



Original paper

## Perception and popular knowledge on crocodiles in the “Área de Protección de Flora y Fauna Manglares de Nichupté”, Quintana Roo, Mexico

## Percepción y conocimiento popular sobre los cocodrilos en el “Área de Protección de Flora y Fauna Manglares de Nichupté”, Quintana Roo, México

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**ABSTRACT.** The success of crocodile conservation programs highly depends on local people’s views, perceptions, and knowledge regarding these reptiles. The present study assessed these variables across the Nichupté lagoon through semi-structured interviews. Answers were grouped into three categories: thoughts regarding the presence of crocodiles in the area, locals’ perception on crocodiles, and local knowledge on crocodiles. Most of the 221 people interviewed showed no aversion to crocodiles, 93.2% knew about the presence of crocodiles in the lagoon, and 98.1% mentioned that it is essential to conserve these reptiles. On the other hand, 77.5%



(men) and 70.5% (women) agreed that "it is fine" to share the lagoon with crocodiles. Concerning people's perceptions about crocodiles, "Quiet", "Indispensable" and "Interesting" were the most frequent answers. Regarding the local knowledge, we found a positive, statistically significant correlation between this variable and education, with those having high school degrees mentioning "Habitat" and those with college degrees mentioning "Reptile" more frequently. Conservation policies should be redesigned to include continuous environmental education programs that promote positive attitudes towards crocodile species. They should also include measures to guarantee the dissemination of necessary information to protect human and crocodile lives, is essential to consolidate conservation programs.

**Key words:** Cancún; conservation; opinion; predator; prehistoric

**RESUMEN.** El éxito en los programas de conservación de cocodrilos depende en gran medida de la percepción y del conocimiento que las personas tienen sobre estos reptiles. El presente estudio evaluó estas variables en la laguna Nichupté a través de entrevistas semi-estructuradas. Las respuestas se agruparon en tres categorías: opinión sobre la presencia de cocodrilos en el área, la percepción, y el conocimiento sobre los cocodrilos por parte de la gente local. La mayoría de las 221 personas entrevistadas no mostraron aversión hacia los cocodrilos, el 93.2% conocía la presencia de cocodrilos en la laguna, y el 98.1% mencionó que es esencial conservar a estos reptiles. Por otro lado, 77.5% (hombres) y 70.5% (mujeres) estuvieron de acuerdo en que "Está bien" compartir la laguna con los cocodrilos. En cuanto a las percepciones de las personas sobre los cocodrilos, "Tranquilo", "Indispensable" e "Interesante" fueron las respuestas más frecuentes. Con respecto al conocimiento de los lugareños, encontramos una correlación positiva y estadísticamente significativa entre esta variable y la educación; es decir, aquellos con estudios de secundaria mencionaron la palabra "Hábitat" y aquellos con títulos universitarios mencionaron "Reptil" con mayor frecuencia. Las políticas de conservación deben ser rediseñadas para incluir programas de educación ambiental continua que promuevan actitudes positivas hacia las especies de cocodrilos. También deben incluir medidas para garantizar la difusión de la información necesaria para proteger la vida de los humanos y los cocodrilos, ya que esto es esencial para consolidar los programas de conservación.

**Palabras clave:** Cancún; conservación; depredador; opinión; prehistórico

## INTRODUCTION

The growing human population has increased human-wildlife interactions (Weladji & Tchamba, 2003). Wildlife conflicts likely increase when an ever-increasing number of individuals tend to gather in a limited area close to natural habitats (Inskip & Zimmermann, 2009), especially with large predators (Lamarque *et al.*, 2009). Crocodiles are large predators and key species associated with aquatic ecosystems that play a vital role in the maintenance of biodiversity and freshwater ecosystems structure and function (Thorbjarnarson, 1992; Ross, 1998; Leslie & Spotila, 2001; Glen *et al.*, 2007). Aside from ecotourism, interactions between people and crocodiles rarely show positive results (McGregor, 2005) and the development of alternatives to reduce conflicts is essential to mitigate the loss of human lives, livestock, and crocodiles (Fergusson, 2002). As

ecotourism became increasingly popular, human-crocodile conflicts also increased (Steubing, 1983; Conover & Dubow, 1997; Aust *et al.*, 2009; Gopi & Pandav, 2009; Wallace *et al.*, 2012). Crocodiles are among a few species that scare human beings, maybe because the fear of being eaten is worse than being bitten (Beard & Graham, 1990). Thus, the success or failure of crocodile conservation programs largely depends on the views and positions of people sharing the same habitat (Woodroffe *et al.*, 2005).

The American crocodile (*Crocodylus acutus*) is distributed from Florida to the coast of the Yucatán Peninsula, Central and South America (Thorbjarnarson *et al.*, 2006). It is locally sympatric with *C. moreletii* in the states of Yucatán and Quintana Roo (Cedeño-Vázquez *et al.*, 2008). Is catalogued as "Vulnerable" by the IUCN (International Union for the Conservation of Nature) Red List of Threatened Species (Ponce-Campos *et al.*, 2012). It is also included in "Appendix I" of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and is subject to "Special protection" by the Mexican environmental regulations (NOM-059-2010; Diario Oficial de la Federación, 2011).

Morelet's crocodile (*C. moreletii*) occurs in marshes, lakes, and rivers along the Gulf of Mexico and the Yucatán Peninsula (Cedeño-Vázquez *et al.*, 2006; Escobedo-Galván & González-Salazar, 2011), including northern Guatemala and Belize (Ross, 1998). Is catalogued as "Least Concern" by the IUCN's Red List (Cedeño-Vázquez *et al.*, 2012), considered under "Special protection" by the Mexican environmental regulations (NOM-059-2010; Diario Oficial de la Federación, 2011), and included in "Appendix II" of CITES, except for Guatemalan populations (CITES, 2018).

By understanding and integrating the cosmogony and knowledge of local communities regarding crocodiles, researchers can establish sound conservation strategies in-line with cultural relations. In the Yucatán Peninsula, Mayans used crocodiles for food, medical, and cultural purposes (e.g., crocodile's jaws were placed on altars and teeth were used to manufacture necklaces; Zamudio *et al.*, 2004). Crocodile's teeth were also found as ornaments in Mayan archeological sites (Lee, 1996). In a study conducted in Quintana Roo, it was observed that crocodile hunting by the contemporary Mayans was an infrequent activity, but as time went by, it became a daily task due to the demand for crocodile hides (Zamudio *et al.*, 2004).

On the other hand, García-Grajales and Buenrostro-Silva (2019) found that the Benito Juárez municipality in Quintana Roo has the highest risk of crocodile attacks. Lucherini and Merino (2008) mentioned, in the case of carnivorous animals that usually cause harm such as preying on livestock or threatening human lives, that understanding the way of seeing and interpreting the world of certain species is fundamental to determine the attitudes and actions taken towards them. The success or failure of crocodile conservation programs largely depends on the views and positions of the inhabitants sharing the same habitat (Woodroffe *et al.*, 2005).

The present study assessed people's perception and knowledge regarding crocodiles (*Crocodylus acutus* and *C. moreletii*) that inhabit the "Área de Protección de Flora y Fauna Manglares de Nichupté" in the Benito Juárez municipality, Quintana Roo, Mexico. We used the

concept of perception developed by Lazos and Paré (2000), who suggest that perceptions are understood as a system of beliefs, attitudes, and estimates established by the individuals about their surroundings. Personal experience, social interaction, besides the historical, cultural, and political processes of a social group, determine these environmental visions (Durand, 2008). The way people perceive their environment directly influences their actions, and consequently, considering them is valuable for developing interventions that tend to transform the society-nature relationship.

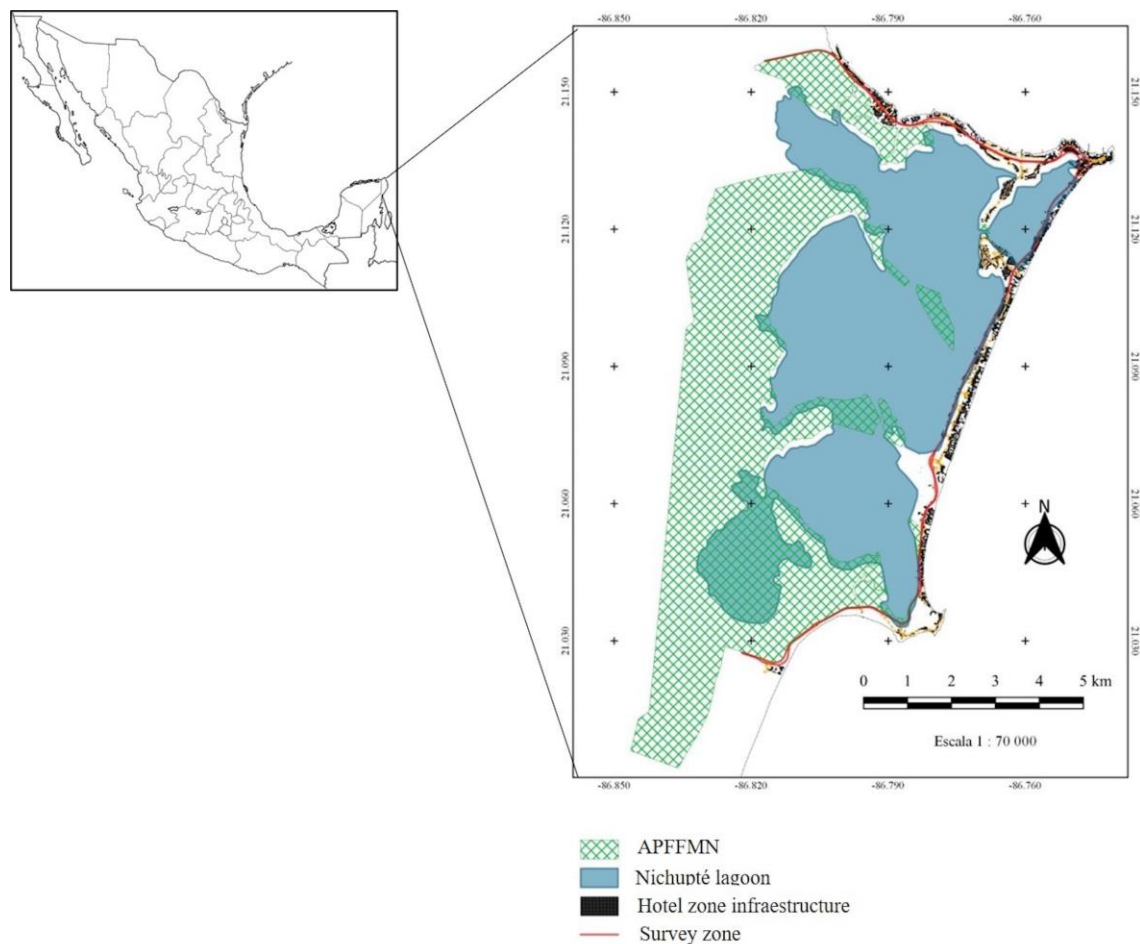
## MATERIALS AND METHODS

**Study area.** The “Área de Protección de Flora y Fauna Manglares de Nichupté” (APFFMN) is located along the Cancún hotel zone boulevard (Fig. 1), where an important diversity of aquatic and terrestrial ecosystems exists, including lowland deciduous forests, mangroves, tular vegetation, and “petenes” (SEMARNAT, 2014). This 4,257hectare lagoon system is part of the 142 Mexican wetlands registered in the RAMSAR Convention, fishing, tourism, and recreational activities are carried out throughout the year and around the lagoon. There are no established human settlements within APFFMN; nevertheless, a dense population is present on the outskirts. According to the National Institute of Statistics and Geography (INEGI, 2010), a total population of 661,176 inhabitants lived in the Benito Juárez municipality in 2010, representing 49.88% of the Quintana Roo entire population. Of this total population, males were predominant with 50.66%, and females with 49.44%, this trend was the same at the state level. From 1980 to 2010, population growth totaled 623,986 people (INEGI, 2010). Tourism is the main activity in this municipality, and Cancún is dominant economic pole. Among the tourist indicators of Quintana Roo according to the Ministry of Tourism (SEDETUR), by 2017 the hotel infrastructure in Cancún had 28,218 rooms, 67.8% hotel occupancy and reported revenues of \$3,072,910,000 (56.4% of the state’s budget) from 3,004,802 tourists.

**Data collection.** We performed semi-structured interviews (Robson, 1993) along the boulevard of the hotel zone from August to September 2018, to explore the human-crocodile relationship in the study area. The semi-structured interviews consisted of having conversations with people in a specific category (Vela, 2001): thoughts regarding the presence, perception, and knowledge on crocodiles in Nichupté lagoon. The interviewees were chosen in two modes: 1) Haphazard, intercepting people walking on the boulevard and by the shores of the lagoon and beaches; 2) Walking into restaurants located on the lagoon shores, always asking for permission from the waiters or managers to interview their customers. A modified spreadsheet software with the topics by categories of the interviewee’s possible responses facilitated and speeds up data collection, this reflects their thoughts on the topic and the most attached to their idiosyncrasy. This format helps grant interviewees the freedom to express their true attitudes (Chanda, 1996; Ringrose *et al.*, 1996). The questions included: 1) *How old are you?*; 2) *What is your job?*; 3) *What is your education level?*; 4) *Do you know that crocodiles live in the lagoon?*; 5) *Do you think it is good or bad that crocodiles are in the lagoon?, why?*; 6) *What do you know about crocodiles?*; 7) *Do you consider their conservation important?* The answers were written on the spreadsheet, for instance, on question 5, every adjective which interviewee mentioned in their answers were registered. On question 6, the properties that interviewees mentioned in reference to their knowledge about crocodiles were

registered. Other demographic information such as income or economic aspects were not collected as it could be perceived as invasive by the interviewees (DiCicco-Bloom & Crabtree, 2006).

**Data analysis.** The data were grouped by age ranges according to the National Population Council (CONAPO), in three categories: teenagers (15–17 years old), young adults (18–24 years old) and adults (25 years old and over). The Shapiro-Wilk test was applied to evaluate data normality ( $\alpha = 0.05$ ; Yap & Sim, 2011). The Pearson correlation ( $\alpha = 0.05$ ) was carried out between range-age, education level and the frequencies of answers about presence, perception, and knowledge on crocodiles.



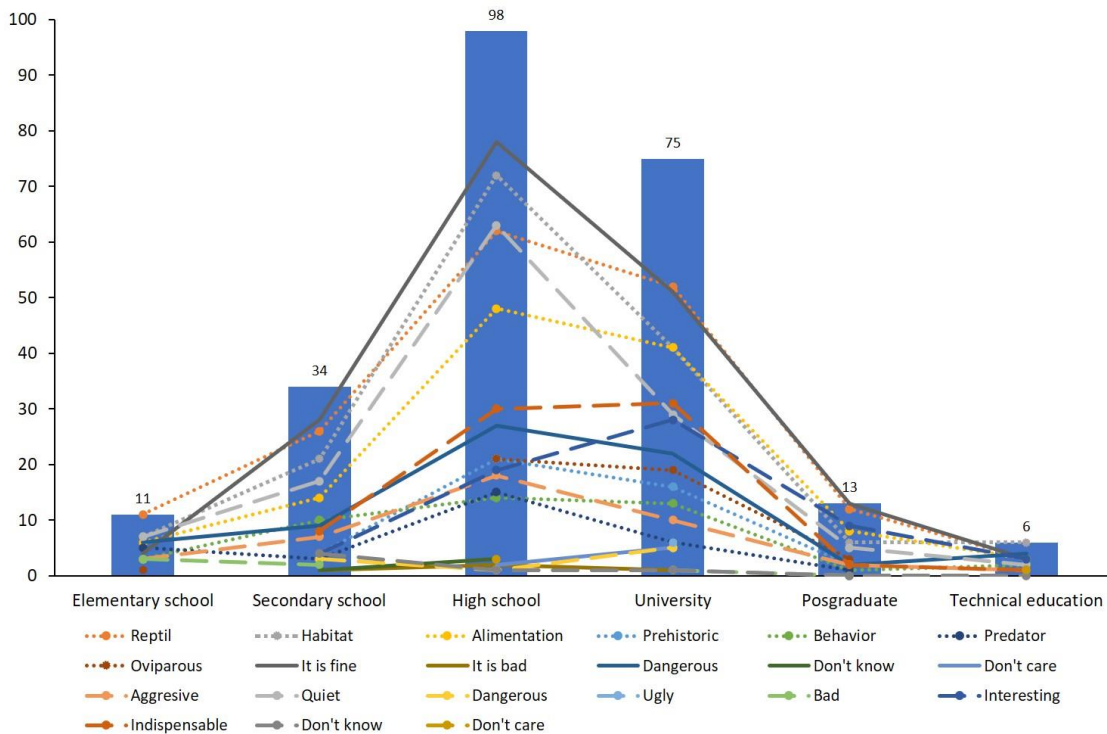
**Figure 1.** "Área de Protección de Flora y Fauna Manglares de Nichupté", located along the Cancún hotel zone boulevard.

## RESULTS

We interviewed 221 persons (136 men and 85 women), including 10 teenagers, 35 young adults, and 176 adults. Regarding educational level, 4.6%, 14.3%, and 41.3% of those interviewed

concluded primary, secondary, and high school, respectively; 2.5% studied a technical degree, 31.6% and 5.4% completed a university and postgraduate degree, respectively. Of the total number of people interviewed, 43.4% were tourists, 21.7% were engaged in different occupations, 16.7% worked in restaurants, 12.6% were salespeople in the hotel zone, 4.9% worked on boats, and 0.4% were fishermen. Of all the people interviewed, 93.2% were aware of the presence of crocodiles in the lagoon. Regarding the question on the importance of conserving crocodiles, 98.1% mentioned that it is important to conserve these reptiles, 1.3% mentioned that they did not know and only the 0.4% said that it is not important to conserve them. People's opinions about the presence of crocodiles in the lagoon differ widely, but some appeared very frequently, 77.5% of men and 70.5% of women agreed that "it is fine" to share the lagoon with crocodiles (Fig. 2). "Dangerous" was the second most frequent response, with 31.6% of men and 28.2% of women. "It is fine" had the highest and "Dangerous" the second most frequent percentages in all age-class categories.

In terms of people's perception on the crocodiles, women and men think that crocodiles are "Quiet" with 50.5% and 52.8%, respectively. "Indispensable" represents the second most common response, with 31.7% for men and 28.4% for women. Regarding people's perception on crocodiles by age class, "Quiet" was mentioned the most by young adults and teenagers (52% and 50%, respectively) followed by "Indispensable" with 24%, 21%, and 14.3% for young adults, adults, and teenagers, respectively (Fig. 2).



**Figure 2.** Bar graphs portraying frequency of response by sex and age-range about the presence and perception on crocodiles in Nichupté lagoon.

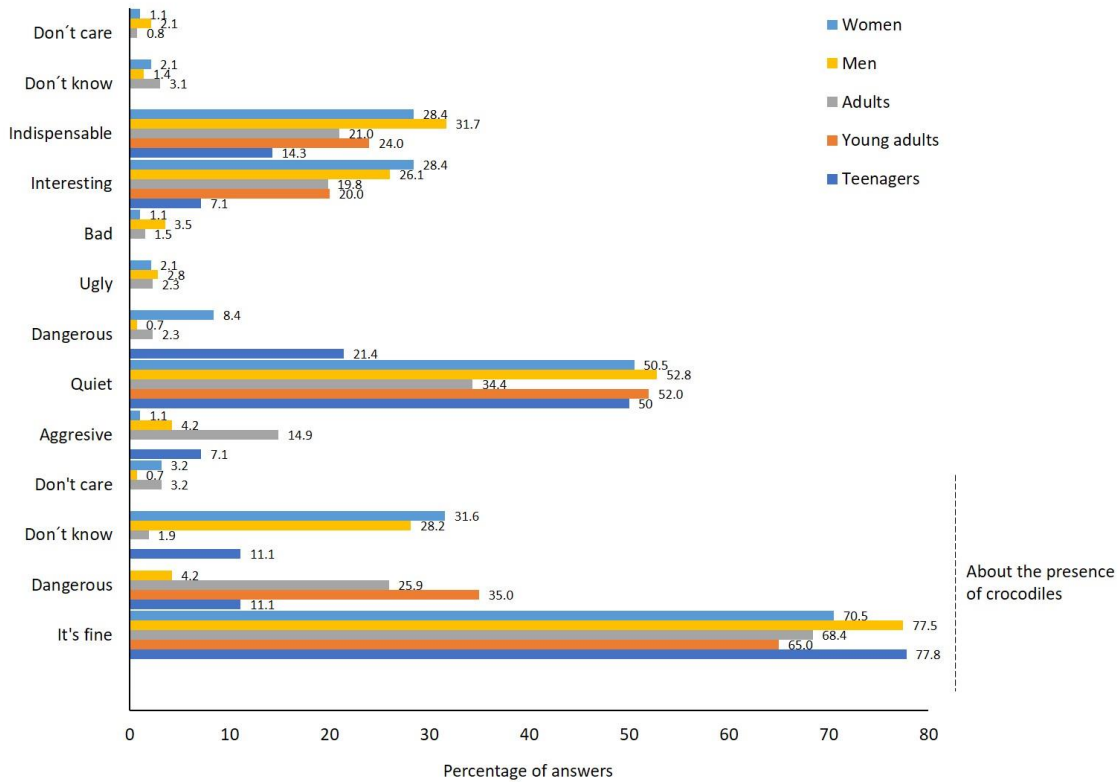
Concerning people's knowledge about crocodiles, "Reptile" was the most frequent response with 75.4% (men) and 63.2% (women), followed by "Habitat" with 68.3% (men) and 58.9% (women), while "Predator" was the least frequent response with 15.5% (men) and 8.4% (women). Regarding age classes, "Habitat" and "Reptile" were the most frequent responses with 31.8% (teenagers), followed by "Habitat" with 31.8% (young adults), and "Reptile" with 28.0% (adults). The least frequent responses were "Feeding", "Prehistoric," and "Oviparous" with 4.5%, respectively (teenagers), followed by "Predator" with 3.5% (young adults) and 5.3% (adults).

Regarding correlations between response frequencies and knowledge of the existence of crocodiles in the lagoon, people with a high school degree had "It is fine" as the highest frequency of responses. In this same aspect, only one significant correlation was found in "It is fine" ( $r = 0.991$ ,  $p = 0.000$ ) and "Dangerous" ( $r = 0.990$ ,  $p = 0.001$ ) with the level of studies. Regarding people's perception on crocodiles, it was found that "Quiet" and "Indispensable" were most often mentioned by those with high school and university education, respectively (Fig. 3). In this same aspect and the degree of schooling of the interviewees, there was only one significant correlation between the response frequency "Aggressive" ( $r = 0.971$ ,  $p = 0.005$ ), "Quiet" ( $r = 0.954$ ,  $p = 0.011$ ), and "Indispensable" ( $r = 0.969$ ,  $p = 0.006$ ). Regarding the knowledge on crocodiles, "Habitat" and "Reptile" were mentioned more frequently by those holding a high school and university degrees, respectively (see Fig. 3). All correlations of knowledge about crocodiles and the level of studies were significant: "Reptile" ( $r = 0.994$ ,  $p = 0.004$ ), "Habitat" ( $r = 0.978$ ,  $p = 0.003$ ), "Feeding" ( $r = 0.992$ ,  $p = 0.007$ ), "Prehistoric" ( $r = 0.992$ ,  $p = 0.000$ ), "Behavior" ( $r = 0.924$ ,  $p = 0.024$ ), "Predator" ( $r = 0.938$ ,  $p = 0.018$ ) and "Oviparous" ( $r = 0.941$ ,  $p = 0.016$ ). On the other hand, only one significant negative correlation was found between the age category and the opinion about the presence of crocodiles: "It is fine" ( $r = -0.414$ ,  $p = 0.004$ ). On crocodile perception and age category there was a negative and weak but significant correlation with "Aggressive" ( $r = -0.297$ ,  $p = 0.022$ ) and "Don't know" ( $r = 0.282$ ,  $p = 0.028$ ). No correlation of any kind was found between knowledge on crocodiles and age categories.

## DISCUSSION

Different types of responses were found regarding people's perceptions about crocodiles along the Cancún Hotel Zone boulevard. What people think about crocodiles is important; their perceptions guide the interactions with these reptiles. Conover (2002) defined the interactions between human and wildlife as situations occurring when an action by either humans or wildlife has an adverse effect on the other. In this respect, we found that most people have no aversion to crocodiles. This is considered a key factor enhancing this conflict despite the significant increase of attacks in Mexico (Sideleau & Britton, 2013; Fukuda *et al.*, 2014; García-Grajales & Buenrostro-Silva, 2019). Padilla & Perera-Trejo (2010) in the Yucatán Peninsula found a higher percentage of people (37%) who consider the crocodiles necessary from an environmental perspective, meanwhile, 25% said crocodiles were not relevant to them, 22% said that their importance relied only on their exploitation, 10% said that are essential for both, the environmental aspects and their exploitation, and a smaller percentage (2%) reported that crocodiles had a scenic value. Peña-Mondragón *et al.* (2013) reported the opposite situation on the coast of Jalisco, where 85% of the interviewees recognized crocodiles as dangerous, whereas the same percentage disliked them.

However, in our study, young adults considering crocodiles as dangerous resulted in the second most frequent response. This can perhaps be attributed to the lack of economic alternatives in rural areas, and, therefore, people use dangerous fishing methods, such as throw net fishing (García-Grajales & Buenrostro Silva, 2015b). In addition to this, swimming in crocodile habitats poses a high risk of attack, and this represents the second activity related to human-crocodile conflicts (García-Grajales & Buenrostro-Silva, 2019). Although García-Grajales and Buenrostro-Silva (2018) stated that seasonal patterns of attacks by crocodiles in the Oaxacan coast are related to nesting and rainy seasons.



**Figure 3.** People's education level and frequency of response about the presence, perception, and knowledge on crocodiles in Nichupté lagoon.

Regarding people's knowledge about crocodiles, the most common response (more than 60% for women and men) was "Reptile", which proves that people have basic knowledge about animals present in the Nichupté lagoon. None of the people interviewed mentioned if there were two different species of crocodiles in the area, compared to what García-Grajales and Buenrostro-Silva (2015b) found in rural communities in the coast of Oaxaca, where 25.9% of the interviewees answered know there are two species of crocodiles, another 25.9% commented that there is only one species, another similar percentage (25.9%) answered that they did not know if there were different types of crocodiles, 16.7% answered that there were three species (the yellow lizard, the dark greenish lizard and the crocodile), and 5.6% answered that there are four species of crocodiles (the aforementioned above plus one species that is always in fresh water). The second most recurrent response (68.3% for men, 58.9% for women) exemplified the fact that they can even



identify the type of habitat in which crocodiles live. These results suggest that people who show a lack of knowledge about crocodiles, even seem to not be interested in knowing more about them. Balaguera-Reina *et al.* (2019) also found in Colombia that 75% of the interviewees have insufficient knowledge of the crocodile species that inhabit the region. Despite the above mentioned, the relationship we found in this research between the degree of schooling and the knowledge that people have about crocodile shows that it is vital to educate the population in environmental aspects, focusing on the reality of each locality or region. Similarly, the correlation found between schooling and the perception that people have about crocodiles, "Indispensable", "Aggressive", and "Quiet" had a reasonably high and significant correlation. This suggests the need to implement a more considerable effort in the dissemination and awareness on crocodile species, which will increase people's knowledge on the importance of crocodiles in the ecosystem functionality, as well as strengthen the importance of preserving them and facilitate planning for their conservation (Balaguera-Reina *et al.*, 2019).

People are aware of the basic aspects related to crocodile feeding and reproduction (oviparous, reproducing once a year, feeding on meat, among others). However, people use to visit the Nichupté lagoon as a recreation ground all year long, including during *C. acutus* y *C. moreletii* mating and breeding season, and they ignore the fact that crocodiles become more aggressive and mark territorial displays (Sánchez-Ramírez, 2001; Casas-Andreu, 2003). Besides, *C. acutus* make their nest by digging holes in the sand (Casas-Andreu, 2003; Barros *et al.*, 2005), and people that are unaware of the danger may walk by a nest and onto a female crocodile protecting it (Platt & Thorbjarnarson, 2000). It is relevant to mention that the area where the interviews were conducted for this study is the one that registers the most crocodile attacks in the municipality of Benito Juárez, Quintana Roo, Mexico (García-Grajales & Buenrostro-Silva, 2019). It is very likely that due to this situation, there is a negative perception of the people on the crocodiles in this area.

About people's perception on crocodiles, in the Nichupté lagoon there is no aversion to these reptiles, as shown by the most frequent responses ("Quiet" and "Indispensable"). However, human-crocodile conflicts can cause a negative recrudescence and perception toward crocodiles as it happens in other sites where crocodiles are present (Hernández-Hurtado *et al.*, 2006; Smithem & Mazzotti, 2008; Wallace *et al.*, 2012; García-Grajales, 2013; Peña-Mondragón *et al.*, 2013; Ponce-Campos, 2014; García-Grajales & Buenrostro-Silva, 2019). On the other hand, in the Yucatán Peninsula, Padilla and Perera-Trejo (2010) found that slightly more than half of all of the interviewees (54%) think that a crocodile is a dangerous animal, 30% see it as a harmless animal, 14% consider that it reacts according to the way it is treated, and a minority (1%) observes that it attacks because it is hungry. Therefore, this indicates that people are aware that the attacks could have been avoided. However, as in other cases recorded on the Pacific coast and in Central America, fishing is the primary practice that can incite or lead to attacks, and secondly, carrying out recreational activities in crocodile areas (Hernández-Hurtado *et al.*, 2006; García-Grajales, 2013; Ponce-Campos, 2014; García-Grajales & Buenrostro-Silva, 2015a; García-Grajales & Buenrostro-Silva, 2018; García-Grajales & Buenrostro-Silva, 2019). In Australia, Leach *et al.* (2009) stated that crocodiles appearing in human settlements or close to them are considered a risk to people and livestock and are hence defined as problem crocodiles. Although our results showed no significant

differences between age ranges and people's perception and knowledge about crocodiles, it is clear that most of the interviewees do not consider crocodiles as a public safety issue even though the attacks can be avoided. In this aspect, it is advantageous to assimilate this information within the species management plan, especially in urban and rural areas, to make the technology transfer more efficient and ensure crocodile conservation.

The Human-Crocodile Contingency Plan (SEMARNAT, 2018) contains a strategy to prevent attacks or reduce any types of negative interactions with crocodiles, regardless that a section about the perception on crocodiles in different parts of the country is missing and which could have helped offset the harmful and fatal encounters. As an example, safety awareness education and problem crocodile removal consist of the two main components of the safety program implemented by the Australian government (Fukuda *et al.*, 2014). In Mexico, few studies on people's perception on crocodiles exist; however, despite the lack of information the crocodile management and conservation policies are yielding results, but these policies must include attitudes and perceptions of local communities soon. The conservation policies need to be redesigned in order to embrace the rapid developments responsible of ecosystems deterioration (Aust *et al.*, 2009). Conducting an ongoing environmental education program that promotes positive attitudes and values about the crocodile species, and taking steps to ensure useful information to safeguard human lives from possible attacks are essential to consolidate crocodile conservation programs (Hernández-Hurtado *et al.*, 2006). Furthermore, it is necessary to carry out crocodile population monitoring and typify fishing, tourism, and recreational activities around the Nichupté lagoon to establish a preventive and awareness program with fishermen, locals, and tourists.

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