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AMERICAN CROCODILE, *CROCODYLUS ACUTUS*, MORTALITIES IN SOUTHERN FLORIDA

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Abstract.—Deaths of 143 American crocodiles (*Crocodylus acutus*) were recorded in southern Florida between 1967 and November 2007. The majority of deceased crocodiles (67.8%) were located adjacent to a road, with vehicle collision the likely cause of death. Mortalities have increased over time with 51% of deaths occurring over the past nine years. Recommendations to reduce vehicle collisions include underpasses, fenced roadways, warning signs and seasonal speed restrictions in areas where crocodiles are known to cross the road or where deaths have occurred.

The American crocodile, *Crocodylus acutus*, is primarily a coastal crocodylian considered vulnerable to extinction by the IUCN—The World Conservation Union (Thorbjarnarson 1992, Ross 1998). Despite protection, anthropogenic factors continue to reduce population numbers in many locations (Thorbjarnarson 1992). Habitat destruction is decreasing the availability of suitable nesting habitat for *C. acutus* throughout its range (Abadia 1996, Arteaga and Sanchez 1996, Platt and Thorbjarnarson 2000). Commercial and local hunting, along with drowning of individuals in monofilament fishing nets, are also primary factors impacting populations of *C. acutus*. Another factor is predation upon nests by humans, which accounts for up to 30% of egg losses in some areas (Thorbjarnarson 1992, Abadia 1996, Schubert et al. 1996).

Crocodylus acutus reaches the northernmost extent of its range in South Florida (Thorbjarnarson 1992). In 1975, the United States Fish and Wildlife Service listed the Florida population as Endangered (Federal Register 40:44151). Habitat loss has been the primary cause of endangerment for the American crocodile in Florida (Mazzotti 1999, Mazzotti et al. 2007). Since *C. acutus* was declared Endangered, the population has gradually started to recover (Mazzotti 1999, Mazzotti

et al. 2007). In Florida, with the increasing number of crocodiles, increasing human population, and development adjacent to crocodile habitat, increased crocodile mortality may be inevitable. Here we report known mortalities of *C. acutus* in southern Florida from 1967 to November 2007.

A total of 143 *C. acutus* deaths have been recorded in Florida, as far north as Naples on the west coast and Fort Lauderdale on the east coast, and as far south as Sugarloaf Key. Although mortalities have been recorded throughout the Florida Keys, 39 deaths have occurred in the upper Keys; 96 mortalities have occurred on the mainland, including 17 recorded at the Florida Power and Light Turkey Point Power Plant, and 15 documented in Everglades National Park (Fig. 1). Total lengths were measured for 97 individuals: 45 adults (≥ 225 cm; mean = 284.5 ± 6.63) and 52 juveniles and sub-adults (>65 cm and <225 cm; mean = 136.2 ± 7.89). Ninety-seven individuals (67.8%) were located along a road, suggesting that vehicle collision was the most likely cause of death. Fifteen deaths (10.5%) were attributed to malicious intent, seven (4.9%) to natural causes, and one individual (0.7%) was reportedly killed in a boat collision. No cause of death was reported for 23 individuals (16.1%). Deaths from natural causes included five individuals that died after hard freezes and two killed by another crocodile. Hard freezes have been reported to cause mortalities of crocodiles (Mazzotti et al. 2007). Of the 51 animals for which sex was determined, the ratio of females to males was 1.2:1 for all animals and 1.3:1 for adults. A chi-square test with the Yates correction showed the ratio was not significantly different from 1:1 for either group (χ^2 , critical value 3.841). Documented mortalities have increased over time ($r^2 = 0.38$; $P = 0.0001$), with more than 51% of deaths occurring in the last nine years. However, it is important to remember that these data represent only the crocodile mortalities that were recorded and does not account for unreported deaths.

In South Florida, US Highway 1 (Florida City to Key Largo), Card Sound Road, and County Road 905 have been responsible for 84.4% of crocodile deaths by vehicle collision (Fig. 1). While we do not know what percentage of crocodiles may have simply been basking on the right of way prior to the collision with a vehicle, these roads create barriers that inhibit natural movements of *C. acutus*. In most cases, crocodiles were killed on roads that divided water bodies (open water, creeks, canals, and ponds) associated with mangrove forests. This has proven especially detrimental for adults during the breeding season (March to August), as individuals travel to find mates and females migrate to or from nesting sites (Ogden 1978, Kushlan and Mazzotti 1989). Of the road-killed adults considered sexually mature (≥ 2.25 m), 24 (63%) were confirmed killed during the breeding season. Given the

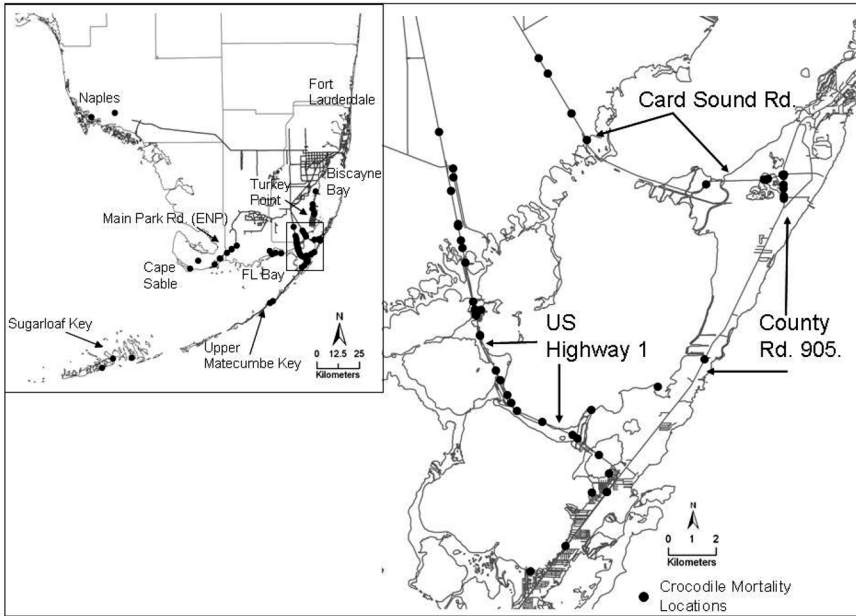


Figure 1. Location of *Crocodylus acutus* mortalities recorded in southern Florida between 1967 and November 2007.

importance of adults to the reproductive health of the population, it is essential that further attempts be made to reduce vehicle collisions along these roads.

We offer several recommendations to reduce the number of vehicle collisions with *C. acutus*. In areas where crocodiles are known to cross the road or where deaths have occurred, underpasses should be constructed, roadways fenced, warning signs erected, and seasonal speed restrictions enforced; some are included in the design for the US 1 expansion currently underway. In conjunction with these measures, a long-term program should be implemented to maintain and repair fences damaged by vehicle collisions or degraded through weathering. Speed restrictions should be applied and enforced during the breeding season (March to August) between dusk and dawn when visibility is poor and *C. acutus* are considered most active (Rodda 1984). The construction of fences with underpasses/culverts at recognized road-kill "hot spots" have reduced vehicle collisions with Florida black bear (*Ursus americanus floridanus*; Roof and Wooding 1996), several species of turtle (Aresco 2005), and deer (Ward 1982, Foster and Humphrey 1995, Romin and Bissonette 1996). The inclusion of speed restrictions and warning signs with fenced roadways and underpasses/culverts have

also proven effective measures for reducing road mortality in Florida panther (*Puma concolor coryi*; Foster and Humphrey 1995, Land and Lotz 1996) and Key deer (*Odocoileus virginianus clavium*; Calvo and Silvy 1996), as well as other mammals, amphibians, and reptiles (Dodd et al. 2004).

The population of *C. acutus* in South Florida has recovered to the extent that the status has been reduced from Endangered to Threatened (Federal Register 72:13027-13047). However, the population of *C. acutus* in Florida is still of limited size and vulnerable to human-induced threats and chance events (Mazzotti 1999, Mazzotti et al. 2007). Human development continues to encroach upon crocodylian habitat, and modified freshwater flow due to upstream development also negatively impacts the crocodile population in South Florida (Mazzotti 1999, Mazzotti et al. 2007). Death by vehicle collision may exceed natural causes of mortality for American crocodiles. Although the number of mortalities increased ($r^2 = 0.38$; $P = 0.0001$) from 1967 to 2007, nesting rates have increased substantially, with a five-fold increase in the annual number of nests identified in Florida during the period 1978- 2004 (Mazzotti et al. 2007). Given the increase in nesting, it does not currently appear that mortality rates are negatively impacting the overall success of the population. However, the successful recovery of this endangered species requires continued, ongoing monitoring, management, and protection.

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