Human Dimensions of Wildlife, 12:15–29, 2007
Copyright © Taylor & Francis Group, LLC
ISSN: 1087-1209 print / 1533-158X online
DOI: 10.1080/10871200601107866

Spatial Distribution of Attitudes Toward Proposed Management Strategies for a Wildlife Recovery

ANITA T. MORZILLO,[1] ANGELA G. MERTIG,[2] NATHAN GARNER,[3] AND JIANGUO LIU[4]

[1]Center for Systems Integration and Sustainability, Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan, USA
[2]Department of Sociology and Anthropology, Middle Tennessee State University, Murfreesboro, Tennessee, USA
[3]Texas Parks and Wildlife Department, Tyler, Texas, USA
[4]Center for Systems Integration and Sustainability, Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan, USA

Wildlife managers regularly incorporate human attitudes into decisions involving wildlife conservation. Knowing the spatial distribution of particular attitudes may further assist managers in determining distribution of support of or threats against wildlife species. Using results from a mail survey and SaTScan 4.0, we assessed the spatial distribution (clustering) of attitudes toward several management strategies for the recovery of black bear in and around Big Thicket National Preserve, Texas. Statistically significant clustering occurred for two attitudes: (a) non-support for a natural (non-human assisted) increase in the bear population near the Angelina National Forest and (b) strong disagreement toward total exclusion of bears from southeastern Texas within the relatively urban Orange County. In addition, respondents closer to the preserve, a potential black bear release site, were more likely to support exclusion of bears. Analysis such as this can greatly assist managers in planning public outreach and monitoring of wildlife populations.

Keywords attitudes, Big Thicket National Preserve, black bear, recovery, spatial analysis

Funding for this research was made possible by Michigan State University, the Texas Parks and Wildlife Department, Western National Parks Association, National Fish and Wildlife Foundation, National Aeronautical Space Administration (NASA) Earth System Science (ESS) Fellowship Program, Canon-National Park Service Fellowship Program, and Safari Club International- Deep Pineywoods Chapter. The National Park Service, Big Thicket Association, USDA Forest Service, US Fish and Wildlife Service, The Nature Conservancy, and Black Bear Conservation Committee provided in-kind support. We are grateful to Kim Borland, Jayson Egeler, Sarah Panken, Nathan Pfost, Andrea Stoddard, Heidi Wade, and Eric White for assistance with survey implementation and data entry, as well as Matthew Nicholson and Ashton Shortridge for assistance with data analysis. We also thank an anonymous reviewer for his or her assistance with manuscript preparation and review. Finally, and of utmost importance, we thank all of the southeast Texas residents who participated in this survey.
Address correspondence to Anita T. Morzillo, US EPA, 200 SW 35th St., Corvallis, OR 97333, USA. E-mail: morzillo.anita@epa.gov

Introduction

As the human population of previously rural areas increases, there are an increasing number of human interactions with wildlife. This escalation in human–wildlife interactions has led to a new paradigm in wildlife management; rather than focusing primarily on the ecological needs of species, managers increasingly appreciate the need to incorporate humans into wildlife management decision-making (Riley et al., 2002). As a key step in understanding the human component of management, many studies have assessed socioeconomic and demographic variables that affect stakeholder attitudes toward a specific species (Bath & Buchanan, 1989; Kellert, 1991; Lohr, Ballard, & Bath, 1996).

Attempts to understand attitudes about a species are exceptionally more difficult for species recovery. Researchers are able to identify potential habitat for a species, but it is nearly impossible to determine *a priori* (a) whether a species will use habitat perceived by humans as suitable, and (b) whether human–wildlife interaction will occur. Potential habitat may be identified by referring to past ecological research on a target species. However, projecting results of human–wildlife interactions is extremely complex and can only be estimated through collection of attitudinal and (anticipated) behavioral information directly from people. Assessing human attitudes toward a species targeted for recovery, as well as how the attitudes are distributed across space, may permit managers to identify locations where humans' attitudes are particularly favorable for a recovery (e.g., supporters may adapt land use practices for habitat management), as well as potentially hostile locations where humans may pose a threat, or risk, to the success of a recovery (e.g., harassment of the species).

Analyses of the spatial distribution of data have been used for research in many disciplines including public health (Knox, 2005), geography (Bailey & Gatrell, 1995), human ecology and agriculture (Naughton-Treves, 1997; Sitati, Walpole, Smith, & Leader-Williams, 2003), environmental valuation (Brown, 2005), and wildlife ecology (Mather, Nicholson, Hu, & Miller, 1996; Kie, Bowyer, Nicholson, Boroski, & Loft, 2002). In the case of public health, for instance, researchers seek to link morbidity rates to environmental factors. For example, Knox (2005) suggested a relationship between childhood cancers and prenatal proximity to emissions from large concentrations of industrial fossil fuel combustion in Great Britain. In another study, the malaria-like infection Human Babesiosis exhibited a clumped distribution related to tick density, the results of which may be used to predict areas of risk of human infection (Mather et al., 1996).

Variation in attitudes toward a particular species in different locations has also been explored. For example, Bowman (2001) surveyed landowners to determine whether differences in attitudes toward black bears existed between landowners in Arkansas and Mississippi, where large and small populations of bears exist, respectively. Neither demographic variables nor knowledge about bears differed between the two locations. However, respondents in Arkansas, who collectively have experienced more bear damage to crops, were less likely than Mississippians to support increasing the bear population size. Similar studies comparing attitudes between different geographic locations have been completed for wolf reintroductions (Pate, Manfredo, Bright, & Tischbein, 1996), grizzly bear restoration (Merrill, Mattson, Wright, & Quigley, 1999), red panda protection (Fox, Yonzon, & Podger, 1996), black bear population expansion (Peyton, Bull, Reis, & Visser, 2001), and cougar management (Riley & Decker, 2000). Bowman, Leopold, Vilella, Gill, and Jacobson (2004) used a demographic model to predict support for black bear restoration throughout Mississippi. Each of the foregoing studies has suggested the importance of assessing attitudes in different locations. To date, however, we are unaware of any studies that have applied spatial analysis of attitudes to assess distribution of individual survey responses. Therefore, our goal was to assess the spatial distribution of attitudes in the context of a potential black bear recovery.

The historical range of the Louisiana black bear (*Ursus americanus luteolus*) included all of Louisiana, southern Mississippi, and southeastern Texas (Black Bear Conservation Committee [BBCC], 1997). Widespread timber extraction and extensive hunting led to the near extinction of the subspecies by the early 1900s. By the second half of the 20th century, only two isolated populations remained, both of which were in eastern Louisiana. Beginning in the 1990s, wildlife managers and bear conservation groups in Louisiana led an effort, through public outreach, to build public support for bear recovery in Louisiana. The BBCC and US Fish and Wildlife Service created recovery plans, an objective of which was to restore the Louisiana black bear throughout its historical range (Bowker & Jacobson, 1995; BBCC, 1997). To date, recovery in Louisiana has been successful (Van Why, 2003), and feasibility analyses were completed for Mississippi with positive results (Shropshire, 1996; Bowman, 1999).

Although there is no known breeding population in eastern Texas, the number of black bear sightings has increased during the past decade. These bears are likely transients from bear populations in Louisiana, Arkansas, and/or Oklahoma. The number of increased sightings prompted the creation of a bear management plan for both eastern and western Texas by the Texas Parks and Wildlife Department (Texas Parks and Wildlife Department, 2005). The ultimate goal of the management plan is to restore habitat for the future reestablishment of black bear as a viable ecosystem component in eastern Texas. Short-term objectives (over the next 10 years) include public coordination, communication, outreach and information dissemination, habitat management, and research (Texas Parks and Wildlife Department, 2005).

Big Thicket National Preserve (BTNP) is one east Texas location that may be targeted for initial steps for bear recovery. BTNP was established as the nation's first National Preserve in 1974 to protect 11 unique ecosystems found within its boundaries. Since establishment, BTNP has also been designated as a UNESCO International Biosphere Reserve, an American Bird Conservancy Globally Important Bird Area (IBA), and member of the United States Man and Biosphere Program. The preserve's 12 land and river corridor management units together total 39,256 ha. Each preserve unit alone is not large enough to contain a viable black bear population, so bears that live within the preserve are likely to wander beyond the preserve's borders. Because private land and residences surround the preserve units, it is essential to determine if local residents will be tolerant of bear presence.

The objectives of this research were to: (a) ascertain the spatial distribution of residents' attitudes across the study area toward potential bear recovery strategies for the southern portion of eastern Texas, and (b) determine whether distance from BTNP is a factor in resident attitudes. We assessed support for three general management options for black bears (described in methods section): (a) natural (non-assisted) recovery, (b) human-assisted reintroduction (which included two equivalent strategies with slightly different wording), and (c) no bear recovery.

Methods

Study Area

Our study area consisted of 12 counties within the southern portion of eastern Texas (Figure 1). Of the approximately 500,000 residents within the study area, about 368,000 are adults (≥18 years of age; US Census Bureau data). A large portion of the area is rural,

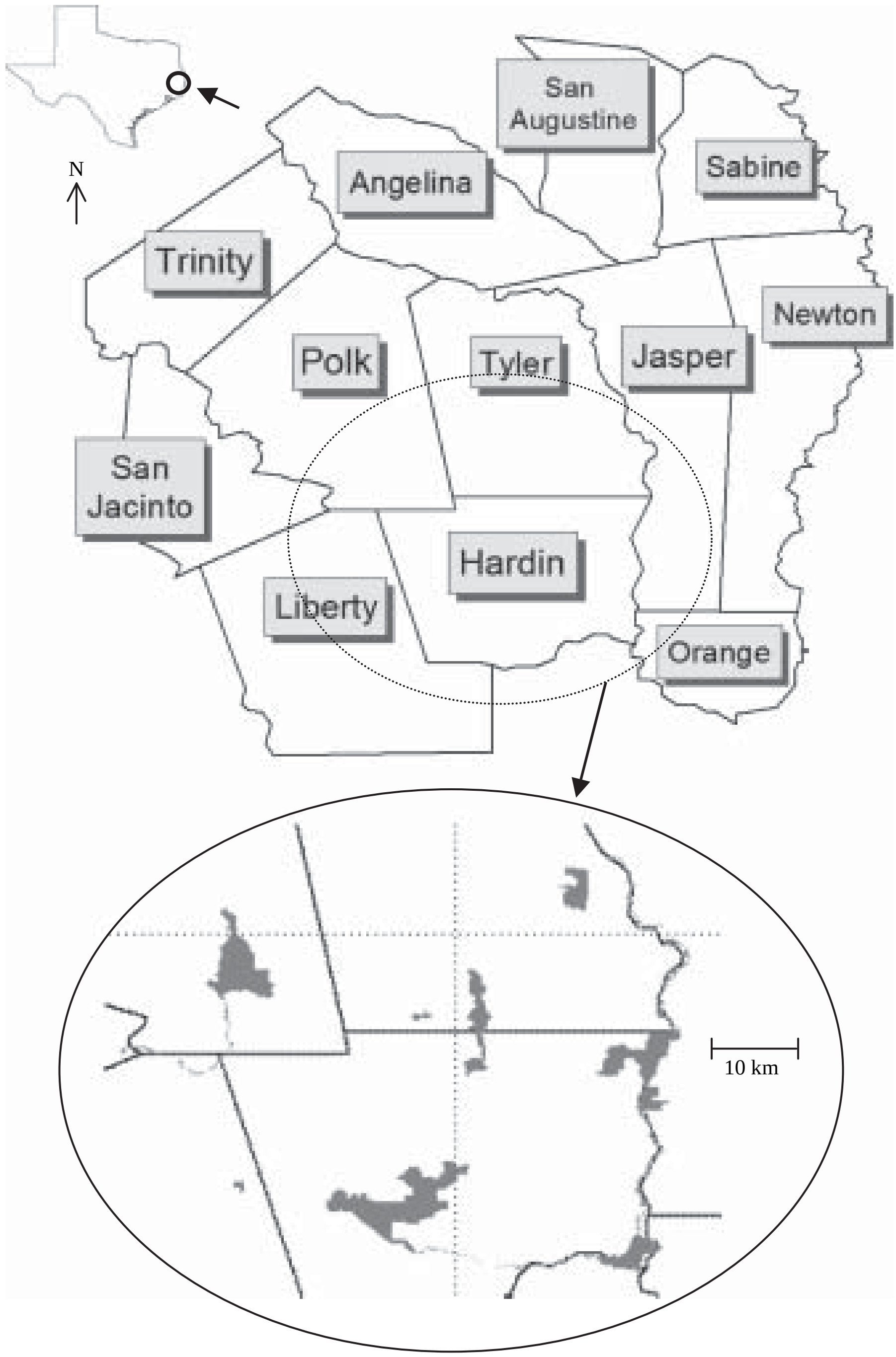

Figure 1. The 12-county region in southeastern Texas used to assess the spatial distribution of resident attitudes toward potential black bear recovery strategies from which survey participants were selected. These counties include and surround Big Thicket National Preserve (shaded areas in ellipse).

with the exception of numerous small towns and one larger community (the City of Lufkin). More than 75% of the land is currently privately managed for timber production or publicly owned at the Federal level (BTNP and the Davy Crockett, Sabine, Angelina, and Sam Houston National Forests). The more densely populated southern edge of the study area consists of suburban development from the cities of Houston and Beaumont.

Survey Design

We developed a mail questionnaire to evaluate local residents' attitudes toward black bear recovery in southeast Texas. Using data from the 2000 census (US Census Bureau data) and ArcView GIS 3.2 (Environmental Systems Research Institute, Inc.), we compared population density among the local zip codes and divided the study area into three mutually exclusive strata. Based on US Census Bureau terminology, the "urban" stratum consisted of towns of ≥2,500 people, locations with a population density of ≥500 people per square mile, and the City of Lufkin. The "rural" stratum consisted of residents residing in villages with populations <2,500 and rural areas containing a population density of <500 people per square mile. Both the "urban" and "rural" strata were distributed across the study area. Because the southern edge of the study area consisted of expanding residential development sprawling outward from Houston and Beaumont, and was substantially different from the other two strata, we designated it as a separate "suburban" stratum.

In January 2004, we mailed the questionnaire to 3,000 residents among the three strata: urban (n = 600), rural (n = 2,000), and suburban (n = 400). Using zip code population estimates from the US Census Bureau online population database, we developed a disproportional stratified random sample (Babbie, 1990). Based on black bear ecology (Pelton, 1982), and on the assumption that residents in rural areas would have the greatest probability of contact with bears, we were concerned with obtaining a sufficient amount of data from the rural stratum, which was also the most sparsely populated. As a result, we adjusted our sampling proportions to oversample, and adequately represent, the rural stratum (Babbie, 1990). Because we oversampled the rural stratum (n = 2,000), the sample size of the urban and suburban strata had to be reduced to maintain the initial n of 3,000. We allocated 600 surveys to the urban and 400 surveys to the suburban strata, respectively, because the urban stratum contained approximately 50% more residents than the suburban stratum. By using this sampling methodology, we were able to choose sample sizes that adequately represented the rural stratum while also maintaining adequate sample sizes of the urban and suburban strata (as determined by anticipated sampling error; Babbie, 1990). Names and addresses of residents were purchased from Survey Sampling, Inc. (Fairfield, CT). We applied the "Tailored Design Method," which uses multiple contacts and careful attention to survey details to increase response rate (Dillman, 2000).

Dependent Variables

We developed four dependent variables to represent three potential management strategies. For three variables (*Natural*, *Assist*, and *Restock*), we asked participants to indicate whether they support, do not support, or are unsure about particular management strategies. Higher numerical scores were used to indicate greater support for a particular scenario (support = 3, unsure = 2, no support = 1). For each strategy, participants indicated support (or lack thereof) for:

Natural—"Do you think black bear populations in East Texas should increase naturally (i.e., without assistance from a natural resource agency)?"

Assist—"Do you think that natural resource agencies should assist in increasing the black bear population size in East Texas?" Specific means of assistance were not provided.

Restock— "Would you support the restocking of black bears into suitable habitats in East Texas by natural resource agencies?" The *Assist* and *Restock* variables were conceptually equivalent, but we sought to determine whether vernacular used would affect response. The different terms could, however, elicit differential responses, as *Restock* is a term closely associated with game harvest (Bolen & Robinson, 1999) and *Assist* is a more general term related to species reintroductions.

No bear—Respondents were also asked whether they agreed or disagreed with the statement "black bears should not exist in southeast Texas." Attitudes toward this strategy, which would involve the complete exclusion of bears from the region, were asked using a scale format (5 = strongly agree, 4 = agree, 3 = unsure, 2 = disagree, 1 = strongly disagree). For consistency with other dependent variables, responses for *No bear* were re-coded into the three category classification (described above) as follows: (a) "strongly agree" and "agree" as support for *No bear,* (b) "disagree" and "strongly disagree" as no support for *No bear,* and (c) "unsure" remained as "unsure."

Non-response Follow-up

After removing incorrect addresses and ineligible participants, the overall response rate was 40% (n = 1,006). We completed a non-response follow-up questionnaire using 10 questions that were similar to those in the actual survey questionnaire. Results from the survey and non-response questionnaire did not differ significantly (n = 163).

Spatial Analysis

We used DeLorme Street Atlas USA® 2004 (DeLorme, Yarmouth, Maine, USA) to plot approximate locations of respondent's addresses. For addresses that were not available through use of DeLorme Street Atlas USA®, a random point (n = 14; 1.4% of addresses) was selected from within the respondent's respective zip code using ArcView GIS 3.2 (Environmental Systems Research Institute, Inc.). For spatial analysis, we converted respondent location information from Latitude-Longitude to Universal Transverse Mercator (UTM, Zone 15, NAD 83) XY coordinates.

To evaluate the spatial distribution, or clustering of responses, we used SaTScan version 4.0 (Kulldorff, 1993; Kulldorff, Athas, Feuer, Miller, & Key, 1998). SaTScan software was designed to evaluate spatial and temporal distribution of designated events (Kulldorff & Nagarwalla, 1995; Kulldorff, 1997). This software has been used to explore the spatial distribution of breast cancer (Kulldorff, Feuer, Miller, & Freedman, 1997), chronic wasting disease in deer (Joly et al., 2003), bacterial infections of herbivores (Smith et al., 2000), West Nile virus (Mostashari, Kulldorff, Hartman, Miller, & Kulasekera, 2003), learning disabilities in children (Margai & Henry, 2003), and toxic parasites (Miller et al., 2002). These examples all involve assessment of risk to a particular population. We used SaTScan to spatially assess human attitudes toward particular black bear population recovery strategies based on the assumption that residents who are unsupportive of a recovery program may represent sources of greater risk to black bears if a recovery occurs (e.g., illegal killing).

The SaTScan's spatial scan statistical procedure involved the creation of three data input files: (a) a case file containing the unique identification number for each respondent and corresponding binary variable on which a one represented a "yes" response to a particular variable and zero equaled all other responses (i.e., no, unsure), (b) a population file containing the unique identification number for each respondent and the binary opposite to the case file (i.e., 0 = "yes" in the case file and all else = 1), which serves as a control, and (c) a geographic file containing the X and Y coordinates for each respondent. The scan statistic applied a growing geographic circle to each "yes" response location (observed responses) with the maximum circle size equal to half of the total data points (i.e., half of all responses), and determined which circles contained a greater number of other "yes" responses than spatial randomness (expected responses). By applying geographic circles to each response, clusters of responses that were more likely to occur than by chance alone were identified. This procedure was based on the alternative hypothesis that there is a greater rate of occurrence of a particular event (in our case a "yes" response) within a particular set of geographic circles than outside of the circles. We applied a likelihood function for a Bernoulli model (Kulldorff, 1993), calculated as:

$$(c/n)^{c}(1-c/n)^{(n-c)}([C-c]/[N-n])^{(C-c)}(1-[C-c]/[N-n])^{(N-n)-(C-c)}\,I(x)$$

where C = the total number of "yes" responses (i.e., responses) across the study region, c = the number of "yes" responses within the particular geographic circle, N = the total number of "yes" responses plus controls (i.e., "no," "unsure") within the data set, and n = the total number of "yes" responses and controls in an identified cluster. Because our objective was to identify high rates of a particular response, I(x) = 1 when the geographic circle had more cases than expected for the null hypothesis (i.e., the rate of occurrence of a given response was no different from random), and I(x) = 0 for all other instances. The cluster least likely to have occurred by chance was identified as the main cluster, and all other identified clusters were called secondary clusters. A maximum likelihood ratio test statistic was calculated for all identified clusters. The p-value for each maximum likelihood test statistic and distribution compared to the null hypothesis was calculated by repeating the same procedure under 999 random replications (SaTScan's default number) of the same data for the null hypothesis using Monte Carlo simulation.

Distance from the Preserve

We used the Nearest Features extension (version 3.8) of ArcView to calculate the distance from each respondent to the nearest boundary of BTNP. For each of the dependent variables, we used a Pearson's correlation to determine whether distance from the preserve boundary was related to support (or lack thereof) for particular strategies. All alpha values were defined at the 95% confidence level.

Results

There were differences in support for each of the four potential strategies (Table 1). The greatest amount of support existed for the *Restock* strategy, and the least amount of support existed for the *No bear* strategy. Respondents were almost evenly divided among responses for the *Natural* and *Assist* strategies. Detailed evaluation of differences in support for each strategy, as well as socioeconomic variables related to support (or non-support), are available in Morzillo (2005).

The spatial scan statistic procedure identified 67 clusters among 14 responses (i.e., three variables with 3 possible responses each; one variable with 5 possible responses;

Table 1
Responses to each of four potential black bear recovery strategies for southeast Texas[a]

Strategy	Support (%)[b]	Non-support (%)	Unsure (%)
Natural (no human assistance; $n = 995$)	38	30	31
Assist (human-assisted reintroduction; $n = 986$)	32	36	32
Restock (restock bears; $n = 991$)	50	23	28
No bear (bears should not exist; $n = 981$)[c]	6	73	21

[a]See Morzillo (2005).
[b]Rows not summing to 100% is as a result of rounding.
[c]Re-grouped from: strongly agree = 2.1%, agree = 4.1%, unsure = 20.8%, disagree = 41.1%, and strongly disagree = 31.8%.

Table 2). Although a main cluster was identified for each response for each variable, the number of secondary clusters varied between variables. Several secondary clusters for a particular variable had similar Log-likelihood ratios, indicating that the individual points were close together. There were two statistically significant clusters identified (Figure 2): (a) non-support for *Natural* (Log-likelihood ratio = 9.88, $p = 0.043$), located in the north-central portion of the study area in proximity to the Angelina National Forest, and (b) strongly disagree for *No bear* (Log-likelihood ratio = 12.19, $p = 0.005$), located in the southeastern, and suburban, portion of the study area.

There was a negative but non-significant relationship between distance from the preserve and support for *Natural* ($r = -0.022$, $p = 0.493$), *Assist* ($r = -0.018$, $p = 0.576$), and *Restock* ($r = -0.048$, $p = 0.134$). However, a weak significantly negative relationship existed between distance from preserve and support for the *No bear* strategy ($r = -0.065$, $p = 0.045$). In other words, respondents closer to the preserve were more likely to support *No bear*.

Discussion

As noted earlier, short-term objectives of the Texas black bear plan include extensive public outreach. Knowledge about distribution of attitudes toward potential bear strategies can provide guidance for managers when planning public information and outreach sessions. For example, if a large number of residents located in proximity to each other share antagonistic attitudes toward a reintroduction, bear managers may concentrate outreach efforts on the location to better understand why such attitudes occur.

Few significant clusters of attitudes toward particular strategies were obvious. The only statistically significant clustering that occurred were non-support for *Natural* (non-human assisted) and strong disagreement with *No bear* (excluding bears from the area). Random chance and lack of a complete enumeration of all area residents (or even substantially higher coverage) are potential reasons why only these two clustering events occurred. Clustering of *Natural* also may be a result of: (a) the individual respondents do not want bears in the area, or (b) the individual respondents support more aggressive bear recovery strategies (i.e., reintroduction and restocking). Both of these reasons are supported. Of the 11 respondents within the statistically significant cluster, 8 indicated support for either the *Assist* or *Restock* strategies, and 2 indicated support for the *No bear* strategy (Morzillo, unpublished data). From the same group, one respondent indicated

Table 2

Analysis of attitudes toward potential black bear recovery management strategies using the spatial scan statistic

Management strategy	Cluster[a]	Number of cases[b] (population size)	Expected risk	Actual risk	Log-likelihoody ratio	p-value
Natural (support)	M	11 (13)	5.28	2.08	5.44	0.818
	S	6 (6)	2.44	2.46	5.43	0.836
	S	14 (18)	7.31	1.91	5.26	0.958
	S	8 (9)	3.66	2.19	4.63	0.972
	S	17 (24)	9.75	1.74	4.59	0.983
	S[c]	5 (5)	2.03	2.46	4.52	0.984
	S[c]	5 (5)	2.03	2.46	4.52	0.984
	S[c]	5 (5)	2.03	2.46	4.52	0.984
Natural (non-support)	M	10 (11)	3.06	3.26	9.88	0.043*[d]
	S	17 (25)	6.97	2.44	8.93	0.121
	S	6 (6)	1.67	3.59	7.72	0.307
	S	39 (86)	23.96	1.63	6.58	0.455
	S	6 (7)	1.95	3.08	5.16	0.891
Natural (unsure)	M	144 (364)	114.70	1.26	8.54	0.128
	S	6 (6)	1.89	3.17	6.97	0.507
	S	5 (5)	1.58	3.17	5.80	0.879
Assist (support)	M	55 (112)	35.81	1.54	8.05	0.141
	S	22 (36)	11.51	1.91	6.69	0.557
Assist (non-support)	M	21 (31)	11.40	1.84	6.31	0.550
	S	10 (12)	4.41	2.27	5.58	0.847
	S	8 (9)	3.31	2.42	5.37	0.871
	S	7 (8)	2.94	2.38	4.48	0.993
	S	10 (13)	4.78	2.09	4.42	0.996

(Continued)

Table 2
(Continued)

Management strategy	Cluster[a]	Number of cases[b] (population size)	Expected risk	Actual risk	Log-likelihoody ratio	*p*-value
	S	4 (4)	1.47	2.72	4.02	0.997
Assist (unsure)	M	94 (239)	74.70	1.26	4.67	0.963
	S	4 (4)	1.25	3.20	4.67	0.963
Restock (support)	M	17 (19)	9.33	1.82	7.17	0.304
	S[c]	10 (10)	4.91	2.04	7.17	0.395
	S	9 (9)	4.42	2.04	6.44	0.643
	S	7 (7)	3.44	2.04	5.01	0.981
Restock (non-support)	M	9 (13)	3.20	2.81	5.81	0.711
	S	23 (50)	12.32	1.87	5.69	0.736
	S	4 (4)	0.99	4.06	5.63	0.948
Restock (unsure)	M	11 (17)	4.46	2.46	5.61	0.739
	S	4 (4)	1.05	3.81	5.37	0.845
	S	4 (4)	1.05	3.81	5.37	0.845
	S	5 (6)	1.58	3.17	4.32	0.991
No bear (strongly agree)	M	3 (6)	0.18	16.78	6.12	0.509
	S	2 (3)	0.09	22.37	5.12	0.687
	S	3 (9)	0.27	11.18	5.13	0.833
	S	2 (4)	0.12	16.78	4.38	0.900
	S	4 (23)	0.69	5.84	4.21	0.944
	S	2 (5)	0.15	13.42	3.81	0.966
	S	2 (8)	0.24	8.39	2.77	0.999

No bear (agree)	M	2 (2)	0.10	20.27	6.06	0.437
	S	2 (2)	0.10	20.27	6.06	0.437
	S	2 (2)	0.10	20.27	6.06	0.437
	S	2 (3)	0.15	13.51	4.20	0.963
	S	2 (4)	0.20	10.14	3.38	0.998
	S	2 (4)	0.20	10.14	3.38	0.998
No bear (unsure)	M	17 (41)	7.42	2.29	6.38	0.624
	S	3 (3)	0.54	5.53	5.15	0.857
	S	3 (3)	0.54	5.53	5.15	0.857
	S	3 (3)	0.54	5.53	5.15	0.857
	S	3 (3)	0.54	5.53	5.15	0.857
	S	3 (3)	0.54	5.53	5.15	0.857
	S	10 (21)	3.80	2.63	4.90	0.984
No bear (disagree)	M	8 (8)	3.45	2.32	6.78	0.532
	S	19 (26)	11.20	1.70	4.94	0.988
No bear (strongly disagree)	M	19 (24)	7.42	2.56	12.19	0.0 05*
	S	5 (5)	1.55	3.23	5.90	0.660
	S	5 (5)	1.55	3.23	5.90	0.668
	S	4 (4)	1.24	3.23	4.71	0.954
	S	4 (4)	1.24	3.23	4.71	0.954
	S	4 (4)	1.24	3.23	4.71	0.954
	S	4 (4)	1.24	3.23	4.71	0.954
	S	22 (42)	12.99	1.69	4.36	0.998

[a]M = Main cluster; S = secondary cluster.
[b]Number of “yes” responses within a particular cluster.
[c]Secondary clusters for which statistics are similar are a result of very close location within a group.
[d]An asterisk (*) indicates significance at the 95% confidence level.

Figure 2. Statistically significant clusters of non-support responses for the *Natural* (solid squares) and the strongly disagree responses for *No bear* (solid triangles) strategies for black bear recovery. Also shown are the locations of respondents (small dots), USDA proclamation boundaries for the (clockwise from bottom left) Sam Houston, Davy Crockett, Angelina, and Sabine National Forests (striped) and Big Thicket National Preserve (shaded).

"unsure" about both the *Assist* and *Restock* strategies, but did not support *No bear*. For respondents who supported pro-bear strategies, these results may suggest that residence near the National Forests is related to an interest in nature and wildlife. For other items on our survey, all 11 respondents indicated an interest in wildlife (Morzillo, unpublished data), but only the 8 who supported a pro-bear strategy indicated that they would like to see bears in the area. Generalizing from these 11 individuals to all of the residents in the area they represent, or to all residents near all four National Forests, is of course problematic.

For *No bear*, the significant cluster of respondents who strongly disagreed (i.e., they did not support excluding bears altogether) was located within the most urbanized part of our study area. Results from both Lohr et al. (1996) and Bowman (1999) suggested that residents of urbanized communities typically have more positive attitudes toward restoration of wolves and bears, respectively. Peyton et al. (2001), however, reported that residents in the heavily populated southern portion of Michigan preferred limited bear presence even though the Michigan bear population is expanding southward. Results from our survey did not indicate that members of this cluster were necessarily more likely to support bear recovery. Of the 24 respondents within the *No bear* cluster, only 5 indicated support for *Natural*, 12 for *Assist*, and 17 for *Restock*. Between the 3 variables, there were also 20 "unsure" responses, which suggests that even though a commonality existed for one management strategy among individuals of these particular clusters, respondents were not in unanimous agreement about an optimum strategy.

The limited number of statistically significant clusters related to particular strategies implies that public outreach will likely be challenging. First, bear managers will likely be met with different opinions when outreach takes place in any location, which makes generalizing results to a larger area (e.g., census block groups; Bowman et al., 2004) and customizing outreach programs for specific locations difficult. Second, movement of urban residents into rural areas may result in amalgamation of urban versus rural wildlife values. Many residents, particularly within the southern half of the study area, make long commutes to jobs in cities such as Houston and Beaumont from rural bedroom communities. In these cases, residents with attitudes typically associated with members of larger communities (e.g., more positive attitudes toward particular carnivores; Lohr et al., 1996; Bowman, 1999) may be increasingly predominant among rural residents.

The negative relationship between distance from the preserve and support for *Natural*, *Assist*, and *Restock* was not significant, which further indicates a wide variety of attitudes toward bear recovery exist within the study area. But respondents closer to BTNP were significantly more likely to support the *No bear* strategy. This significant relationship, although relatively weak, is critical information, especially because BTNP is a target area for bear recovery. Bears that wander beyond the preserve's borders may be met with hostile actions from residents. We suggest public outreach near the preserve and in between preserve units.

In conclusion, the objective of our research was to illustrate the application of spatial analysis to social survey research. Even though our results identified two statistically significant clusters related to attitudes toward potential bear management options, such findings do not lead to unanimous agreement on the "best" management option. The suggestion that residents near BTNP are less supportive of a bear recovery may initially pose a big challenge to bear recovery efforts. Bear managers must determine if conditions exist for which non-supporters near the preserve will be willing to tolerate bear presence (e.g., movement of bear if nuisance problems occur; financial incentives), or if such residents will immediately threaten a bear's well-being (e.g., shoot it immediately). Should a reintroduction occur, and the bear population expands, the possibility exists that attitudes across the study area will change. Having residents throughout the study area who support a black bear recovery via *Assist* or *Restock* may allow for widespread initial support for TPWD's bear management goals, but support may decrease if bears become a nuisance at any time and in any given location. Unfortunately, several development proposals are threatening the ecologically fragile landscape of BTNP and the surrounding area. Decisions involving divestment of timberlands and urban development may drastically change the area's landscape. Rapidly growing cities in Texas, such as Houston, Austin, San Antonio, and Dallas–Ft. Worth, are playing a role in plans for an eight-lane superhighway and water diversion projects. These threats have resulted in BTNP's inclusion among the National Parks Conservation Association's (NPCA) 10 most endangered parks in the United States (NPCA, 2004). Potential land use decisions that threaten ecological landscape components are common among areas surrounding public lands that are targeted for species recovery programs. Spatial analysis of attitudes like this study can provide managers with insight toward where local support and non-support exists for conservation and species management goals.

References

Babbie, E. (1990). *Survey research methods* (2nd ed.). Belmont: Wadsworth Publishing Company.

Bailey, T. C., & Gatrell, A. C. (1995). *Interactive spatial data analysis*. Harlow: Pearson Education Ltd.

Bath, A. J., & Buchanan, T. (1989). Attitudes of interest groups in Wyoming toward wolf restoration in Yellowstone National Park. *Wildlife Society Bulletin, 17,* 519–525.

Black Bear Conservation Committee (BBCC). (1997). Black bear restoration plan. Baton Rouge, Louisiana.

Bolen, E. G., & Robinson, W. L. (1999). *Wildlife ecology and management* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Bowker, B., & Jacobson, T. (1995). Louisiana black bear (*Ursus americanus luteolus*) recovery plan. U.S. Fish and Wildlife Service, Atlanta, Georgia, USA.

Bowman, J. L., Leopold, B. D., Vilella, F. J., & Gill, D. A. (2004). A spatially explicit model, derived from demographic variables, to predict attitudes toward black bear restoration. *Journal of Wildlife Management*, *68*, 223–232.

Bowman, J. L., Leopold, B. D., Vilella, F. J., Gill, D. A, & Jacobson, H. A. (2001). Attitudes of landowners toward American black bear compared between areas of high and low bear populations. *Ursus*, *12,* 153–160.

Bowman, J. L. (1999). *An assessment of habitat suitability and human attitudes for black bear restoration in Mississippi*. Unpublished doctoral dissertation, Mississippi State University, Mississippi State.

Brown, G. (2005). Mapping spatial attributes in survey research for natural resource management: Methods and applications. *Society and Natural Resources*, *18*, 17–39.

Dillman, D. (2000). *Mail and Internet surveys: The tailored design method* (2nd ed.). New York: John Wiley and Sons.

Fox, J., Yonzon, P., & Podger, N. (1996). Mapping conflicts between biodiversity and human needs in Langtang National Park, Nepal. *Conservation Biology, 10,* 562–569.

Joly, D. O., Ribic, C. A., Langenberg, J. A., Beheler, K., Batha, C. A., Dhuey, B. J., Rolley, R. E., Bartlelt, G., Van Deelen, T. R., & Samual, M. D. (2003). Chronic wasting disease in free-ranging Wisconsin white-tailed deer. *Emerging Infectious Disease*, *9,* 599–601.

Kellert, S. R. (1991). Public views of wolf restoration in Michigan. *Transactions of the North American Wildlife and Natural Resources Conference*, *56*, 152–161.

Kie, J. G., Bowyer, R. T., Nicholson, M. C., Boroski, B. B., & Loft, E. R. (2002). Landscape heterogeneity at differing scales: Effects on spatial distribution of mule deer. *Ecology*, *83,* 530–544.

Knox, E. G. (2005). Childhood cancers and atmospheric carcinogens. *Journal of Epidemiology and Community Health*, *59,* 101–105.

Kulldorff, M. (1993). SaTScan™ User Guide. Software for the spatial and space-time scan statistics. Information Management Services Inc., Silver Spring, Maryland. Available at http://www.satscan.org

Kulldorff, M. (1997). A spatial scan statistic. *Communications in Statistics: Theory and Methods, 26*, 1481–1496.

Kulldorff, M., & Nagarwalla, N. (1995). Spatial disease clusters: detection and inference. *Statistics and Medicine*, *14,* 799–810.

Kulldorff, M., Feuer, E. J., Miller, B. A., & Freedman, L. S. (1997). Breast cancer clusters in the Northeast United States: a geographic analysis. *American Journal of Epidemiology, 146,* 161–170.

Kulldorff, M., Athas, W., Feuer, E., Miller, B., & Key, C. (1998). Evaluating cluster alarms: A space-time scan statistic for brain cancer in Los Alamos. *American Journal of Public Health*, *88,* 1377–1380.

Lohr, C., Ballard, W. B., & Bath, A. (1996). Attitudes toward gray wolf reintroduction to New Brunswick. *Wildlife Society Bulletin*, *24*, 414–420.

Margai, F., & Henry, N. (2003). A community-based assessment of learning disabilities using environmental and contextual risk factors. *Social Science & Medicine*, *56,* 1073–1085.

Mather, T. N., Nicholson, M. C., Hu, R., & Miller, N. J. (1996). Entomological correlates of *Babesia microti* prevalence in an area where *Ixodes scapularis* (Acari: Ixodidae) is endemic. *Journal of Medical Entomology, 33,* 866–870.

Merrill, T., Mattson, D. J., Wright, R. G., & Quigley, H. B. (1999). Defining landscapes suitable for restoration of grizzly bears *Ursus arctos* in Idaho. *Biological Conservation*, *87*, 231–248.

Miller, M. A., Gardner, I. A., Kreuder, C., Paradies, D. M., Worcester, K. R., Jessup, D. A., Dodd, E., Harris, M. D., Ames, J. A., Pankham, A. E., & Conrad, P. A. (2002). Coastal freshwater runoff is a risk factor for *Toxoplasma gondii* infection of southern sea otters (*Enhydra lutris nereis*). *International Journal of Parasitology, 32,* 997–1006.

Morzillo, A. T. 2005. *Integrating ecology and socioeconomics for species restoration: Feasibility of a Louisiana black bear reintroduction in and around Big Thicket National Preserve, Texas*. Unpublished doctoral dissertation, Michigan State University, East Lansing.

Mostashari, F., Kulldorff, M., Hartman, J. J., Miller, J. R., & Kulasekera, V. (2003). Dead bird clusters as an early warning system for West Nile Virus activity. *Emerging Infectious Diseases*, *9*, 641–646.

Naughton-Treves, L. (1997). Farming the forest edge: Vulnerable places and people around Kibale National Park, Uganda. *Geographical Review, 87,* 27–46.

NPCA. (2004). NPCA Press Releases. Big Thicket named to list of endangered national parks. Accessed: 17 May 2005 from http://www.npca.org/media_center/bigthicket.asp

Pate, J., Manfredo, M. J., Bright, A. D., & Tischbein, G. (1996). Coloradans' attitudes toward reintroducing the gray wolf in Colorado. *Wildlife Society Bulletin*, *24,* 421–428.

Pelton M. R. (1982). Black bear. In J. A. Chapman and G. A. Feldhamer (Eds.). *Wild mammals of North America* (1st ed.; pp. 504–514). Baltimore: John Hopkins University Press.

Peyton B., Bull, P., Reis, T. & Visser, L. (2001). Public views on bear and bear management in the lower peninsula of Michigan. Report to the Michigan Department of Natural Resources, Wildlife Division. Lansing, Michigan, USA.

Riley, S. J., & Decker, D. J. (2000). Wildlife stakeholder acceptance capacity for cougars in Montana. *Wildlife Society Bulletin*, *28*, 931–939.

Riley, S. J., Decker, D. J., Carpenter, L. H., Organ, J. F., Siemer, W. F., Mattfeld, G. F., & Parsons, G. (2002). The essence of wildlife management. *Wildlife Society Bulletin*, *30*, 585–593.

Shropshire, C. C. (1996). *History, status, and habitat components of black bears in Mississippi*. Unpublished doctoral dissertation, Mississippi State University, Mississippi State.

Sitati, N. W., Walpole, M. J., Smith, R. J., & Leader-Williams, N. (2003). Predicting spatial aspects of human-elephant conflict. *Journal of Applied Ecology*, *40*, 667–677.

Smith, K. L., DeVos, V., Bryden, H., Price, L. B., Hugh-Jones, M. E., & Keim, P. (2000). *Bacillus anthracis* diversity in Kruger National Park. *Journal of Clinical Microbiology*, *38*, 3780–3784.

Texas Parks and Wildlife Department. (2005). *East Texas black bear conservation and management plan* (PWD PL W7000-1046 [6/05]). Austin, Texas.

Van Why, K. R. (2003). *Feasibility of resorting the Louisiana black bear (*Ursus americanus luteolus*) to portions of their historical range*. Unpublished master's thesis, Louisiana State University, Baton Rouge.