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Nuisance American alligators: an investigation into trends and public opinion

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Abstract: The population rebound of the American alligator (*Alligator mississippiensis*; hereafter, alligator), with the rapid growth of populations throughout its range, has caused an influx of human–alligator conflicts. We quantified 5,838 nuisance alligator reports from 2000 to 2011 to develop more site-specific strategies of management and to determine where management should be focused to minimize the conflict. We also surveyed the general public's attitude toward and knowledge of alligators (n = 98) as a technique to better understand human dimensions of nuisance alligator management in Texas. Counties that received the largest numbers of nuisance alligator reports were Jefferson (16%), Fort Bend (14%), Matagorda (11%), Brazoria (10%), Harris (7%), Jackson (5%), Orange (5%), Chambers (5%), Calhoun (5%), and Liberty (3%) counties. We found that of the nuisance alligators reported, 45% were male, 18% were female, and 38% were reported as unknown. Most residential situations occurred in Fort Bend County, while more roadway and worksite situations occurred in Jefferson County, and more livestock depredation occurred in Matagorda County. Conflict resolution differed by alligator size. Most (41%) alligators <1.5 m in length were relocated, and most (66%) alligators >1.5 m in length were removed through lethal means. Most (93%) survey responders would support an alligator removal program that conducted capture and relocation, but they were unwilling to have alligators relocated near their homes. Only 15% of survey responders would support an alligator management program that utilized lethal removal. Visitors with more education (bachelor's degree or higher) were more willing to support lethal control of alligators. We determined that survey responders had some knowledge of alligators and that an alligator educational program targeted to residents of the northern Texas Gulf Coast could help reduce the number of human–alligator conflicts.

Key words: American alligator, *Alligator mississippiensis,* human–wildlife conflicts, nuisance, public opinion, Texas, wildlife management

The American alligator (*Alligator mississippiensis*; hereafter, alligator) is an endemic species iconic to the U.S. Gulf Coast and lower Atlantic coastal plains of North America, inhabiting rivers, swamps, marshes, lakes, bayous, as well as ephemeral bodies of water (Conant and Collins 1998). Market hunting, poaching, and wetland habitat losses resulted in a reduction of this species throughout the southeastern and Gulf coast states during the late 1800s and early 1900s (McIlhenny 1935). Alligators were declared an endangered species in 1967 and were given federal protection through the Endangered Species Preservation Act of 1966 (U.S. Department of the Interior 1967).

Federal protection has allowed alligators to repopulate, flourish, and expand their traditional range throughout the U.S. Gulf Coast (Conant and Collins 1998). The restoration of alligators throughout the southern United States has been attributed to strict harvest regulations, intensive management strategies, and wetland conservation (Saalfeld et al. 2008). As a result, alligators were reclassified as threatened throughout the entirety of their range (U.S. Department of the Interior 1987).

Thompson et al. (1984) accredited alligators' come back not only to the passage of the Endangered Species Acts (1969, 1973), but also to modifications of the Lacey Act in 1969, which expanded protection to other reptiles. Thompson et al. (1984) also highlighted the importance of the elimination of the alligator hide market in the United States, as well as the strong protective classification in concurrence with regulations controlling international commerce through the Convention on

International Trade in Endangered Species of Wild Fauna and Flora (1973).

The rebound of alligators has initiated rapid growth of their populations throughout their range (Potter 1981). This recent growth has caused an influx of human–alligator conflicts. The number of complaints regarding these conflicts has been directed to state wildlife agencies, and they have increased dramatically over the years following this species' recovery (Johnson et al. 1985). By 1975, some wildlife officials were spending >50% of their time handling nuisance alligator reports at an estimated annual cost of $250,000 (Hines and Woodward 1980). Human interactions with alligators pose a multifaceted wildlife management challenge. In Texas, reports of negative encounters with alligators now number several hundred annually, with most of the reports occurring in coastal areas that also host a substantial human population (Johnson et. al. 1985). Such negative encounters with alligators are the result of human encroachment and range recolonization by alligators (Woodroffe et al. 2005, Skogen et al. 2008). Currently in Texas, all nuisance alligators are handled by the Texas Parks and Wildlife Department (TPWD). If a citizen reports a nuisance alligator, a TPWD game warden, wildlife biologist, or contracted nuisance alligator hunter responds. Upon arrival, the responder decides if the alligator is indeed a nuisance animal. If so, the responder decides how to resolve the conflict. Typically, a responder has only a few options available as resolution strategies. Responders may lethally remove the alligator, capture, restrain, and relocate it, or leave the alligator as is and consider it not a nuisance problem.

We evaluated trends in nuisance alligator reports in Texas and quantified public opinion about alligators and their management. We hypothesized that a large number of nuisance male alligators would be 1.5 to 1.8 m in length. The objectives of this study were to: (1) identify trends in nuisance alligator reports in the state of Texas by year, month, county, alligator size, sex, situation, and action taken; (2) determine agency priority of nuisance alligator management based on these trends; and (3) determine public opinion about alligators and their management.

Methods

Nuisance alligator trends

Data on nuisance alligators were collected by TPWD's nuisance alligator management program, that included state wildlife biologists, game wardens, and TPWD-contracted nuisance alligator hunters. Data included date, sex, length (to nearest meter), description of situation, and conflict resolution. In situations that resulted in the handling of a nuisance alligator, the animal's length was measured, and sex was determined through cloacal examination. Cloacal examination of alligators is done by manually palpating the cloaca anteriorly through the cavity and feeling for the presence or lack of a penis (Chabreck 1963). In situations that did not warrant the physical handling of individuals, a visual estimation of size was recorded using the methods of Chabreck (1966); in such cases, sex was recorded as unknown. Estimating the size of alligators can be achieved by viewing the length from the eyes to the nares (i.e., nostrils), as this corresponds to total length (Chabreck 1966). Alligators were grouped into size and age categories. Those classified as juveniles were 0 to 1.2 m in length. Subadult alligators were 1.21 to 1.8 m in length. Alligators that measured >1.8 m in length were classified as adults. Due to the availability of data, we analyzed data collected from 2000 to 2011 to determine trends in nuisance reports.

Situation-type data were separated into 8 categories: (0) not recorded, (1) residential area, (2) private ponds, (3) roadways, (4) public areas, (5) commercial areas or worksites, (6) habituation, and (7) livestock depredation. No report was placed in >1 category. For example, if nuisance alligator reports included 2 situation types, such as an alligator reported in a private pond that occurred within a neighborhood or residential area, the report would be placed in the category that was the underlying cause of the conflict or nuisance report. If a nuisance alligator was reported in a private pond and the pond did not occur in a residential area, the report was placed in category 2. Additionally, if an alligator was near a residential area but causing livestock depredation, the report would be placed in category 7. All nuisance alligators that were reported in the vicinity of a home, neighborhood, or subdivision were placed in category 1. Any alligator that was reported as a nuisance in a privately owned pond or lake that was not near a residential area or worksite, caused livestock depredation, or was habituated to humans, was placed in category 2. Although ponds were privately owned, not all occurred near a residence; therefore, these situations warranted a category of their own. All alligators that were reported as a road hazard, irrespective of road size or amount of roadway traffic, were placed in category 3. If an alligator occurred in a roadway, even if it was within a residential area, the report was placed in category 3. The occurrence of a nuisance alligator in any type of public area (e.g., golf course, park, school, boat ramp; Figure 1) was placed in category 4. Alligators that were reported in any type of worksite (e.g., power plant, refinery, construction site) were put into category 5. Reports of habituation were compiled into category 6; this included reports of alligators that were fed, handled, or illegally kept as pets to the point that they became a safety risk to complainants. Nuisance alligators that were reported as causing, or had the potential to cause, livestock depredation were placed in category 7. Most reports that were ranked in this category consisted of alligators that were found in commercial fish and shrimp farms, but also included domestic livestock and poultry, as well as household pets. Animals and livestock were not attacked in every report of livestock depredation. If farmers, ranchers, or pet owners thought that there was a threat of an alligator causing livestock depredation, and this threat was validated by a TPWD responder, the nuisance alligator was removed, and, subsequently, the alligator was placed in category 7.

Categorical ranking of conflict resolution was done in the same manner. Conflict resolution was broken into 7 categories: (0) not recorded; (1) lethal, removal by TPWD employee; (2) lethally removed by state contracted nuisance alligator hunter; (3) relocation of nuisance alligator; (4) resolved on site (i.e, complainant was educated about alligators either verbally or through the use of promotional literature about the species, the alligator occurred in natural habitat which did not merit removal, or the situation was determined low risk and not a nuisance problem); (5) dead upon responder arrival; and (6) captured alive to be moved to a commercial alligator farm by a contracted nuisance alligator hunter.

Figure 1. Adult male American alligator on front lawn of nature center at Brazos Bend State Park, Fort Bend County, Texas. (*Photo courtesy K. Dankert*)

Public opinion

To understand human attitudes toward alligators, we developed a questionnaire for visitors at Brazos Bend State Park in Needville, Texas (Appendix 1); the park's main attraction is its large population of wild alligators. The park was chosen as a study sight due to its proximity to an urban population of wild alligators. Most park visitors are local residents who have encountered nuisance alligators. We believe that the population of people surveyed was representative of a human population that was both familiar with and had opinions about nuisance alligator issues and management. Further, the park not only attracts people who enjoy alligators, but also bird watchers, hikers, bicyclists, picnickers, and people who are new to the area and indifferent to wildlife and the outdoors. During times of high visitation, park guests were randomly chosen and asked to complete the survey. This survey was conducted from June 1 to August 1, 2012, by graduate students, park employees, and park volunteers. Human fear of alligators, knowledge of alligator biology, support for various alligator management strategies, and demographics of survey respondents were assessed. The survey also gauged human support for programs that involved lethal removal and relocation of alligators to sites near residential areas.

Statistical analyses

We used a categorical data analysis approach

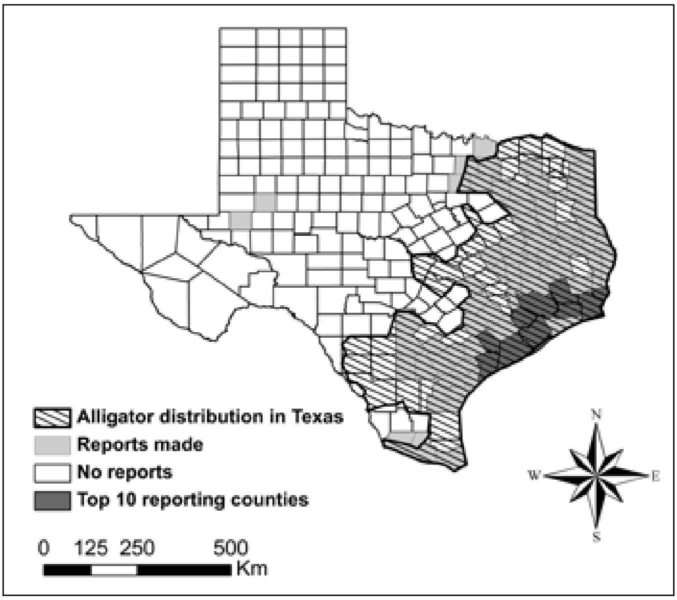

Figure 2. Top 10 Texas counties with largest number of nuisance alligator reports and alligator distribution in Texas. We believe the 2 counties outside of the normal alligator distribution in Texas are not natural occurrences, but rather the result of human-mediated transport and subsequent release into the wild.

Figure 3. Top 10 Texas counties with the largest number of nuisance alligator reports from 2000 to 2011.

(PROC FREQ; Stokes et al. 1995) to examine frequency of occurrence among variables measured for all nuisance alligator reports. Two-way frequency tables were created based on the comparison of each variable assessing alligator demographic (e.g., size, sex), situation, and conflict resolution. Each frequency table compared 2 variables, and all possible comparisons were made. Output was expressed on a percentage basis, and proportions of each category were determined. An analysis of variance (ANOVA; PROC ANOVA; Scheffe 1959) and Chi-square analysis were used to determine if distributions of conflict and situation variables (dependent variables) were statistically different based on temporal (month and year) and demographic variables (independent variables). If significant interactions were detected, single variates of the interaction were analyzed separately within each grouping of the other main effects. In the Chi-square analysis, the numbers of annual reports were compared to determine if the observed number of nuisance alligator reports in each year differed from the expected value. We used loglinear models to test effects of sex, size category, and situation, as well as all of their interactions, on frequency of nuisance calls (Bishop et al. 1975), following the analytical approach described by Sokal and Rohlf (2012); that is, the 3-way interaction was tested first; if this effect was not significant, then, 2-way interactions were tested. When a 2-way interaction was significant, then distributions of nuisance calls across 1 factor were compared in a pairwise sense among levels of the second factor (Snedecor and Cochran 1980). In the case that size or sex was not reported, the data were excluded from the analysis.

The public opinion survey was analyzed using analysis of variance (ANOVA; PROC ANOVA; Scheffe 1959) to determine if distributions of categorical variables differed from one another for each survey question. Survey participants were separated categorically by education, ethnicity, gender, and age (independent variables). Variability of response to each question (dependent variable), based on variability of these participant categories, was determined.

Results

Nuisance alligators

From 2000 to 2011, 5,838 nuisance alligators reports were made in Texas. The largest

Table 1. Annual number of nuisance alligator reports for top 10 reporting Texas counties and Chi-square analysis of number of annual reports.

County	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Range
Jefferson	61	66	58	76	57	27	78	59	143	183	69	75	952	27–183
Fort Bend	65	63	50	71	166	71	84	57	45	46	57	52	827	45–166
Matagorda	8	6	6	12	65	64	167	80	58	67	48	62	643	6–167
Brazoria	29	25	4	33	90	55	63	53	32	59	49	80	572	4–90
Harris	13	28	25	20	63	59	66	34	31	12	22	23	396	12–66
Jackson	24	39	23	41	43	11	18	21	20	14	19	7	280	7–43
Orange	15	22	12	36	19	9	25	25	14	68	24	9	278	9–68
Chambers	10	17	22	13	13	11	18	21	30	56	29	25	265	10–56
Calhoun	8	13	12	9	62	35	36	27	21	18	16	4	261	4–62
Liberty	4	8	6	3	11	17	11	30	22	26	21	8	167	3–30
Total	237	287	218	314	589	359	566	407	416	549	354	345	4641	218–589
Total Texas reports	280	338	269	445	774	477	690	469	561	698	444	393	5838	
Top 10 counties % of Texas total	85%	85%	81%	71%	76%	75%	82%	87%	74%	79%	80%	88%	80%	
χ^2 of annual reports	87.7*	45.3*	97.2*	3.5	169.0**	0.2	85.1**	0.6	11.4	91.9**	3.7	18.0	614.5	
Yearly % of χ^2 value	14.3%*	7.4%*	15.8%*	0.6%	27.6%**	0.0%	13.8%**	0.1%	1.9%	14.9%**	0.6%	2.9%	100.0%	

* The number of nuisance reports is less than expected for that year.

** The number of nuisance reports is more than expected for that year.

Figure 4. Researcher (top) captures an adult male alligator and (bottom) measures it. (*Photo courtesy-George Regmund*)

number of reports (13%) took place in 2004, and the lowest number of reports (5%) occurred in 2002. Years 2004, 2006, and 2009 had a greater number of reports than would be expected, while some years (2000, 2001, 2002) experienced fewer reports than would be expected (χ^2 = 614.5, df = 11, P < 0.001; Table 1).

Of the 254 counties in Texas, 75 (30%) received nuisance alligator reports from 2000 to 2011 (Figure 2). Of these 75 counties, we identified ten as counties of concern (Figure 3) because 72% of all reports occurred in them (Table 1). These counties included Jefferson (16%), Fort Bend (14%), Matagorda (11%), Brazoria (10%), Harris (7%), Jackson (5%), Orange (5%), Chambers (5%), Calhoun (5%), and Liberty (3%) counties (Table 1; Figure 3). These counties are located in coastal southeast Texas (Figure 2). There was a significant interaction (F = 24.51, df = 63, P < 0.0001) between the top 10 counties and situation type (Table 2) and conflict resolution (F = 4.63; df = 54; P < 0.0001; Table 3). The most noteworthy differences were a greater number of residential situations that occurred in Fort Bend County, while more roadway and worksite situations occurred in Jefferson County, and more livestock depredation occurred in Matagorda County (Table 2).

Although size, sex, and situation acted independently (χ^2 = 19.88, df = 14, P = 0.13) in their effects on frequency of nuisance calls, each of the 2-way interactions was significant (for sex × situation, χ^2 = 45.64, df = 21, P = 0.001; for size × sex, χ^2 = 68.57, df = 16, P <0.0001; and for size × situation, χ^2 = 182.6, df = 28, P < 0.0001). Further analysis focused on the 2-way interactions.

Alligator sex × situation. The distribution of nuisance calls across situations differed (χ^2 = 45.64, df = 21, P = 0.001) between the 2 sexes. For example, of the 2,583 nuisance calls involving male alligators, 517, 407, 383, 356, 333, 312, 251, and 24 calls were due to situations 1, 4, 0, 7, 3, 5, 2, and 6, respectively. Similar trends of situations were observed for calls involving female nuisance alligators, with the exception that category 5 was ranked higher; 226, 174, 163, 128, 113, 102, 97, and 11 nuisance calls were due to category 1, 4, 5, 0, 7, 3, 2, and 6, respectively. The distribution of nuisance calls between sexes differed among categories, as well. For example, the proportion of nuisance calls between males and females in category 6 was similar to the proportion of nuisance calls between sexes in each of the other situations. Other pairs of categories differed, however. For example, the most dissimilar (P = 0.0002*)* categories were situations 5 and 7; 65% of the nuisance calls in category 5 involved males, whereas, 76% of the nuisance calls in category 7 involved males.

Alligator sex × alligator size. The distribution of nuisance calls across situations differed (χ^2 = 68.57, df = 16, P < 0.0001) between the 2 sexes (Table 4). For both sexes, only about 18 to 19% of the nuisance calls involved animals in size class 1; however, for males, nearly 50% of the nuisance calls involved size class 3, and nearly a third of the nuisance calls involved size class 2, whereas, for females, 44% of the calls involved size class 2, and only 37% of the calls involved size class 3 (Table 4). The distribution of nuisance calls between sexes differed (χ^2 = 64.82, df = 16, P < 0.0001) between size classes 2 and 3, but was similar between both size classes 1 and 2 (χ^2 = 7.68, df = 8, P = 0.4653) and size classes 1 and 3 (χ^2 = 13.59, df = 8, P = 0.0930).

Table 2. Average annual (± SE) number of reports of each nuisance alligator situation in top 10 Texas counties from 2000 to 2011. Means, followed by the same capital letters, are not significantly different ($P > 0.05$) among counties of the same situation type. Means, followed by the same lowercase letter, are not significantly different ($P > 0.05$) among situation types of the same county.

County	Not recorded (0)	Residential (1)	Private pond (2)	Roadway (3)	Public area (4)	Work site (5)	Habituation (6)	Livestock depredation (7)
Jefferson	13.8 (4.1) Aabcd	14.3 (3.3) Babc	3.3 (0.9) ABCbcde	15.5 (5.0) Aba	8.5 (1.5) ABCabcde	19.3 (3.9) Aa	1.0 (0.3) Ae	1.5 (0.8) Bed
Ft. Bend	5.9 (3.1) ABb	29.3 (4.9) Aa	5.2 (1.3) ABb	6.8 (1.6) Bb	9.6 (2.1) ABb	2.5 (0.9) Bb	1.3 (0.9) Ab	3.4 (1.1) Bb
Matagorda	4.1 (1.8) ABb	4.7 (1.7) CBDb	5.4 (1.1) ABb	3.9 (0.8) Bb	3.3 (0.9) BCb	5.0 (1.5) Bb	0.0 (0.0) Ab	26.5 (10.2) Aa
Brazoria	1.8 (0.5) Bb	14.2 (2.8) CBa	5.8 (1.7) Ab	4.8 (0.9) Bb	7.4 (1.7) ABCab	7.3 (3.1) Bab	0.6 (0.1) Ab	3.0 (0.9) Bb
Harris	4.4 (1.9) ABabc	7.2 (1.4) CBDba	2.2 (0.6) ABCbc	4.3 (0.9) Babc	8.8 (2.5) ABCa	2.1 (0.5) Bbc	0.2 (0.1) Ac	0.6 (0.3) Bc
Jackson	3.2 (2.0) Bb	3.3 (1.4) CDb	0.8 (0.4) Cb	2.8 (0.7) Bb	11.6 (2.4) Aa	0.6 (0.3) Bb	0.0 (0.0) Ab	0.5 (0.2) Bb
Orange	4.8 (1.9) Aba	4.8 (1.1) CBDa	2.3 (0.8) ABCab	1.6 (0.5) Bab	2.2 (0.6) Cab	4.8 (1.1) Ba	0.3 (0.2) Ab	1.0 (0.6) Bab
Chambers	3.5 (1.7) Babc	6.3 (2.1) CBDa	1.3 (0.3) BCbc	5.3 (1.1) Bab	1.6 (0.6) Cbc	1.8 (0.7) Bbc	0.0 (0.0) Ac	1.1 (0.4) Bbc
Calhoun	3.3 (2.0) Ba	3.0 (1.1) Da	2.1 (0.8) ABCa	2.2 (1.2) Ba	4.4 (1.3) ABCa	3.2 (0.8) Ba	0.6 (0.5) Aa	2.3 (1.0) Ba
Liberty	1.6 (0.5) Bab	3.7 (1.2) CBDa	2.0 (0.5) ABCab	2.3 (0.5) Bba	2.2 (0.9) Cab	0.3 (0.1) Bb	0.0 (0.0) Ab	1.4 (0.7) Bab

Table 3. Average annual (± SE) number of each human-alligator conflict resolution type in top 10 Texas counties from 2000 to 2011. Means followed by the same capital letters are not significantly different ($P > 0.05$) among counties of the same situation type. Means followed by the same lowercase letter are not significantly different ($P > 0.05$) among situation types of the same county.

	Resolution category						
County	Not recorded	Lethal removal by TPWD	Lethal removal by contract hunter	Relocation	Resolved on site	Dead upon arrival	Relocated to commercial farm
Jefferson	9.3 (7.7) Ab	2.1 (0.6) ABb	44.7 (8.7) Aa	14.8 (2.3) ABb	5.0 (0.8) CBb	3.1 (0.8) Ab	0.4 (0.2) Ab
Ft. Bend	2.5 (1.3) Ab	2.7 (1.0) Ab	22.5 (5.3) ABa	22.5 (5.3) Aa	17.3 (3.0) Aa	0.6 (0.2) Bb	0.8 (0.8) Ab
Matagorda	1.3 (0.5) Ab	0.8 (0.3) ABb	41.5 (12.1) Aa	5.6 (1.4) BCb	2.5 (1.0) CBb	0.8 (0.3) Bb	1.1 (1.1) Ab
Brazoria	1.4 (0.7) Ab	2.5 (0.7) ABb	23.0 (5.2) ABa	10.1 (2.0) BCb	8.8 (1.7) Bb	0.6 (0.3) Bb	1.3 (1.1) Ab
Harris	1.9 (0.6) Ab	1.1 (0.3) ABb	10.5 (2.8) Ba	9.8 (1.6) BCa	8.5 (1.9) Ba	0.6 (0.2) Bb	0.6 (0.3) Ab
Jackson	0.2 (0.1) Ab	1.3 (0.6) ABb	13.1 (2.1) Ba	4.4 (1.3) BCb	3.1 (1.3) CBb	0.6 (0.3) Bb	0.8 (0.8) Ab
Orange	3.1 (2.5) Ab	0.2 (0.2) Bb	12.5 (2.5) Ba	5.8 (1.3) BCb	1.4 (0.4) Cb	0.1 (0.1) Bb	0.1 (0.1) Ab
Chambers	2.3 (1.8) Abc	0.6 (0.2) ABc	9.4 (1.4) Ba	6.3 (1.4) BCba	1.0 (0.4) Cc	1.3 (0.4) Bc	1.0 (0.8) Ac
Calhoun	0.5 (0.4) Ac	0.8 (0.5) ABbc	11.0 (2.7) Ba	6.8 (2.1) BCba	1.8 (1.1) Cbc	0.4 (0.2) Bc	0.5 (0.5) Ac
Liberty	0.9 (0.7) Ab	0.6 (0.2) ABb	8.7 (2.2) Ba	1.4 (0.7) Cb	1.3 (0.4) Cb	1.0 (0.4) Bb	0.1 (0.1) Ab

[a] Means with the same capital letters are not significantly different ($P > 0.05$) between counties of the conflict resolution type.

[b] Means with the same lowercase letter are not significantly different ($P > 0.05$) between conflict resolution types of the same county.

Table 4. Frequency of nuisance alligator reports, cross-classified by sex and size, in Texas from 2000 to 2011.

	Size			
	Juvenile	Subadult	Adult	Total
Male	469	848	1,266	2,583
Female	194	442	378	1,014
Total	663	1,290	1,644	

Table 5. Frequency and percentage of nuisance alligator reports cross-classified by alligator size class and situation in Texas from 2000 to 2011.

		Situation[a]								
		0	1	2	3	4	5	6	7	Total
Juvenile	Frequency	104	194	72	40	85	61	3	104	663
	Size (%)	20.4	26.11	20.7	9.20	14.6	12.8	8.6	22.2	18.4
	Situation (%)	15.7	29.26	10.9	6.03	12.8	9.2	0.5	15.7	
Subadult	Frequency	171	249	125	128	205	169	14	229	1290
	Size (%)	33.5	33.51	35.9	29.43	35.3	35.6	40.0	48.8	35.9
	Situation (%)	13.3	19.30	9.69	9.92	15.4	13.1	1.1	17.8	
Adult	Frequency	236	300	151	267	291	245	18	136	1644
	Size (%)	46.2	40.38	43.3	61.38	50.1	51.6	51.4	29.0	45.7
	Situation (%)	14.4	18.25	9.2	16.24	17.7	14.9	1.1	8.3	
Total		511	743	348	435	581	475	35	469	3597
	Situation (%)	14.2	20.7	9.7	12.1	16.2	13.2	1.0	13.0	100

[a] Situation categories: (0) not recorded, (1) residential area, (2) private ponds, (3) roadways, (4) public areas, (5) commercial areas or worksites, (6) habituation, and, (7) livestock depredation

Situation × alligator size. Situation and size class interacted (χ^2 = 182.63, df 28, P = < 0.0001) in their effects on frequency of nuisance calls (Figure 4). Because of this interaction, 2 additional analyses are appropriate and meaningful. First, consider comparisons of size-class distributions between pairs of situations. For example, the distribution of nuisance calls across size classes in situation 0 were 20, 33, and 46% of nuisance calls in sizes 1, 2, and 3, respectively; similarly, we found 20, 35 and 43% of the calls corresponded to sizes 1, 2, and 3, respectively (Table 5). When comparing the distribution of nuisance calls across situations, every size class differed from every other size class (for size classes 1 and 2, χ^2 = 43.74, df = 14; for size classes 1 and 3, χ^2 = 119.28, df = 14; and for size classes 2 and 3, χ^2 = 97.70, df 14, P < 0.0001 for all tests; Table 6).

Conflict resolution differed by alligator size (F = 21.22, df = 14, $P \leq 0.001$). Most (41%) alligators <1.5 m in length were relocated, and only 25% were lethally removed, while most (66%) alligators >1.5 m in length were removed through lethal means, and only 15% were relocated.

Although nuisance alligators were reported in all months (Figure 5), the mean number of calls per month was greatest (F = 27.4, df = 11, $P \leq 0.001$) during spring and early summer. The largest number of reports occurred in May (21%), followed by June (17%), and April (14%; Figure 3).

Public opinion

Ninety-eight park visitors were surveyed at Brazos Bend State Park during the summer of 2012. Several responses varied by participant sex and education level. Females were more fearful or more willing to admit a fear of alligators (F = 14.95, df = 1, $P \leq 0.001$) than were males. Females also admitted that they were not

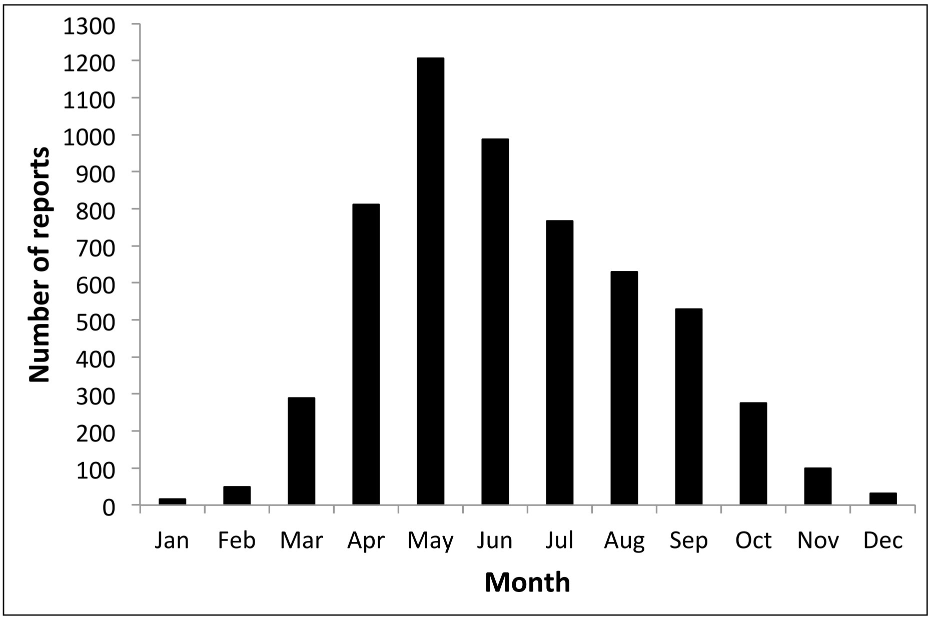

Figure 5. Number of nuisance alligator reports made by month.

Table 6. *P* values associated with comparisons of the distributions of nuisance alligator reports across alligator size classes between pairs of nuisance alligator situation types in Texas from 2000 to 2011.

	Situation							
Situation[a]	0	1	2	3	4	5	6	7
0		0.1323	0.4171	<0.0001	0.0890	0.0015	0.4551	<0.0001
1			0.2817	<0.0001	<0.0001	<0.0001	0.1229	<0.0001
2				<0.0001	0.0680	0.0154	0.2910	0.0002
3					0.0005	0.1402	0.3506	<0.0001
4						0.4480	0.7469	<0.0001
5							0.6006	<0.0001
6								0.0367
7								

[a] Situation categories: (0) not recorded, (1) residential area, (2) private ponds, (3) roadways, (4) public areas, (5) commercial areas or worksites, (6) habituation, and (7) livestock depredation

as willing to be near an alligator ($F = 5.60$, df = 1, $P = 0.02$) as did males. Most participants (83%) said that they would support a management program to increase the alligator population in a state park or natural area. Only 42% responded that they would support a program to increase an alligator population that was within a mile from their home. Additionally, 40% of respondents indicated that they would support the removal of alligators from a state park or natural area for management purposes, while 68% would support an alligator removal program for management purposes within a mile of their home. Only 15% of people would support a lethal alligator removal program as a management strategy, whereas 93% would support an alligator removal program if the program conducted only capture and relocation. However, only 40% of these respondents would support an alligator relocation program if alligators were relocated near their home. Survey participants with higher education (greater than a bachelor's degree) were more willing to support lethal control of alligators ($F = 2.96$, df = 5, $P = 0.01$).

Knowledge about alligators varied. Ratio of respondents who gave the incorrect response of "true" to survey statements (Appendix 1) included the following: 70% responded "true" to "Alligators are found in sewer systems of most urban areas in the United States"; 54% responded "true" to "Alligators can run up to 32.2 kilometers per hour (20 mph) on land"; and 34% responded "true" to "Alligators eat anything ranging from garbage to humans." Conversely, when asked to give a true-false response to the statement, "The length of an alligator can be estimated by estimating the length of the head from eye to nare", 55% of respondents gave a correct answer of "true." When participants were asked what their first response would be if an alligator were in their front yard blocking them from their vehicle, responses were that they would call a game warden to come remove it (70%), wait for it to leave (19%), try to get the alligator to move (4%), feed it and take photographs (4%), and shoot and kill it (3%).

Discussion

Human–wildlife conflicts are increasing in both frequency and intensity and will presumably continue to increase through time (Madden 2004). The alligator population and number of nuisance alligator complaints are on the rise within their range across the country (Langley 2010). In Florida, the number of nuisance alligator reports has increased from 4,917 in 1987 to 18,307 in 2006 (Langley 2010). This increase supports the hypothesis that the number of human–alligator encounters will increase as the human population expands and increases in the southern states (Langley 2010, Johnson et al. 1985). Without the enactment of proper management, the incidences of these conflicts could grow to a point at which alligator population health is compromised. Better knowledge of what type of human–alligator interaction situations exist and where they are occurring is essential to enhance the management strategies employed to reduce human–alligator conflics.

An explanation for the large number of reports in 2004 and the low number of reports in 2002 may be fluctuations in rainfall. It is likely that each of these years exhibited lag results from the conditions of the previous year. This is because Texas received roughly the same amount of rainfall in 2002 as it did in 2004 (~124 cm; Texas Agrilife Extension, unpublished data). For example, 2001 was considered a wet year (145 cm annual rainfall), and 2002 was an average year (124 cm) for rainfall, which may indicate that alligators had to move less in search of suitable wetland habitat.

Our data highlights "hot spots" on the Texas coast that generated a substantial number of nuisance alligator reports. Alligator management in Texas should focus on these top 10 counties as a means to reduce the number of human–alligator conflicts. These counties are among the most populous in the state (U.S. Census Bureau 2012). Human populations for these 10 counties consisted of 5,756,067 people, which comprised 22% of the human population of Texas in 2012 (Texas Department of State Health 2013). Additionally, Houston, Texas, the county seat of Harris County, is the fourth most populous city in the United States (U.S. Census Bureau 2012). We found that large human populations occur within the range of alligators in Texas, and, more specifically, within the top 10 counties of concern. The large human populations that occur in the range of the alligator are undoubtedly a factor contributing to the large amount of conflict. This is why the majority of reports originated from residential and public areas. Matagorda County is the exception to this hypothesis. Matagorda County hosts a large aquaculture industry (e.g., commercial fish and shrimp farms); therefore, the number of livestock depredation incidents composed a substantial proportion of the nuisance alligators reported in this county.

Alligators reach sexual maturity at a particular size rather than age (Wilkinson and Rhodes 1997). Males and females both reach sexual maturity at about 1.8 m in length (Chabreck and Joanen 1979). It is believed that the onset of sexual maturity causes these individuals to disperse from their natal range (Lance et al. 2011). The large number of adult male alligators reported as nuisances is likely the result of the increased movement and home range size experienced by adult males during the breeding season. When these

Figure 6. Juvenile and subadult American alligators basking. (*Photo courtesy Kim Dankert*)

ecology and general life history. Hines and Woodward (1980) also found that most nuisance alligators are reported during this time.

The differences in conflict resolution reflect current nuisance alligator management strategies. Hines and Woodward (1980) found that the use of contracted hunters was the most cost effective strategy to handle nuisance alligators. Hines and Woodward (1980) also found that nuisance alligator hunters lethally removed alligators at equal proportions in each size class. They indicated that this result showed that hunters did not select for smaller, easier-to-remove alligators or larger, more valuable alligators. However, our hypothesis was that the use of contracted nuisance alligator hunters would result in a larger number of alligators that are lethally removed and sold into the commercial market. Our results better reflect our hypothesis than that of the findings of Hines and Woodward (1980). The compensation that nuisance alligator hunters receive for the meat and hide of lethally removed animals is incentive to volunteer for the program. Another factor is that the monetary value of an alligator in the commercial market is based on the length of a hide. In recent years, alligator hides have sold for about $5 (USD, 2012 price) per centimeter and meat for about $10 (USD, 2012 price) per kg (Agricultural Marketing Resource Center, <www.agmrc.org>, unpublished data). Therefore, the larger an alligator the more valuable it is. Also, alligator hides do not become marketable until individuals reach a minimum of 1.2 m in length. Although the value of the hide is offered to compensate volunteers for their time and efforts, contracted nuisance hunters may be more inclined to lethally remove larger more valuable alligators for monetary gain.

Most responders to nuisance alligator complaints perform their duties alone, primarily due to a paucity of volunteers and employees. For example, there is typically only 1 to 2 TPWD game wardens assigned to a county and usually only 1 nuisance alligator hunter who covers an area that includes several Texas counties. This

individuals expand their range outside of their normal territories in attempts to locate females and breed, they inhabit or pass through nonconventional habitats (e.g., residential areas, roadways, worksites, etc.). It is when these circumstances prevail that they are reported as nuisance animals. Also, the large number of subadult male alligators reported as nuisance animals are likely those that are coming into maturity and that are dispersing and seeking out territories. Lance et al. (2011) noted that smaller alligators cannot defend a territory from larger ones. This explains why smaller-sized and sexually maturing alligators move more often and farther distances than larger conspecifics (Lance et. al. 2011). Female alligators did not follow this pattern. A large proportion of the females that were reported as causing problems were subadults. This is probably the result of dispersal events where subadult female alligators that have recently come into maturity are seeking territories away from their natal ranges. Conversely, the number of adult females reported was much less in comparison to that of adult males. Due to the site fidelity and reduced movement of adult female alligators, individuals in this cohort are less likely to be reported as nuisance animals.

The number of nuisance reports decreased as months progressed into the nesting season. This was followed by a decrease in nuisance reports into the more dormant fall and winter months as alligators began to settle into overwintering areas. Peak times in nuisance reports adhered to significant times in the species' reproductive restricts the availability of responders who can handle nuisance alligators or who can work together on 1 nuisance alligator complaint. This severely limits the size of alligator that a lone responder can safely restrain and relocate. Such circumstances also may contribute to the large number of alligators <1.5 m in length, resulting in a relocation and removal majority of alligators >1.5 m through lethal means. The differences in conflict resolution among counties (Table 3) may highlight differences in the number of available responders in certain areas of the state.

Survey respondents' knowledge of alligators appears surrounded by sensationalized myths. Public opinion results demonstrated that people have a fear of this animal that may be exaggerated, considering that there have been only 24 human deaths from alligator attacks reported in the United States since 1948, a number that is much lower than those caused by other North American wildlife species (Langley 2010). Of those 24 deaths, twenty-two occurred in Florida, and two in Georgia (Langley 2010). Although Texas has had 15 documented attacks, there has never been a recorded fatality in the state (Langley 2010). Fear of alligators, coupled with the knowledge of TPWD's authority over the state's wildlife, make the public more likely to call a game warden to remove a nuisance alligator. The public enjoys alligators in places where it feels that alligators should naturally occur (e.g., state parks, natural areas), and it shows high support for a population increase in these areas (Figure 6). In addition, the public does not feel that alligators should be removed from natural areas, even for management purposes. On the contrary, the public does approve of alligators being removed when the animals are within the vicinity of their homes, and does not want these same alligator populations to increase. The public's view of alligators is a seamless example of the not-in-my-backyard perspective. This is evident in the large amount of nuisance reports in areas where humans reside. Even further evidence for this is revealed in the public's exceptionally high support for a relocation program, as long as alligators are not relocated near their homes.

The effects of relocation on alligators are largely unknown. We postulate that an alligator must travel an extensive distance from the site of the reported nuisance situation for relocation to be successful. Due to this, there are no set guidelines in Texas for nuisance alligator responders to follow when relocating nuisance animals. Relocations do not involve any kind of negative conditioning of nuisance alligators. When nuisance alligator hunters relocate an alligator, the release site must be approved by TPWD personnel. Usually, alligator release sites are areas where the population is thought to be at low densities and far enough away from residential areas that the released alligator will not become a nuisance again (B. A. Eversole, Texas Parks and Wildlife Department, personal communication). Although relocation judgment calls are made to the best of the ability of TPWD staff, they are, nonetheless, subjective judgments because of the lack of scientific knowledge of what constitutes a proper release site. A relocation of a nuisance alligator is considered successful when an alligator is relocated to a new area without causing harm to the habitat or population in which it is introduced and does not return or become a nuisance again (Texas Parks and Wildlife Department, unpublished data). Rodda (1984) determined that alligators have navigational and homing abilities. However, the distance an alligator must be taken before it can no longer navigate back to its original location has not been determined. Therefore, it is possible that nuisance alligator responders may not be traveling sufficient distances to relocate nuisance alligators. Such knowledge can greatly reduce the cost efficiency of management programs. In addition, by relocating individuals without knowing the outcome, managers could inadvertently jeopardize the health of alligator populations receiving relocated alligators. Relocated individuals entering areas already occupied by conspecifics may cause social disruptions and intraspecific aggression (Treves and Karanth 2003). In the absence of scientific certainty, managers should exercise caution (Cooney 2004).

The low public approval of a lethal alligator management program may illustrate the need for public education. Support for lethal removal of alligators as a management strategy will be gained only through public education about pros and cons of all available management options (Hines and Scheaffer 1977, Treves and Karanth 2003). The possible ecological effects of alligator relocation should be communicated to the general public. The general public most likely does not realize that by adding new individuals to a population that is already at, or close to, carrying capacity can put more strain on valuable resources. Such lack of understanding of basic ecology may be the cause of low support for lethal removal programs. In these instances, it is the responsibility of wildlife agencies to convey this information to the public so that people understand why alligators have to be lethally removed in some situations. Another aspect of this management challenge that may not be fully appreciated by the general public is the monetary cost involved in relocating alligators. As noted by Hines and Woodward (1980), a successful alligator relocation program, especially involving larger alligators, requires substantial manpower with no way of recovering the costs. Hines and Woodward (1980) noted that the financial burden is ultimately put on the public.

Educating the public about such issues would help to build a human tolerance and understanding of alligators and support for their management. This in turn may alleviate some human–alligator conflicts and foster more human–alligator coexistence. This approach would be most effective by tailoring education to the specific causes of human–alligator conflicts on an area-specific basis. For example, in counties where the primary cause of human–alligator conflicts is the threat of livestock depredation (i.e., Matagorda County), education should target livestock producers. Additionally, in areas where the majority of human–alligator conflicts occurs in residential areas, education should be geared to create coexistence between residents and alligators that occur near home sites. Gore et al. (2006) found that site specific education strategies for alleviating human–bear conflicts in the northeastern United States can be effective at creating coexistence between humans and black bears. Beckman et al. (2004) suggested that education can be more effective at reducing the number of human–bear conflicts than bear-focused deterrent techniques. Although deterrent techniques typically are not utilized to decrease human–alligator conflicts, public education may be an effective resolution strategy for alligators, as well.

We suggest that future research determine the effectiveness of differing conflict resolutions and management strategies. Specifically, research should determine the effect that lethal removal and relocation have on population dynamics of both populations from which individuals are being removed and populations that are receiving relocated alligators. Research also should establish guidelines relative to the relocation of nuisance alligators. For instance, responders need knowledge of the viability of relocation as a conflict resolution and the adequate relocation distance of nuisance alligators. Also, the effectiveness of education in reducing the amount of human–alligator conflicts should be determined.

Management implications

This study identifies not only areas where human–alligator conflicts are the most prevalent in Texas, but also where management strategies should be focused to reduce this conflict. The counties, situations, and alligators identified as having the potential to foster nuisance alligators should become management targets. We conclude that education and management programs should attempt to increase awareness of and social tolerance for alligators, especially in areas of high human–alligator conflict. Wildlife agencies can use our recommendations to reduce the amount of human–alligator conflicts.

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Appendix 1

Questionnaire given to visitors of Brazos Bend State Park to assess level of fear (0 to 10) and opinions about alligators and alligator management.

Demographic information								
Sex	Male	Female						
Ethnic background	White	African-American	Native-American	Asian	Hispanic	Middle-Eastern	Other	
Age	Teenager	20s	30s	40s	50s	60s	70s	80s

Fear	None					Moderate					Extreme
Alligator	0	1	2	3	4	5	6	7	8	9	10
Rattlesnake	0	1	2	3	4	5	6	7	8	9	10
Horned lizard	0	1	2	3	4	5	6	7	8	9	10
Garter snake	0	1	2	3	4	5	6	7	8	9	10
Mountain lion	0	1	2	3	4	5	6	7	8	9	10
Grizzly bear	0	1	2	3	4	5	6	7	8	9	10
Coyote	0	1	2	3	4	5	6	7	8	9	10
Dog	0	1	2	3	4	5	6	7	8	9	10
House cat	0	1	2	3	4	5	6	7	8	9	10
Barn owl	0	1	2	3	4	5	6	7	8	9	10
Hawk	0	1	2	3	4	5	6	7	8	9	10
Mockingbird	0	1	2	3	4	5	6	7	8	9	10

1. Alligators eat everything, ranging from garbage to humans.	True	False
2. Alligators actively seek and hunt dogs and cats.	True	False
3. Alligator attacks on people are common in the United States.	True	False
4. Alligators can grow to over 6 meters in length.	True	False
5. Alligators can run on land up to 32 kilometers per hour	True	False
6. Alligators are found in the sewer systems of most urban areas in the United States.	True	False
7. The length of an alligator in feet is equivalent to the length in inches from its eyes to the tip of its nose.	True	False
8. Alligators are overly aggressive because they have all those teeth and no toothbrush.	True	False

Continued on next page...

9. How close are you willing to stand next to a wild alligator? (meters)
   a) <3 b) 1.5 c) 3 d) 6 e) 15 f) I wouldn't get near a wild alligator.
10. If an alligator was in your front yard blocking you from your car, your first response would be:
    a.) Shoot and kill it.
    b.) Throw things at it to get it to move.
    c.) To wait for it to leave.
    d.) Call a game warden to remove it.
    e.) Feed it and take photographs of it.
11. Would you support a program to increase the alligator population at a state park or natural area? Yes No
12. Would you support a program to increase the alligator population in a lake that is within a mile from your home? Yes No
13. Would you support the removal of alligators from a state park or natural area for management purposes? Yes No
14. Would you support the removal of alligators from an area within a mile from your home for management purposes? Yes No
15. Would you support an alligator removal program if the program used lethal methods? Yes No
16. Would you support an alligator removal program if the program only conducted capture and relocation? Yes No

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