Colegio de Postgraduados

The relationship between the fishermen and the American crocodile (*Crocodylus acutus*) in the Mexican central western Pacific: a narrative analysis

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ABSTRACT

Objective: To analyze the relationship between the fishermen of central western Mexico and the river crocodiles (*Crocodylus acutus*), emphasizing the resulting conflict.

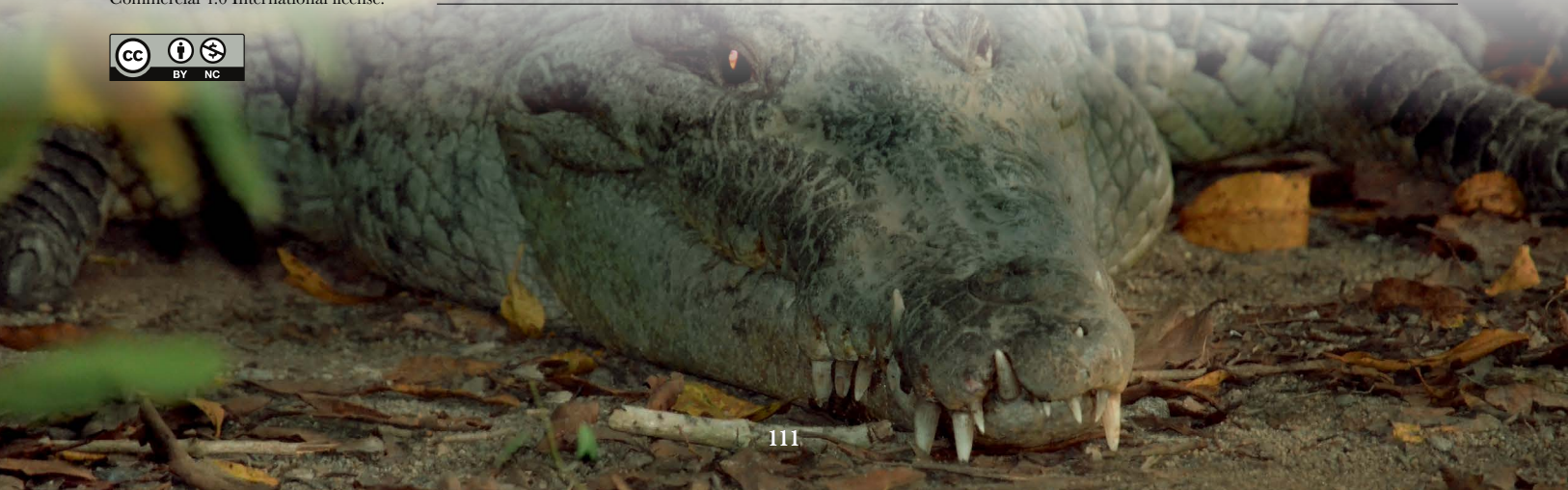
Design/Methodology/Approach: The work was carried out with 22 fishermen from the Cuyutlán and Alcuzahue lagoons in Colima, Mexico. Four participative workshops were organized per community, in order to explore the positive and negative aspects of the relationship, the perception and knowledge about the ecosystem functions of the crocodile, and the management practices and actions associated with this relationship, as well as to determine the natural participants and factors that influence the said relationship. The workshops were recorded and the resulting data was subjected to a narrative analysis and a summary.

Results: Harmonious relationships are recorded, including the creation of bonds between humans and crocodiles and recognizing the benefits to fishing and the ecosystem function of the crocodile. The conflictive relationships identified were related to fishing, the reduction of fishing resources, and accidents. The strategies used to prevent conflicts are related to the dangerous zones, the behavior of the crocodiles, and the killing of the animals to reduce their presence. Additionally, compensation schemes, a collective management of fishing resources, and the replacement of fishing by the exploitation and capture of the crocodile were taken into consideration.

Study Limitations: Besides the fishermen's, the point of view of other participants should be determined.

Conclusions: The relationship between fishermen and crocodiles is both harmonious and conflictive. On the one hand, both receive benefits; on the other hand, fishermen suffer economic, operative, and life style impacts, which create inauspicious scenarios for the conservation of the reptile.

Keywords: animal damage, conflict, crocodile, relationship, fisheries.



INTRODUCTION

Fishing has shaped several life styles around the world for at least 92,000 years (Dahlet, Himes-Cornell, and Metzner, 2021; Lackey, 2005) and, even in the early 19th century, fishing resources were considered inexhaustible (Lackey, 2005). Afterwards, the scarcity of the resources led to their initial management and farming. By the mid-twentieth century, the management of fishing was based on the maximum possible yield (Andrew *et al.*, 2007; Lackey, 2005).

The studies about fisheries management have been focused on biological and ecological indicators, paying scarce attention to the social mechanisms and dynamics that are part of the activity (Andrew *et al.*, 2007). These type of studies include works that seek to understand the social conflicts involved in fishing (Dahlet *et al.*, 2021). Some researches focus on the fishermen-wildlife conflict, in which both parties cause and suffer damage (Szteren and Páez, 2002; Tixier *et al.*, 2021).

These conflictive relationships are usually caused by the loss of fishing, the risk of facing wildlife, the damage caused to the work equipment, and the association of wildlife with the reduction of fishing resources. All these elements threaten food and economic security, making the life style of fishermen even harder (Guerra, 2019; Tixier *et al.*, 2021). Wildlife dies as a result of the reprisal of the fishermen or trapped in their nets; consequently, their populations and conservation are endangered (Guerra, 2019; Wickens *et al.*, 1992).

Researches about this subject have analyzed this phenomenon from a quantitative point of view, calculating economic losses (Guerra, 2019; Tixier *et al.*, 2021). For example, Szteren and Páez (2002) determined that the damage caused to the fishermen's equipment by wildlife amount up to 71% of their operative cost.

Nevertheless, the relationship between fishermen and wildlife is not well known and there is a gap of qualitative variables, including experiences, beliefs, myths, discourses, values, and perspectives (Serfass, Bohrman, Stevens, and Bruskotter, 2014; Tixier *et al.*, 2021). Additionally, the studies have been focused on the interaction between mammals or birds and fishermen. There is less information about the fishermen-crocodile relationship, although some studies have determined that it is conflictive in nature (Aguilar-Olguín, Rivera-Rodríguez, Hernández-Hurtado, and Ramírez-Martínez, 2021; Aranda-Coello *et al.*, 2016; Das and Jana, 2018). However, the analysis has been almost exclusively focused on the general aspects of the fishermen-crocodile conflict or in their relationship (Brackhane *et al.*, 2019; Kpéra *et al.*, 2014; Peña-Mondragón *et al.*, 2013). Few studies analyze the specific aspects of that relationship. Most of the studies are focused on the quantitative and economic aspects of the fishermen-crocodile relationship (Aust, Boyle, Fergusson, and Coulson, 2009). Therefore, the objective of this study was to analyze that relationship, focusing on the resulting conflict, but also seeking to reflect the phenomenon from a coexistence point of view (Pooley, Bhatia, and Vasava, 2021).

MATERIALS AND METHODS

Study sites

The study was carried out with fishermen that work in two water bodies inhabited by *Crocodylus acutus*, in Colima, in western Mexico. The first is the Alcuzahue lagoon (18° 54'

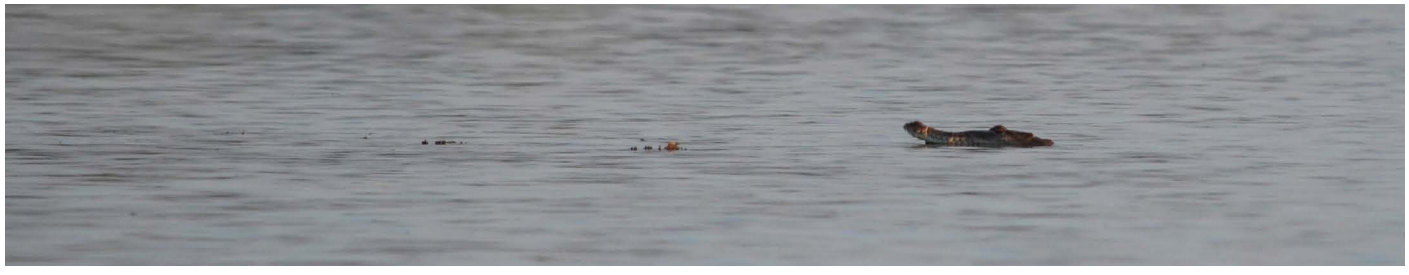
42.50" N and 103° 46' 32.33" W), located in the municipality of Tecomán. The second is the Cuyutlán lagoon, a massive body of water which —as a result of its hydrological characteristics— is usually divided into four sections. This lagoon extends into the territory of various municipalities. This research was carried out in the Vaso IV (18° 54' 05" N, 104° 01' 53" W), in the sites popularly known as Estero Palo Verde and La Laguna. Both sites are located in the municipality of Armería. In both localities, the fishermen have formed cooperatives, which have an exclusive permit for the exploitation of the fishing resources. However, some fishermen carry out this activity without being members of the said cooperatives or without a permit. Both groups use fishing methods such as cast netting or trammel net. Their catch is used for self-consumption and/or sold at the local market. Consequently, their activity is considered artisanal or small-scale fishing.

Data generation

Data generation was carried out through participative workshops (Geilfus, 2002; Gerritsen, 2016) that took place from January to February 2021. The participants were members of the Sociedad Cooperativa de Producción Pesquera Laguna de Alcuzahue and non-associated fisherman from both Alcuzahue and Cuyutlán. The fishermen were 36-64 years old and all of them had at least 5-year experience as fishermen in the said sites. However, most of them had been fishing for 20-30 years in coastal areas. Twenty-two fishermen attended the four participative workshops that were organized in each community, following the methodology proposed by Geilfus (2002) and Gerritsen (2016). Overall, the workshops sought to understand the fishermen-crocodile relationship. The first workshop explored the positive and negative aspects of the relationship, while the second confirmed these aspects, emphasizing perceptions and knowledge about the ecosystem functions of the crocodile (Somaweera *et al.*, 2020). The third workshop focused on management practices and actions associated with these relationships. Finally, the fourth workshop sought to understand the natural participants and factors that influence the phenomenon, especially management practices and actions.

Data analysis

The workshops were recorded with the prior authorization of the participants. Subsequently, the dialogues were transcribed (Elliott, 2005; Poland, 1995) and the transcriptions were subjected to a narrative analysis. Categories based on common and contradictory elements of the different narratives of the participants were developed for the narrative analysis. After reading and re-reading the workshop transcriptions, these patterns



were grouped , in order to create a synthesis (Elliott, 2005; Lieblich, Tuval-Mashiach, and Zilber, 1998; Riessman, 2008; Wertz *et al.*, 2011). Finally, the results are expressed as an unified text, where some categories are depicted as prototype fragments of the fishermen's words (Riessman, 2008). The fishermen are identified in the results section with their code plus an ordinal number (*i.e.*, Fisherman 1, Fisherman 2).

RESULTS AND DISCUSSION

In average, the fishermen were 40 years old. Five of the fishermen were not members of a fishing cooperative and only three were women, who occasionally fish along with their partners. Additionally, six fishermen were directly or indirectly related to crocodile conservation projects. Regarding the fishermen-crocodile relationship, two types of relationships were established: harmonious and conflictive.

Harmonious relationships with crocodiles

The fishermen mentioned that they create bonds with some of the crocodiles and that they acknowledge the benefits that crocodiles bring to fishing. According to Himes and Muraca (2018), these aspects influence their lifestyles.

The harmonious relationships that were found have already been reported in other researches. However, they were no more than short comments in extensive articles that mainly focused on the conflict. This is a typical characteristic of the studies about the overall human-wildlife relationship (Pooley, Bhatia *et al.*, 2021). Consequently, this research aimed to find the highest possible number of positive fishermen-crocodile relationships.

Regarding the bonds, those fishermen said that they are created because they spend a lot of time in the fishing spots and coexist with certain specimens. They like and name these animals. Additionally, they feed them and are aware of their temperament. Fishermen consider that this is a reciprocal behavior because the reptile also recognizes them. For example, Fisherman 1 told us:

> *"Bonds are created between humans and animals. [...] The crocodile comes closer, and I feed her. [...] Some of them have names. [...] Some of them have a different temperament. The one I always talk to in the canal (Muñeca) doesn't come closer. [...] She has her babies and I pass near them and the animal doesn't attempt to attack me."*

Nevertheless, some researchers argue that feeding crocodiles is a potentially dangerous situation that can result in attacks (Pooley *et al.*, 2021). About this situation, Fisherman 1 said:

> *"Of course, it's dangerous, [...] we know how dangerous crocodiles are. [...] Fishermen feed crocodiles because they enjoy watching them eat."* (Fisherman 1).

Crocodiles provide ecosystem benefits to fishing. Four of these benefits can be included as part of their ecosystem functions (Somaweera et al., 2020) they are top predators; they favor the nutrient flux; they are an ecosystem indicator and engineers; and they are the

"guardians" of fishes. Since this last function is not included in the literature, we will attempt to explain it.

The crocodile cause fear among some people. Fear drives fishermen away and, consequently, more fishes can be found in the water bodies. Fisherman 3 explains:

> *"Crocodiles protect the fishes and there are still enough fishes. [Otherwise] people would go as far as they could and fish as much as they could."* Fisherman 3

Regarding their ecosystem functions, crocodiles are predators that reduce the populations of certain species that also feed on fishes. Additionally, crocodile constructions such as "caves", "canals", "pools", and "*echaderos*" (places where the crocodile sunbathes) create ideal conditions for fish abundance and diversity.

Meanwhile, some fishermen say that they use these "*echaderos*" as indicators that "*there are fishes here*" and, consequently, good fishing. Camacho (2015) reported similar results in other places. Other fishermen affirm that fishes eat the nutrients "*freed*" by the movements of the reptile.

These benefits for fishing and the bonds created with the crocodiles have been scarcely explored in scientific researches, which mainly focus on the crocodile-fishermen conflicts (Pooley, Bhatia *et al.*, 2021). However, understanding these conflicts provide useful information to manage conflictive situations, because fishermen that had harmonious relationships with the reptiles were the most involved in or receptive to crocodile conservation.

Conflicts between fishermen and crocodiles

The conflict between fishermen and crocodiles has three aspects: the first is the "*theft*" of the catch and the damage caused to the nets; the second relates to accidents involving crocodiles; and the third is the association of the crocodile with the reduction of fishing resources. These situations are separated for analytical purposes; however, they all can happen simultaneously.

The "*theft*" and the damage to the equipment take place when a fish is caught in the net and the crocodile "*comes and takes it*" (Fisherman 7) to eat it, ruining the fishing equipment. This phenomenon has been reported in other researches about the coexistence of fishermen and crocodiles (Aust *et al.*, 2009; Kpéra *et al.*, 2014). Similar conflicts have been recorded between humans and aquatic mammals (Guerra, 2019; Szteren and Páez, 2002).

The damage caused to the nets depends on the particularities of each fishing method. Passive fishing methods (such as the trammel net method) require that the nets stay longer in the water, which results in greater damage (Szteren and Páez, 2002), while cast netting is a more active and maneuverable method which results in longer-lasting nets. Fisherman 8 told us:

> *"I've got cast nettings from last year. They last longer, because they occupy a small area. If you see [the crocodile], you just quickly pull them out."*

In short, this conflict causes economic damages, which is the main operative expenditure of the fishermen (Aust *et al.*, 2009; Tixier *et al.*, 2021). If the damage can be fixed, it takes time and money (Aust *et al.*, 2009; Guerra, 2019). Additionally, since most of the interviewees does not know how to fix their nets, they can spend at least US$15.00 in repairs, tantamount to what they normally earn in a day. Besides, while the nets are being repaired, the fishermen cannot fish (Guerra, 2019), unless they own more than one piece of such equipment. Fisherman 7 says that "*you need to own at least four*" to mitigate the crocodile effect.

Therefore, each time their equipment is completely damaged, fishermen have to invest about US$45.00-US$100.00 in new equipment. These situations vary in frequency: some of the fishermen told us that these damages take place every time they fish, while others told us it happens two or three times a month. The frequency of the attacks mentioned by the fishermen matched the findings of other studies (Aust *et al.*, 2009). Finally, in addition to these expenditures, fishing is reduced because of damaged equipment, as Fisherman 6 told us:

"*Right now, I catch 5 kg of fish; if there are no crocodiles, I catch 20 kg.*"

The conflict with the crocodiles causes great operative difficulties for the fishermen. This situation is similar with other wildlife species (Szteren and Páez, 2002). However, accidents are a very important characteristic of the relationship with crocodiles. These accidents can take place when the fishermen are moving throughout the water body, while they operate their equipment or they "clean" the catch, which can attract crocodiles. All the fishermen that participated in the workshops recounted accidents involving those repitles. Fishing is the human activity that is impacted by more crocodile attacks in Latin America (Pooley, Siroski *et al.*, 2021). However, although the frequency of the attacks is high, in some cases they are "*just a fright*", while in other cases, the consequences are wounds that leave permanent scars and, in a few cases, lead to amputations. Additionally, some fishermen mentioned that, when they "*fight*" with a crocodile to retrieve the net, the risk of falling into the water poses a deadly risk, especially where the mud has turned "*rubbery*". Understandably, many fishermen fear for their lives. Therefore, fishing is a high risk activity, just like in other continents (Das and Jana, 2018; Wallace, Leslie, & Coulson, 2011). Some fishermen have doubts about pursuing this activity, while others are angry:

"*I would like to pull out a gun and just kill it.*" (Fisherman 12).

The last reason for the conflict is the "*excess of crocodiles*" (Fisherman 9) related to the reduction (both in quantity and diversity) of animals of commercial interest. For example, Fisherman 6 argues that "*one of the reasons why sometimes we do not find fishes*" is because crocodiles eat them. This situation was also reported in other studies (Aranda-Coello *et al.*, 2016) and it is one of the most common elements in the conflicts between fishermen and wildlife in general (Recharte, Bowler, and Bodmer, 2008; Serfass *et al.*, 2014). However, from a scientific point of view, these affirmation cannot be proved, because quantitative

data about the populations of commercial interest and the trophic relationship of the crocodile are required (Hilborn, Oscar, Anderson, Baum, and Branch, 2020; Maunder and Punt, 2013).

Overall data is scarce (Nifong *et al.*, 2014; Somaweera *et al.*, 2020) or non-existent, particularly for the sampling sites; however, this perception is not based on scientific facts and, along with abovementioned impacts, justifies the negative behavior and perspectives about the conservation of the crocodile (Guerra, 2019; Vaclavikova, Vaclavik, and Kostkan, 2011). Additionally, the alleged reduction (regardless of the cause) can increase the conflicts (Szteren and Páez, 2002). Nevertheless, fishermen also mentioned that the reduction of resources could be caused by fishermen who do not comply with the "*close season*", their chosen fishing method, and how long they keep the trammel nets in the water. Consequently, there is an overexploitation of the sites, which has a direct impact on the resources. African fishermen have already mentioned that crocodiles are not the only cause of the reduction of the fishing resources (Kpéra *et al.*, 2014); meanwhile, from a scientific point of view, overexploitation is the main cause of the reduction of fishing resources (Hilborn *et al.*, 2020).

Strategies to avoid conflict

There are only few scientific reports about the strategies used by fishermen to avoid the impacts of the crocodiles (Hayman *et al.*, 2014). The information usually focuses on the imprudent activities of the fishermen that could lead to an incident (Pooley, Siroski *et al.*, 2021). However, the fishermen interviewed in this research are aware of the dangerous areas, they understand the behavior of the crocodiles, they refrain from attracting them, and they also kill them to reduce their presence in the area.

Fishermen told us that crocodiles can be found all over the fishing sites but that in certain, more dangerous areas they are "*more aggressive*". These areas match with places of biological importance for the crocodiles: their caves, their nests, and their "*echaderos*". Crocodiles usually defend these sites, because they are "*territorial*" or "*they are nesting*" (Fisherman 7). These findings match the findings of Aranda-Coello *et al.* (2016) and González-Desales *et al.* (2021) who reported that the reproductive season of the crocodiles is the most dangerous period.

This zoning indicates danger; nevertheless, it does not imply that fishermen avoid those sites, because they are known as places "*where more fish can be found*" (Fisherman 9). Additionally, this spatial acknowledgment of the danger is unknown by fishermen that do not usually fish in the area. They do not notice the temporal changes associated with the biological, social, or climatic variables, such as the reproductive cycle of the reptile, feeding the crocodiles, or the rainy season (which modifies the water level). The third variable is a factor associated with accidents suffered by fishermen in other sites (Das and Jana, 2018).

In order to avoid crocodiles, some fishermen told us that they carry out their activities at 11:00 am, when crocodiles "*are not [in the water], most of them are out [of the water], sunbathing on the banks, as if they are just waking up.*" (Fisherman 1). Additionally, some fishermen have a wide knowledge about the biological and ethological aspects of the crocodile. However, they have had accidents involving crocodiles. This situation contradicts the findings of

other authors, who mention that accidents involving crocodiles are caused by the ignorance of people (Pooley, Siroski *et al.*, 2021).

Nevertheless, this knowledge allows fishermen to understand certain "*signs*" that the crocodile sends, showing that it is angry or at ease. Fisherman 1 told us that when crocodiles are angry, they "*keep still and splash, their trunk curves, and their tail bends*". Fisherman 1 also told us that it is better to keep away from these specimens. However, when they approach him, he follows this strategy:

> "*This is what I do: I come closer in a much more aggressive way, so instead of feeling fear, I try to scare them. I swear [yelling] to make them afraid. They feel the aggression in my voice and may be [this is how] you can make them feel fear*" (Fisherman 1).

Additionally, a fisherman who fishes on foot told us that he avoids killing the fishes, because their blood can attract crocodiles. He has already observed this behavior when he eviscerates his catch on the shore. Therefore, he prefers to keep the catch alive in a burlap bag that he ties loosely to his body, keeping it in the water all the time. This is how he avoids the risky behavior followed by other fishermen who keep dead fishes close to their chest (Pooley, Siroski *et al.*, 2021; Wallace *et al.*, 2011).

Nevertheless, fishing would be less dangerous on a boat (Pooley, Siroski *et al.*, 2021) but, "*not anybody can fish on a motorboat. You need to be a member of a cooperative. If you are not, they don't let you. And right now, a share costs 60 thousand pesos. Then you have to add the boat, the engine [...]*" (Fisherman 1). It is not that the fishermen are unwilling to belong to a cooperative; rather, the lack of social structures causes a conflict between cooperative members and "free" fishermen, giving rise to accidents involving crocodiles. This conflict between humans for fishing rights (Peterson, Birckhead, Leong, Peterson, and Peterson, 2010) is very common in this sector, whose management is partially the responsibility of the government institutions (Dahlet *et al.*, 2021).

Finally, some fishermen attempt to get rid of these negative impacts by killing the crocodiles. This situation is less frequent in Cuyutlán than in Alcuzahue, where some fishermen declared that they kill the reptiles, while others do not disapprove this activity, although they do not kill the crocodiles themselves. Meanwhile a third, small group opposes the killings. Their stance also has led to risky situations, as Fisherman 6 told us:

> "*There were two young men fishing, they both carried rifles. 'If it [the crocodile] shows up now, I will kill it.' Hey! [we told them], you are shooting at the crocodiles. You can't do that. And I heard one of them say: we will even kill you!*"

However, the fishermen that do kill crocodiles say that they eat them. In fact, the consumption of crocodile meat is widely known (Klemens and Thorbjarnarson, 1995) and it has also been reported in other sites (Camacho, 2015). Fisherman 12 told us:

> "*When I kill one, I eat it. The meat is very good, my friend!*"

Conflict solution and management proposals

Meanwhile, four potential solutions or strategies to manage the conflict were proposed. These proposals were classified as activities that fishermen could carry out themselves and those that require external participants, especially government institutions.

The fishermen believe that at least four aspects require "*more control*" (Fisherman 3): gun ownership, poaching, accident prevention and solution, and the payment or replacement of equipment damaged by the crocodiles. Fisherman 9 told us:

> "*[The government] should come and say that crocodiles are here to stay and that they will provide a compensation every two months, so we don't have to risk being eaten by a crocodile. That will help us to survive.*"

Compensation schemes to deal with conflicts involving other animal species have already been used with a certain level of success (de Klemm, 1996; Guerra, 2019). However, some operative difficulties should be taken into account for the implementation of the compensation scheme, including obtaining a source of funds (Maclennan, Groom, Macdonald, and Frank, 2009) and reducing the bureaucracy and the waste of time of the mechanism (Vaclavikova *et al.*, 2011). These are instrumental schemes and they do not necessarily resolve the relationship conflicts (Himes and Muraca, 2018). Some fishermen proposed quitting fishing, which implies searching for a job that involves less risks and involves earning enough money to continue their life style (Than, Zaw, and Hughes, 2020). The fishermen themselves proposed exploiting the crocodiles' meat and skin, which would allow them to change from fishermen to "*businessmen*". This alternative has been economically and environmentally successful (Larriera and Imhof, 2006; Webb, 2020). Nevertheless, there is scarce scientific proof about its impact on life styles; therefore, its efficiency should be consider instrumental (Himes and Muraca, 2018).

Finally, the discussion turned towards the need to comply with fishing regulations, in order to avoid overexploitation. This proposal should include the management of the conflict and the protection of the crocodiles within an ecosystem conservation perspective, changing the competitive view that prevails in the area where the crocodile-human conflict exists (Balaguera-Reina and González-Maya, 2010) for a vision in which crocodiles carry out useful ecosystem functions (Somaweera *et al.*, 2020) guaranteeing fishing resources. This objective could be achieved using strategies based on the collective management of the fishing resources (Domondon, Tirona, Box, and Pomeroy, 2021; Marriott *et al.*, 2021) and the abovementioned perceptions and knowledge about the environmental role of the reptile and the bonds with specific crocodiles.

CONCLUSIONS

The relationship between fishermen and crocodiles is both harmonious and conflictive. On the one hand, both receive benefits; on the other hand, fishermen suffer economic, operative, and life style impacts, which create inauspicious scenarios for the conservation of the reptile. Economic and operative damages can be covered with compensatory schemes;

however, their planification and implementation should take into account operative deficiencies and challenges.

The fishermen of the study sites have developed a set of strategies to reduce the conflicts. They have a great knowledge about the ecology, biology, and even ethology of the crocodiles. Nevertheless, the impacts caused by crocodiles remain the same. The substitution of economic activity can be a tool to modify the crocodile-human relationship. However, further research must be carried out to evaluate the feasibility of this type of projects and the effects that they will have on the life style of the fishermen. The reduction of fishing resources is a priority for the fishermen. Generating projects for the collective management of ecosystems will require technical data and social work. The said project will allow the integration or the promotion of a positive view about the crocodile and its environmental functions. Finally, the results of this research mirror the fishermen's point of view. This is the first research to analyze this specific phenomenon. Nevertheless, government institutions and the academia also play an important role. Therefore, further research should be carried out, in order to analyze other social sectors involved in the fishing industry.

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