the dike primarily responded to approach on foot. Individuals of these species were approachable because they tended to perch near the borrow ditch <20 m from the dike. Herons and egrets frequently flew away from visitors. In addition, most species were disturbed by the noise treatment. Such disturbance may disrupt interspecific and intraspecific relationships because wading birds will defend feeding territories (Kushlan 1978:264).

Some great egrets (41%), green-backed herons (33%), and yellow-crowned night-herons

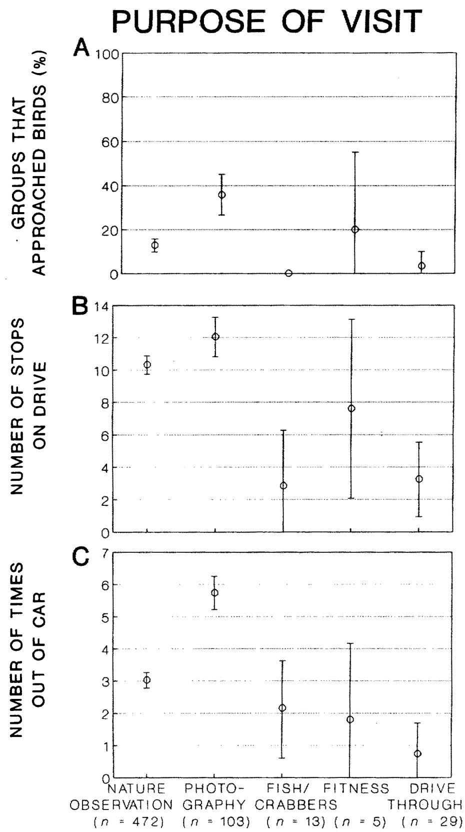

Fig. 4. (A) Percentages (95% CI) of human groups that approached waterbirds, (B) mean (95% CI from ANOVA) stops and (C) mean number of times people left their cars in relation to their purpose for visiting J. N. "Ding" Darling National Wildlife Refuge, Florida, June 1987–May 1988.

(49%) tolerated the presence of people and remained relatively undisturbed until approached closely. Thus, there may have been 2 distinct behavioral groups (Keller 1989) for these 3 species.

Kaiser and Fritzell (1984) suggested that green-backed herons can serve as "indicators" of human disturbance. They observed reduced foraging success during periods of high visitation on rivers in the Missouri Ozarks. They also found that a high density of canoeists correlated with reduced use of the river edge and increased use of backwater areas by these herons. Based on my data, I suggest that some green-backed herons seemingly tolerated humans, whereas sensitive individuals departed. Thus, green-backed herons would not serve well as indicators of disturbance at DDNWR.

Disturbance by Visitors

My results support previous reports that indicate out-of-vehicle activity is more disruptive than vehicular traffic (Vaske et al. 1983, Vos et al. 1985, Freddy et al. 1986). At DDNWR, most birds fled when approached. Photographers were the most likely visitors to approach birds. Frequent approach of birds at DDNWR may cause some species of waterbirds to avoid foraging habitat near the dike.

Groups that spoke with refuge staff were less likely to disturb wildlife than any other groups besides those who were fishing and crabbing. I did not determine whether these visitors were predisposed not to disturb wildlife, or whether information provided by roving refuge volunteers helped to reduce wildlife disturbance.

Research Needs

A survey of visitor attitudes toward wildlife at the refuge would be helpful in designing educational programs. In addition, effectiveness of current information sources (i.e., the visitors' center and roving-volunteer program) and any new educational programs in promoting non-disruptive behavior should be examined.

Ducks and shorebirds on the mid-Atlantic coast have exhibited sensitivity to joggers (Burger 1981, 1986). This also may be a problem at DDNWR, but further investigation targeting this visitor type for observation is necessary because of the small number of fitness visitors observed during this study.

During the tourist season, visitors will crowd around individual animals engaged in behaviors such as courtship displays and active feeding. A study observing birds' responses to this additional aspect of visitor behavior may be warranted.

Individual birds could be marked for identification and studied under known levels of disturbance, including minimal or no disturbance. By calculating time spent foraging, resting, and searching for foraging sites, it may be possible to determine whether human disturbance actually reduces foraging time or opportunities for individual birds.

MANAGEMENT IMPLICATIONS

Effective visitor education is crucial because people are more likely to support restrictions if they understand how wildlife will benefit (Buell 1967, Seketa 1978, Shay 1980, Duda 1987*b*, Purdy et al. 1987). Apparently, recreationists do not feel responsible for their actions as long as they obey prescribed rules and regulations (Thompson et al. 1987). Many do not believe that their activities affect wildlife in any way, even if they see animals respond to their actions (Cooper et al. 1981:38).

Based on data from my study, I suggest that instructional discussions with refuge personnel could modify visitor behavior at DDNWR. Public education programs could include this type of interactive education. Visitor education should stress reducing the incidence of people approaching animals on foot. Providing observation and photography blinds may reduce the perceived need for approach. In addition, most Americans, including Floridians, have a humanistic attitude towards wildlife (Kellert 1980, 1984; Duda 1987*a*:103–104), and focus their wildlife appreciation on individual animals. Visitors should be told how causing a bird to flee may reduce its feeding opportunities.

Visitors should be aware of their role in reducing access to foraging habitat. By emphasizing regional habitat loss (Erwin et al. 1986, Howe 1987, Weller 1988) and importance of natural areas to wildlife populations, such a program could help people associate their own actions with national conservation issues. Photographers should be targeted for education programs because they tend to be the group type that disturbs the most species of waterbirds. Guided tours may be especially effective because the visitors could receive personalized attention from the guide.

SUMMARY

I subjected waterbirds to experimental disturbance at DDNWR in Florida to investigate the effects of human actions on their behavior. I also unobtrusively observed refuge visitors, categorizing their behaviors to assess their potential for disturbing wildlife.

Approaching birds on foot was the most disruptive of the usual activities of refuge visitors. Photographers were most likely to engage in this activity. Visitors who spoke with refuge staff early during their visit caused the least disturbance. Educational programs, coupled with the use of observation blinds or guided tours, could help reduce bird disturbance.

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PERCEIVED AND REAL CROP DAMAGE BY WILD TURKEYS IN NORTHEASTERN IOWA

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Wild turkey (*Meleagris gallopavo*) populations are flourishing throughout agricultural regions of the Midwest because of successful reintroduction programs (Clark 1985). Concurrently, the number of unsubstantiated reports of spring and fall turkey damage to corn, soybeans, alfalfa, and oats are increasing in several states including Iowa (D. H. Jackson, unpubl. data). Increasingly, private landowners in Iowa have expressed concern over perceived agricultural losses from turkeys. With 98% of Iowa in private ownership (Huemoller et al. 1976), wildlife managers find themselves in the challenging position of managing a highly valued game bird as a public resource on private lands where its presence may be considered potentially damaging to crops and personal income.

The publicity and attention created by perceived damage to crops by turkeys can influence management decisions (Craven 1989) and strain relations between landowners and management agencies. Therefore, wildlife managers need biological information concerning actual (vs. perceived) crop depredation by turkeys before establishing hunting seasons, modifying current regulations, and discussing the issue with landowners. Wildlife managers must have data from both the sociological and biological arenas to be effective in communicating with landowners. Our objectives were to determine landowner attitudes toward wild turkeys and crop damage using a mail survey (copy available from the Ia. Coop. Fish and Wildl. Res. Unit), and to determine the extent of turkey damage to corn by sampling agricultural fields in a mixed forest-agriculture ecosystem.