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Local community perceptions of sea turtle egg use in Tortuguero, Costa Rica

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ABSTRACT

Tortuguero is a small Caribbean village of Costa Rica, where sea turtles have always played a central role in the culture and economy. Historically, Tortuguero based its economy on the exploitation of natural resources, including marine turtles. However, thanks to long term conservation efforts, policy modifications and a change in the mindset of the community, this village is now globally recognized as an example of how marine turtles can be used to generate significant revenue in a non-extractive way, through ecotourism. Nevertheless, poaching of nests and egg trade still occurs in the area. This study identifies the perceptions and attitudes of the local community towards the consumption and trade of sea turtle eggs and its impact on conservation. From October to December 2017, a total of 187 questionnaires were distributed to the community of Tortuguero, and 17 semi-structured interviews were conducted with local key informants. Our results show that sea turtle egg consumption still persists within the community, and it is perceived as a frequent practice (Questionnaire Respondents (QR); 62.2%, n = 51/Interview Respondents (IR); 58.8%, n = 10). There is awareness among villagers about the negative effects of sea turtle egg consumption mainly on the economy (QR; 76.7%, n = 89), tourism (QR; 88.4%, n = 107) and conservation (QR; 87%, n = 107), and the practice is negatively regarded (QR; 77%, n = 107/IR; 76.5%, n = 13). Nevertheless, consumption continues as a traditional practice (QR; 26.7%, n = 28/IR; 41.2%, n = 7), facilitated by the ease to obtain eggs (QR; 19.4%, n = 20/IR; 76.5 n = 13) and the persisting belief of their aphrodisiac properties (QR 18.6%; n = 19/IR 23.5%; n = 4). Despite this and the perceived lack of enforcement, interviewees stated that most consumers do not risk taking the eggs and they buy them from local poachers (IR; 88.2%, n = 15), who are usually associated with substance abuse problems. In addition, most interviewees (94.1%, n = 16) affirmed that consumption in the community has decreased over the last 10 years, and that the majority of eggs extracted from Tortuguero are traded with nearby Caribbean communities (76.5%, n = 13). The destination of the eggs seems to depend on the area from which they were taken and prices range widely depending on the seller and the trade area. Overall, this study provides an improved understanding of the local perception of egg consumption and trade dynamics. Additionally, it provides insights into the challenges of tackling this issue in Costa Rica's Caribbean coast. We hope that our conclusions will contribute to the improvement of current conservation and management strategies in the region.

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1. Introduction

In many cases around the world, the role of local communities has been deemed essential in the conservation of natural resources (Ancrenaz et al., 2007; Campbell, 2007; Risien and Tilt, 2008). However, community engagement can sometimes become one of the greatest conservation challenges, especially when people have different attitudes towards the use of these resources (Barrios-Garrido et al., 2019; Heinen, 1993). Positive attitudes towards biodiversity conservation are essential for the success of community-based conservation projects (Infield, 1988; Vannelli et al., 2019). Nevertheless, positive attitudes do not guarantee positive behaviors (Friedrich et al., 2014; Köhl et al., 2009; Liu et al., 2011), even when people are benefiting directly by the conservation of the natural resource (Infield and Namara, 2001; Young, 1999).

For thousands of years, marine turtles have been part of many societies around the world; some of the oldest evidence of human-turtle interactions date back to 5000 BC (Álvarez-Varas et al., 2020; Frazier, 2003; Olijdam, 2001). These ancient reptiles have traditionally been used for many purposes such as medicine, cultural symbols, ornaments, and especially as a food resource (Antczak et al., 2007; Barrios-Garrido et al., 2018; Frazier, 2005). In the Caribbean, sea turtles played a major role in the subsistence of many coastal impoverished communities (Ankersen et al., 2015; Barrios-Garrido et al., 2018; Lagueux et al., 2017; Nietschmann, 1995). Almost the entire animal is used (meat, fat, eggs, cartilage, viscera, skin, shell), especially the meat and eggs, which represent one of the main sources of protein in certain communities (Fleming, 2001; Lagueux et al., 2017; Place, 1985). Other parts of the marine turtles are used as medicinal resources (Barrios-Garrido et al., 2018; Delgado and Nichols, 2005; Fretey et al., 2007), as well as their eggs, that are also harvested due to their believed aphrodisiac properties (Spotila, 2004).

In Tortuguero, a small village on the Caribbean coast of Costa Rica, sea turtles have always played a central role in the culture and economy of the community; however, the motive has shifted over the years. Since its foundation, early in the 20th century, the village of Tortuguero based its economy on the exploitation of natural resources, being sea turtles one of the main sources (Jacobson and Robles, 1992). When Dr. Archie Carr arrived to Tortuguero in the 1950s, nearly every green turtle (*Chelonia mydas*) that came to nest was captured and used for subsistence consumption and trade with nearby communities (Bjorndal, 1999). The extraction of sea turtles and their eggs decreased over time thanks to tourism, long term conservation efforts, such as the work of Dr. Carr and the Caribbean Conservation Corporation (CCC) (currently Sea Turtle Conservancy, STC), the prohibition of egg and turtle collection at Tortuguero in 1963 (Government of Costa Rica, 1963), and the establishment of Tortuguero National Park (TNP) in 1970 (Government of Costa Rica, 1970) (Ankersen et al., 2015; Campbell, 2002; Trøeng and Rankin 2005). Since the mid-1980s, ecotourism was promoted as an alternative source of income in Tortuguero, becoming the primary industry in the village, which has turned into one of the main tourist destinations in the country (Hunt and Vargas, 2018; Jacobson and Robles, 1992; Meletis and Campbell, 2009). In fact, due to its popularity and the massive numbers of visitors, the ecotourism in Tortuguero has even been described as “softer” ecotourism (Meletis and Harrison, 2010). Simultaneously with tourism growth, the community changed its mind-set, supporting marine turtle conservation and benefiting from ecotourism (Peskin, 2002).

Thanks to all these changes, Tortuguero nowadays is globally recognized as an example of how the non-consumptive marine turtle use (Meletis and Campbell (2007) argued that labeling ecotourism as non-consumptive can be misleading and suggested a re-conceptualization of the term, although we acknowledge this argument, for simplicity we will use this designation in the present study) can generate more revenue, economic growth, social development and employment opportunities than a consumptive one (Trøeng and Drews, 2004). Currently, TNP protects the largest rookery in the Western

Hemisphere of the endangered green turtle (Seminoff, 2004; Trøeng and Rankin, 2005). In addition, this beach has nesting presence of critically endangered hawksbill turtles (*Eretmochelys imbricata*) (Mortimer and Donnelly, 2008), as well as leatherback turtles (*Dermochelys coriacea*), endangered at a regional level (The Northwest Atlantic Leatherback Working Group, 2019), and a few loggerhead turtles (*Caretta caretta*), considered a least concern at a regional level (Ceriani and Meylan, 2017).

However, despite all the efforts to conserve marine turtle populations, the increase of ecotourism and the support from the community, poaching and trade of turtles, and especially their eggs, still occur in the area (Hunt and Vargas, 2018; Restrepo et al., 2018; Rojas-Cañizales et al., 2019). For instance, during the 2017 green turtle monitoring season in Tortuguero, a total of 130 poached nests were recorded by the STC during daily censuses, which given the massive nesting numbers of green turtles in the area accounted for less than 1% of green turtle nests. Nevertheless, these poached nests accounted for up to 28.6% of leatherback nests, which have been suffering an accelerating decline for two decades at this beach, and 18.8% of the already fragile population of hawksbill turtles (Restrepo et al., 2018). Although many residents of the village are invested in turtle tourism, local people who do not receive any direct or indirect benefits from the tourism industry may still poach sea turtle eggs as a source of income, especially if there is still a demand of these products (Hart et al., 2013). Differing perspectives, attitudes, and behaviors in a local community towards natural resources may result in potential conflict (Kinan and Dalzell, 2005). In fact, the consumptive use of marine turtles and their products in locations where people benefit indirectly from these animals has been identified as one of the major challenges and sources of conflict related to marine turtle conservation in the Caribbean Basin (Barrios-Garrido et al., 2019).

Whilst different approaches have been taken to measure the extent of the extraction of sea turtle eggs, there is still a lack of understanding about why the demand persists and the dynamics of egg consumption (Hart et al., 2013). Even though it might be challenging to comprehend the drivers of illegal behaviors due to their clandestine nature (Hancock et al., 2016; Nuno & St. John, 2015; Mancini and Koch, 2009), it is essential to understand them to achieve effective conservation (Veríssimo et al., 2020). Applying interdisciplinary research may be critical to develop a complete understanding of conservation problems (Barrios-Garrido et al., 2020b; Mancini and Koch, 2009; Reading and Keller 1993; St. John et al., 2013). Effectively preserving sea turtle nests in Tortuguero not only requires vigilance and comprehensive protection efforts, but also a qualitative approach for understanding the dynamics of sea turtle egg consumption. The aim of this study was to identify the perceptions and attitudes of the local community towards the consumption and trade of sea turtle eggs and its impact on sea turtle conservation. Ultimately, we aimed at providing an improved understanding of the egg consumption dynamics in the area, as well as an insight into the challenges of tackling this issue in the region, to thus contribute with an updated context to improve the current conservation strategies.

2. Methods

2.1. Study area

The study was conducted in Tortuguero village, 10°32'N 83°30'W, which is located in the Pococí Canton, Limón province, Costa Rica. It lies between the northern end of the TNP and the southern end of the Dr. Archie Carr Wildlife Refuge (ACWR) (MIRENEM, 1994) (Fig. 1). Tortuguero is a small (1.2 km length) and isolated village situated on a sandbar, separated from the mainland by the Tortuguero River and bordering on the other side with the Caribbean Sea. The only access to the village is by boat or plane (Campbell and Vainio-Mattila, 2003).

According to the Costa Rican government statistics, this village

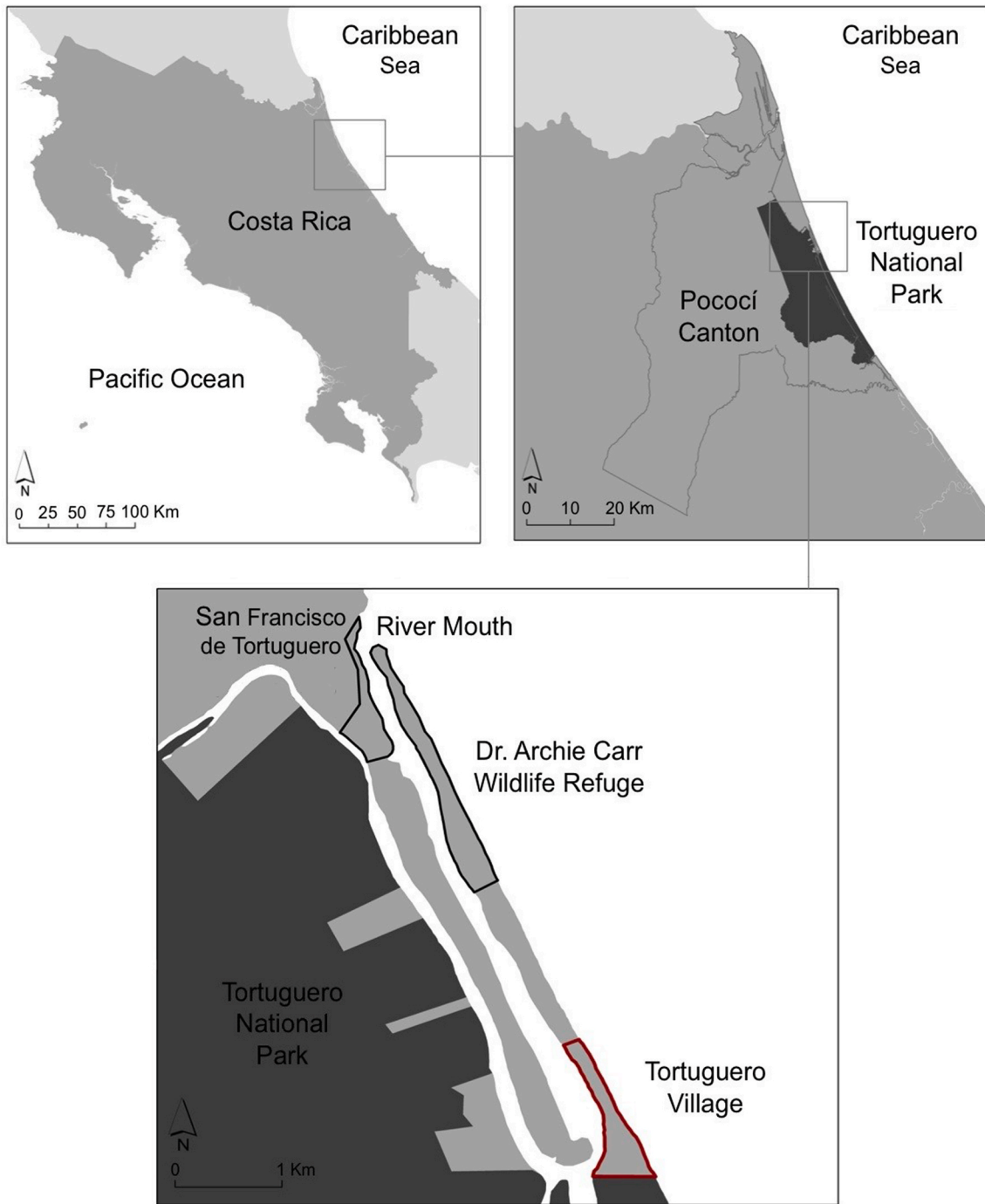


Fig. 1. Map of the study area. Tortuguero village (red polygon), where residents participated in the questionnaires and semi-structured interviews. Tortuguero village is surrounded by the ACWR and San Francisco de Tortuguero village (black polygons) on the north, and TNP (darker area) on the south. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

belongs to a region with low social and economic development, when compared to the rest of the country (MIDEPLAN, 2017). The community of Tortuguero is comprised of people of Hispanic, Afro-Caribbean and West Indian descent (Jacobson and Robles, 1992). The latest official report from EBAIS (2010) (Equipos Básicos de Atención Integral en Salud, or First Response Team for Integral Health Attention, in English) in Barra de Tortuguero (EBAIS, 2010), estimates that the population is around 580 inhabitants. However, according to Tortuguero Police, in 2017 the Tortuguero village had a population of around 1500–2000 inhabitants (Police Force, October 2017. Personal communication).

2.2. Data collection

In the beach areas surrounding Tortuguero village, poaching incidents have been recorded during the green sea turtle nesting season for many years (Restrepo et al., 2018). To obtain an improved understanding of the perceptions of the local community of egg consumption and poaching in the area, a mixed method approach was taken, by conducting standardized questionnaire surveys, and qualitative semi-structured interviews (Brannen, 2005).

Questionnaires were constituted of standardized open-ended, closed questions and Likert scales designed to gather: (i) socio-demographic

data, and (ii) people's general perception of consumption dynamics and awareness of this practice; without inquiring the level of involvement of the participant in the subject due to its illegal nature (See Appendix A). Semi-structured interviews included an extended version of the questionnaire, comprising Likert scales and open-ended questions about: (i) perceptions of consumption dynamics (amount of people involved, frequency, drivers, mean of acquisition, change over the years), and (ii) perceptions of trade dynamics inside and outside Tortuguero (people involved, destinations, prices, among other details) (See Appendix A). The interview also included some repetitive questions, with the purpose of triangulation, to verify more than once the participant's answers about certain sensitive topics (Newing, 2010).

Both surveys were conducted between October and December 2017. Before the distribution of the questionnaires, a pilot survey was carried out, which consisted of a first round of questionnaires with a small group of local people ($n = 6$), selected by convenience sampling, to make sure that all the individual questions were appropriate and understandable (Newing, 2010).

In total, 187 questionnaires were individually administered and completed by the general public. Since there was not an up-to-date census, questionnaire's participants were selected by a non-probability convenience sampling (Senko et al., 2011), and the sample size was set trying to cover at least 10% of the adult population according to the reports from Tortuguero Police (Police Force, October 2017. Personal communication). Participants included any local resident over 18 years of age on the streets who was encountered and agreed to take part. To reduce the sampling bias of interviewing people at selected places (Bernard, 2000), questionnaires were distributed around the whole village, at different hours of the day, on every day of the week, so participants were as representative of the Tortuguero population as possible. Questionnaires were self-administered by respondents. When distributing the questionnaires, a date and a location were arranged to collect them from the individuals. Non-respondents were politely followed up after the initial approach. If respondents did not provide the questionnaire after the third visit, they were discarded.

On the other hand, a total of 17 interviews were conducted individually with local key informants who were selected by targeted sampling and chain referral or "snowball" sampling (Newing, 2010). Key informants were categorized in different groups according to the main reason for being selected: (a) members of native families ($n = 4$), considering native families those who had been living in Tortuguero for at least three consecutive generations; (b) poachers ($n = 2$), either specialized or opportunistic; (c) consumers ($n = 2$), people who purchase marine turtle eggs for personal consumption; (d) local authority ($n = 4$), i.e., Tortuguero police officers, in charge of detentions and National Park employees, in charge of the TNP surveillance and marine turtle eggs confiscations; (e) turtle spotters ($n = 5$), people who benefit directly from turtle tourism by looking for turtles and informing tourist guides (Meletis and Harrison, 2010). Interviews with the different key informants were conducted by the authors CMB, GB and RG, as informal but guided individual talks in Spanish at the location of the participant's choice (Barrios-Garrido et al., 2017).

We are aware that given the clandestine nature of marine turtle egg consumption in the study area, there is a risk that the information concerning this illegal behavior might be biased (Mancini and Koch, 2009; Senko et al., 2009). However, two of the interviewers had lived with the community for a long period and the locals trusted them; this minimized miscommunication and established a feeling of trust between the interviewee and the interviewer (Barrios-Garrido et al., 2020a). For both questionnaires and interviews, participation was voluntary and respondents could choose not to answer specific questions. In addition, participants were informed in advance of the purpose of the study and guaranteed that all information provided was anonymous.

2.3. Analysis

For questionnaires, analysis was conducted using the Statistical Package for the Social Sciences (SPSS) ver. 23. Percent frequencies of the closed questions were compared. Responses to the open question concerning local's attitude towards sea turtle egg consumption were coded as; "in favor", "neutral", "against" or "do not know", bearing in mind the assumption that "do not know" could indicate a potential negative attitude (Newmark et al., 1993). Relationships between socio-demographic variables and local's perceptions and attitudes towards sea turtle egg consumption were analyzed using the chi-squared test. Statistical differences and rejection of the null hypothesis were assumed if $p < 0.05$.

To analyze the qualitative data of the interviews, responses related to the interviewees' perception of sea turtle egg consumption were classified into categories and presented with their frequency of response. In addition, we extracted common themes mentioned during the interviews and illustrated them with an example. When looking at the interviewee's responses in regards to egg commerce, we classified the different poaching areas and commerce routes. In addition, prices of the eggs were calculated by 1US dollar per 561.79 Costa Rican Colon (December 2017).

3. Results

3.1. Questionnaire results

Of the total administered questionnaires ($N = 187$), 148 questionnaires (79%) were successfully collected. However, only 139 were included in the study as 9 of the respondents were either younger than 18 years old or not Tortuguero residents. Thus, our study sample size represented at least 7% of Tortuguero's current population. The response level within the evaluated questionnaires varied slightly for every aspect, as some of the participants did not answer all the questions. The number of responses processed for each question is indicated in parenthesis as part of the information analysis.

3.1.1. Demographics

Men were predominant (57.4%, $n = 78$) among respondents ($n = 136$). Regarding age ($n = 137$), 26–35 years was the most prevalent age range (35.8%, $n = 49$), followed by 36–50 years (35%, $n = 48$), 19–25 years (16.8%, $n = 23$), 51–60 years (7.3%, $n = 10$) and lastly more than 60 years (5.1%, $n = 7$). Most residents of Tortuguero that participated in the survey ($n = 132$) were originally from Costa Rica (62.1%, $n = 82$), followed by Nicaragua (31.8%, $n = 42$) and other nationalities (6.1%, $n = 8$). Time living in Tortuguero ($n = 134$) was classified in ranges from less than a year to more than 20 years, being the most prevalent range between 16 and 20 years (22.4%, $n = 30$), followed by more than 20 years (20.9%, $n = 28$), 6–10 years (17.2%, $n = 23$), 11–15 and 1–5 years (14.9%, $n = 20$ each), and finally less than 1 year (9.7%, $n = 13$). From the respondents ($n = 127$), the majority were directly related to the tourism sector; 18.9% ($n = 24$) worked as tour guides, 23.6% ($n = 30$) worked in the hotel and catering sector, and 26% ($n = 33$) were merchants, while 31.4% ($n = 40$) were employed in non-tourism related jobs. According to the results of the chi-square tests, perceptions of sea turtle egg consumption were not related significantly to demographic variables (See Appendix A, Table C1).

3.1.2. Participants' perception of sea turtle egg consumption

With the purpose of having more visual and clarifying charts, "do not know" responses were excluded from the frequency of the responses regarding egg consumption dynamics (Fig. 2). However, these responses were very frequent, especially when looking at how many people ate sea turtle eggs (32.6%, $n = 45$), the frequency of consumption (40.6%, $n = 56$), the means of acquisition (14.5%, $n = 28$) and the drivers of consumption (12.8%, $n = 34$). Even though "do not know" answers were frequent along the study, results also accounted for the multiplicity of

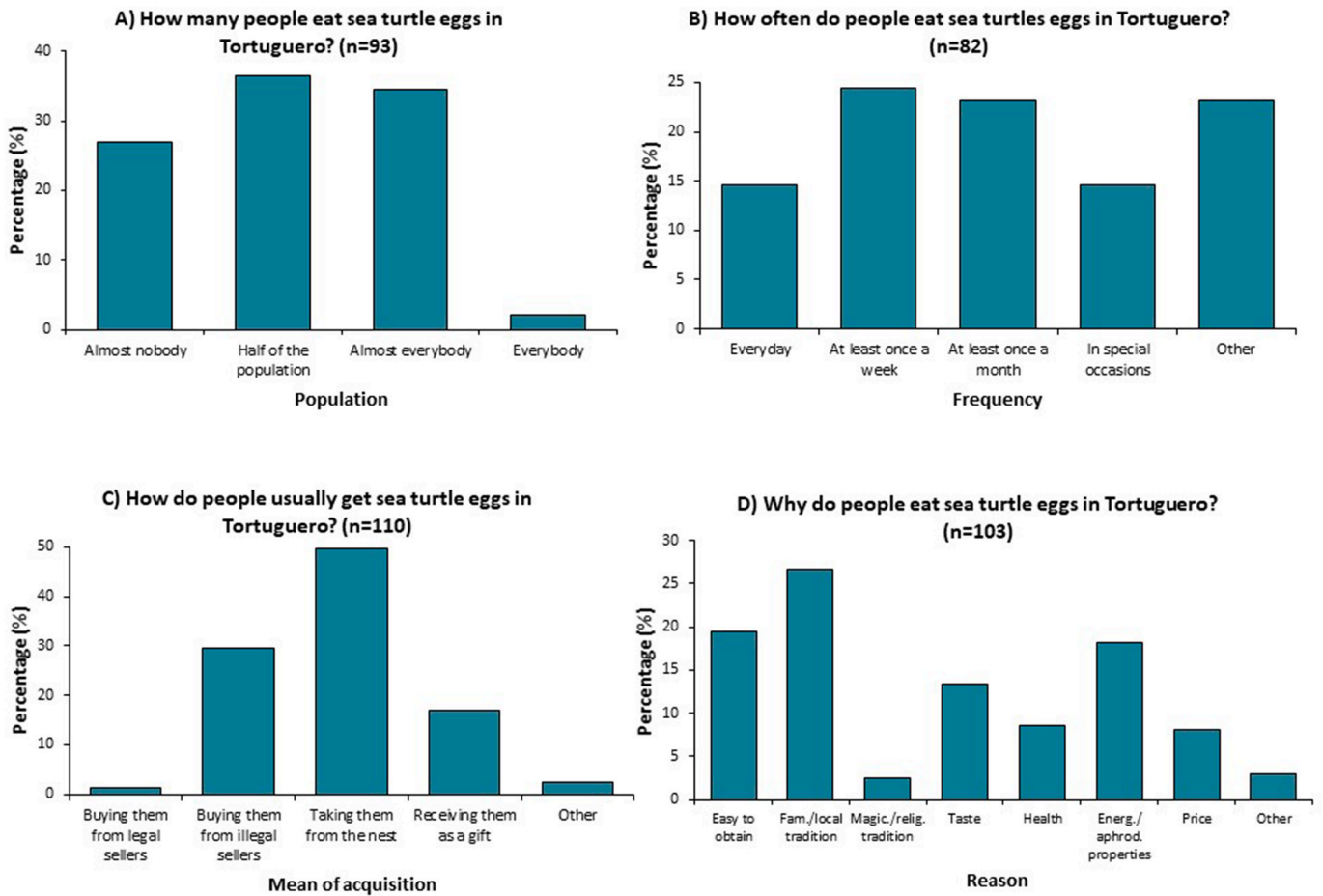


Fig. 2. Perceptions of sea turtle egg consumption at Tortuguero according to questionnaire participants: Amount of residents consuming (A), frequency of consumption (B), means of acquisition (C) and drivers of consumption (D).

reasons expressed by participants in one or more questions, which created a large variability on the sample size for each individual question. Thus, each inquiry was analyzed independently, regardless of the number of participants involved.

The general perception is that at least half of the population or

almost everybody still consumed marine turtle eggs. Nevertheless, almost a third of respondents believed that almost nobody consumed them (Fig. 2A). On the other hand, the estimated frequency in which this phenomenon seemed to occur was about once a week (“Other” category included a wide variety of responses; i.e. depending on the season, when

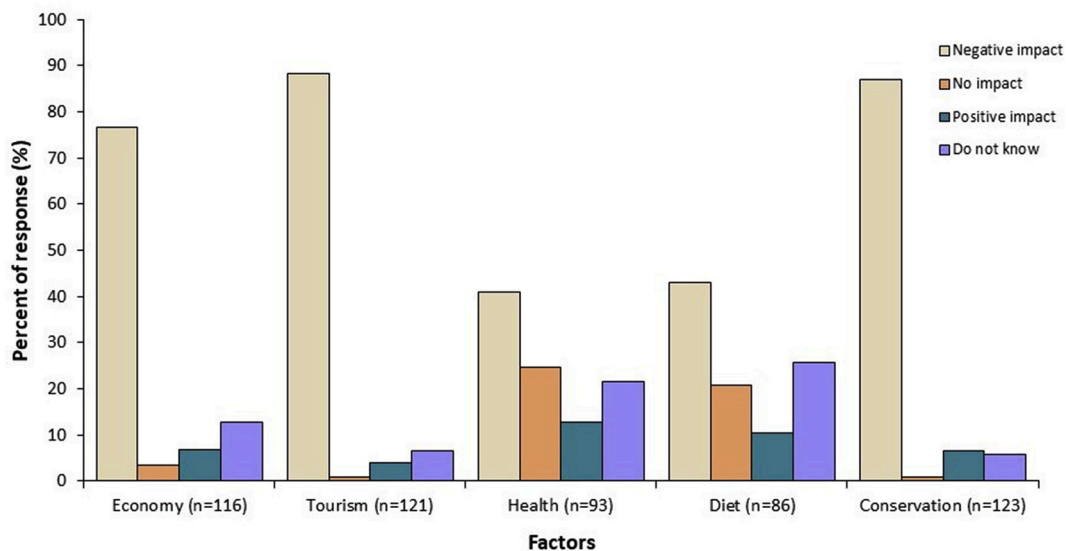


Fig. 3. Impacts of sea turtle egg consumption on different factors, according to questionnaire respondents.

they want to ...) (Fig. 2B). In addition, the information gathered from the questionnaires suggested that the most common means of acquisition of sea turtle eggs by consumers was taking them from the nest or buying them from illegal sellers ("Buying them from legal sellers" was an option included in the questionnaire, as there are legal sea turtle egg sellers in the country even though there is no record of any in Tortuguero) (Fig. 2C). This practice is driven by a traditional family paradigm, potentiated by the ease in which the eggs are obtained. Also, the mystical belief in the aphrodisiac effect of turtle eggs was still part of the collective mindset of the Tortuguero villagers and constituted a powerful driver of their consumption (Fig. 2D).

Regarding the impacts of sea turtle egg consumption, the majority of respondents perceived a predominant negative impact of this activity in all the following factors: economy, tourism, health, diet and conservation (Fig. 3). However, the perceived negative impact was higher when related to the economy, tourism and conservation. On the other hand, the perceived positive impacts, even though still less dominant than the negative ones, were higher when related to health and diet, as well as neutral impacts and "do not know" answers.

3.1.3. Attitudes toward sea turtle egg consumption

The majority of respondents that expressed their attitudes toward sea turtle egg consumption through the open ended questions claimed to be against it (Table 1). The reasons behind this attitude were mainly due to its effect on conservation and economy. A small percentage of the respondents were in favor of consumption regarding it as a tradition.

3.2. Interview results

3.2.1. Participants' perception of sea turtle egg consumption

For face to face interviews, we obtained a 100% response rate (n = 17); however, some respondents preferred not to answer specific questions. The main results from the interviews regarding sea turtle egg consumption are reported in Fig. 4. Responses were divided into categories comparable with questionnaire responses.

We found that regardless of the personal involvement on egg consumption, the majority of respondents (76.5%; n = 13) were very critical about this practice, expressing their concerns about its impacts on tourism and criticizing the involvement of people who benefited directly from tourism, such as the tour guides (Table 2.). In relation to this topic, we discovered that most of the consumers did not take the risk of getting caught poaching eggs. Instead, they usually asked known local poachers to get the eggs for them. We also found that poaching was a low prestige activity and poachers were usually associated with substance abuse problems.

Almost all of the interviewees (94.1%, n = 16) stated that egg consumption in Tortuguero had decreased over the last 10 years. However, three of the respondents, a local authority, a turtle spotter and a poacher, mentioned that the local consumption had decreased, but the poaching to sell outside the Tortuguero village had increased.

3.2.2. Participants perceptions on sea turtle egg commerce

All 17 respondents provided information regarding the commerce of sea turtle eggs in the area. Most of the interviewees believed (76.5%; n

Table 1
Reported attitudes towards sea turtle egg consumption (n = 139).

Opinion	Reason
Against consumption (77%, n = 107)	Conservation (41.1%, n = 44) Economy (34.6%, n = 37) Other (24.2%, n = 26)
Neutral (0.7%, n = 1)	
In favor of consumption (7.2%, n = 10)	Tradition (60%, n = 6) Other (several reasons) (40%, n = 4)
No response (15.1%, n = 21)	

= 13) that turtle eggs poached in the area of Tortuguero were consumed in other places.

According to the respondents, we could differentiate three areas in Tortuguero depending on where the egg poaching occurred, the people involved and the destination of the eggs. These three areas were: the Tortuguero river mouth on the North end of the beach in the ACWR, where poachers usually crossed from the neighbouring community of San Francisco de Tortuguero and where the eggs were mainly consumed within this community; the poaching that happened in front of the Tortuguero village, which was usually carried out by a few locals and eggs were consumed within the village; and lastly, the poaching that happened in TNP, which was thought to be the largest and carried out by people coming mainly from Parismina and Limón (Fig. 5). It was difficult to determine the amount of people involved in egg poaching activities. However, respondents believed that 2–10 people were responsible for the extraction in front of Tortuguero village, while in TNP, this number increased to 20, and up to even 500 people involved in the egg poaching and trade. It was also mentioned that sometimes these events could be linked to other illegal activities, such as smuggling of narcotics. We received no information about the amount of people involved in the egg poaching on the river mouth.

We also found that most of the eggs poached in the Tortuguero area were traded outside the protected area within the province of Limón (Fig. 5). Nevertheless, respondents stated that the eggs even reached other provinces like San Jose (the capital) and Cartago.

The reported prices for sea turtle eggs (all of them referred to as green turtle eggs) varied widely according to the place of purchase. Prices ranged from US\$1.78 to US\$8.90 for a clutch bought in Tortuguero village. Our respondents affirmed that the variation in prices was connected with the immediate financial needs of the sellers, which again was related to a substance abuse problem. In contrast, participants reported higher prices for clutches bought outside Tortuguero village, where they were less accessible, ranging from US\$8.90 to US\$17.80, even reaching elevated fares as US\$3 for a single egg.

4. Discussion

4.1. Tortuguero's case

It is essential to consider the results of the present study in light of Tortuguero's privileged history. Tortuguero's conservation successes are a result of long-term conservation efforts (Troëng and Rankin, 2005). This made Tortuguero a popular sea turtle destination, being ecotourism the economic engine of the village, which included developing turtle tour systems to address undesirable tourism-associated impacts (Meletis and Harrison, 2010). Policy decisions have been crucial for the protection of sea turtles in Tortuguero: a ban on egg and turtle collection in Costa Rica was declared on 1963 (Government of Costa Rica, 1963), with the exception of eggs coming from Ostional Wildlife Refuge since 1983 with the Wildlife Conservation Law 6919 (Campbell, 1998). In 1970, working very closely with the government of Costa Rica, the CCC helped to establish TNP (Government of Costa Rica, 1970). After TNP was established, Tortuguero residents were allowed to harvest a few green turtles per week, to share among the community. By the mid-1990s, stronger protection laws put an end to these harvest rights (Campbell 2002, 2007). Along with the policy changes and a community dedicated to ecotourism, Tortuguero counts with the longest running monitoring program for sea turtles in the world, under the auspices of the STC (formerly CCC), which was created in 1959 by Dr. Archie Carr (Troëng and Rankin, 2005). Environmental education and outreach efforts have been carried out by the STC in collaboration with TNP and other environmental organizations, including a junior research assistant program to introduce local adolescents to sea turtle monitoring protocol and practices (López-Torrents, 2019).

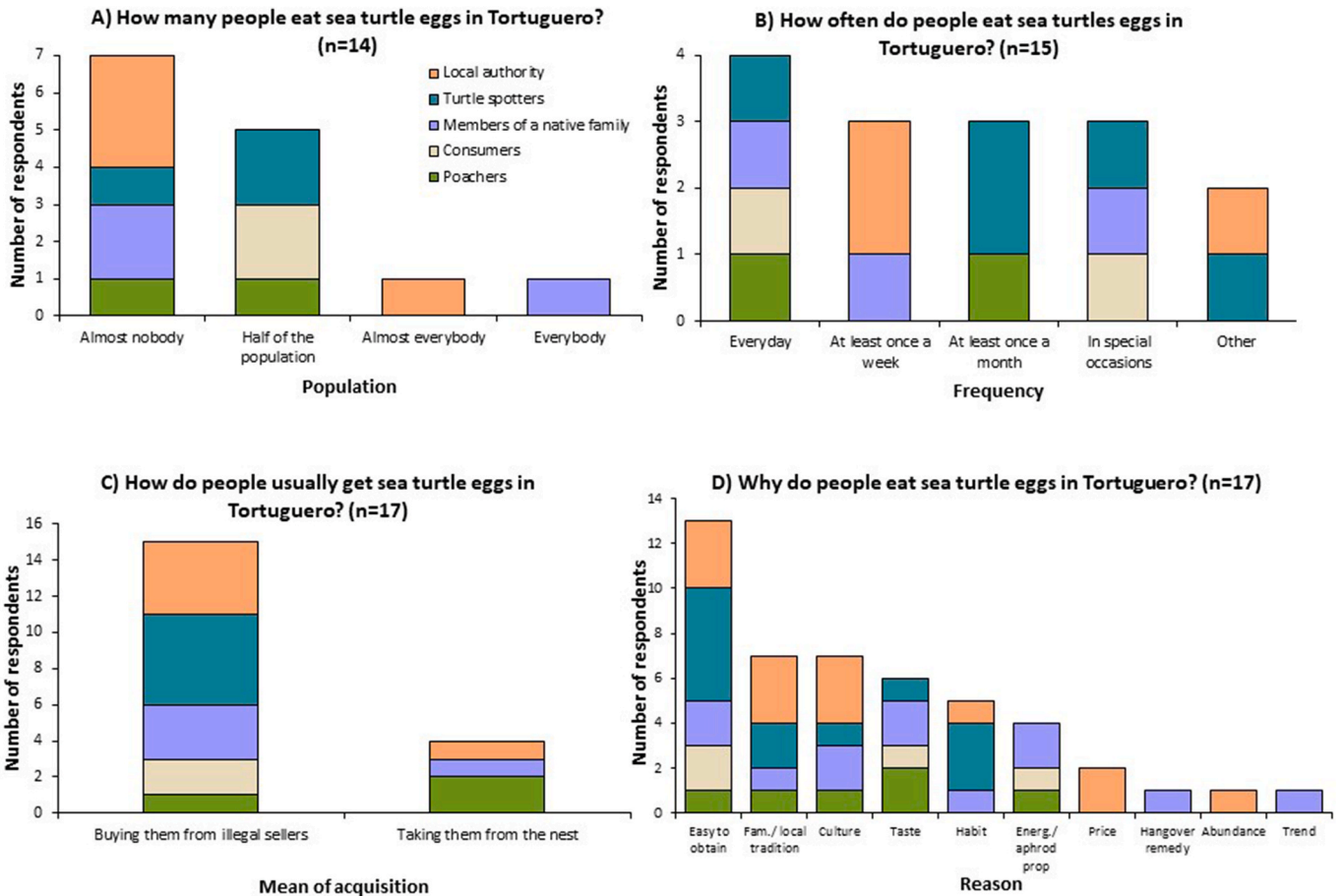


Fig. 4. Responses from interviews to key informants at Tortuguero regarding sea turtle egg consumption: Amount of residents consuming (A), frequency of consumption (B), means of acquisition (C) and drivers for consumption (D). Note: Respondents could mention more than one response.

Table 2

Recurrent themes mentioned by interviewed respondents, number of respondents and an illustrated example.

Theme	N° of respondents	Illustrated example (Key informant)
Poaching is related to substance abuse	n = 11	“Poaching is more of a social issue than an environmental one” (Local authority)
People do not take the risk	n = 9	“If there is no supply, there is no demand, as most of the people do not poach nests. Many of the consumers work as guides and have a family, so they do not take the risk” (Local authority)
Tour guides are consumers	n = 6	“The majority of the eggs are sold outside Tortuguero, but in Tortuguero there are also people that buy, like the guides” (Poacher)
Egg consumption is detrimental to tourism	n = 5	“We are killing the goose that lays the golden eggs” (Member of a native family)
Lack of enforcement from local authorities	n = 4	“Last year turtle spotters used to go after midnight to take some eggs, everybody knew it and nobody did a thing” (Poacher)
Sense of belonging	n = 2	“There is a social pressure to consume sea turtle eggs, it is as if you do not eat them, you are not a true citizen of Tortuguero” (Turtle spotter)
Difference between species	n = 2	“A true citizen of Tortuguero does not eat leatherback eggs; they eat either hawksbill or green turtle eggs. Hawksbill eggs are a delicacy” (Member of a native family)
Energetic/aphrodisiac properties of the eggs	n = 2	“Load and fire” (Turtle spotter)

4.2. Demographics

Although we applied a non-probability convenience sampling (Senko et al., 2011), trying to cover a 10% of the adult population, our results were indeed consistent with the demographics of Tortuguero, which has a young population with mainly males (EBAIS, 2010; Flores-Larios and Rojas-Herrera, 2016), and an influx of immigrants coming mainly from Nicaragua (Avendaño-Flores, 2011). In addition, most of the respondents had been living in Tortuguero most of their lives, so we assumed that our sample was representative of Tortuguero residents. Moreover, as expected, the majority of participants were related to the tourism sector, as this is the primary source of income in the village (Hunt and Vargas, 2018; Jacobson and Robles, 1992). The perceptions of the egg consumption problem did not vary according to socio-demographic factors, suggesting a unified vision across the participants.

4.3. Participants’ perception of sea turtle egg consumption

It is difficult to accurately assess the number of people conducting an illegal activity or how frequently it occurs due to its clandestine nature (Nuno & St. John, 2015). In fact, we received a very high rate of “do not know” responses, reaching over 40% of the total responses for some questions. Although it is preferable to have participants responding that they do not know rather than randomly guess (Krosnick and Presser, 2010), we acknowledge that these answers may be a sign of a negative attitude or distrust (Newmark et al., 1993), due to the sensitivity of the subject. Nevertheless, the surveys included some repetitive questions about their perception of sea turtles and the consumption of their eggs



Fig. 5. Illustrative map showing reported destinations for sea turtle eggs poached in Tortuguero. Figure was elaborated with information from personal interviews with key informants in Tortuguero. The width of the arrows is directly proportional to the frequency of the destination mentioned by respondents, being Cariari and Limón the main reported destinations.

with the aim of receiving a more genuine opinion (Newing, 2011). Moreover, the results of this study showed that while the amount of perceived consumers differed between questionnaire and interview respondents, there existed the perception that part of the Tortuguero population still consumed sea turtle eggs.

It is especially interesting that one of the interviewed poachers and the two recognized consumers believed that this practice was still carried out by *half of the population*, coinciding with the majority of the questionnaire respondents. Not only that: this consumption was still perceived to be frequent (between *every day* or *at least once a month*) by the majority of participants in both surveys, rather than an activity related to special occasions, as it has been observed in other areas with the consumption of sea turtle and their products (Mancini and Koch, 2009). On the bright side, almost all the interviewees perceived that this consumption had decreased over the last 10 years. Nevertheless, the fact that this behavior was perceived to still occur in a place renowned worldwide for its ecotourism and conservation efforts shows the

complexity of the issue. Moreover, Tortuguero is not the only case where this happens. Globally, ecotourism, though a powerful tool, has not been able to eradicate illegal egg harvest. This is the case of Cape Verde (Hancock et al., 2016), Brazil (Pegas and Stronza, 2010) or even closer to Tortuguero in Costa Rica's Caribbean (Hart et al., 2013).

Due to the complexity of this issue, it is essential to have a deeper understanding of the drivers of this behavior. Our results showed that family/local tradition, ease to obtain the eggs, the energetic/aphrodisiac properties and the taste (even differentiating between eggs of different sea turtle species), were perceived as main reasons for egg consumption in both questionnaires and interviews. Furthermore, recognized consumers mentioned these last three reasons when asked about their motives. The consumption of sea turtles and their products is considered a traditional practice in many coastal areas worldwide. For example, Nada and Casale (2011) reported a traditional consumption of these products in Egypt, as well as Mutalib et al. (2013) in the case of coastal villages in Malaysia. In the coast of Costa Rica, Hart (2013) also confirmed that sea

turtle meat and egg consumption was regarded as a tradition. Moreover, interviewees mentioned culture as a main reason, even linked with a sense of belonging and being a “true citizen of Tortuguero”. This is not surprising as Tortuguero is a village characterized by the presence and use of these animals (Jacobson and Lopez, 1994). Indeed, sea turtles have been deeply rooted in the culture of many Caribbean communities, although their use and management by those communities have been different, as exemplified by the indigenous Wayúús in Venezuela (Barrios-Garrido et al., 2018) or in the Miskito Islands in Nicaragua (Ankersen et al., 2015), among others.

Our results also revealed the ease of obtaining eggs as a main reason for consumption. In contrast of our questionnaire results we discovered that, according to interviewees, most people did not take the risk of getting caught poaching eggs; rather, they usually asked known local poachers to get the eggs for them.

Although there is a legal source of sea turtle eggs in the country harvested from Ostional Beach (Campbell, 2002), this legal path is not really used as Ostional is across the country, in the Pacific coast of Costa Rica, and respondents affirmed that they prefer fresh eggs, and, though illegal, there is plenty of this resource in Tortuguero. In fact, participants stated how easy it was to harvest the eggs in Tortuguero. Moreover, we received several complains by the interviewees about the lack of vigilance and law enforcement; these results are in agreement with those by Veríssimo et al. (2020) in São Tomé, Aguirre and Nichols (2020) in Baja California or by Hart et al. (2013) in the Caribbean of Costa Rica. Interestingly, the lack of vigilance has been identified as one of the most common conflicts by marine turtle conservation projects in the Caribbean (Barrios-Garrido et al., 2019). Other reasons for consumption were the energetic/aphrodisiac properties, which have been attributed to sea turtle eggs in the past (Mutalib et al., 2013; Spotila, 2004; Wilson and Tisdell, 2001), as well as the palatability of sea turtle eggs (Hart et al., 2013; Mutalib et al., 2013). This last driver for consumption may have a direct impact on sea turtle populations, since eggs from the critically endangered hawksbills were the most desired and a delicacy according to interviewees, and hawksbill egg poaching may even account for almost 20% of the nests in a nesting season (Restrepo et al., 2018).

On the other hand, despite the perpetuation of this activity, there was awareness among respondents about the negative impacts of this consumption on sea turtle conservation and therefore, on tourism and the economy. This was expected, as the conservation program for these species started in 1959, and Tortuguero has since become an example of an economy based on sea turtle tourism (Troëng and Drews, 2004). So, it is not surprising that the residents were aware of the negative impacts of the direct use of turtles and their products. Nevertheless, the perceived negative impacts were not as dominant when looking at the health and diet aspects, which may indicate a lack of information about the risk of consuming sea turtle eggs to human health (Aguirre et al., 2006; Guzmán et al., 2020; Mutalib et al., 2013; Senko et al., 2009).

4.4. Attitudes toward sea turtle egg consumption

Only a few participants were openly in favor of sea turtle egg consumption, mainly due to a desire to follow the tradition. Nevertheless, most respondents were strongly against it, primarily for conservation and economic reasons. In fact, our results were consistent with those found by Álvarez-Varas et al. (2020) in Rapa Nui an island of the Chilean Pacific, where the consumption of sea turtles is widely rejected by the community as they are considered beneficial animals, mainly for tourism. Our results are also in line with the findings of Hart et al. (2013) in the Caribbean of Costa Rica, with the majority of interviewees being very critical with egg consumption practices, expressing their concerns about their impact on tourism and criticizing the involvement of people who benefited directly from the tourism, such as the tour guides. Behavioral changes in relation to sea turtle consumption are only achievable if there is knowledge to make informed decisions (Senko et al., 2009). However, despite the knowledge and the increased

awareness reported in this study, our results were similar to those found by Hancock et al. (2016) in Cape Verde, where awareness campaigns and conservation efforts were successful to improved local people’s awareness but did not result in a change of the consumptive behavior.

4.5. Participants perceptions on sea turtle egg commerce

Interview respondents identified three poaching areas in Tortuguero. This information was consistent with the poaching data collected by the STC, during the 2017 green turtle nesting season (Restrepo et al., 2018). The first one, on the Tortuguero river mouth in the ACWR, carried out by people from the neighbouring community of San Francisco de Tortuguero, which barely benefits from sea turtle tourism. Hart et al. (2013) found contrasting perceptions of sea turtle egg consumption between neighbouring communities with different benefits from ecotourism, with lowest levels of awareness in the communities where tourism was not a main source of income. The second area was Tortuguero village, which is done by a few local poachers. Our results suggested that poaching was considered a low prestige activity and the few local poachers were usually associated with substance abuse problems and use the income of the egg sales to support their relatively small drug purchases. This result coincides with the findings presented by Meletis (2007) where she questioned some common believed topics of Tortuguero. According to the respondents, most people did not risk getting caught and the only reason why this activity persisted was that there was still a supply from people who were willing to take the risk due to a necessity/dependence. The third one is the largest area and is the poaching that happened in the National Park, which is believed to be related to drug smuggling. Increasing evidence has been collected worldwide of organized crime sharing smuggling routes for parallel trafficking of drugs and wildlife (Cook et al., 2002). In fact the illegal poaching of marine turtles and their products has previously been linked to the occurrence of illegal activities in the Caribbean (Barrios-Garrido et al., 2019) and in Latin America (Aguirre and Nichols, 2020). According to our findings, most egg commerce appeared to happen outside the Tortuguero village. It makes sense that TNP is where most of the poaching occurs as the beach is 24 km long and presents a higher challenge in terms of vigilance and law enforcement. Previous studies have investigated main traffic routes for sea turtles and derived products, considering this knowledge key for the development and enforcement of policies and legislations to better protect sea turtles (Barrios-Garrido et al., 2017; Mancini and Koch, 2009). Our findings suggested that most of the eggs poached in Tortuguero are traded to nearby communities, staying in Limón province, coinciding with the findings of Meletis (2007) and a study that used GPS enabled decoy eggs to track poached nests in Costa Rica (Pheasey et al., 2020). However, our results also suggested that poached eggs may even reach, although is less common, other provinces like San Jose (the capital) and Cartago. In addition, our results coincided with previous studies where the price of sea turtle products was conditioned by a wide range of factors (Barrios-Garrido et al., 2017). In our study, the price of sea turtle eggs varied largely depending on where the trade occurred, being more expensive outside Tortuguero village, coinciding with the results of Mancini and Koch (2009) where the price of turtle meat increased as the distance from the capture point increased, and depending on the seller and whether it was linked to a problem of necessity due to substance abuse.

5. Conclusions and recommendations

The results presented in this study provide an improved understanding of the complexity of sea turtle egg consumption in Tortuguero. This study though, was not designed to measure or estimate the magnitude of egg poaching in the study area. Despite long-term conservation efforts and an economy based on sea turtle tourism that might have resulted in a general increase in awareness and attitude change, the perception exists that there is still a presence of this illegal behavior.

Nevertheless, most respondents negatively regarded the consumption and illegal egg extraction. Egg consumption was perceived to have decreased in Tortuguero village over the years, and the commercial demand of sea turtle eggs appeared to be higher outside Tortuguero for commercial purposes.

We recommend a community-based approach, increasing community involvement in sea turtle conservation and improving inter-institutional collaboration among the local authorities, neighborhood an guide associations and environmental NGOs. We also consider necessary to expand this collaboration between the NGOs, Government sector and communities to a broader geographic scale as the consumption and trade of sea turtle eggs is an issue that is affecting other areas of the Caribbean Coast of Costa Rica. In fact, this threat is more likely to be more severe in areas with less protection than TNP. Therefore, we suggest frequent meetings between the corresponding entities to design and implement a unified strategy to tackle this issue.

In terms of law enforcement, as resources are limited, we suggest enhancing the vigilance in the identified areas where most poaching was perceived to occur, mainly in TNP. To facilitate enforcement, the results of this study are being communicated to the local authorities (police and National Park rangers). We also recommend maximizing enforcement resources, considering that usually egg and sea turtle poaching converge with the trafficking of other illegal goods (e.g. drugs). So, even though increasing enforcement may be challenging, it may be key to prevent other types of crime. A possible solution for the lack of vigilance could be solved following the strategy proposed by Aguirre and Nichols (2020). This strategy consists in empowering the local community by giving them limited monitoring and enforcement roles. Furthermore, this strategy involves generating information within the communities allowing enforcement agents to target known poachers and trade locations.

In addition, to achieve a deeper change in the Tortuguero community, we believe it is essential to address complex social issues. We encourage increasing alertness and taking action about youth's substance use in the area to reduce local poaching, as most consumers are opportunistic and buy the eggs from local poachers who are engaged in substance abuse in the community. Initiatives such as the junior research assistants program of the STC can be really helpful to encourage and provide environmentally friendly educational and leisure options for local adolescents, as well as future job opportunities.

On the other hand, our study revealed that there is awareness and knowledge about sea turtles in Tortuguero, which even though had a major impact in great part of the population, has not resulted in a definite change of behavior in the entire community. Nevertheless, in terms of awareness, there is still the misconception that sea turtle eggs are beneficial for human health. In light of this, we recommend creating an awareness campaign, targeting all sectors of the population, about the health risks of sea turtle egg consumption. Ideally, this campaign would be developed in collaboration with the EBAIS and local health care professionals. Moreover, we believe it is essential to extend the reach of this campaign and continue creating awareness and job opportunities in the neighbouring community San Francisco de Tortuguero.

Lastly, besides the constant sea turtle monitoring and evaluation of population trends, tasks that are conducted by the STC every year, further research is needed to ascertain the magnitude and the impact of the illegal egg extraction on the different sea turtle populations that nest in the area, as not all of them seem to be similarly vulnerable to this practice. Specifically, hawksbill and leatherback are particularly vulnerable given the low abundance of these species in the area. We also estimate important to investigate the current situation and local's perception of sea turtle meat consumption, as sea turtle poaching is also an issue present in the area.

We hope that these results help to decrease sea turtle egg consumption and trade in Tortuguero, and serve as an example for other communities with similar situations. The management recommendations presented in this study have to be taken in light of Tortuguero's

case, a place that already counts with a sound conservation basis, which includes protection policies, a protected habitat for sea turtles, profitable employment opportunities generated from non-extractive use, awareness among the majority of the population and a constant and long-lasting monitoring and research program. Tortuguero is an example to follow in terms of sea turtle conservation, however this study shows that is necessary to go a step further. It is important to acknowledge that completely erasing the practice of sea turtle egg consumption, if indeed possible, would require gradual and sustained changes that may take several generations.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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