SRAS Final Report:

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Abstract

The endemic Philippine crocodile (*Crocodylus mindorensis*) is considered one of the most threatened crocodile species globally and is listed as critically endangered on the IUCN Red List (IUCN, 2024). The species was considered extinct on Luzon Island until the discovery of a remnant population in 1999. This led to the first in-situ conservation measures and later community-based conservation. Public perception has proven highly significant in the conservation efforts of *C. mindorensis*. Although venerated in pre-colonial Philippines, many factors have caused respect to turn into fear. Despite current efforts, fear persists, which impedes conservation initiatives. This study aimed to assess public perception in areas with and without crocodiles through interviews to deduce why people harbour fear and how it may impact conservation incentives. A total of 192 respondents were included in the analyses. Following a sentence-level sentiment analysis, respondents in areas with crocodiles were significantly more positive ($p<0.05$) and accepting of reintroduction initiatives ($p<0.001$). However, a term frequency-inverse document frequency (tf-idf) analysis revealed the term “zoo” was characteristic when querying about reintroduction incentives. Contrastingly, synonyms of fear were more prominent in regions without crocodiles, significantly decreasing overall sentiment ($p<0.001$). A linear regression suggested that depictions of crocodiles on television ($p<0.05$) and their physical characteristics ($p<0.05$) were correlated with negative terms. While current efforts have effectively garnered support, communities continue to harbour fear. Thus, continuous monitoring and community engagement are essential to address concerns and accumulate support for conservation in areas of potential reintroduction. In conclusion, the conservation of *C. mindorensis* requires a multifaceted approach that combine different disciplines and stakeholders.

Introduction

C. mindorensis is a critically endangered species with less than 150 mature individuals in the wild (van Weerd, 2010; van Weerd & van der Ploeg, 2008). The IUCN Crocodile Specialist Group (CSG) considers *C. mindorensis* the most threatened crocodile species globally, making it a top priority for conservation action (van Weerd & van der Ploeg, 2004). *C. mindorensis* is a small, legally protected crocodilian endemic to the Philippine archipelago (Republic Act No. 9147, 2001). The species occupies various freshwater habitats including creeks, shallow ponds, man-made water reservoirs, and marshes (Manalo & Alcala, 2015; van Weerd, 2010). Furthermore, *C. mindorensis* lives in fast-flowing rivers with deep pools and hides in caves (van Weerd, 2010). It has also been observed in saline waters along Luzon’s coast (van Weerd et al., 2016). In Ligaswasan Marsh on Mindanao and the coastal wetlands of Isabela, Luzon, the species occurs sympatrically with *C. porosus.*

Historically, the Philippines were >85% forested and *C. mindorensis* was widely distributed throughout (Brown et al., 2021; van Weerd & van der Ploeg, 2003). However, land conversion, wetland drainage, and reclamation have drastically diminished natural habitats, with the archipelago retaining only 4-8% of its original forest cover (Brown et al., 2013; Sespene et al., 2016). In addition, *C. mindorensis* is threatened by water pollution, entanglement in fishing nets, and indiscriminate persecution out of fear and for the meat and skin trade. Consequently, *C. mindorensis* is today restricted to only four localities (Northern Luzon, Mindanao Island, Dalupiri Island, and Siargao Island) (Manalo & Alcala, 2015; van Weerd et al., 2016; van Weerd & van der Ploeg, 2003).

In-situ conservation remained scarce until the discovery of a remnant population in Isabela Province in 1999 (van Weerd, 2010). The discovery by the Northern Sierra Madre Natural Park-Conservation Project (NSMNP-CP) led to the first in-situ conservation efforts. The Philippine Crocodile Research and Conservation Programme was continued by the Mabuwaya Foundation Inc., established by the Isabela State University and Leiden University, in 2003 (van Weerd & van der Ploeg, 2003). The Foundation focuses on community-based conservation, engaging local communities via communication, education, and public awareness (CEPA)

campaigns (e.g. posters, calendars, and school and field visits). This has led to the acceptance of the species by the broader public (van Weerd, 2010; van Weerd & van der Ploeg, 2003), demonstrating the efficacy of combining social science and conservation biology. Declared a flagship species in San Mariano, *C. mindorensis* became the advocate of such conservation efforts (van Weerd & van der Ploeg, 2003).

Despite being declared a flagship species, public perception of crocodiles in the Philippines remains diverse. Negative attitudes are still prominent and challenge in-situ conservation efforts (Banks, 2005). Crocodiles are widely perceived as a threat to children and livestock and, within mainstream Filipino culture, are associated with greed and corruption (Cureg et al., 2016). This may impede reintroduction efforts as political bodies may avoid associating with crocodiles due to concerns about losing public support (Pers. Comm. March 1, 2024). Moreover, many are unaware of its legal protection. It is therefore crucial to inform the public about environmental legislation, and the benefits provided by wetland and crocodile conservation. More research is thus needed to further engage communities and comprehensively understand their attitudes towards crocodiles. Engaging communities not previously exposed to CEPA campaigns could help mitigate negative attitudes and enhance knowledge of crocodiles. Evaluating public perception in regions with crocodiles can provide insight into personal experiences and attitudes toward the species. Additionally, understanding the efficacy of current campaigns may offer valuable knowledge for raising community awareness in areas where crocodiles are no longer present. Understanding public perception and acceptance in areas where reintroduction is of interest is crucial to promoting community acceptance before reintroduction.

Despite current efforts, *C. mindorensis* populations remain fragmented occupying only a fraction of their historical distribution. With public perception proving highly significant for conservation, this study aimed to assess public attitudes in areas of reintroduction interest. Communities in sites with and without crocodiles were investigated to gain a comprehensive understanding of their attitudes towards crocodiles. This will enable us to tailor future campaigns to garner support for the conservation of *C. mindorensis* in areas of reintroduction interest.

Methodology

All fieldwork was conducted under the authorisation of the Mabuwaya Foundation Inc., the Philippine Department of Environmental and Natural Resources (DENR), and Local Government Units (LGU). All respondents were provided full disclosure of the project and Prior Informed Consent was obtained from all individuals, communities, and Municipalities within the study. No personally identifiable data was obtained without prior consent and respondents were guaranteed full anonymity unless otherwise agreed.

The research was conducted between January and March 2024 in the Municipalities of Baggao, Peñablanca, San Mariano, and Diadi within the Cagayan Valley (fig 1). The Cordillera and Northern Sierra Madre Mountain (NSM) ranges enclose the valley on the western and eastern sides respectively. The largest river in the Philippines, the Cagayan River, flows northward through the valley into the Babuyan Channel. The climate is characterized by frequent tropical cyclones, a short dry season (February to May), and a wet season (Bagtasa et al., 2023; van Weerd & van der Ploeg, 2004).

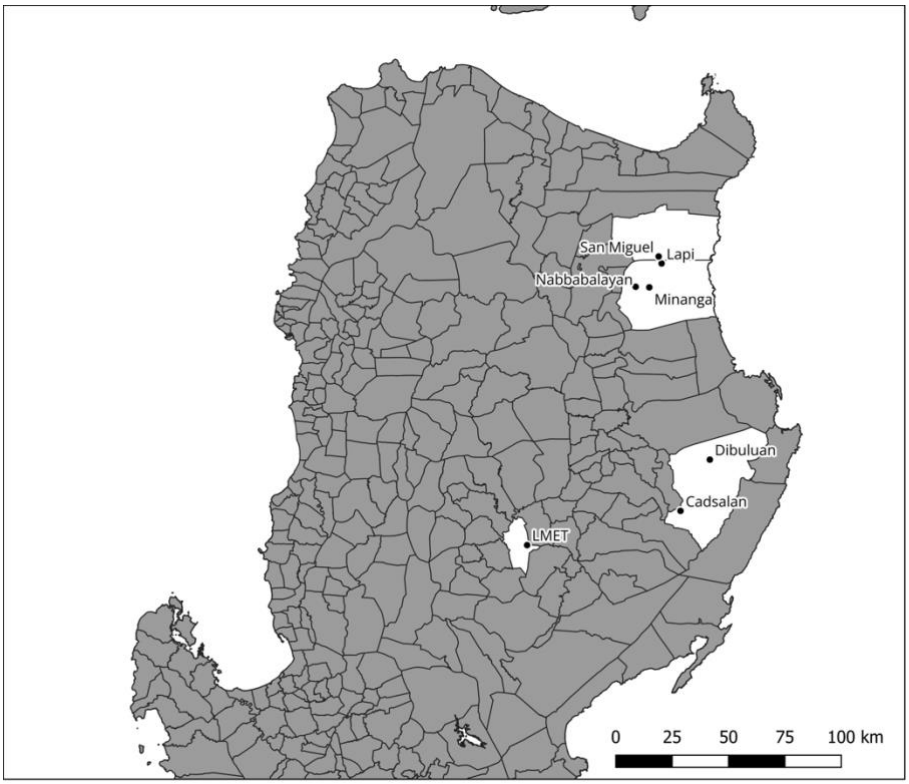


Figure 1. Municipalities of Northern Luzon. White Municipalities denote study areas with respective Barangays where interviews were undertaken. The Lower Magat Eco-Tourism Park (LMET) is partly enclosed by Barangay San Luis, where some interviews took place.

Two surveys were formulated using resource packages and previous interviews (Mathers et al., 2000, 2007; van der Ploeg et al., 2011). Demographic information was formulated using the Standard International Age Classification with slight modifications to account for Agta communities who are unaware of age (UN, 1982). Both surveys included closed-ended questions on demographic aspects and their attitudes towards crocodiles and their conservation. Open-ended and follow-up questions were included to explore general knowledge, cultural and historical associations to *C. mindorensis*. Respondents were randomly selected through direct voluntary interaction. Respondents were always encouraged to provide their own opinions and where possible interviewed alone. Surveys were trialled through face-to-face interviews at the Philippine Crocodile Conservation Centre (PCCC), Isabela State University, and at the Bambanti Festival, attended by the Mabuwaya Foundation. Questions were edited accordingly to avoid misinterpretation and leading questions. Interviews were thereafter undertaken in areas with (Barangays Dibuluan and Cadsalan in the Municipality of San Mariano) and without crocodiles (Barangays San Miguel, Lapi, Nabbabalayan, Minanga, and San Luis (LMET) in the Municipalities of Baggao, Peñablanca and Diadi).

Statistical analysis

Sites were categorised into crocodile presence and absence before analysis. Likert scale responses were collated, transformed to the ordinal scale, and analysed in R vers. 4.4.0 using the packages likert and psych (Bryer & Speerschneider, 2016; Revelle, 2024). Open-ended questions were excluded because responses did not fit the pre-defined categories. A reliability analysis of Likert responses was conducted to ensure construct validity, where Cronbach's alpha represents internal consistency (Duhachek & Iacobucci, 2004).

Sentiment analysis (SA) is an emerging central tool to identify key opinions surrounding a particular topic (Lui, 2022). As applied for this project, SA parses affective states of sentiments to deduce perception towards crocodiles across the surveys. Four lexicons (Cambria et al., 2016; Hu & Liu, 2004; Jockers, 2017; Mohammad & Turney, 2010), alongside the default lexicon in the R package sentimentr, developed for general language use were selected to conduct a sentence-level SA. Sentiment scores within lexicons vary, thus amalgamating scores

could mitigate word connotation bias. An adjusted z-score approach was used to aggregate sentiment scores to gain insight into multiple lexicons and avoid arbitrary selection (Lennox et al., 2019). Sentiment scores were standardized and summed to get an overall sentiment score.

Term frequency-inverse document frequency (tf-idf) is a quantitative statistic measuring the relative frequency of words within a document relative to the inverse of the specific term over an entire document collection (Ramos, 2003). Tf-idf determines term relevancy within a specified document, where less frequent words have a higher tf-idf value (Qaiser & Ali, 2018). Despite diminutive application in conservation biology, tf-idf has proven an effective method of keyword extraction within information retrieval systems and language processing (Jalilifard et al., 2021). Thus, tf-idf was used to determine key topics within each question of the surveys. Questions in regions with and without crocodiles were assessed against Zipf's power law to verify that frequency inversely correlated with rank. Rank refers to the commonality of a word, where a rank of 1 signifies high frequency. Subsequently, as rank increases, term frequency decreases (Piantadosi, 2014).

Statistical analysis was performed in R using the packages ggplot2, dplyr, tidytext, tidyverse, textdata, quanteda, and quanteda.textstats (Benoit et al., 2018; Hvitfeldt, 2024; Silge & Robinson, 2016; Wickham, 2016; Wickham et al., 2019, 2023). Standardized summed sentiment scores were used to explore how themes including synonyms of "fear", acceptance of reintroduction, and the presence of crocodiles drove sentiment. Residuals were tested for normality using the Shiparo-Wilko test. Data was log-transformed if residuals significantly differed from normal. A generalized linear model was employed using corrected frequencies for conjugations of bite, to explore relationships with incidents in areas with crocodiles. Finally, a log-linear regression was conducted to determine the association between fear, TV, and physical characteristics in areas without crocodiles.

Results

In total, 234 participants were interviewed. Questions were tested on 33 individuals and the surveys edited accordingly to avoid bias. Responses from these interviews were omitted due to potential bias from the question structure. Nine key informants were interviewed across the Philippines, Denmark, and Sweden, but were not included in the overall analysis due to interview structure. Thus, a total of 192 respondents (79 and 113 in areas with and without crocodiles respectively) were included for analysis.

Likert scale

Cronbach's reliability analysis yielded a relatively high internal consistency (Cronbach's $\alpha = 0.77$) with low measurement error (α'standard error (ASE) = 0.031) in regions without crocodiles. Contrastingly, an acceptable internal consistency (Cronbach's $\alpha = 0.67$) was detected when measuring attitudes in areas with crocodiles, although measurement error was slightly higher (ASE = 0.055).

In areas with crocodiles, a higher percentage of respondents were knowledgeable about the threat status of *C. mindorensis* and associated them with an array of benefits and intrinsic value (fig 2). Conversely, respondents in locations without crocodiles, expressed uncertainty regarding the status and significance of protecting threatened crocodiles (fig 3). The disparity between locations may be attributable to ongoing communication campaigns and other conservation work in San Mariano.

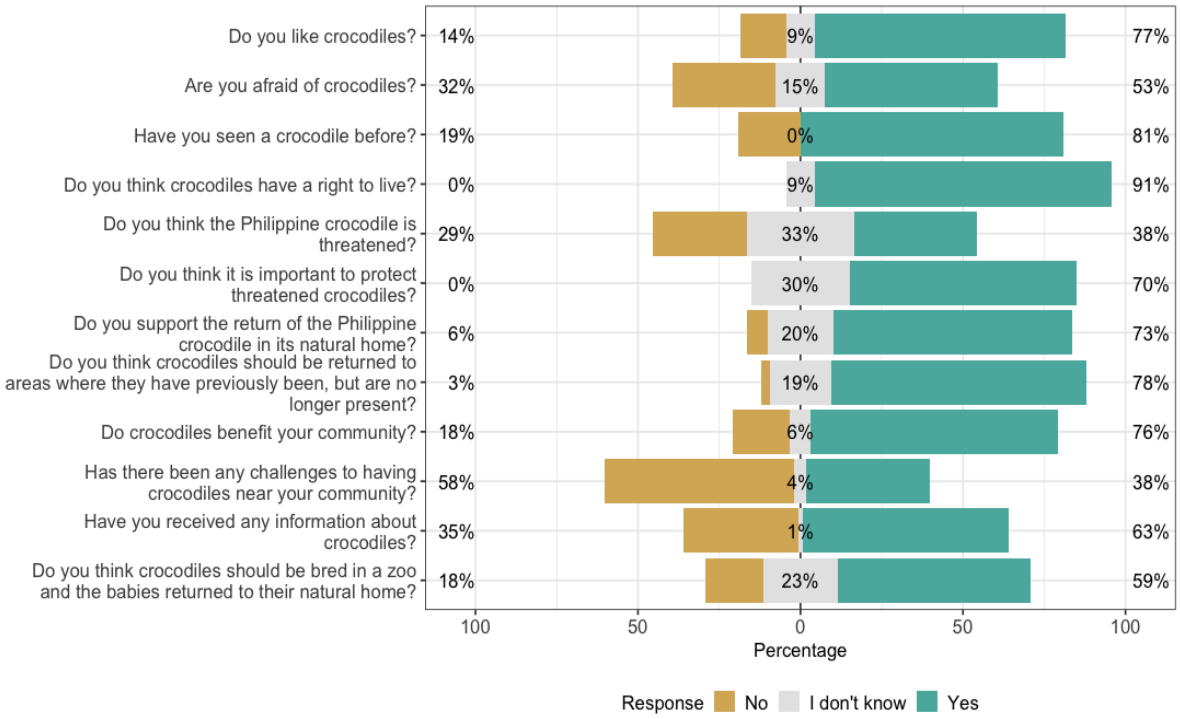


Figure 2. Percentage of respondents answering yes (green), no (yellow), or I don't know (grey), during interviews in San Mariano.

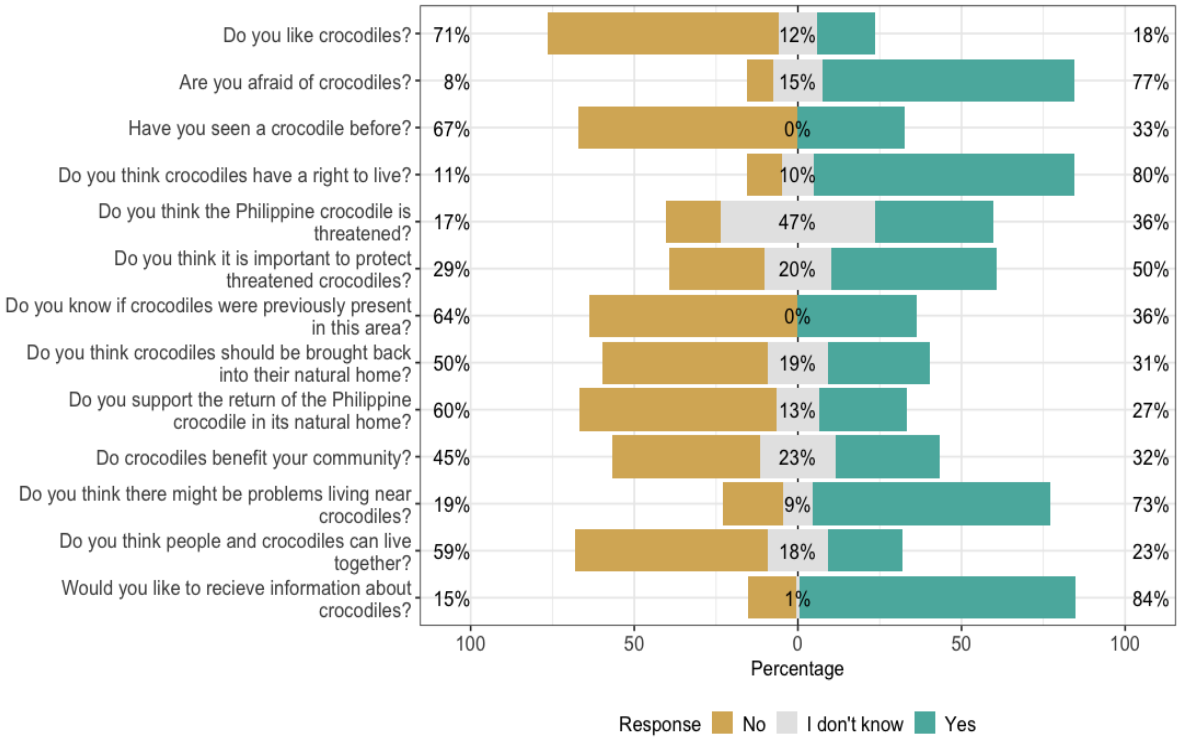


Figure 3. Percentage of respondents answering yes (green), no (yellow), or I don't know (grey), during interviews in regions without crocodiles (Municipalities of Baggao, Peñablanca, and Diadi).

Over half of the respondents in both regions expressed fear of crocodiles. In areas with (53%) and without (77%) acknowledged they were afraid of them. Fear seemed to persist in regions with crocodiles regardless of knowledge of benefits, with some stating "If crocodiles are hungry, they may eat livestock or people". Despite

apparent fear, respondents supported breeding and reintroduction initiatives and thought crocodiles benefitted their community. Additionally, a lower percentage (38%) mentioned challenges to having crocodiles near their community. In areas without crocodiles, respondents were less supportive of reintroduction initiatives (fig 3), however highlighted the importance of receiving information, with one articulating “Providing information will help us not fear the animals. Learning about the benefits and disadvantages of having crocodiles would enlighten people.”

Respondents in areas without crocodiles also mentioned the benefits of having crocodiles near their community. Such benefits were often associated with tourism and personal consumption: “Crocodiles are good for tourism. People can pay to see them, and the money can be used to improve our community” and “Crocodiles are beneficial because we can eat them.” One respondent articulated that living near crocodiles would educate children about the animals. Additionally, respondents thought the presence of crocodiles increased fish populations by scaring fishermen. This is congruent with other findings, where Bucol et al. 2020, concluded crocodiles promoted sustainable fishing methods by acting as deterrents toward fishermen. Respondents within this study also argued fish were important not only for themselves but also for visitors. For example, “The river will not be abused by fishermen, because they will be scared to go fishing” and “Fish are important so that we can provide visitors with food. If there are crocodiles, we will feed them so that we have permission to fish.”

Sentence-level sentiment analysis

The sum of standardized scores exhibited higher variability between questions compared to individual lexicons (fig 4). Questions consistently expressing positive or negative scores influenced the summed sentiment score. This occurs because standardized scores are aggregated across all sentences within each question. Consequently, standardized scores mirror the sign of questions with consistently positive or negative sentences. Resultingly, the absolute value will be higher when totalled (Lennox et al., 2019).

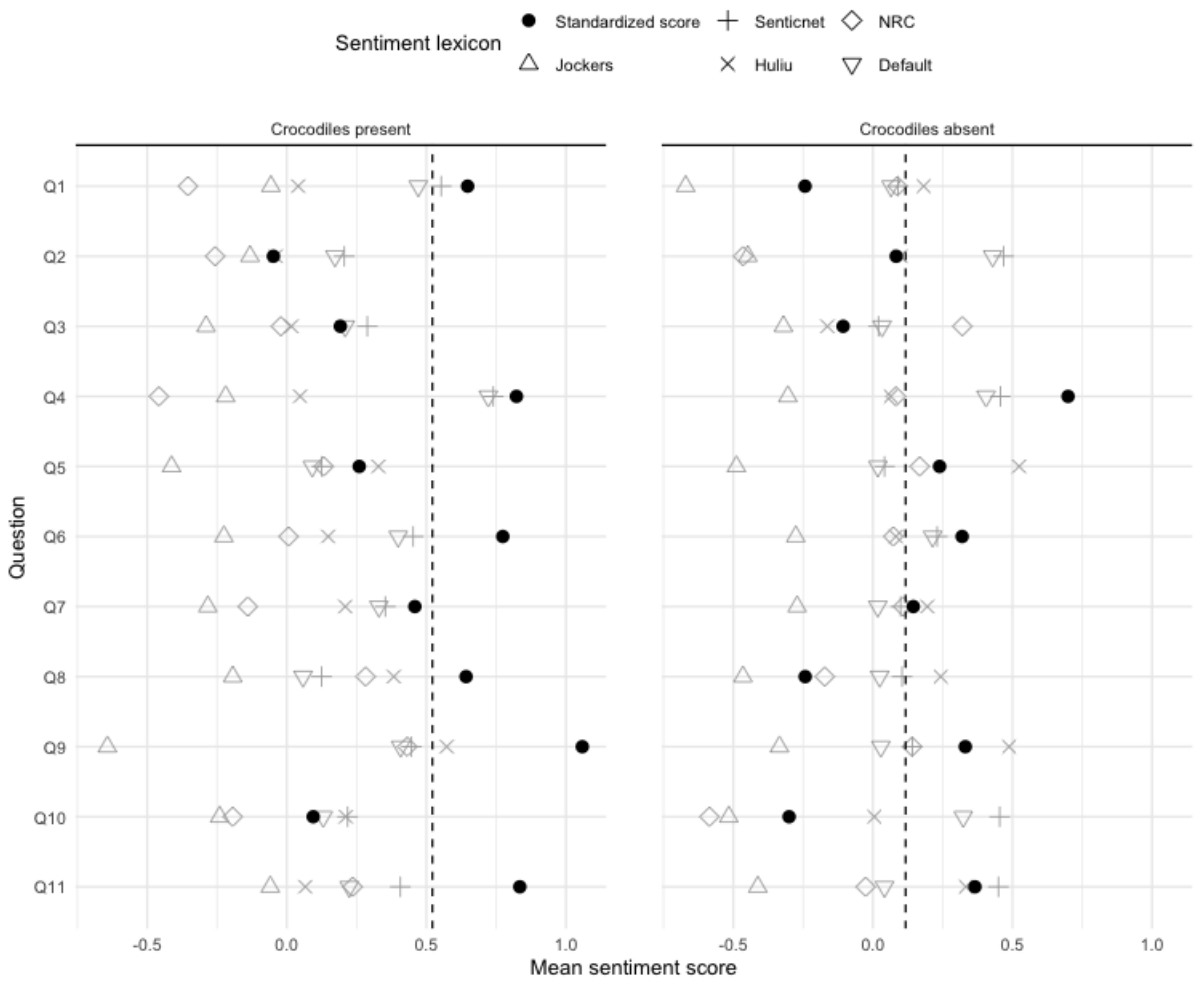


Figure 4. Mean sentiment score of responses in regions with (left) and without crocodiles (right) using five lexicons (light grey). The standardized score (black) refers to the aggregated standardized sentiment scores and the dashed line illustrates the mean sentiment score of the aggregated standardized sentiment.

Responses from locations inhabited by crocodiles were significantly more positive ($t = 2.828$, $df = 19.711$, $p < 0.05$) (fig 4). Acceptance of reintroduction ($t = 6.972$, $df=697$, $p<0.001$) and presence of crocodiles ($t = 5.406$, $df = 697$, $p<0.001$) were predictive of positive sentiment values. Conversely, synonyms of "fear" (e.g. "scared", "afraid", "worried") significantly decreased standardized scores ($t= -20.252$, $df=1757$, $p<0.001$) in areas without crocodiles.

Question 9 ("Do crocodiles benefit your community?") had the highest positive standardized score (x̄ score = 1.06) in areas with crocodiles (fig 4). Contrastingly, question 4 ("Do you think crocodiles have a right to live?") had the highest mean score (x̄ score = 0.699) in regions without crocodiles. Questions 2 ("Are you afraid of crocodiles?") and 10 ("Has there been/would there be problems in having crocodiles near your community?") attained the lowest mean scores in regions with (x̄ score = - 0.0480) and without (x̄ score = -0.300) crocodiles respectively.

Questions 11 ("Have you received any information about crocodiles?") and 8 ("How do crocodiles affect your community?") had the most positive response across sites with (standardized score = 6.115) and without crocodiles (standardized score = 4.793), respectively. Positivity may stem from respondents' willingness to acquire information (fig 3). Notably, one respondent highlighted a lack of knowledge regarding the benefits of crocodiles.

In contrast, responses to questions 3 (“Have you seen a crocodile before?”) and 5 (“Is the Philippine crocodile endangered?”) received the lowest scores with (standardized score = -3.888) and without crocodiles (standardized score = -4.637), respectively.

Inverse document term frequency

Tf-idf was employed to identify characteristic terms within each question. The analysis encompassed all survey questions from sites with and without crocodiles, leading to variations in question numbers. Therefore, question numbers do not correspond with previous analyses.

In areas with crocodiles, all 15 questions adhered to Zipf’s law with only slight deviations. The terms “school” and “supplies” were prominent in questions 1 (“Do you like crocodiles?”) and 10 (“Do crocodiles benefit your community?”). When querying how crocodiles affect the community (fig 5; Q9), a combination of positive (“lucky” and “benefit”) and negative (“trauma”) terms emerged. Despite characteristic negative terms, positive responses were more prevalent (t=5.080, SE=0.123, p<0.001) in regions with crocodiles.

Conjugations of the term “bite” were prevalent throughout, particularly in questions 1 (“Do you like crocodiles?”), 2 (“Are you afraid of crocodiles?”) and 11 (“Has there been any problems living near crocodiles?”) (fig 5). Conjugations were associated with past incidents (t= 3.885, SE=0.001, p<0.001), suggesting assumed biting incidents to some extent contribute to fear.

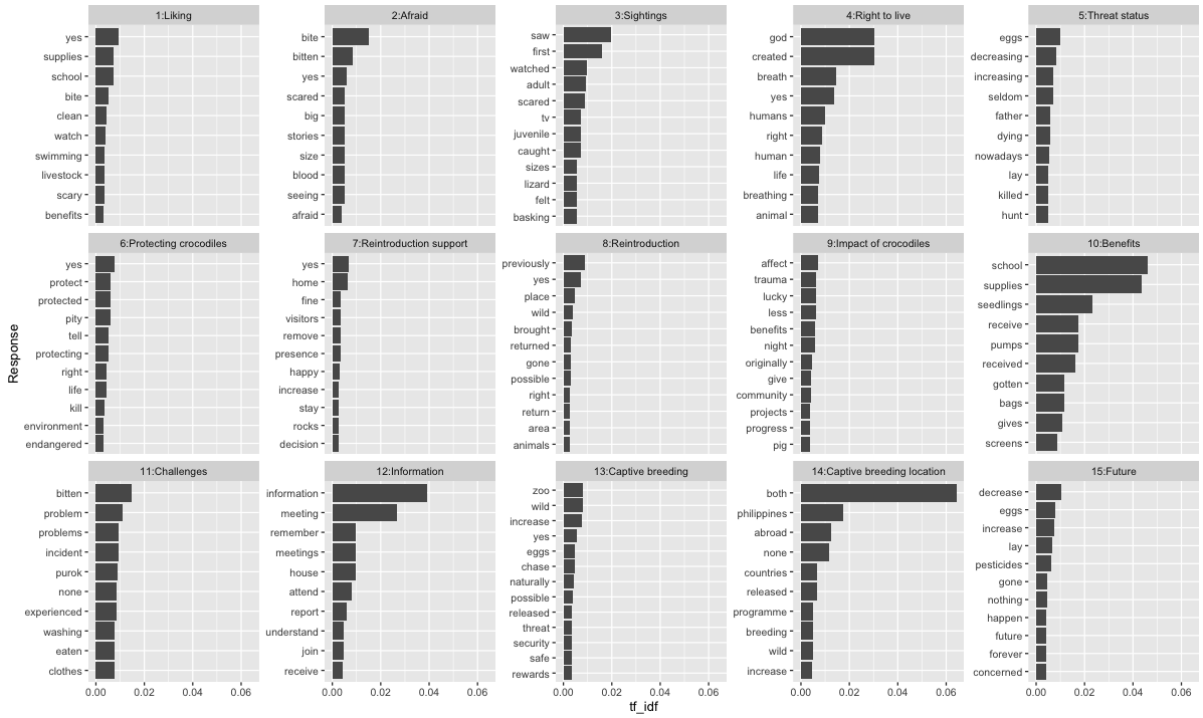


Figure 5. Words with the highest tf-idf categorised by the questions posed in areas with crocodiles. Greater tf-idf values indicate higher term significance within each question.

The term “zoo” was most characteristic when querying captive breeding and release into the wild (fig 5; Q13). Despite the apparent agreement with reintroduction, some emphasized the necessity for captivity and fencing, “...crocodiles were in a zoo/cage because then they cannot harm anyone.” Respondents appeared supportive of a combined national and international breeding initiative (fig 5; Q14). However, concerns regarding population growth and livestock safety were expressed: “ People will become scared because crocodiles will increase if we have a breeding programme”. Additionally, insecurities were voiced regarding international breeding practices and the possible aggressive behaviour of internationally bred crocodiles: “Crocodiles bred abroad will be aggressive. If they are released, they might harm people and livestock.”

Tf-idf values from interviews in regions without crocodiles were also examined, where the 17 questions adhered to Zipf's law. Respondents expressed fear referencing the physical characteristics of crocodiles (e.g. "spikes", "scales" and "teeth") which may have been enunciated by what they saw on TV (fig 5; Q1, Q3, Q4). A linear regression isolating question 4 ("Have you seen a crocodile before?") suggested TV ($t= 2.319$, $SE = 0.1411$, $p<0.05$) and physical characteristics ($t = -0.483$, $SE = 0.207$, $p<0.05$) were significantly correlated with negative terms (e.g. "scared", "afraid" and "dangerous"). However, the model only explained approximately 10% of the variance, implying alternative predictors may influence term frequency ($F2,73=5.05$, $R2= 0.0974$, $p<0.01$).

Although not significant ($p=0.377$), information appeared primarily sourced from TV. For instance, when querying *C. mindorensis* threat status, respondents based their answers on what they saw on TV e.g. "...in TV, I saw crocodiles were killed because they ate people" and "I saw on the news that crocodiles are decreasing because people are killing them" (fig. 5; Q6). Additionally, respondents seemed to rely on TV for knowledge of crocodiles e.g. "(receiving) information will not change my mind, because I still believe what I see on TV" and "we have already judged crocodiles based on what we see on TV."

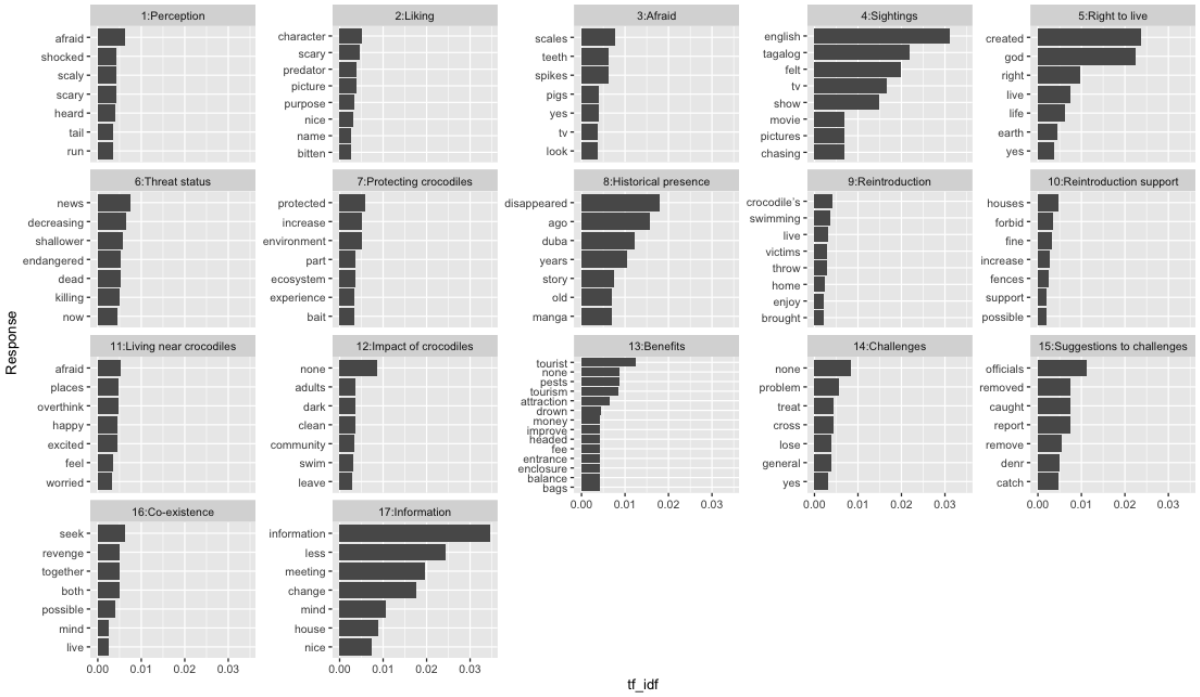


Figure 5. Words with the highest tf-idf are categorised by the questions asked in areas without crocodiles. Greater tf-idf values indicate higher term significance within each question.

Diverse responses arose when addressing the prospect of crocodiles residing near communities (fig 5; Q11). When examining potential benefits, monetary outcomes, tourism, and establishment of zoo-like conditions were apparent (fig 5; Q13). One respondent articulated that crocodiles should be released because "we will receive benefits like the rewards. More crocodiles mean more money rewards." Discussions of potential problems surrounding crocodiles varied, ranging from an absence of challenges to concerns regarding the impact on livelihood e.g. "The community would be scared...We would not be able to go fishing" (fig 5; Q14).

Half of the respondents in regions without crocodiles opposed reintroduction (fig 3), arguing victimization of animals and people e.g. "if there are no more animals left, the crocodile might start eating people". Conditions for having crocodiles near communities often included reporting crocodiles to the officials and expecting the establishment of secure fencing "to prevent crocodiles escaping". Additionally, respondents usually provided solutions involving the removal of crocodiles from the area e.g. "If there is a crocodile in our community, I would beg the Municipality to remove the crocodile from the river" and "Crocodiles should be caught and removed from our community." (fig 5: Q15). Removal of nuisance crocodiles was previously a common strategy within crocodile conservation in the Philippines. However, such strategies often led to unsustainable resource use

and financial fatigue (Manalo and Aquino, 2020). Alternative approaches such as the installation of warning signs, public consultation, and facilitating alternative livelihood have become a priority in addressing concerns toward crocodiles (Corvera et al., 2017). Additionally, enhancing cultural knowledge has proven an effective strategy to promote co-existence (Corvera et al., 2017). Contrastingly, respondents supportive of reintroduction argued it would prevent children from going to the river and potentially drowning. Additionally, two respondents expressed interest in reintroduction for hunting and personal consumption.

In areas without crocodiles, a large proportion did not think crocodiles and people could co-exist (59%) (fig 3), "because the crocodiles might harm people". Other respondents stated crocodiles should be in a cage because they were dangerous: "Crocodiles are dangerous", "Crocodiles bite and eat people" and "Crocodiles are cruel". Contrastingly, some respondents thought co-existence was possible if people did not harm crocodiles. In such cases crocodiles were believed to seek revenge only if harmed: "[We can co-exist] if people will not harm crocodiles. If harmed, crocodiles might seek revenge" and "[we can co-exist] if we do not provoke the crocodiles. I saw a movie where people used dynamite in the water and the crocodile sought revenge." (fig 5; Q16).

Despite the inherent fear of crocodiles and scepticism about coexisting with people, respondents expressed a keen interest in acquiring information about crocodiles. Respondents stated that receiving information would serve as a remedy to alleviate fear. Respondents also stated their fear stemmed from the lack of information on the species. Learning about the behaviour and benefits of crocodiles could help change their attitudes: "There is a lack of information, that is why we are afraid" and "It might change my mind if there are benefits to our Barangay".

Conclusion

The challenges of conserving large predators, such as the Philippine crocodile, in human-dominated landscapes underscore the need for approaches that combine biological knowledge with social sciences. Preserving the species requires addressing the complex interactions between humans and crocodiles. Despite ongoing campaigns, communities continue to harbour fear. Continuous monitoring and engagement are essential to address concerns and garner support for conservation.

The influence of media, biting incidents, and physical features of crocodiles on public attitudes emerged as significant factors impacting attitudes towards crocodiles. Additionally, colonial influences have contributed to negative perceptions and altered the dynamic relationship between humans and crocodiles. Addressing these challenges requires multifaceted approaches that integrate cultural, economic, and ethical considerations. While economic incentives play a role in conservation, they should not overshadow intrinsic values or cultural significance. Communities living alongside crocodiles generally had a positive view of them compared to areas where crocodiles are no longer present. This project illustrated that personal experiences with a predator, which is not as dangerous as the media depicts, can encourage acceptance. Conversely, the lack of such experiences can be a barrier against accepting crocodiles.

Furthermore, initiatives such as CEPA campaigns play a crucial role in shaping public attitudes and fostering acceptance of crocodiles. Tailored campaigns are essential for enhancing knowledge and dispelling misconceptions. Communities must be equipped with the correct knowledge of crocodiles before release. International breeding initiatives should therefore only occur once communities are adequately informed and accepting of crocodiles.

In conclusion, the successful conservation of *C. mindorensis* requires a holistic approach that integrates biological, social, and cultural factors. Learning the attitudes of people living near crocodiles can help determine what people value. Such knowledge can be applied to communities that live in areas where crocodiles are no longer present. The nuanced attitudes of communities provide a valuable foundation for designing more targeted education campaigns. Addressing underlying drivers of conflict and fostering a mutual understanding can help pave the way for sustainable co-existence between humans and crocodiles in the Philippines.

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