Density of Saltwater Crocodile (*Crocodylus porosus*) and Crocodile-Human Conflict in Menipo Natural Recreation Park, East Nusa Tenggara, Indonesia

Final Report Project
IUCN-SSC Crocodile Specialist Group
Student Research Assistance Scheme (SRAS)

Andreas Mario Rani Agon
Widya Mandira Catholic University, Faculty of Science and Technology, Biology Department, St. A. Yani, Fatubesi, Kupang City, East Nusa Tenggara-Indonesia; email: agonandreas@gmail.com

Abstract

The saltwater crocodile (*Crocodylus porosus*) is one of the four species of crocodiles found in Indonesia, with the widest distribution compared to the other three species. One of its habitats in Indonesia is located in East Nusa Tenggara (NTT) and, in certain years, NTT has recorded the highest number of crocodile attacks in Indonesia. However, studies on the population and human-crocodile conflicts in NTT remain limited. This research aimed to investigate the population of saltwater crocodiles and human-crocodile conflicts in NTT, particularly in the Menipo Nature Tourism Park (TWA Menipo), Enoraen Village, East Amarasi Subdistrict, Kupang Regency by surveying the crocodile population density as well a conducting a social survey on human-crocodile conflicts. The results of the spotlight survey was calculated to be 0.7 individuals/km. For the social survey, the researchers successfully interviewed the families of two victims, 1 traditional leader, 1 park ranger, and 12 fishermen and shellfish collectors from Enoraen Village. The responses obtained provided insights into how human-crocodile conflicts occur, traditional perspectives on the relationship between crocodiles and humans, efforts by park authorities, and suggestions to reduce conflict-related casualties, as well as the perspectives of fishermen when operating in crocodile habitats.

Introduction

Indonesia is home to a high diversity of crocodile species, the largest of which is the saltwater crocodile (*Crocodylus porosus*), with a wide distribution across the country. This broad distribution often triggers conflicts between humans and crocodiles, particularly in East Nusa Tenggara (NTT), which has the highest conflict rate in Indonesia. Data from 2007 to 2023 recorded 142 crocodile conflicts, resulting in 80 fatalities and 62 injuries (BBKSDA, unpublished report). Located within NTT is the Menipo Nature Tourism Park (TWA Menipo) where, nine cases of crocodile attacks were reported during this same period, causing six deaths and injuring three others, mostly fishermen engaged in fishing activities.

These conflicts are believed to be driven by factors such as an increasing crocodile population, habitat degradation, and human activities near crocodile habitats (BBKSDA, 2017). Although the assumption of population growth is frequently cited as the main cause of conflicts, there is still no adequate survey data to support or confirm this claim (Brian, et al. 2015; Kayat, et al. 2016). TWA Menipo, as one of the largest saltwater crocodile habitats in NTT, has an ideal mangrove ecosystem (Kayat, et al. 2016). However, information on the density of crocodile populations and human-crocodile conflicts within TWA Menipo remains limited and is the focus of this study.The outcomes of this research is expected to provide valuable contributions to developing conflict mitigation strategies and conservation efforts for saltwater crocodiles in NTT, particularly on Timor Island.

Methods

1. Spotlight Survey

The crocodile density survey was conducted at night using the spotlight survey method along the Menipo Island coastline, from the western to the eastern estuary. A team of seven individuals was

assigned specific tasks: two drivers, one recorder (coordinates), one path guide, and three observers equipped with flashlights to detect crocodile eye reflections. Crocodile eyes reflect bright red light when illuminated, visible from distances exceeding 300 meters under clear weather conditions (Fukuda et al., 2013). Data collected included the number of crocodiles, encounter coordinates, time of encounter, crocodile positions, and estimated sizes.

Crocodile density was calculated as the number of individuals per kilometer, using the highest count from four repetitions. This approach provided a relative density index rather than an absolute population size, useful for monitoring population changes (Bayliss, 1987; Messel et al., 1981 in Kayat, 2016). The formula for crocodile density is:

Crocodile Density = Total crocodiles observed (individuals) / Survey distance (km).

The four repetitions also facilitated mapping crocodile hotspots based on encounter locations. These maps, combined with data on crocodile attack victims, were used to identify high-risk areas. This information aims to increase local community awareness of potential danger zones.

2. Social Survey

The social survey used a purposive sampling method, targeting respondents with relevant knowledge and experience regarding human-crocodile conflicts. Semi-structured interviews were conducted to gather insights on the causes of conflicts, local perceptions of crocodiles, and proposed solutions. Respondents included the families of two victims, one traditional leader, 12 fishermen frequently active in TWA Menipo, and one TWA Menipo resort officer.

Interview questions (Appendix I) were designed to allow flexibility and in-depth exploration, covering topics such as community perceptions of crocodiles, personal encounters, and conflict mitigation strategies.

3. Data Analysis

Crocodile density data were analyzed quantitatively, while the social survey data were analyzed qualitatively. The qualitative analysis provided insights into the causes of human-crocodile conflicts and potential solutions from the local community's perspective. The results aimed to inform effective conservation and conflict management strategies, addressing both ecological and social dimensions.

Results and Discussion

1. Crocodile Density:

Across four survey repetitions, the highest crocodile count was 18 individuals, resulting in a density of 0.7 individuals/km (Figure 1). Encounter data revealed clusters of crocodiles in mangrove areas and shallow waters, particularly near the jetty, which is also a popular fishing site. The identified high-risk zones underscore the need for public awareness campaigns and improved signage.

The survey methodology highlighted the influence of environmental factors such as tide levels and moon phases on crocodile visibility (Figure 2). During the survey, more crocodiles were observed during the new moon (dark moon) phase, while sightings decreased as the moon became brighter. This pattern may be explained by the crocodiles' nocturnal behavior and hunting strategies. During darker nights, reduced visibility may provide crocodiles with an advantage when hunting, making them more active and easier to spot in the water or along riverbanks. In contrast, during brighter moon phases, increased illumination could make crocodiles more cautious, leading them to stay submerged longer or remain hidden in vegetation to avoid detection by prey or potential threats. Additionally, changes in light levels may influence prey availability and movement, indirectly affecting crocodile activity. These factors suggest that lunar phases play a role in shaping crocodile behavior and sighting probabilities during surveys. During full moon phases, crocodile sightings decreased, as they likely retreated to denser vegetation due to increased visibility. These findings align with studies by Fukuda et al. (2014), which suggest conducting surveys during new moon phases for optimal visibility.

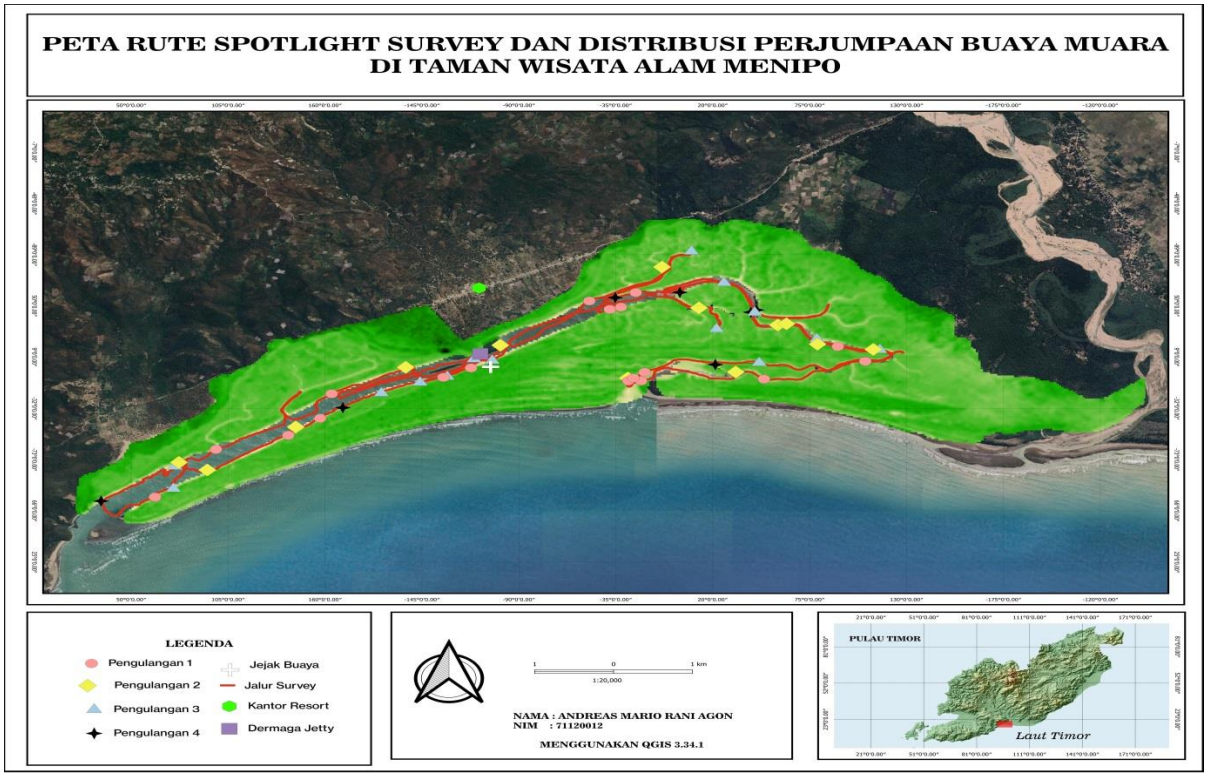


Figure 1. Spotlight survey route and distribution of saltwater crocodile encounters.

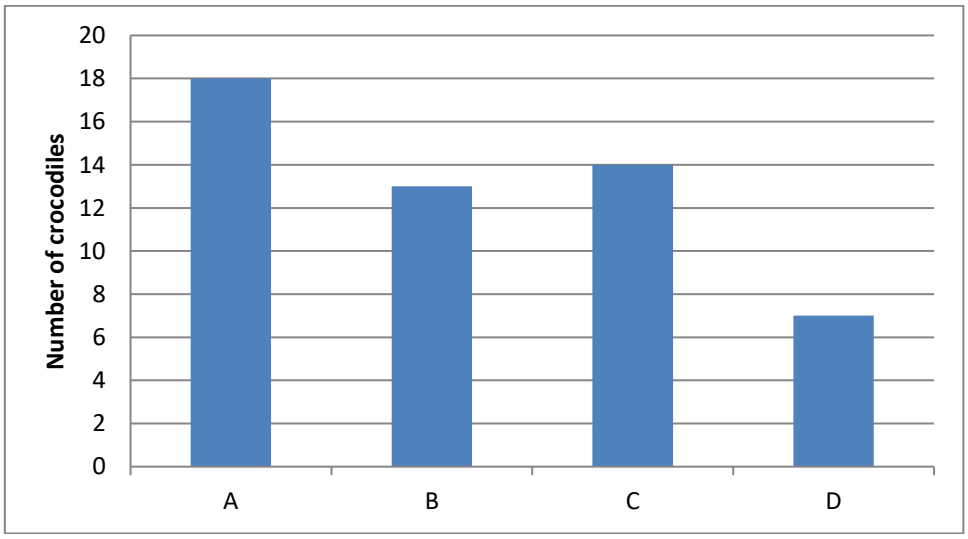


Figure 2. Number of crocodiles sighted during the 4 spotlight surveys along the Menipo Island coastline showing the effect of the different lunar phases: A) New moon (dark moon), B) waxing crescent, C) waxing gibbous and D) full moon.

2. Human-Crocodile Conflicts:

Interviews revealed multiple drivers of human-crocodile conflicts, including habitat encroachment, increasing crocodile populations, and traditional beliefs. Some community members regard crocodiles as sacred, which influences their response to conflicts. Fishermen expressed concerns about safety but emphasized the ecological importance of crocodiles (Appendix II). Notably, traditional leaders proposed rituals and cultural practices to maintain harmony between humans and crocodiles.

Recommendations from respondents included:

1. Enhanced community education on crocodile behavior and habitat safety.
2. Installation of warning signs in identified high-risk zones.
3. Regulation of activities near crocodile habitats to minimize encounters.

Conclusion

This study provides a comprehensive overview of the coexistence challenges between humans and saltwater crocodiles in TWA Menipo. With a documented crocodile density of 0.7 individuals/km and significant insights into conflict dynamics, it offers a foundation for targeted conservation and management strategies. Key recommendations include community education, improved habitat protection, and the development of culturally informed conflict mitigation mechanisms. Future studies should focus on long-term monitoring of crocodile populations and the effectiveness of implemented strategies to ensure sustainable coexistence.

Acknowledgement

I express my gratitude to God Almighty for His grace and blessings, enabling me to complete this research and compile this scientific journal successfully. I extend my deepest appreciation to Mr. Dadang Suryana, S.Hut. T., M.Sc., and Mr. Gaudensius U. U. B. Duhan, S.Si., M.Sc., as my supervisors, who have provided guidance, direction, and support throughout the research and writing process. I also greatly appreciate all lecturers and staff of the Biology Study Program, Widya Mandira Catholic University, who have imparted knowledge and motivation during my studies.

I sincerely thank the IUCN SSC Crocodile Specialist Group SRAS program that have providing me some funding towards this research. I am also thank East Nusa Tenggara Natural Resources Conservation Agency (BBKSDA NTT) and the Menipo Nature Tourism Park resort officers for granting research permits and assisting in the data collection process in the field. I am also very grateful to my beloved family, especially my parents, who have always provided moral and material support throughout my studies. Additionally, I extend my gratitude to all respondents and the community around Menipo Nature Tourism Park who were willing to share information related to this research.

Lastly, I appreciate my fellow students and friends who have given their support, encouragement, and camaraderie throughout the research and journal writing process. I hope this journal will be beneficial for the advancement of scientific knowledge and the conservation efforts of saltwater crocodiles in Indonesia.

References

BBKSDA NTT. 2019. *Human and Crocodile Conflic Managemen: Experience Sharing from East Nusa Tenggara Profince of Indonesia.* Presented at the Crocodile Workshop in Balikpapan, East Kalimantan, on November 15-18, 2019. (unpublished data).

BBKSDA NTT. 2017. Standard Operating Procedures (SOP): Handling Conflicts Between Humans and Crocodile Wildlife in East Nusa Tenggara Province. (data not published).

Fukuda, Y., K. Saalfeld., G. Webb., C. Manolis., & R. Risk. 2013. Standardised 23 Population and Habitat Characteristics of the Saltwater Crocodile Method of Spotlight Surveys For Crocodiles in The Tidal rivers of The Northern Territory Australia. *Northern Territory* Naturalist. 24:14-32

Fukuda, Y., Manolis, C., & Appel, K. 2014. Featured article: Management of human-crocodile conflict in the Northern Territory, Australia: Review of crocodile attacks and removal of problem crocodiles. The Journal of Wildlife Management, 78(7), 1239-1249.

Kayat, Grace S. Saragih, Dani Sulistiyo Hadi, Budiyanto D. P, Oki Hidayat. 2016. Kajian Habitat dan Populasi Buaya di Provinsi NTT; Konservasi Keanekaragaman Hayati untuk Biosecurity, Bioprospecting, Jasa Lingkungan dan Restorasi.

Appendix I

Table 1. Survey questions for interviews with victims and victims' Families

No	Question
1	Name of Resource Person
2	Victim's Name
3	Age of Resource Person
4	Gender
5	Work
6	Status
7	Chronology of Events
8	Victim's Condition
9	The position of the crocodile when attacking
10	Crocodile size
11	Perspective of the victim or victim's family about the existence of crocodiles in TWA Menipo
12	Is there an increase in population?
13	Advice to avoid crocodile attacks

Table 2. Survey questions for interviews with the traditional leader

No	Question
1	Name Age Gender Work
2	Crocodile designation in the local language
3	Community relations with crocodiles
4	Is there a ritual there specifically for crocodiles?
5	Why do crocodiles attack humans?
6	Is there a family or clan dedicated to guarding Menipo Island
7	What is the role of traditional leaders in responding to the problem of crocodile-human conflict
8	Taboos that visitors should pay attention to
9	Is there an increase in crocodile attacks on humans?

Table 3. Survey questions for interviews with TWA Menipo resort staff

No	Question

1	What efforts do resort staff make to prevent crocodile-human conflict?
2	Efforts of resort officers in handling cases of crocodile-human conflict

Appendix II

The results of interviews with 12 resource persons who are often active as fishermen and shellfish finders in TWA Menipo are summarized in the form of the graph below. This is aimed at seeing the difference in perspective and presentation of answers to the questions asked.

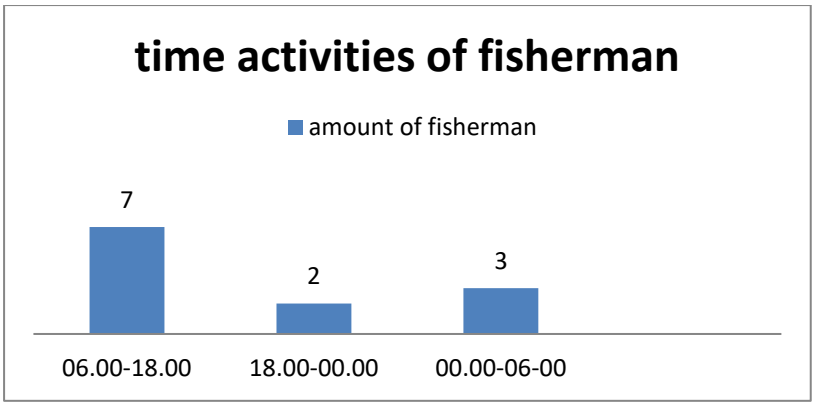
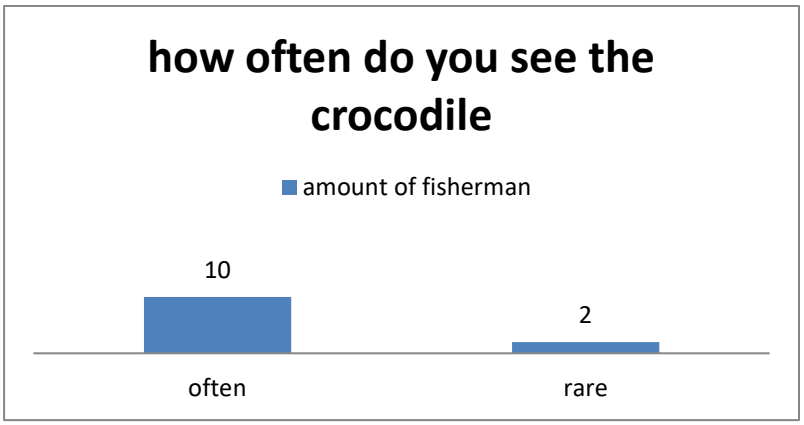
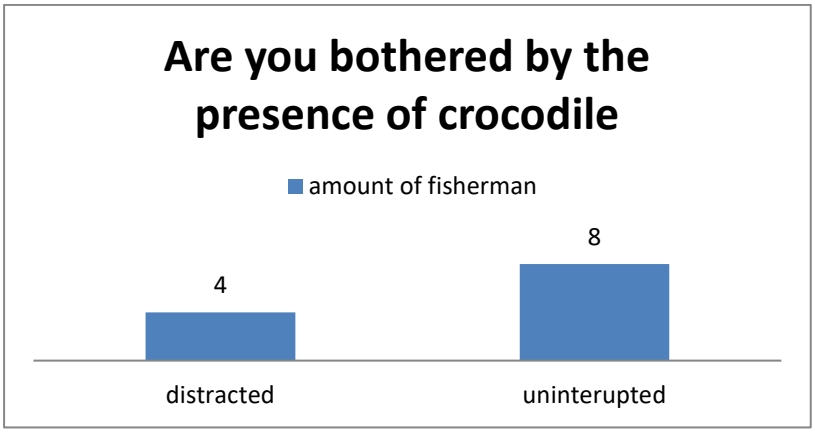
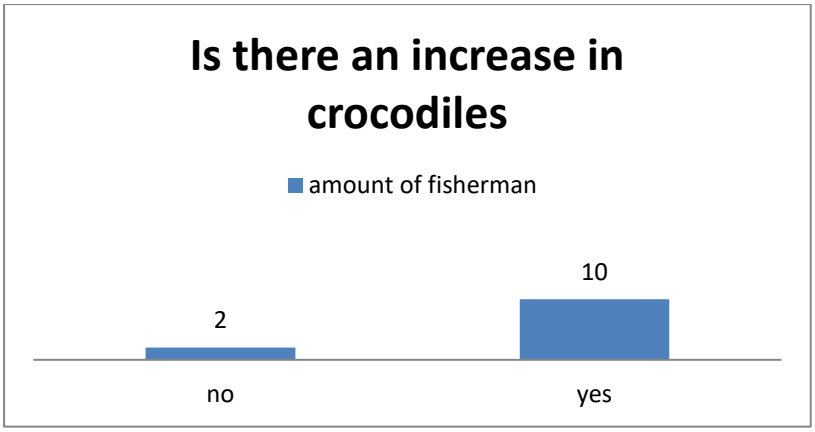
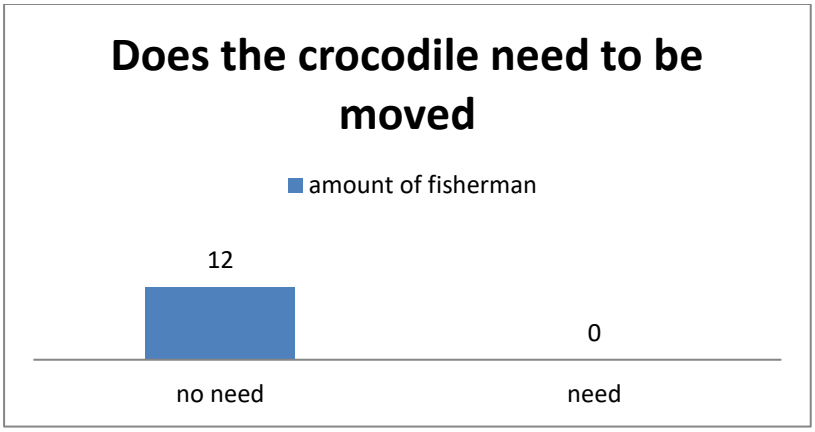


Chart 1.






Is there an increase in crocodiles
amount of fisherman
2
10
no
yes


Does the crocodile need to be moved
amount of fisherman
12
0
no need
need