

ORIGINAL RESEARCH

Alligator Attacks on Humans in the United States

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Objective.—Encounters with alligators are increasing in the United States. Both severe injuries and fatalities can occur from an alligator attack. This study provides information on alligator attacks reported in the United States as well as infections that are commonly associated with alligator bites.

Methods.—In order to collect information on the number of alligator bites, nuisance calls, and estimated alligator population of each state, calls were made to wildlife offices in all southern US states, and an online search for lay press articles was performed. Detailed information was available from Florida and is presented regarding the types of injuries and the activities of the victims at the time of the injuries.

Results.—From 1948 to August 1, 2004, 376 injuries and 15 deaths have been reported in the United States as a result of encounters with alligators. The number of nuisance calls as well as the alligator population is increasing.

Conclusions.—As the human population encroaches on the habitat of alligators, attacks and nuisance complaints increase. A uniform reporting system among states should be developed to obtain more complete information on alligator encounters.

Key words: alligator, bites, animal attacks, *Aeromonas*, *Vibrio*

Introduction

The alligator is one of the few nonvenomous reptiles that can cause serious or fatal injuries in humans. The American alligator (*Alligator mississippiensis*) is the most common of the 2 crocodylians native to the United States and is 1 of 22 crocodylian species in the world.¹ The other species is the American crocodile (*Crocodylus acutus*), which is found only in the southern tip of Florida. In the United States, alligators can be found in Florida, Georgia, South Carolina, North Carolina, Louisiana, Alabama, Arkansas, Mississippi, Texas, and Oklahoma (Figure 1). Occasional sightings in other states have been reported, but these are thought to be alligators that were pets and have been released or are occasional visitors to rivers in states bordering states where alligators are indigenous. Low winter temperatures limit the northern range of alligators.

Alligators (Figure 2) were extensively hunted during the first half of the 20th century. In 1967, the alligator was listed as an endangered species. In the early 1970s, it was provided effective federal protection and the pop-

ulation recovered, and in 1987 it was removed from the endangered species list.² Since then, the alligator population in the southern United States has increased. Because more people are moving to coastal areas in this region, their interactions with and complaints (nuisance calls) about alligators, especially in Florida, will likely increase, too (Figure 1).

Although thousands of deaths are reported worldwide from alligator and crocodile attacks,³ few case reports on alligator attacks in the United States are found in the medical literature,^{4–8} and there is no documented report of a crocodile attack on humans in the United States. This study will update the one review of alligator attacks on humans in the United States.⁹

Methods

A literature review of PubMed was performed with the search terms “alligator or crocodile bites or attacks,” “alligator and oral flora,” and “alligator and infection.” Additionally, a Web search (www.google.com) was performed of newspaper articles that reported recent alligator attacks with the search terms “alligator” and “bites.” Officials with Divisions of Environment and Natural Resources or Wildlife from each of the 10 states

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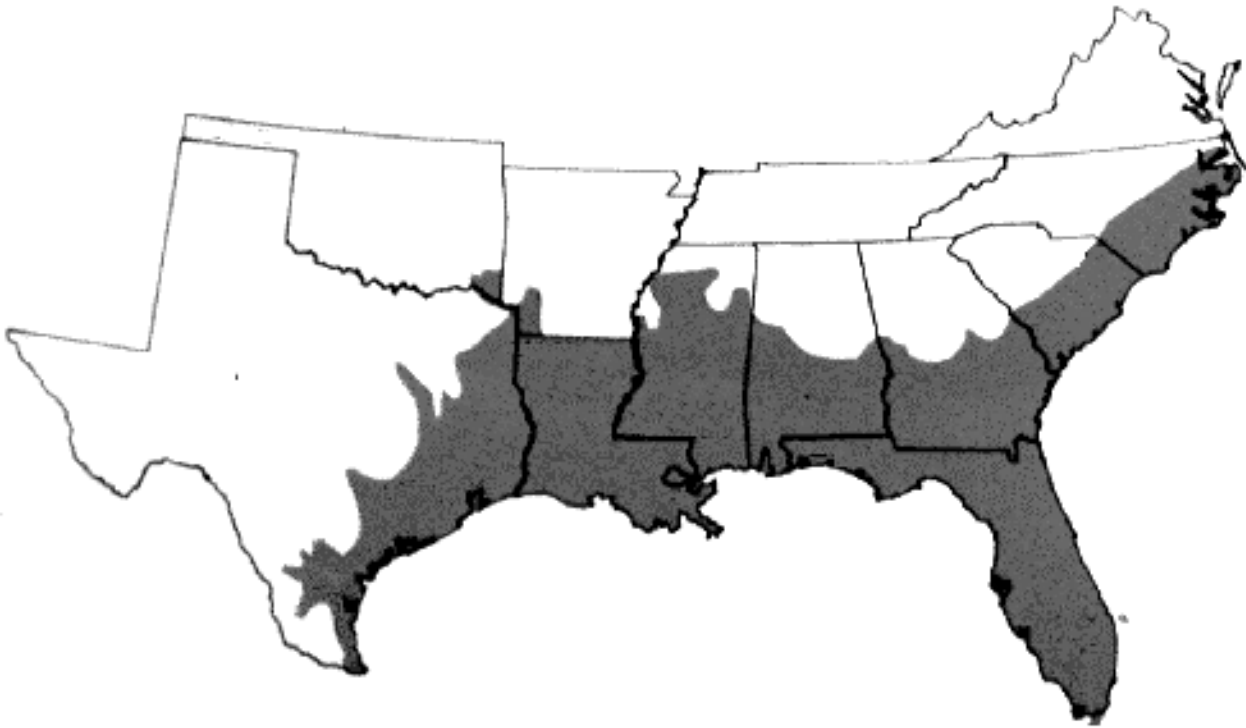


Figure 1. Range map of the American alligator (*Alligator mississippiensis*).

noted in the “Introduction” were contacted by telephone and were asked how many cases of alligator attacks on humans they were aware of in their state, how many nuisance alligator complaints they receive annually, and what the estimated alligator population is in their state.

Reports of alligator bites from previous surveys^{9,10} were also evaluated for additional cases of bites or attacks that current state officials may not be aware of, for different personnel may currently be responsible for alligator complaints.



Figure 2. *Alligator mississippiensis* photograph courtesy of the United States Fish and Wildlife Service. Available at <http://images.fws.gov>.

Table 1. Alligator attacks reported in the United States

<i>State</i>	<i>No. of attacks documented</i>	<i>No. of yearly nuisance complaints and alligators removed</i>	<i>Estimated alligator population</i>
Florida	334 (14 fatalities)*	17 000 (about 6000 alligators removed)	≥1.5 million
Texas	15	460	300 000–400 000
Georgia	9 (1 fatality)	400–450 alligators removed	200 000
South Carolina	9	750 (200–250 alligators removed)	100 000
Alabama	5	150–250	Thousands?
Louisiana	2	3000–4000 (1500–2000 alligators removed)	1.5 million
North Carolina	1	Unknown	Low thousands?
Arkansas	1	70–100	5000–10 000
Oklahoma	0	4–6	250 ± 100
Mississippi	0	Unknown	32 000–38 000

* Eight other cases in Florida involved individuals who may have been dead before the alligator attack.

Results

As of August 1, 2004,* various sources reported 376 cases of alligator bites to have occurred and been documented in the United States since 1948 (Table 1). Deaths were reported in 23 cases, but wounds from alligator attacks in 8 of these cases may have been post-mortem.

Of the 376 injuries that have been reported, the data from Florida were the most complete. Specific injury data from Florida are presented in Table 2. Florida officials provided detailed data on 305 nonfatal cases from a total of 334 cases. The average age of the victims (287 cases with reported age) was 34.3 years with a range from 3 to 82 years. Males were attacked in 257 cases (85.4%) and females in 44 cases (14.6%). The sex of the victim was unknown in 4 cases.

Other nonfatal injuries in the Florida cases were reported, but the types of injuries or body parts injured were not specifically described. Injuries included minor cuts or scratches ($n = 19$); puncture wounds or lacerations ($n = 13$); minor leg or foot injuries ($n = 4$); severe or mangled arms or hands ($n = 4$); severe leg injuries ($n = 3$ [1 required amputation]); minor arm or hand injuries ($n = 2$); soft-tissue wound to calf ($n = 1$); injury to chest, shoulder, or cheek ($n = 1$); injury to upper lip, forehead, or thumb ($n = 1$); water in lungs ($n = 1$), bump on head ($n = 1$); other ($n = 5$), unknown ($n = 1$), and none reported ($n = 7$). One arm injury was reported to have become infected.

Activities at the time of the attacks were varied. Table 3 provides information on the various activities according to 305 nonfatal cases reported in Florida. Examples of “other” activities included hunting; feeding fish, ducks, or alligators; falling off the dock; working or splashing in water; rafting; stepping on an alligator; and washing hands in water.

The time of attacks of the 305 nonfatal Florida cases is as follows: 20 attacks from midnight to 6:00 AM, 40 attacks from 6:01 AM to noon, 132 attacks from 12:01 PM to 6:00 PM, and 77 attacks from 6:01 PM to midnight. Most attacks occurred between June and August.

Twenty-two deaths were reported from Florida. For 8 deaths it was unknown if the alligator wounds were post-mortem. The average age of the victims (21 cases) was 36.6 years with a range of 2 to 83 years. Regarding the sex of the victims, 13 were male, 8 were female, and 1

Table 2. Number of injuries by body site* ($n = 305$)

<i>Site</i>	<i>Laceration/scratch</i>	<i>Bite/puncture</i>	<i>%</i>
Hands	53	49	29.4
Arms†	34	27	20.2
Legs	32	34	19.3
Foot/ankle	23	21	13.5
Torso	14	13	7.8
Head/face	12	6	5.2
Shoulder	7	2	2.6
Hip	2	2	1.4
Neck	0	2	0.6

* Since the completion of this study, there have been 2 additional alligator attack fatalities: 1 female death in September 2004 and 1 male death in March 2005.

* Attack may include injury to more than 1 body site.

† Hand and arm fractures combined.

Table 3. Activity at time of attack* ($n = 305$)

Activity	No. (%) [†] of attacks
Attempting to capture/pick up/exhibit	53 (17.4)
Swimming	51 (16.7)
Fishing related	30 (9.9)
Retrieving golf balls	29 (9.5)
Wading/walking in water	16 (5.3)
Snorkeling	13 (4.3)
Pulling weeds or planting along bank	11 (3.6)
Standing/walking/sitting along water bank	11 (3.6)
Working on/falling out of boat	8 (2.6)
Walking (other than on bank)	8 (2.6)
Skiing/canoeing	8 (2.6)
Other	66 (21.7)

* Based on Florida data.

[†] May not add to 100% because of rounding.

was not indicated. The length of the alligators associated with fatalities ranged from 5 feet 7 inches to 12 feet 5 inches, and most were over 8 feet long. In 4 cases no information on the alligator was known. In 1 of the cases, up to 6 alligators may have been involved in the attack, but the majority of the victim's body parts was found in only 1 of the animals. In the other cases, only 1 alligator was mentioned in each attack.

Reported activities of victims at the time of the attacks in the fatal cases included swimming ($n = 5$), snorkeling ($n = 1$), fishing ($n = 1$), wading into water ($n = 2$), walking a dog ($n = 1$), wandering away from a nursing home ($n = 1$), standing or walking on the bank ($n = 1$), landscaping ($n = 1$), consuming an alcoholic beverage ($n = 1$), and unknown ($n = 8$).

The use of alcohol or other substances was reported in 3 cases. In the 14 cases where the time of attack was noted, 7 were from 12:01 PM to 6:00 PM, 4 were from 6:01 PM to midnight, 1 was from 6:01 AM to noon, and 2 were at dusk.

Discussion

Fossil evidence shows that crocodylians have existed for millions of years. Research shows that the American alligator lives up to 50 years in the wild and even a few years longer in captivity.¹¹ The average size is 8.2 feet for an adult female and 11.2 feet for an adult male. However, males can grow up to 16 feet long and weigh nearly 1000 pounds.¹¹ Alligators are ectothermic, becoming most active at warmer temperatures and dormant at temperatures below 13°C. They usually breed in late May

or early June, and the female lays a clutch of 30 to 50 eggs. Alligators are carnivorous and eat fish, snails, crustaceans, birds, frogs, and mammals that come too near the edge of the water. They use their very strong jaws and sharp teeth to seize their prey. Bites are characterized by puncture wounds or torn flesh. Alligators may spin on their long axis after biting to tear off the limbs and drown their prey.¹

Alligators are not generally aggressive toward humans, but aberrant behavior may occur. Smaller alligators usually bite only once; however, up to one third of attacks may involve repeated bites.¹ Serious and repeated attacks usually are made by alligators over 8 feet in length and are probably attributed to chase and feeding behavior.¹ Female alligators will defend their nest and young. Alligators quickly become conditioned to people, especially when food is involved. These food-habituated alligators lose their fear of humans and can be very dangerous to an unsuspecting person.¹

Traumatic bites from alligators and crocodiles may cause amputations or even death. In a study of crocodile attacks in southern Malawi, 60 patients were injured during a 4-month period.¹² Twenty-four (40%) had serious injuries resulting in permanent deformity, and 1 died from sepsis. In a study in the Northern Territory of Australia, 16 crocodile bites were reported during a 10-year time period.¹³ Four of the attacks were fatal. Injuries of the survivors ranged from minor lacerations and puncture wounds to major abdominal, chest, and limb trauma. External injuries may appear minor, but massive internal injuries may occur from direct heavy crushing injuries by a crocodylian's jaws.⁶

If a person survives the traumatic injury, his or her wounds may be infected by various microbial organisms, especially gram-negative bacteria. Numerous aerobic, anaerobic, and fungal species have been cultured from the mouths of alligators and crocodiles. *Pseudomonas*, *Enterococcus*, *Aeromonas*, and *Clostridium* species were isolated from crocodile-attack wounds in Australia.¹³ *Aeromonas hydrophila*, *Enterobacter agglomerans*, and *Citrobacter diversus* were isolated from an alligator bite in Louisiana.⁸ *A. hydrophila*, *Serratia* spp, and *Pseudomonas* spp have been isolated in other alligator-bite injuries in Florida.⁴⁻⁶ Crocodile attacks in other countries have been infected with *Burkholderia pseudomallei* and *Bacteriodes* species.¹³

Aeromonas species infections may be rapidly progressive and manifest within 24 to 48 hours after injury. These organisms are found in water and soil. Infection may appear as cellulitis or bullae, progressing to areas of frank necrosis or drainage of foul-smelling material.⁸ Appropriate antibiotic therapy includes a fluoroquinolone or third-generation cephalosporin.¹⁴

Another gram-negative organism, *Vibrio vulnificus*, may also cause rapidly progressive infections after an external injury, particularly in people with underlying liver disease or hemochromatosis. Cutaneous lesions often develop into hemorrhagic bullae or vesicles and then necrotic ulcers. Howard and Burgess⁶ reported a case of *Vibrio* infection after an alligator injury. Treatment should include doxycycline and surgical drainage.¹⁴ Other *Vibrio* organisms that have been associated with wound infections include *Vibrio alginolyticus* and *Vibrio damsela*.^{6,14,15}

General management of alligator-bite wounds includes thorough debridement of wounds, fixation of fractures, restoration of vascular integrity, repair of nerve and tendon injuries, antitetanus prophylaxis, and appropriate broad-spectrum prophylactic antibiotics. Because actual medical records were not reviewed, it is unknown how many wounds actually became infected.

Deficiencies in obtaining information on alligator attacks became apparent from the telephone surveys. One problem with attempting to obtain information on alligator attacks is there is no uniform system for collecting information and no mandatory reporting. Some states do not track nuisance calls, and the definition of a nuisance may vary by state. Information about alligator attacks might not be passed on when wildlife officials retire; therefore, the number of bites reported in a previous survey may not match the number reported by the current official. This study uses the highest number of attacks reported if more cases were reported in previous surveys than were provided by current officials.

Alligator farming is practiced in several southern US states. The frequency of injuries from encounters with farm-raised alligators is unknown. In a review of occupational fatalities from animal encounters from 1992 to 1997, no deaths were reported among alligator farmers.¹⁶ Minor traumatic injuries are probably not reported to wildlife officials, again resulting in undercounts.

In many parts of the world, crocodile and alligator attacks are increasing. Overfishing and dumping of waste into rivers has been suggested as possible causes of increased attacks.¹⁷ Scott and Scott¹⁷ even suggest that menstruating women may be at greater risk of attacks by crocodiles. No information on the menstrual status of women who have been attacked has been collected in the US cases. More research in this area needs to be done before considering this as a risk factor for women visiting areas where alligators may be present.

The alligator population is increasing in the United States and so is the number of nuisance complaints.^{17,18} Thousands of nuisance complaints are reported yearly. Florida and Louisiana report the most nuisance complaints, and many alligators are moved to other areas of

the state or are harvested once a complaint is investigated (Table 1). It is likely that the number of alligator attacks will increase as more people move to coastal areas of the southern United States. A uniform reporting system should be developed for states to use to obtain more information about alligator encounters.

Safety tips to prevent alligator attacks have been recommended.^{19,20} Actions to be avoided include allowing small children to approach bodies of water that may be inhabited by alligators; swimming outside posted swimming areas; swimming at dawn, dusk, or nighttime when alligators most actively feed; feeding or enticing alligators; throwing fish scraps into the water or leaving them on shore; allowing pets to swim in waters not known to be free of alligators; and removing alligators from their natural habitat or accepting one as a pet. Furthermore, people should call their fish and wildlife office to report a nuisance alligator.

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