

# Negative human–crocodile interactions in Kariba, Zimbabwe: data to support potential mitigation strategies

JOSHUA MATANZIMA, IVAN MAROWA and TAMUKA NHIWATIWA

**Abstract** Interactions between people and wild animals often result in negative impacts, and different views on the management of such interactions can lead to conflicts. Both intentional and unintentional negative human–wildlife interactions are increasing problems in many places where people share space with wild animals. Here we focus on negative interactions between people and Nile crocodiles *Crocodylus niloticus* in and around Lake Kariba in Zimbabwe. In the study area, crocodile attacks on people occur frequently, leading to people being injured or killed, which in turn prompts retaliatory actions against crocodiles. However, despite the negative impact of such interactions on both people and crocodiles, little is known about the spatio-temporal patterns of crocodile attacks or environmental conditions under which attacks occur. We collected information about crocodile attacks on people that occurred during 2000–2020, including the date, time, season and location of attacks, the age of victims and the activities they were carrying out when attacks occurred, and water conditions during attacks. We analysed these data to discern patterns and trends of crocodile attacks on people. Attacks occurred in clear as well as turbid water, and nearly half of all reported attacks were at night or in the early morning. The locations with the highest number of recorded attacks were Nyanyana and Charara lakeside, and the fewest attacks occurred at Andora harbour. Most victims were 26–40 years old, and most were attacked in the dry-hot season, while they were fishing. Our findings can be used to design area-specific mitigation strategies to reduce negative human–crocodile interactions.

**Keywords** Attacks, crocodiles, human–wildlife conflict, Lake Kariba, mitigation, policy, wildlife conservation, Zimbabwe

## Introduction

Across their global range, crocodylians are frequently involved in negative interactions with people (Gonzalez-Desales et al., 2021). Such negative interactions appear to be increasing across Africa because of human population growth, which in some areas coincides with a recovery of crocodile populations (Aust, 2009). As human and/or crocodylian populations grow, demand for resources such as water and fish increases, resulting in competition between people and crocodiles.

Nile crocodiles *Crocodylus niloticus* in particular affect the lives and livelihoods of many riverine communities. The major threat crocodiles pose to these communities are predatory attacks on people and livestock (Aust et al., 2009; Chihona, 2014; Wallace et al., 2011). In many such attacks, people are killed or sustain life-changing injuries. In fishing communities, crocodiles also destroy nets and feed on fish caught in these nets (McGregor, 2005; Chihona, 2014; Zakayo, 2014; Marowa et al., 2021).

In retaliation, people attack crocodiles by stoning them or by hitting or stabbing them with stakes (Marowa et al., 2021), in some cases killing the crocodiles. In rural communities in Binga (north Zimbabwe), for instance, fishers kill crocodiles with spears (McGregor, 2005). Such activities threaten crocodile conservation (Chihona, 2014; Zakayo, 2014; Amarasinghe et al., 2015), but their impact on crocodile populations is difficult to quantify as little is known regarding the fate of injured crocodiles after a hostile encounter with people (Pooley, 2015). Wildlife authorities, if notified of such events, often struggle to locate affected crocodiles, especially within large water bodies such as lakes. It is presumed that injured crocodiles become vulnerable to predation by other crocodiles.

Designing and implementing an effective mitigation strategy is critical to reduce negative human–crocodile interactions in Lake Kariba, but there is a dearth of reliable data regarding past and current incidents involving crocodiles in the area. Therefore, we collected information on cases of human–crocodile interactions. Based on our findings, we make recommendations for minimizing negative interactions between people and crocodiles.

## Study area

Kariba town is located in north-west Zimbabwe, adjacent to Lake Kariba (Fig. 1), the largest human-made lake in

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Received 24 August 2021. Revision requested 27 October 2021.  
Accepted 2 February 2022. First published online 15 September 2022.

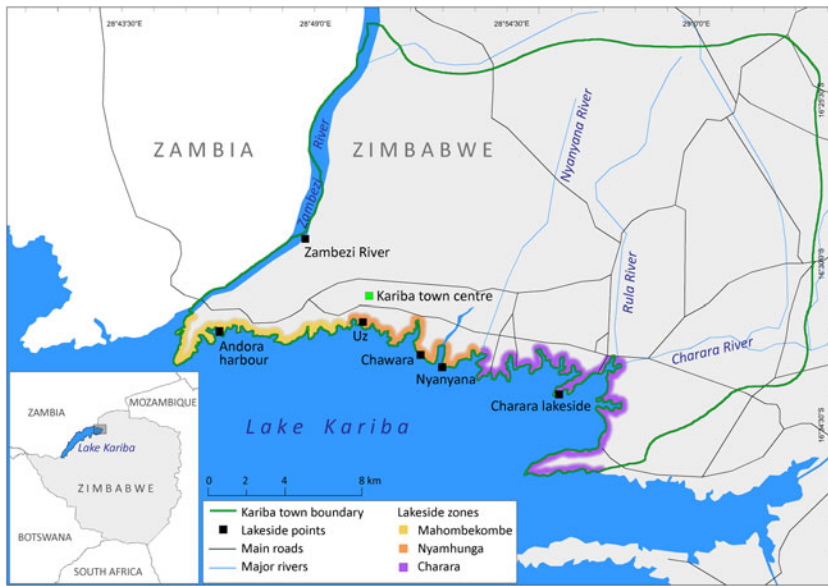


FIG. 1 Location of the study zones and lakeside points along Lake Kariba in Kariba town, Zimbabwe.

Zimbabwe. The lake along the Zimbabwe–Zambia border was created in 1958 for the purpose of electricity generation; it is now a tourist attraction and supports the fishing industry in both Zimbabwe and Zambia. Lake Kariba is c. 300 km long, with an area of 5,500 km<sup>2</sup> when the water level is at its maximum. The lake is divided into five basins, also known as fishing zones. Kariba town is located along Sanyati Basin (Basin 5). There is little to no rainfall during the dry season (April–October), and high volumes of rainfall during the rainy season (November–March). The mean monthly maximum temperature is > 30 °C throughout most of the year, and mean monthly minimum temperature is < 15 °C during April–September.

## Methods

We conducted this research during December 2018–December 2020 in Kariba town. We obtained detailed data on the trends and dynamics of the occurrence of negative human–crocodile interactions at Lake Kariba using a data collection sheet designed by S. Pooley with IUCN Crocodile Specialist Group colleagues (Pooley et al., 2020). We collected data on date and time of the incident, location, age of victim, activity of the victim at the time of the attack, and water conditions.

For our analysis, we divided the lakeside of Kariba town into three zones in which crocodile attacks had been reported: Mahombekombe (including Andora harbour), Nyamhunga (including Uz/Kasese Bay, Nyanyana and Chawara), and Charara (including Charara lakeside and the mouths of the Rula and Charara Rivers; Fig. 1).

In each of the three zones, we recruited one research assistant to help with data collection, and trained them on how to complete the data collection sheet. The research assistants

were permanent residents of Kariba town who knew the local area well and spoke the local language (ChiShona); they also had knowledge of past human–crocodile incidents. The research assistants learnt of additional incidents when following up on the cases of which they had prior knowledge. They also relied on snowballing, whereby victims would refer them to other victims they knew.

In total, we collated 106 reports of crocodile attacks on people: 48 in Nyamhunga, 30 in Charara and 28 in Mahombekombe. These involved both fatal and non-fatal cases, and victims reporting minor and serious injuries. From these 106 incidents, we selected 60 for further analysis (20 from each of the three zones). We focused on cases that occurred during 2000–2020 and for which victims were able to provide all data to complete the fact sheet, as we considered these to be the most reliable reports. We interviewed surviving victims directly and obtained information on deceased victims either from their relatives or from eye witnesses of the incidents.

We obtained prior, informed consent from all participants interviewed in this study. We analysed the descriptive data obtained from the fact sheets to investigate trends and patterns in the dynamics of human–crocodile interactions at Lake Kariba and in the surrounding area, including data relating to water conditions, age of the victim, activities at the time of attack, time of day, month and location of the incident.

## Results

Interviewees reported that victims were attacked in both clear and turbid water (because of an error in the data collection we are unable to report quantitatively on the proportions of victims attacked in clear vs turbid water).

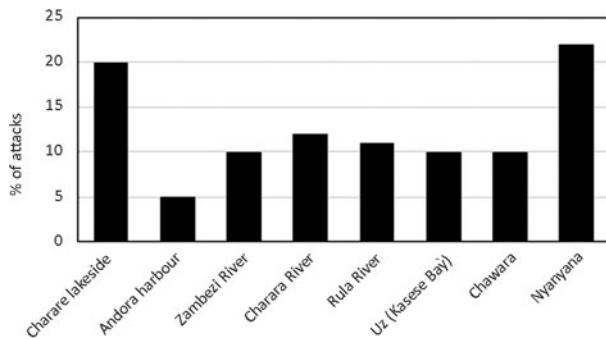


FIG. 2 Locations at which people were attacked by Nile crocodiles *Crocodylus niloticus* at Lake Kariba (Fig. 1), with the per cent of all attacks included in our analysis (n = 60) for each location.

Nearly half (49%) of all recorded attacks occurred at night or in the early morning hours (00.00–08.00), 15% during the late morning (08.00–12.00), 21% during the early afternoon (12.00–15.00) and 15% during the late afternoon and evening (15.00–0.00).

The locations with the highest number of recorded attacks were Nyanyana and Charara lakeside (22 and 20% of the analysed sample, respectively), followed by Charara River (12%), Rula River (11%), Zambezi River (10%), Chawara (10%) and Uz (Kasese Bay; 10%). The fewest attacks occurred at Andora harbour (5%; Fig. 2).

Most victims were 26–40 years of age (45%), followed by 41–64 years (38%). People aged  $\leq 25$  years and  $\geq 65$  years were rarely attacked by crocodiles (13 and 4%, respectively).

The majority of victims (41%) were attacked in the dry-hot season (August, September and October; 12, 17 and 12% of attacks, respectively) and in the short cool-wet season (March and April; 17 and 13%, respectively). There were fewer attacks (22%) in the hot-wet season (November, December, January and February; 3, 7, 2, 10%, respectively), and only 7% of attacks occurred during winter (May, June and July; 3, 2 and 2%, respectively; Fig. 3).

Most victims were attacked while fishing (58%), followed by those attacked while carrying out domestic chores (27%). Few were attacked while crossing rivers (8%) or rowing boats (7%).

## Discussion

Although we expected that people would mostly be attacked by crocodiles when the water is turbid because they would not be able to see the crocodiles easily, our interviews suggest that victims were also attacked when the water was clear. This could be because reflections off the water surface make it difficult to see crocodiles, particularly as the animals are also camouflaged by their colouration. Crocodiles are able to attack people under any water conditions as their physiology 'allows them to see, smell, and hear (all of

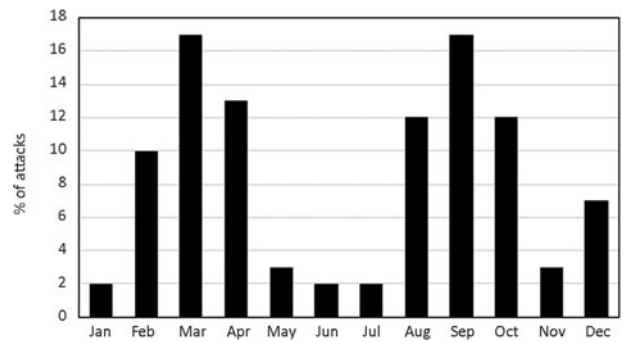


FIG. 3 Crocodile attacks on people at Lake Kariba by month, in per cent of the attacks included in our analysis (n = 60).

these senses are acute) while remaining almost fully submerged. Large crocodiles can hold their breath for over an hour' (Pooley, 2017, p. 395). Furthermore, crocodiles are highly effective ambush predators, observing where animals (including humans) regularly access or cross water and 'when hungry, they will wait patiently near these places for the prey to approach . . . then submerge, and approach silently and invisibly; lunging with great speed and power at the last moment to seize the victim' (Pooley, 2017, p. 395).

The majority of victims were attacked at night and in the early morning, and most while fishing. Crocodiles are active at night, a time when much illegal fishing occurs (Pooley, 2015). Fishing activities at night are usually illegal, involving use of nets with a mesh size that does not adhere to fishing regulations, and illegal twine nets, and occurring in areas where fishing is prohibited such as the rivers and their mouths around Lake Kariba (Magqina et al., 2020).

In the study area, people have been attacked at different types of water bodies including Kariba Lake itself and the rivers that flow into it. A large proportion of attacks occurred at Charara lakeside and Nyanyana, whereas few attacks occurred in Uz (Kasese Bay) and Andora harbour (Fig. 1). Previous studies noted that several ecological and anthropogenic factors such as habitat fragmentation and alteration influence the distribution of crocodiles in water bodies (Sai et al., 2016). Crocodiles of different sizes (i.e. juveniles and adults) favour different areas and types of water bodies (Sai et al., 2016). Thus, incidents in areas favoured by juvenile crocodiles are rarely fatal, as juveniles are less capable than adult crocodiles of attacking large mammals such as humans. These factors may also play a role in the distribution of crocodile attacks at Kariba.

There were variations in the distribution of crocodile attacks across seasons at Lake Kariba. This corroborates previous findings at Ruti dam in Buhera District (Chihona, 2014) and observations of a significant drop in attacks in winter in South Africa and Eswatini during 1949–2016 (Pooley et al., 2020). It has been suggested that crocodiles attack more often during the hot season because they are ectothermic and are more active (and therefore hungrier)

during the warmer months of the year (Pooley et al., 2020). In addition, some reports suggest crocodiles are more dangerous during the breeding season (McGregor, 2005), but more data are required to examine this potential factor at Lake Kariba.

Our data from the area around Lake Kariba concur with findings from other countries where crocodile attacks occurred while people were fishing, crossing rivers, obtaining water for domestic use or bathing (Wallace et al., 2011; Zakayo, 2014; Pooley et al., 2020). Fishing was the most common activity that people carried out when they were attacked by crocodiles at Lake Kariba. Many economically disadvantaged people in Kariba town turn to fishing for their livelihoods and are thus particularly vulnerable to crocodile attacks. Fishing carries a risk of crocodile attack whether the water is clear or turbid, so people cannot mitigate this risk based on water conditions (e.g. by fishing only in clear water). In addition, common fishing practices in the area involve people entering the water, for example using fishing rods while standing in knee-deep water or deploying fishing nets in breast-deep water and hitting the water surface with logs to disturb the fish and drive them into the nets. These practices expose people to a higher risk of crocodile attacks, whereas fishing with rods while standing on the shore would be less risky.

Few victims were attacked while carrying out domestic chores, as most people in Kariba town have a piped water supply and thus do not visit the lake to fetch water for domestic purposes such as bathing or washing. Few victims were attacked while rowing boats or crossing rivers.

The proportion of crocodile attack victims was distributed unevenly across age groups. Most victims were in the economically active group of 26–40 years of age. It has been hypothesized that poverty could prompt people to enter rivers or lakes to fish and thus risk crocodile attacks. In Zimbabwe's current economic crisis, with high levels of unemployment, an increasing number of people have come to rely on fishing for their livelihoods (Dunham et al., 2010; Ndhlovu et al., 2017). Even though Lake Kariba has a large population of crocodiles, both men and women continue to fish there. People aged 65 years and older rarely visit the lake and represented fewer of the victims. Children and young adults with no economic responsibilities were also rarely attacked because they do not visit the lake as often as adults who need to provide for their families.

Although children are rarely attacked by crocodiles at Lake Kariba, it is important to educate them about potential negative interactions with crocodiles. Such information could be integrated into the school curriculum, and it has been suggested that this strategy should be promoted by local governments (Garcia Grajales & Buenrostro Silva, 2018). Educating children is crucial so that, when they become economically active adults, they can engage in

fishing safely, equipped with knowledge about coexisting with crocodiles.

Fishers and other lake users must also be educated about the dangers of fishing or otherwise entering the lake even when the water is clear. We recommend that National Park authorities display informative posters in all areas with a high risk of crocodile attacks around Lake Kariba. Posters and signboards have been widely used as educative tools to raise awareness regarding the risk of crocodile attacks, particularly in hotspot areas (van der Ploeg et al., 2011; Cureg et al., 2016). At Lake Kariba, posters should display clear warning messages regarding the dangers of entering the lake and they should be written in the local languages (ChiShona and CiTonga) to ensure that they are understood by local populations. Egg collection during the annual dry season, when crocodiles nest, could be promoted in high-risk zones to reduce the density of crocodiles there (Zimbabwe National Parks and Wildlife Management Authority, 2006; Fergusson, 2010a,b). Crocodile eggs can be hatched in incubators, to support crocodile conservation and for commercial purposes, the proceeds of which could benefit local communities. Such economic benefits for local people could also contribute to increased support for crocodile conservation.

Based on our findings of frequent attacks at night, an effective mitigation strategy would need to include an increase in night-time patrols by the Zimbabwe National Parks and Wildlife Management Authority, to address illegal fishing and the related risk of crocodile attacks. Our data on the specific locations of attacks can be used by policymakers to identify areas that need to be closed for fishing during periods of frequent crocodile attacks (i.e. in summer).

A mitigation strategy to address the negative human–crocodile interactions is crucial because it could save people's lives and at the same time promote crocodile conservation. There is no such strategy currently in place for Lake Kariba, and conflicts could arise if negative interactions are not addressed. Such conflicts can result in significant impacts on both human and crocodile populations, including eroding support for wildlife conservation. The Nile crocodile is a keystone species in the Lake Kariba area and a decline in its population could result in cascading negative effects on the ecosystem (Botha et al., 2011; van der Ploeg et al., 2011; Sai et al., 2016). In addition to their ecological role, crocodiles also have economic value through ecotourism (Wallace et al., 2013); their conservation therefore benefits the local economy as well as supporting vital ecosystem functions.

**Acknowledgements** We thank the University of Zimbabwe Lake Kariba Research Station for providing funding for this study and the three research assistants; Simon Pooley for providing the fact sheet used for data collection, reading a draft version of the manuscript and providing constructive feedback; and the community of Kariba town for agreeing to participate in this study.

**Author contributions** Data collection and analysis: JM; writing: all authors; sourcing research funds: TN.

**Conflicts of interest** None.

**Ethical standards** This research was approved by the University of Zimbabwe Lake Kariba Research Station and adhered to the social science research ethics. Research permits were granted by local authorities and participants provided free and informed consent. This research otherwise abided by the *Oryx* guidelines on ethical standards.

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