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Human perceptions before and after a 50% reduction in an urban deer herd's density

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Abstract Overabundant white-tailed deer (*Odocoileus virginianus*) populations in urban and suburban areas can be controversial because of potential damage to landscape vegetation, deer–vehicle collisions, and fear over transmission of tick-borne diseases. Herd reduction is often proposed to solve these problems; however, the ability of human residents to accurately perceive a herd reduction has not been demonstrated. We used mail surveys to study effects of a 50% localized deer herd reduction on the perceptions of residents in 2 areas (one control, one treated) on Hilton Head Island, South Carolina, over 2 time periods (before vs. after herd reduction). Residents in the treated area perceived a decrease ($P \leq 0.001$) in the relative abundance of deer using their yards after the herd reduction; residents in the control area (where no deer were removed) did not. Residents in the treated area reported seeing about 50% fewer deer after the herd reduction ($P < 0.001$); residents in the control area saw about the same number of deer. Nonpermanent residents did not perceive the herd reduction that was noticed by permanent residents. Residents in both the control and treated areas wanted to see fewer deer in their yard in the future. Residents did not report a decrease in the money required to replace plants damaged by deer during our one-year study. Our results indicate that costs to implement deer-herd reduction programs in urban and suburban areas may be justified based on the benefits perceived by the residents.

Key words human dimensions, *Odocoileus virginianus*, urban deer, wildlife damage

The biologically dominated perspective of wildlife biologists may not reflect the diversity of public opinion (Decker et al. 1992, Decker and Chase 1997). The public has grown increasingly interested in wildlife management issues (Manfredo 1989, Decker and Chase 1997), and public involvement is mandated by most state and federal environmental laws. Incorporating public opinion in wildlife management planning has become critical to contemporary wildlife management (Doig 1987, Decker et al. 1989). Failure to respond to public opinion may jeopardize biologically sound wildlife management programs.

Perceptions of various user groups have been used to help managers make informed decisions regarding deer management programs. Irby et al. (1996) used farmers' and ranchers' perceptions to quantify damage to forage crops caused by native ungulates. Perceptions of threats of deer-vehicle collisions influence preferences for the size of the

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herd and support for various deer management objectives (Stout et al. 1993). Decker and Purdy (1988) used human experiences and beliefs to form the concept of wildlife acceptance capacity.

The problems associated with overabundant deer in urban and suburban areas have been documented thoroughly (Ishmael and Rongstad 1984, Conover et al. 1995, McAninch 1995, Warren 1997). In many cases removal of deer is proposed as a solution. Although removing deer addresses the biological consequences of deer overabundance, it does not address the attendant social issues, which may be complex. Many of the conflicts that deer create with humans in urban areas (e.g., damage to landscape vegetation) can continue even after deer densities are reduced. The eventual success or failure of an urban deer management program may depend on the perceptions of residents living in the affected areas.

Residents' opinions and perceptions have been used in the development of management programs for urban and suburban deer herds. Cornicelli (1992) used the opinions of residents in Carbondale, Illinois, to characterize trends in deer population size. Connelly et al. (1987) found that residents in northern Westchester County, New York, believed the costs associated with a large deer population outweighed the benefits. Decker and Gavin (1987) reported that residents' concerns over Lyme disease and damage to landscape plantings might lead to a future preference for a reduced deer population in Islip, New York.

It is not known whether removing a certain number of deer results in residents perceiving a corresponding decrease in the abundance of deer in their area. This knowledge is important for cost–benefit analyses that might be required for programs to reduce deer herds. Therefore, our objectives were to implement a 50% localized deer-herd reduction in a residential–resort community on Hilton Head Island, South Carolina, and to determine its effect on residents' perceptions of deer abundance and landscape plant damage.

Study area

Hilton Head Island was an 11,600-ha barrier island located in Beaufort County along the southern coast of South Carolina. The island had about 25,000 permanent residents and 1.5 million tourists annually. Sea Pines was established in the 1950s as a 2,137-ha residential–resort community located on the southern tip of the island. About 95% of the available lots were developed when we did our research. The 242-ha Sea Pines Forest Preserve, in the northern part of Sea Pines, was the only significant portion of land left undeveloped. Henderson et al. (2000—see accompanying article) provide a detailed description and figure of our study site.

Deer have always been present on Sea Pines; however, since the early 1990s, residents have reported increased conflicts with them. These conflicts included damage to landscape plants, deer feces in yards, deer–vehicle collisions, and fear over transmission of tick-borne diseases. Deer–vehicle collisions killed about 40–50 deer/year on Sea Pines (G. Breed, Sea Pines Security Chief, personal communication).

Community Services Associates, Inc. (CSA) is the homeowners' organization responsible for maintenance and security within Sea Pines. Thus, many residents requested that CSA, in cooperation with the South Carolina Department of Natural Resources, initiate a deer management program. However, the residents had diverse opinions on how deer should be managed, ranging from no action to live-capture and relocation (Cromwell et al. 1999) to euthanasia (Schwartz et al. 1997). Official Code of the Town of Hilton Head prohibited hunting deer with firearms.

Materials and methods

Herd-reduction treatment and spotlight surveys

We conducted this experiment on the 260-ha Gull Point and 212-ha Baynard Cove areas within Sea Pines (Henderson et al. 2000). Both areas had

Many residents surveyed expressed frustration over deer depredation to landscape plantings.

We conducted public meetings at our study area to inform residents of our deer research project and receive their comments.

similar deer-herd densities, numbers of human residents, and patterns of housing development (Henderson 1998, Henderson et al. 2000). The Gull Point and Baynard Cove areas were separated by Baynard Creek, which effectively limited movement of deer between the 2 areas (Henderson et al. 2000).

Henderson et al. (2000) provided details on the herd-reduction treatment and spotlight surveys for this study. About 50% of the deer in the Baynard Cove area were removed using lethal and nonlethal methods, although most were removed by live-capture, transport, and confinement, as described by Henderson et al. (2000). We followed procedures established by South Carolina Department of Natural Resources (L. Rogers, unpublished data) for spotlight surveys on Gull Point and Baynard Cove areas before and after herd reduction. We used these spotlight surveys to assess the effectiveness of the herd reduction in Baynard Cove.

Resident surveys

We obtained names and mailing addresses of all property owners in Gull Point and Baynard Cove from CSA. Males were usually listed first on the property owner list; therefore, we chose randomly between the first and second names for the mailing address to promote an equal distribution of female respondents. We defined permanent residents as those who had a Sea Pines mailing address and nonpermanent residents as those who had mailing addresses outside Sea Pines. We surveyed 100% of the permanent residents and 25% of the nonpermanent residents because nonpermanent residents spent little time in Sea Pines during the study period.

We designed a self-administered, mail-back survey (Henderson 1998) to characterize residents and their properties. The surveys were identical for permanent and nonpermanent residents, except we also asked nonpermanent residents if they had resided in Sea Pines during the study. We queried residents about their perceptions of current deer use and abundance in their yard, future preferences for deer use, the plants most damaged by deer, and costs required to replace plants damaged by deer during the study. For the relative deer use questions, we asked residents to chose one of 5 possible answers that ranged from decreased significantly (1) to increased significantly (5). We left blank the questions on deer abundance, plants damaged by deer, and money required to replace damaged plants (i.e., residents provided an estimate).

We sent a pre-survey letter and a maximum of 2 subsequent mailings, following a modification of the Total Design Method for mail surveys (Dillman 1978, Salant and Dillman 1994). We numbered all surveys for identification purposes. We implemented the mail surveys in August 1996 (one to 2 months before the herd reduction began in Baynard Cove) and again in February 1997 (2–3 months after the herd reduction ended, Henderson et al. 2000). We did not inform residents about which areas were control (Gull Point) or treated (Baynard Cove). To minimize the chance of bias in residents' responses, we simulated field work (i.e., presence of research personnel and vehicles) associated with deer removal in the control area (even though no deer were removed) during the same time that the herd was being reduced in the treated area. For each resident, the survey identification

Our deer research project received substantial media attention because of divergent opinions among residents regarding deer management options.

number was the same during both surveys. The February survey was identical to the August survey, with 2 exceptions: we omitted the questions designed to characterize residents and we asked all residents whether they knew of deer-removal efforts on Sea Pines. The University of Georgia's Institutional Review Board, Office of Human Subjects approved all aspects of our mail survey (Project #H970019).

Experimental design and statistical analysis

Surveys mailed to property owners in Gull Point and Baynard Cove during August 1996 represented the pre-treatment data for both areas. During fall 1996, we randomly assigned the treatment to the Baynard Cove area, wherein we reduced deer numbers by about 50% (Henderson et al. 2000). We left the Gull Point herd unchanged. We gathered post-treatment survey data from the same residents surveyed in Gull Point and Baynard Cove during February 1997.

We used summary statistics to describe residents' characteristics and the plants most damaged by deer in their yard. For the questions concerning relative deer use and abundance and money required to replace landscape vegetation damaged by deer, we conducted an Analysis of Variance (ANOVA) with a repeated measures design on residents (SAS Institute 1990, Cody and Smith 1991). In instances of heterogenous variances, we performed a log transformation of data. We analyzed only data from residents who provided valid responses to a particular question on both mail surveys. We eliminated data from nonpermanent residents who had not lived at their home in Sea Pines during the previous 3 months for either mail survey.

For our analysis, we compared the pre-treatment responses of residents to their post-treatment responses. Main effects in the model were area (Gull Point or Baynard Cove) and year (1996 = pre-treatment vs. 1997 = post-treatment). Thus, there was no treatment during 1996, only during 1997. The untreated Gull Point area enabled us to control for differences in resident responses between pre- and post-treatment periods.

Results and discussion

Spotlight surveys and deer-herd reduction

Spotlight surveys confirmed that deer densities were similar between Gull Point and Baynard Cove before the herd reduction (43–50 deer/km^2); the Baynard Cove herd declined to about 50% (about 20 deer/km^2) of the Gull Point herd (about 40 deer/km^2) after the removal of 53 deer during the treatment (Henderson et al. 2000). The 50% lower deer density on Baynard Cove relative to Gull Point persisted while the second survey was completed (Henderson et al. 2000).

Resident surveys

Response rates. Response rates for the August 1996 and February 1997 surveys in both areas ranged from 83% to 86% for permanent residents, compared to 69% to 78% for nonpermanent residents. When we used only valid responses for each particular question from the August 1996 and February 1997 surveys, response rates for the permanent residents in Gull Point and Baynard Cove averaged 70%; adjusted response rates for the nonpermanent residents in Gull Point and Baynard Cove averaged 30% and 35%, respectively. Equal numbers of males and females responded to the survey.

The great response rates for permanent residents probably reflected the high public interest in deer management on Hilton Head Island. The local newspaper published many articles and letters to the editor concerning the Sea Pines deer issue. Additionally, we held numerous public meetings for Sea Pines residents as part of the research project. Nonpermanent residents were not exposed repeatedly to deer management issues and were probably less aware of the controversy.

Characteristics of residents. Most residents (permanent and nonpermanent) contracted a professional landscaping service. Residents in Gull Point and Baynard Cove spent an average of $1,640 and $1,370 annually to landscape and maintain their yard, respectively. Overall, permanent residents had lived longer at their current address (mode = "≥17 years") in Sea Pines than nonpermanent residents (mode = "<5 years"). Most permanent and nonpermanent residents indicated that they grew up in urban areas. Permanent residents were slightly older (mode = "65–74 years") than the nonpermanent residents (mode = "55–64 years"). Seventy percent of permanent residents and 77% of nonpermanent residents reported they had received a post-baccalaureate college degree. Responses of all residents indicated a range of professional-educational backgrounds; however, business-finance was most common.

Table 1. Matched responses of repeatedly surveyed residents in 2 areas of Sea Pines (one control, one treated) to a mail survey distributed before and after a 50% deer herd reduction treatment, Hilton Head Island, South Carolina. The question: "In the past three months, do you feel the number of deer using your yard has: (Check one)"; possible responses ranged from 1 = decreased significantly to 5 = increased significantly.

		Residents					
		Permanent[c]			Nonpermanent		
Area[a]	Time[b]	n	$\bar{x}$	SE	n	$\bar{x}$	SE
GP	Aug 96	96	3.2	0.12	20	3.0	0.23
	Feb 97	96	3.1	0.10	20	2.8	0.16
BC	Aug 96	194	3.0	0.08	14	3.1	0.21
	Feb 97	194	2.3	0.08	14	2.9	0.20

[a] GP = Gull Point (control area), BC = Baynard Cove (treated area).

[b] Aug 96 = pre-treatment, Feb 97 = post-treatment.

[c] Repeated measures ANOVA; area effect ($P < 0.001$), time effect ($P < 0.001$), area × time ($P \leq 0.001$).

Responses to questions concerning the herd-reduction treatment. We asked all residents on the February 1997 survey whether they had heard of any efforts to remove deer from Sea Pines during the last 6 months. Among permanent residents in Gull Point and Baynard Cove, 11% and 16%, respectively, answered "YES." Among nonpermanent residents in Gull Point and Baynard Cove, 33% and 12%, respectively, answered "YES." These results suggest that residents' knowledge of the herd reduction was not a significant source of bias between areas that could have affected the results from our February 1997 survey.

The responses to the question concerning the relative number of deer using residents' yards produced significant effects for area, time, and area × time interaction (Table 1). Permanent residents in Gull Point reported the number of deer using their yard as the same for the pre-treatment and post-treatment surveys. Permanent residents in Baynard Cove reported that number of deer using their yards decreased moderately in the post-treatment survey. The area × time interaction effect probably reflected the change in response from the Baynard Cove residents before versus after the herd-reduction treatment (Table 1), compared to no change in response for Gull Point residents. Nonpermanent residents in both areas did not notice a difference in the relative number of deer using their yards before versus after the herd reduction (Table 1), which was expected given their limited residence in the area.

When asked to estimate number of deer seen in their yards, permanent residents in Gull Point saw about the same number of deer before versus after the herd-reduction treatment. Permanent residents in Baynard Cove saw about 50% fewer after the treatment (Table 2). The analysis indicated significant effects for area, time, and area × time interaction (Table 2). The area effect resulted because permanent residents in Gull Point saw about twice as many deer as permanent residents in Baynard Cove. The time effect probably reflected the change in responses from Baynard Cove residents before versus after the herd reduction. The responses of nonpermanent residents indicated a nearly significant area effect (Table 2).

Permanent residents in Baynard Cove perceived about 50% fewer deer after the herd-reduction treatment. This reduction correlated extremely well with the known number of deer removed. We suspect that the high visibility of deer, combined with the continual presence of permanent residents, allowed them to accurately perceive the reduction. Nonpermanent residents in Baynard Cove spent less time in the area and thus were less likely to perceive the effects of the herd reduction.

The question regarding future preferences for number of deer using their yards revealed no significant effects for permanent residents (Table 3). Permanent residents in both areas wanted number of deer using their yard in the future to decrease moderately (Table 3). Results for nonpermanent residents were similar, except the area effect was

Table 2. Matched responses of repeatedly surveyed residents in 2 areas of Sea Pines (one control, one treated) to a mail survey distributed before and after a 50% deer herd reduction treatment, Hilton Head Island, South Carolina. The question: "In the past three months, how many deer have you seen (on average) in your yard per week?"

		Residents					
		Permanent[c]			Nonpermanent[d]		
Area[a]	Time[b]	n	$\bar{x}$	SE	n	$\bar{x}$	SE
GP	Aug 96	86	23.3	2.81	17	13.5	6.00
	Feb 97	86	21.2	2.66	17	7.8	2.10
BC	Aug 96	178	13.3	1.31	12	4.6	2.27
	Feb 97	178	7.4	0.86	12	4.3	2.47

[a] GP = Gull Point (control area), BC = Baynard Cove (treated area).

[b] Aug 96 = pre-treatment, Feb 97 = post-treatment.

[c] Repeated measures ANOVA; area effect ($P < 0.001$), time effect ($P < 0.001$), area × time ($P < 0.001$).

[d] Repeated measures ANOVA, area effect ($P = 0.076$).

Table 3. Matched responses of repeatedly surveyed residents in 2 areas of Sea Pines (one control, one treated) to a mail survey distributed before and after a 50% deer herd reduction treatment, Hilton Head Island, South Carolina. The question: "In the future would you like to see the number of deer using your yard: (Check one)"; possible responses ranged from 1 = decreased significantly to 5 = increased significantly.

		Residents					
		Permanent			Nonpermanent[c]		
Area[a]	Time[b]	n	$\bar{x}$	SE	n	$\bar{x}$	SE
GP	Aug 96	95	1.9	0.11	20	2.2	0.26
	Feb 97	95	1.8	0.11	20	2.2	0.24
BC	Aug 96	199	1.9	0.07	14	1.9	0.23
	Feb 97	199	2.0	0.07	14	1.9	0.25

[a] GP = Gull Point (control area), BC = Baynard Cove (treated area).

[b] Aug 96 = pre-treatment, Feb 97 = post-treatment.

[c] Repeated measures ANOVA, area effect ($P = 0.081$).

nearly significant. Nonpermanent residents in Gull Point did not want the abundance of deer to decrease in the future as much as did nonpermanent residents in Baynard Cove (Table 3).

All residents reported azalea as the most frequently damaged landscape planting in their yard; >3 times as many residents reported deer-browsing damage on azalea as compared to camellia, the next most damaged plant (Henderson 1998). Responses of permanent residents relative to cost estimates to replace plants damaged by deer produced a significant area effect (Table 4). Permanent residents in Gull Point reported about twice as much damage as permanent residents in Baynard Cove. For permanent residents in both areas, estimates of the cost to replace plants damaged by deer did not change after the herd reduction. For nonpermanent residents the area effect was nearly significant (Table 4). Nonpermanent residents in Gull Point reported more damage after the herd reduction. This can probably be attributed to random effects in the small sample size. Nonpermanent residents in Baynard Cove did not report a decrease in costs to replace plants damaged by deer after the herd reduction (Table 4).

The herd reduction in Baynard Cove did not reduce damage to landscape plantings, probably because there was no vegetative growing season between the August 1996 and February 1997 surveys for plants to recover from browsing. Kilpatrick and Walter (1999) reported that residents noticed less damage after one complete growing season following a deer-herd reduction in Connecticut. In addition, after an intensive deer-population reduction in a coastal Georgia community, one to 2 growing seasons were required before residents started removing fences designed to prevent deer damage (J. Butfiloski, United States Department of Agriculture, Wildlife Services, personal communication). Baynard Cove residents may have noticed less damage to landscape plantings if they had been surveyed after at least one growing season had elapsed following herd reduction.

Management implications

Our results indicate that the permanent residents in this community unknowingly and accurately perceived the level of herd reduction achieved by our deer-removal efforts. Wildlife professionals sometimes assume that public perceptions of wildlife populations are subjective or biased. Indeed, Decker (1983) showed that farmers' perceptions of the abundance of deer on their farms was biased according to the amount of damage the farmers had sustained from deer browsing. Therefore, our results have important implications to the management of deer in urban and suburban areas. Inclusion of informed, interested citizens in setting goals and objectives for urban deer management has always been important. Based on our results, urban deer managers may be able to justify the cost of management programs based on the benefits perceived by residents in the community,

Table 4. Matched responses of repeatedly surveyed residents in 2 areas of Sea Pines (one control, one treated) to a mail survey distributed before and after a 50% deer herd reduction treatment, Hilton Head Island, South Carolina. The question (if they had indicated damage was done during the last 3 months to their yard from deer): "How much would it cost (in dollars) to replace these damaged plants?"

		Residents					
		Permanent[c]			Nonpermanent[d]		
Area[a]	Time[b]	n	$\bar{x}$	SE	n	$\bar{x}$	SE
GP	Aug 96	44	707	166	4	475	125
	Feb 97	44	729	166	4	875	415
BC	Aug 96	68	324	50	6	418	186
	Feb 97	68	376	67	6	342	136

[a] GP = Gull Point (control area), BC = Baynard Cove (treated area).

[b] Aug 96 = pre-treatment, Feb 97 = post-treatment.

[c] Repeated measures ANOVA, area effect ($P < 0.001$).

[d] Repeated measures ANOVA, area effect ($P = 0.076$).

knowing that the residents may objectively perceive these benefits (i.e., fewer deer). Future research is needed to quantify the relationship for differing numbers of deer removed from a residential community and the corresponding perceptions of fewer deer by the residents. Obviously, the cost of removing individual deer can be expected to increase as more deer are removed from an area. Therefore, there will likely be a point of diminishing return beyond which the cost of removing additional deer is not justified by the corresponding benefit (i.e., perception of fewer deer).

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