Oryx

How do temperature, water levels and breeding season influence when crocodilians attack people?

By Simon Pooley, 15th June 2020

Across 65 countries in the tropics and subtropics, crocodilians bite more people per year than does any other large terrestrial carnivore. Mitigation of these harmful interactions is important for the safety of both people and crocodilians: retaliatory killing, and lethal control by conservation management authorities, are frequent responses to attacks. A striking finding of research into attacks shows very strong seasonality of bites across many territories. In our case study areas, there are overlaps in breeding, rainy and hot seasons.

In our article we discuss three non-mutually exclusive hypotheses that may explain these findings:

1. Crocodilians are ectotherms, and their ability to hunt and digest food is affected by ambient temperature.
2. Increased attacks reflect heightened crocodilian aggression during the breeding season.
3. Attack likelihood may increase with higher water levels because this facilitates wider dispersal of crocodiles, resulting in more encounters with crocodilians.

In the warm summer months, American alligators travel overland to natural and artificial waterways including small lakes, canals, and golf course ponds. Brevard County, Florida, USA. Photos: Frank Robb.

When considering temperature, we know that as ectotherms crocodilians have a narrow temperature band for successful functioning and reproduction. Minimum temperature is the limiting factor on most behaviour. We therefore focused on two species that occur at the southernmost and northernmost ranges of crocodilians worldwide: the Nile crocodile *Crocodylus niloticus* in South Africa and Eswatini, and the American alligator *Alligator mississippiensis* in Florida, USA. Both species bite humans, with Florida having the highest number of bites of all the US states where alligators occur.

In analysing long-term attack data for South Africa and Eswatini, co-authors Pooley and Powell were struck by the challenge of working with data where only the hits (i.e. the bites) are counted, and not the misses. Attack records are presence only data, and there is no reliable measure of human–crocodilian exposure to quantify when attacks do not occur. However, when absence data are unavailable, models can use background points that are randomly sampled. This is the approach used in environmental niche modelling—the method we adapted to examine the relationships between abiotic and biotic variables and attacks on people. In the model, attacks are regarded as an entity that can only occupy a specific environmental niche defined by particular biophysical limits (for crocodilians, proximity to certain water bodies, and altitude and temperature range).

A large Nile crocodile gaping: it is speculated that this helps to cool down the head of the animal. Photo: Joe Kristoffer Partyka

We compiled a dataset of environmental variables that could be spatially and temporally linked to attacks. These included 20-year means of daily and monthly mean temperature and rainfall. Historical data were not available for crocodile and alligator population densities across the study regions, but human population density was included in the model. The data comprised 188

crocodile attacks in South Africa and Eswatini (1951–2016) and 335 alligator attacks in Florida (1971–2014).

Three key findings emerged from the modelling for both Nile crocodiles and American alligators. Firstly, temperature was the most important abiotic temporal predictor of attack occurrence. Secondly, attack likelihood increased sharply when daily mean temperature exceeded 18 °C. Thirdly, the probability of attacks was highest above 28 °C.

A male Nile crocodile basking: as ectotherms, crocodiles can’t control their own body temperature. Photo: Adam Britton

Little evidence links aggression with attack incidence in our study regions. In the USA, studies of testosterone levels found this was not correlated with attack frequency. The limited research on hormones and breeding undertaken on captive Nile crocodiles suggests that heightened hormone levels and breeding occur during the late winter months, when attack occurrence is low. Regarding human activities, clearly this is important: in South Africa and Eswatini, nearly half of all attacks occurred on weekends and holidays. However, numerous attacks also occurred when people were performing domestic chores or crossing water bodies, which happens all year.

We argue that improving our knowledge about the abiotic conditions (notably temperature) affecting attack rates can help mitigate bites and resulting distress and conflicts over how to respond. Irregular activities such as dam repair should be in winter-time and, where crocodilian-inhabited waterways must be used frequently, doing so at the coolest times of day would be best.

Crocodilians warm up by basking on sandbanks, and cool down by immersing in water. Photo: David Kirshner

With global warming, it is likely that attack seasons in areas where temperature is a limiting factor will become longer (in Africa for example, temperatures are predicted to increase by 5–8% by 2050). In tropical countries such as India or Bangladesh, where average temperatures rarely drop below 23 °C, the influence of temperature on attack seasonality is likely to be marginal.

Our results also suggest that explanations of crocodile attack seasonality based on water levels or aggression linked to breeding season require rigorous testing. In our study areas, it seems they are not significant factors. Looking beyond crocodiles, our finding that crocodilian attack patterns can be influenced by physiological constraints that are common to all ectotherms suggests that similar methods could be applied to understanding situations where there are negative interactions between humans and other species, such as snakes.

The article Using environmental niche modelling to investigate the importance of ambient temperature in human-crocodilian attack occurrence for two species of crocodilian is available in Oryx—The International Journal of Conservation.

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