



Local ecological knowledge and community perceptions of a nascent arribada beach in Costa Rica

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ABSTRACT

Arribadas present many research challenges, such as establishing historical baselines and the elucidation of their formation and evolution. For local communities arribadas mean addressing shifts in areas such as tourism, sea turtle egg extraction and animal predation dynamics, representing a potential catalyst for changing attitudes towards sea turtle conservation. This study aims to provide insights about the onset and evolution of Corozalito, a nascent Costa Rican arribada beach, by compiling local ecological knowledge (LEK), and by identifying the local perceptions towards the mass nesting event and its socio-economic and conservation impacts. From October to December 2018, we conducted two types of semi-structured interviews: 10 to key informants (KIs) gathering LEK of Corozalito arribada and 15 to local respondents assessing perceptions about this phenomenon. According to KIs, Corozalito arribadas started in the late 1990s, early 2000s, exhibiting a growing trend in magnitude and frequency, which is consistent with published monitoring data. There was a general basic understanding among community members about the importance of sea turtle conservation. Regarding threats to sea turtles during arribadas, animal nest predation was the most frequently mentioned; nonetheless, most respondents attributed it to a natural process. In contrast, sea turtle egg extraction presented the most divided opinions, being reported as a source of conflict in the past for the community. Most respondents

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expressed concerns about egg removal for commercial purposes. Clutch density, nest destruction, and legal egg extraction in similar arribada sites, were occasionally mentioned as arguments favoring sea turtle egg extraction. Additionally, there was a general feeling that tourism should be promoted with regulations for economic revenue in the short-term. Overall, this study provides useful information about the establishment and evolution of Corozalito arribadas along with its impacts on the local community, which can inform future management and conservation strategies.

1. Introduction

Local ecological knowledge (LEK) can fill information gaps and provide insights about natural resources and their value in the lives of local inhabitants (Flores et al., 2021; Shephard et al., 2021). Understanding LEK, perceptions and attitudes of the local communities has become increasingly important in the conservation and management of natural resources (Azzurro et al., 2011; Flores et al., 2021). In sea turtle conservation, past studies have used LEK to reconstruct historical population trends, gain information about species distribution, and identifying main threats and human-sea turtle interactions (Barrios-Garrido et al., 2018; Early-Capistrán et al., 2020; Flores et al., 2021). Interdisciplinary research has also been applied in sea turtle conservation studies to develop an improved understanding of the attitudes and perceptions of local communities regarding the conservation and management of these species (Senko et al., 2011; Mejías-Balsalobre et al., 2021; Rojas-Cañizales et al., 2022a).

The olive ridley (*Lepidochelys olivacea*) is listed as ‘vulnerable’ by the International Union for the Conservation of Nature’s Red List of Threatened Species (Abreu-Grobois and Plotkin, 2008). Along with nesting in a solitary manner similar to other sea turtle species (Eckrich and Owens, 1995), this species is also known to nest synchronously *en masse* in a phenomenon known as “arribada”, a Spanish word meaning arrival (Hughes and Richard, 1974), which is a behavior exclusive to the genus *Lepidochelys* (Pritchard, 1997). Arribadas occur only at a few beaches worldwide, in the eastern Pacific, the western Atlantic and the northern Indian Ocean (Bernardo and Plotkin, 2007). However, arribada events are ephemeral in time and usually occur in remote areas, which has resulted in multiple arribada beaches remaining unknown to the scientific community for years, or even decades, giving rise to the issue of shifting baselines (Pritchard, 2007). For that reason, little is still known regarding the mechanism of their formation and evolution (Bernardo and Plotkin, 2007; Fonseca et al., 2009).

Sea turtles have played a major role in the culture and economy of many coastal communities worldwide (Frazier, 2005; Álvarez-Varas et al., 2020; Mejías-Balsalobre et al., 2021). Great aggregations of turtles such as arribadas can define the economy of the surrounding communities (Campbell, 1999; Ocana, 2010). Due to the large numbers of nests during arribadas, these events have mainly served as a food resource for the local communities as well as for commerce, either legally or illegally (Kar, 1980; Campbell, 1998; Valverde et al., 2012). In addition, given its outstanding nature, this phenomenon attracts people from all over the world, which has promoted ecotourism as an alternative source of income for the surrounding communities of arribada beaches (Campbell, 1999; Sharma and Pandey, 2020).

A great example of how arribadas can impact the livelihoods of a local community is the Ostional National Wildlife Refuge case in Costa Rica. Ostional is renowned for its egg-harvesting project managed by the local community, the Association for the Integral Development of Ostional (ADIO, for its acronym in Spanish). This is the only legal source of sea turtle eggs for the national market (Valverde et al., 2012) since the ban on egg and turtle extraction was declared on 1963 (La Gaceta 121, 1963). Additionally, sea turtle tourism and hospitality have considerably contributed to Ostional’s economy (Sardeshpande and MacMillan, 2019). In contrast, Nancite, an arribada beach protected inside Santa Rosa National Park, is characterized by the absence of sea turtle egg extraction and restricted tourism (Eckrich and Owens, 1995; Valverde et al., 1998; Fonseca et al., 2023). At a midpoint of these two well-known beaches, Costa Rica hosts a third arribada beach on public unprotected land, Corozalito (Rojas-Cañizales et al., 2022b).

Corozalito is a small (~768 m long), nascent arribada beach in Costa Rica’s Pacific coast that hosts small-scale arribadas, with as many as ~21,000 nesting turtles during a single event (reported in October 2021) (Rojas-Cañizales et al., 2022b). Rocky outcrops border both ends of the beach, with an estuary on the southern end (Viejobueno et al., 2012). The first official report of an arribada in Corozalito dates back to 2007, and since 2008 it has been monitored by the Sea Turtle Restoration Program (PRETOMA, for its Spanish acronym), from 2008 to 2013, and since 2014 by the Rescue Center for Endangered Marine Species (CREMA, for its Spanish acronym) (Viejobueno et al., 2011; Rojas-Cañizales et al., 2022b). However, there is a lack of information regarding the onset of this phenomenon prior to 2007, although it seems to be in its early stages of development (Pritchard, 2007; Rojas-Cañizales et al., 2022b). This arribada beach is located in an isolated rural area near the village of Corozalito (Viejobueno et al., 2012).

Sea turtle egg consumption, whether from legal or illegal sources, remains a prevalent practice in Costa Rica (Hart et al., 2013; Mejías-Balsalobre et al., 2021; Pheasey et al., 2024). In Corozalito, the surge in nesting activities coincided with a notable uptick in sea turtle egg extraction, occasionally leading to the total depletion of all the nests laid within a single night. In response to the surge in the nesting activity and the extraction of nests, some members of the local community took proactive steps and created a volunteer group in the late 1990s to safeguard turtles by maintaining the beach free of debris, guiding hatchlings to the sea upon emergence from nests, and protecting sea turtle nests against egg extraction. These efforts occurred before the involvement of any NGO (CREMA, unpublished). This local environmental group has since evolved into the Association for the Integral Development (ADI) of Corozalito. In addition, by the early 2010s, a growing interest in turtle tourism began to flourish, attracting visitors keen to witness this natural spectacle. By 2013, tour operators had established themselves in the area, primarily hailing from nearby communities. As of today,

they continue to operate and expand their presence (personal observation).

This study had two main objectives: first, considering the scarcity of information surrounding arribadas' formation, we aimed to provide insights about the onset and evolution of Corozalito arribadas by compiling LEK that community members had gained at the beach. Secondly, given the noteworthy event of a nascent arribada beach and the scarcity of social studies regarding this phenomenon, we aimed to identify attitudes and perceptions of the local community towards the mass nesting event and its socio-economics and conservation impacts.

2. Methods

2.1. Study area

The study was conducted in Corozalito village ($9^{\circ}51'37.4''\text{N}$; $85^{\circ}22'01.6''\text{W}$), which is located in Bejuco district, Guanacaste Region, Costa Rica (Fig. 1). The area is rural and unpopulated as the entire Bejuco district has only ~ 3300 residents (McGovern et al., 2020). Bejuco is characterised by a low social and economic development, when compared to the rest of the country (MIDEPLAN, 2017). Corozalito is a small and isolated village, with an estimated 162 residents, and an economy based on agricultural-livestock with high rates of unemployment and emigration (Almeyda et al., 2010; Picón-Cruz et al., 2014). This village is only accessible by one road (Viejobueno et al., 2012), flanked by Bejuco village, approximately 5 km to the south, which is characterized as a traditional fishing community (Villalobos-Rojas et al., 2014). North of Corozalito, Punta Islita (~ 3.5 km west) and Samara (~ 17 km west) two very tourist-oriented villages (Sorensen, 1990; Almeyda et al., 2010). Finally, Camaronal Wildlife Refuge-a Marine Protected Area (~ 9 km north) (La Gaceta 79, 1994), which is also an important sea turtle nesting beach (Cáceres-Farías et al., 2022).

2.2. Data collection

We conducted semi-structured in-depth interviews during October–December 2018 (within the season of local arribadas (August–January) as reported by Rojas-Cañizales et al. (2022b)) in Corozalito village to gain a better understanding about Corozalito arribadas and their impact on the community. Data collection involved two types of interviews: the first one compiling LEK about the onset and evolution of the mass nesting events (hereafter referred to as the LEK interview), and the second one, assessing local's perceptions and attitudes about the phenomenon, sea turtle use and conservation (hereafter referred to as the perception interview). To inform our research hypotheses and the interviews, we first conducted semi-structured pilot interviews with residents ($n = 3$).

To identify and extract the available LEK about the origins and dynamics of Corozalito arribadas, a total of 10 key informants (KIs)

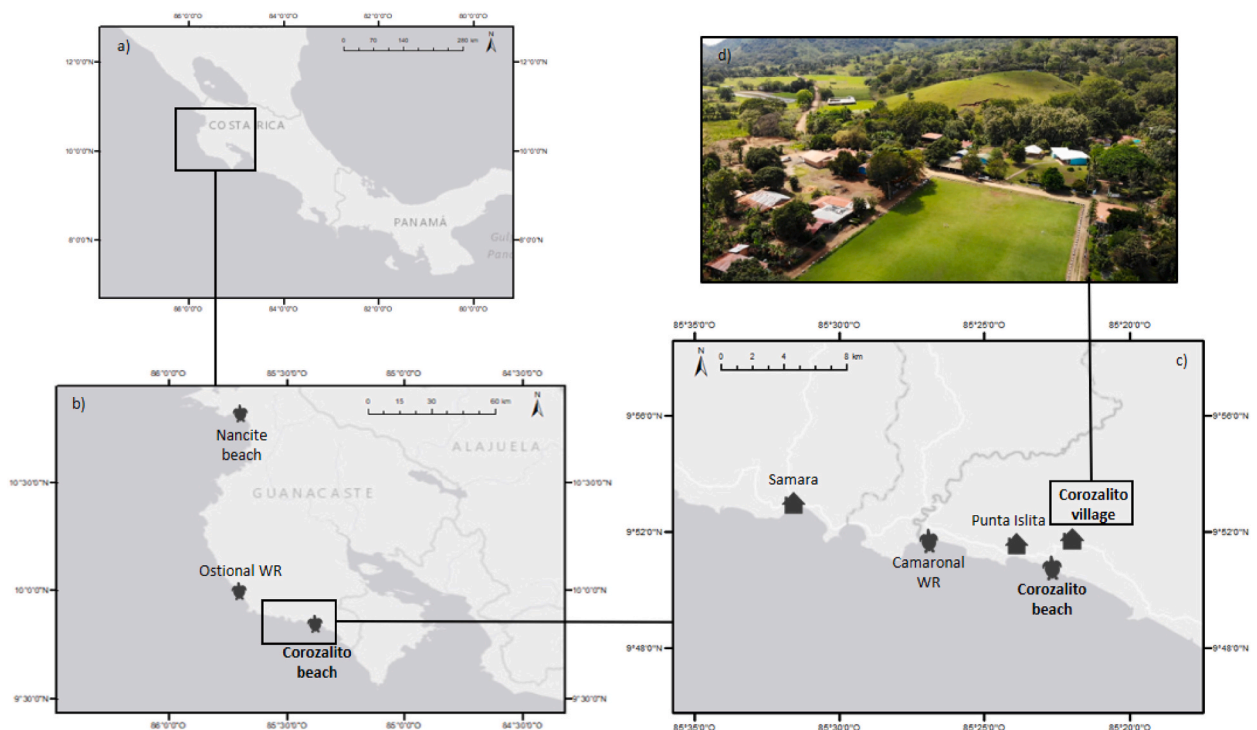


Fig. 1. Map of the study area: a) Geographic location of Costa Rica; b) Location of the established arribada nesting beaches in the country; c) Location of Corozalito village as well as surrounding tourist villages and important nesting grounds; d) Aerial photo of Corozalito village by Fernando Cortez.

were interviewed (Barrios-Garrido et al., 2017). These KIs were selected through purposive sampling by consulting community members to identify knowledgeable locals (who have lived in Corozalito at least 20 years and used to go to the beach at least 2/3 times per week) (Davis and Wagner, 2003). In addition, for the perception interview, 15 local respondents were surveyed to gain a deeper understanding of community perceptions. Ten of these respondents were the same individuals from the LEK interviews, the remaining five respondents were chosen through snowball sampling (Newing, 2010). Both types of interviews involved a set of open-ended questions in a specific order but allowing participants to discuss any information at will (Mejías-Balsalobre et al., 2021).

For the LEK interview, socio-demographic data was recorded first, followed by the LEK about the arribadas. For the perception interview, socio-demographic data was recorded as well as the respondent's perception about: 1) the arribada phenomenon; 2) threats to sea turtles at this site; and 3) views on existing tourism and potential conflicts or benefits of its increase. All in-depth interviews were conducted face-to-face by CMB and RFM, co-authors of this research, in Spanish and individually at the households of the interviewees. Before the interview was conducted, interviewees were informed about the nature and aim of the study, then assured that all recorded information was anonymous and confidential and that participation was voluntary, with the possibility of discontinuing their participation in the survey (Barrios-Garrido et al., 2019). Interviews were recorded in writing and audio whenever the interviewee consented (Newing, 2010). All respondents were over 18 years of age.

2.3. Data analysis

Data were analyzed based on two broad categories corresponding to the two types of interview (a) LEK of Corozalito arribadas, and (b) perceptions about the arribadas and their impacts. The second category was then divided in (b1) feelings about the phenomena, and (b2) perceived socio-economic and conservation impacts of the arribadas. Feelings about the phenomena (b1) were analyzed using a word cloud. Perceived socio-economic and conservation impacts were categorized into themes and ranked using a post-survey Likert-like construction (PSLCs) (Doubleday et al., 2022); using the responses from semi-structured we constructed five-point scale system from multiple themes after the completion of interviews (Fig. 2). These codes/themes were plotted afterwards in bar charts and scatter plots. In addition, a median was calculated for each impact. Lastly, a content analysis was used to extract common themes in the perception interviews (Álvarez-Varas et al., 2020).

3. Results

3.1. Profile of the respondents

All respondents (n = 15) whom we approached agreed to be interviewed. However, some respondents decided not to answer particular questions and others gave multiple responses in one or more questions, thus creating a variability on the sample size for each question. Most interviewees were men (n = 11). The age of the interviewees ranged from 25 to 77 years and most of them (n = 9) were between 41 and 70 years old. Most participants (n = 10) were descendants from locals of Corozalito, while the rest moved to the village for different reasons and have lived in Corozalito for at least 15 years. Hospitality was the most common occupation (n = 6), followed by agriculture (n = 2) and construction (n = 2).

3.2. Local ecological knowledge of Corozalito arribadas

Of the ten KIs interviewed, seven recalled the approximate year when the arribadas started at Corozalito beach. The most common response dated it to the late 1990s and early 2000s (n = 5). In fact, three of the respondents remembered witnessing this phenomenon in 2000 and 2001; one of them stated:

"In 2001 I saw my first arribada. I was with my stepdad, and we were surprised, so we started counting them. We counted 400 turtles. I believe this was the first arribada at Corozalito, as no one had mentioned witnessing one before" (R1: local environmentalist, 25 years old)

Another one detailed:

"I recall witnessing arribada tracks for at least 20 years, but people did not really care. We would just say 'look there were tons of turtles' we did not even know the word arribada" (R2: farmer, 61 years old)

When asked about the origin of arribadas at Corozalito, seven of the KIs attributed them to the hatchery that some locals started in the late 90s, which operated for approximately 4 years. However, some of them believed it was a confluence of factors, being ocean currents the most recurrent response (n = 3), while others believed that since an earthquake that occurred in 2012 (n = 2), more turtles nest at Corozalito.

In addition, all the KIs (n = 10) felt that arribadas have increased over time: several of them stated that they have increased in size (n = 7), frequency (n = 5), and a minority (n = 3) mentioned that their occurrences have increased across the months of year (spreading into the dry season). When asked about the reason for this increase, the most frequent answers where: sea turtle fidelity (n = 3) and the fact that the beach has little human disturbance (n = 3). Nonetheless, most respondents (n = 6) felt that they will decrease in the future, while a minority (n = 3) believed that they will continue growing.

Finally, most of the respondents (n = 8) could name another beach with high density of nesting: seven of them alluded to Camaronal, while five informants recalled Ostional.

	ANIMAL PREDATION	SEA TURTLE ABUNDANCE
1	Extremely concerned/Something must be done to address this problem	Extremely concerned/Something must be done to address this problem
2	Quite concerned/It is excessive and should be monitored	Quite concerned/It has many negative consequences
3	Somewhat concerned/ It is too much; we will have to see its impact in the future	Somewhat concerned/It is too much; we will have to see its impact in the future
4	Moderately concerned/It is a lot, but there is nothing we can do about it	Moderately concerned/It is a lot, but there is nothing we can do about it
5	Not at all concerned/It is part of nature	Not at all concerned/It is part of nature

	SEA TURTLE EGG EXTRACTION	ECOTOURISM
1	Strongly oppose/It should cease	Strongly oppose/It should be reduced and regulated
2	Somewhat oppose/It should not happen unless it is necessary	Somewhat oppose/Do not promote it and regulate it
3	Neutral/Maintained, only a few nests for locals	Neutral
4	Somewhat in favor/Promote it with regulations	Somewhat in favor/Promote it with regulations
5	Strongly in favor/Promote it with no regulations	Strongly in favor/Promote it with no regulations

Fig. 2. Schematic for interpreting post-survey Likert scores (1–5) for animal predation, sea turtle abundance, sea turtle egg extraction and ecotourism.

3.3. Feelings about the phenomenon

The word cloud highlighted the most common adjectives that local respondents ($n = 14$) used to describe the arribadas at Corozalito in the perception interview (Fig. 3). As expected, most of the perceptions denoted positive attitudes towards the phenomenon or pointing out its massive nature. One of the respondents mentioned:

“My mum is 95 years old. When there is an arribada she loves going to the beach, sitting on a chair while drinking her coffee and watching the turtles pass by her side. Even if she has seen it tons of times, she feels the joy of sharing. It is part of the tradition¹” (R15: hotelier, 68 years old)

Nevertheless, not all the descriptions were positive as the large numbers of turtles caused aversion to some respondents. For example, one of them stated:

“It is scary, too many critters” (R7: unemployed, 58 years old)

3.4. Perceived socio-economic and conservation impacts

Animal predation was named as the main threat ($n = 10$) for nests at Corozalito beach, followed by human sea turtle egg extraction ($n = 3$), light pollution ($n = 2$) and the abundance of sea turtles during arribadas ($n = 2$). All the respondents ($n = 15$) in the perception interviews expressed their opinion in favor or against the different factors related to the arribada (Fig. 4), which were subsequently coded with the corresponding post-survey Likert scores (1–5). When asked about their perspective on the amount of predation at Corozalito, the median rank was 4 (*moderately concerned/it is a lot, but there is nothing we can do about it*), the same as for their views on

¹ Literal translation of the interviewee's statement. The correct English term would be custom “a commonly accepted manner of behaving or doing something in a particular society, place or time”.



Fig. 3. Word cloud detailing the most common adjectives to describe the arribada phenomenon by the local respondents.

ecotourism (*somewhat in favor/promote it with regulations*). Nevertheless, as can be observed on the graph (Fig. 4), participants' perceptions on ecotourism were less diverse and mainly in favor of promoting it in a regulated way, although there did not seem to be a clear consensus on how. Sea turtle egg extraction was the subject with the most divided opinions with a median of 3 (*neutral/main-tained, only a few nests for locals*). On the other hand, the abundance of turtles due to the arribadas had a median of 2 (*quite concerned/it has many negative consequences*), pertaining to the negative aspects of sea turtle density in a small beach (nest destruction, odor, bacteria, etc.).

In addition, we compared interviewees' perception on sea turtle egg extraction and sea turtle abundance in a scatter plot (Fig. 5) to study their relatedness. As Fig. 5 shows, many participants that were extremely or quite concerned about sea turtle abundance due to the arribadas (scores 1–2), were also in favor of sea turtle egg removal (a majority for consumption, but also to relocate them), with or without regulations (scores 4–5). When comparing perceptions of the consumptive use (sea turtle egg extraction) versus the non-consumptive use (ecotourism) of sea turtles and their products during the arribada it was noticeable that they were not mutually exclusive. As it can be seen on Fig. 5, all interviewees ($n = 4$) from the youngest group (18–40 yrs) were extremely opposed to sea turtle egg extraction. Common themes mentioned during the interviewees as well as personal comments from respondents are shown in Table 1.

4. Discussion

4.1. LEK of Corozalito arribadas

According to the LEK compiled in this study, Corozalito arribadas started in the late 1990s-early 2000s, setting a new point of reference for this phenomenon, as the first official report of this event in Corozalito dates back to 2007 (Rojas-Cañizales et al., 2022b). Several aspects could affect the discovery of this arribada beach, such as the sporadic nature of the events, their coincidence with the rainiest months of the year, and the distance from the beach to the small village (2.5 km) (Rojas-Cañizales et al., 2022b). Thus, it is reasonable to assume that this event may have gone undetected for several years, making the establishment of an exact moment of the onset of the arribadas quite challenging.

LEK can provide an improved understanding of arribadas and their first occurrences, especially considering how easily these events go undetected (Pritchard, 2007). For instance, Ostional arribadas have been monitored since 1970 (Richard and Hughes, 1972). However, the residents recall this phenomenon since the 1940s (Campbell, 1998). It is not necessary to go so far back in time, as arribadas continue to be reported on specific beaches worldwide. For example, arribadas in Rushikulya (India) started in 1994 (Pandav et al., 1994), in Ixtapilla (Mexico) in the late 1990s (Cáceres-Farías et al., 2022), and more recently in Harguna beach (Middle Andaman Island, India) in 2012 (Namboothri et al., 2015), but little is still known about the exact moment of their onset.

All KIs agreed that the arribada is increasing in size, frequency, and/or occurrences across the months of the year. These results are consistent with the findings of Rojas-Cañizales et al. (2022b), which revealed that Corozalito arribadas, though small, display an increasing trend in magnitude and frequency with large fluctuations, indicating that it is still at its early stages. Interestingly, most KIs believed that the arribada is going to decrease in the future. Though this may eventually happen, as witnessed in other arribada populations in the country (Valverde et al., 1998; Fonseca et al., 2023), Corozalito's high hatching success rates, relative to those of older arribada beaches, suggest that the phenomenon at this site is consistent with a young arribada population, where nest destruction and microbial load are not yet critical (Rojas-Cañizales et al., 2022b).

There is no certainty of the mechanism and cues that lead to the establishment of these synchronic mass nesting events, which was reflected in the diverse opinions received in the present study. It has been hypothesized that arribadas are built gradually over time, driven by high hatching rates at a given beach (Valverde et al., 1998; Fonseca et al., 2009). In concordance with this hypothesis, some participants believed that Corozalito arribadas were established due to sea turtle fidelity and the high volume of hatchlings from the local hatchery. However, using tag-recapture data it was shown that the large arribadas at Corozalito are also nurtured by nesting females from other areas along the Pacific coast of Costa Rica (Rojas-Cañizales et al., 2022b). Rojas-Cañizales et al. (2022b) suggested that arribadas first establish relatively quickly as large groups of sea turtles that spin off aggregations, which, to some extent, could work in concert with arribadas building over time due to high hatching rates. Interestingly, participants mentioned that Camaronal used to have arribada nesting events, but they decreased over time, in contrast to Corozalito. Indeed, Camaronal has been cited as an

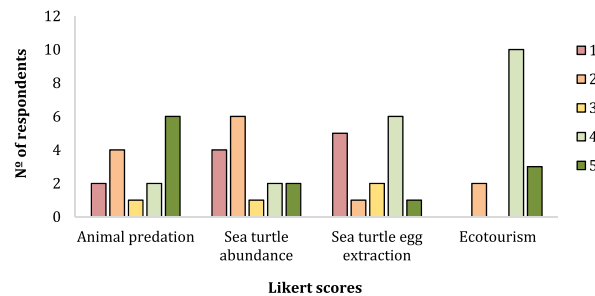


Fig. 4. Subjective assessment of participant's perception on different factors related to Corozalito arribada beach. The colored bands refer to post-survey Likert scores (1–5; see Fig. 2.).

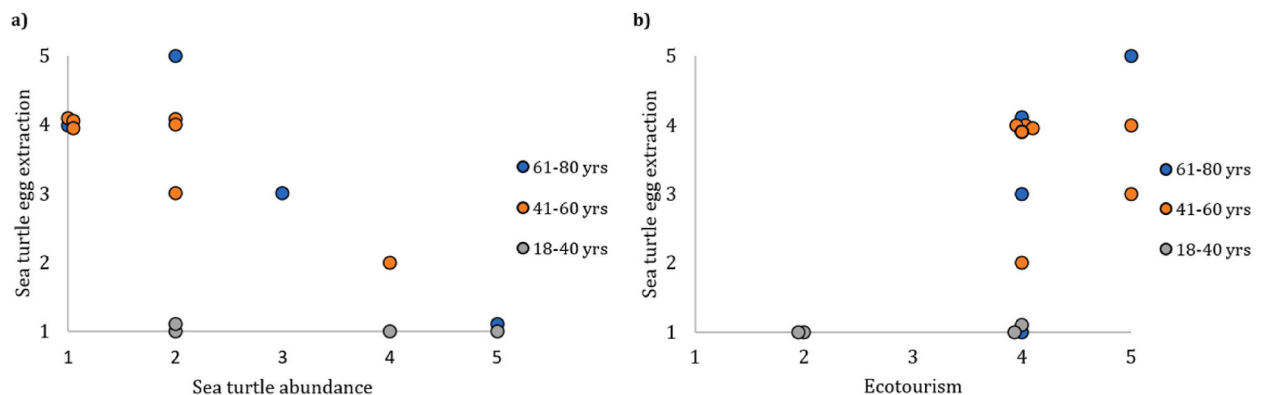


Fig. 5. Scatter plot of participant's perception on sea turtle egg extraction compared with turtle abundance and tourism at Corozalito arribada beach. Points represent the perception of each respondent after being categorized in the post-survey Likert scale (1–5) (see Fig. 2.). Participants were grouped based on age.

Table 1

Recurring themes by respondents of the perception interview and illustrated examples.

Theme (No. of respondents)	Illustrated example
Animal predation has increased since the arribadas started (n = 8)	"In the past, packs had 7-10 raccoons. Now I have seen more than 100 together." (R6: constructor, 52 years old)
There is greater protection of sea turtle nests in the community nowadays (n = 10)	"The mentality has changed. There is 90-95% of protection, and egg take is only carried out by 4-5 locals with drinking problems or foreigners." (R6: hotelier, 45 years old)
Part of the community has made great efforts in the past to protect sea turtles (n = 10)	"We started protecting the turtlesit was hard ... I feel like we won the battle." (R2: farmer, 61 years old)
It is a tradition to eat sea turtle eggs (n = 8)	"It is a tradition to eat eggs. They used to say that the ecological balance was going to break, but it never did." (R9: teacher, 70 years old)
Local egg extraction is low, and it is not a problem, the problem is trade (n = 7)	"In Corozalito the locals that poach sea turtle eggs always get caught. The real problem is people from other towns. On arribada days, they even come from San José." (R5: baker, 38 years old)
Ostional's effects (n = 8)	"It should be regulated like in Ostional. Otherwise, many turtles will end up dead. If arribadas follow this increasing trend, they will eventually decrease." (R15: hotelier, 68 years old)
	"In local bars around Corozalito you can buy sea turtle eggs. There is a place where they have permits to take the eggs. If the bar keeps the permit card that comes with the legal sea turtle eggs, it is impossible to tell if the ones that they sell come from there or from Corozalito" (R9: teacher, 70 years old)
The beach can get 'contaminated' (n = 9)	"When turtles dig other nests, the smell is terrible The beach is small, sometimes you cannot even walk ... hopefully this contamination due to so many eggs does not affect them" (R7: unemployed, 58 years old)
Tourism should be promoted, with regulations (reduced groups, timetables, red lights, etc.) (n = 10)	"Now there are guides with 30-60 people, when the maximum should be 10-12. Tourists should be divided into groups and have schedules to enter" (R1: local environmentalist, 25 years old)
Tourism should benefit locals from Corozalito (n = 9)	"Tour operators from other towns have been coming to Corozalito since 2013, more local guides should be involved in sea turtle tourism" (R11: laborer, 46 years old)

arribada beach (Cáceres-Farías et al., 2022). However, arribada nesting information at this potential site is scarce. In addition, interviewees referred also to Ostional, when questioned about other arribada beaches, which was foreseeable as it is a renowned arribada beach in the country (Sardeshpande and MacMillan, 2019). It is also worth mentioning that Rojas-Cañizales et al. (2022b) reported a

synchronicity during nine arribadas at Corozalito and Ostional in the span of 3 years.

4.2. Socio-economic and conservation impacts of Corozalito arribadas

Our respondents exhibited assorted perceptions about the impacts of these massive synchronic events, especially in relation to their consumptive use or their economic benefits through sea turtle tourism. Conversely, our results clearly demonstrate the power of sea turtles as a cultural service, as even though many participants pointed out the excessive and overwhelming nature of the arribadas, the majority expressed their enriching and aesthetic values. Sea turtles have been reported in the past as cultural key species that provide important ecosystem services for residents and non-residents (Campbell, 2003; Barrios-Garrido et al., 2018; Álvarez-Varas et al., 2020). The present study provides further evidence of the non-material benefits that people can obtain from these animals. Therefore, arribadas not only entail ecological, economic and provisioning advantages but also cultural ones, through spiritual enrichment, recreation and aesthetic experiences, among others.

4.2.1. Animal predation and sea turtle abundance

In the Pacific of Costa Rica animal predation is considered one of the main threats for olive ridley nests (Reavis et al., 2022). Likewise, animal predation was the greatest threat for sea turtle nests in Corozalito according to the interviewees, who pointed out that the number of predators and predated nests has increased in recent years. Nonetheless, they attributed it to a natural process. These findings agree with the theory that states that although arribada nesting may reduce the chances of being predated due to predator satiation, it may increase overall predation by attracting predators (Bernardo and Plotkin, 2007). In fact, it has been reported that Corozalito predation rates for solitary nests have increased in recent years (Espinoza-Rodríguez et al., 2023).

On the other hand, sea turtle abundance was a concern among the majority of respondents, as they are worried about the beach getting 'contaminated'. This problem has been ascribed in the past in relation to other arribada beaches like Nancite, where the olive ridley arribada population, although increasing at present, still exhibits lower abundance than recorded in the 1970s (Fonseca et al., 2023). This arribada nesting population suffered a continuous decline for 36 years (Fonseca et al., 2023), which has been mainly attributed to the low hatching rate that the beach exhibited for years (Cornelius et al., 1991). This low hatching rate may be the result of the high nest density and large amount of organic matter on the beach from destroyed clutches by nesting females (Valverde et al., 1998; Clusella-Trullas and Paladino, 2007). High densities of organic matter may result in a high microbial load, leading to an alteration of the respiratory microenvironment in the nest (Ackerman, 1977). Hatching success in Corozalito is higher than in Nancite and Ostional, suggesting that it is a young arribada beach, and that nest destruction and microbial load are not yet critical (Rojas-Cañizales et al., 2022b). Nonetheless, gas levels and sand conditions that are important factors to consider in arribada nesting beaches have not been studied yet at this beach.

4.2.2. Sea turtle egg extraction

The extraction of sea turtle eggs from their nesting beaches, a traditional exploitation method by members of coastal communities, has been banned in Costa Rica since 1963 (La Gaceta 121, 1963). An exception was created for the community established in Ostional, where the arribada allows for the extraction of some nests under biological criteria (Brenes and Cedeño, 2017). The majority of respondents acknowledged that sea turtle egg consumption in Corozalito is a traditional practice, and almost half of the respondents were in favor of extracting the eggs, which coincides with previous studies that reported sea turtle egg consumption as a deeply rooted tradition for coastal communities (Nada and Casale, 2011; Mejías-Balsalobre et al., 2021). Nonetheless, the extraction of eggs turned out to be a controversial topic among study participants, as we obtained the most discordant answers when compared to other assessed topics. Differing perspectives, attitudes, and behaviors in a local community towards a natural resource may result in potential conflict (Kinan and Dalzell, 2005; Barrios-Garrido et al., 2019), and this is precisely the case of Corozalito.

To better understand the current situation in Corozalito, it is necessary to consider its history. Respondents indicated that in the past, nearly all sea turtle nests in Corozalito were extracted. In the late 1990s, several community members began initiatives to clean debris from the beach, guide hatchlings towards the sea, and safeguard turtle nests, thus reducing egg extraction. These initiatives were started by local individuals before any environmental organizations became involved in the area. While some locals were motivated to safeguard sea turtles, others saw the abundance of nests as an important resource for personal consumption or trade. The difference in perspectives led to confrontations and grievances between these two groups. According to one of the respondents, in Corozalito this discord escalated tensions, to the point of threats and sporadic acts of vandalism, such as punctured tires, targeting those advocating for restricting egg extraction. The consumptive use of sea turtles and their products in communities where people benefit indirectly from these activities has been identified as one of the major challenges and sources of conflict related to sea turtle conservation in Latin American countries, including Costa Rica (Barrios-Garrido et al., 2019). Furthermore, in the study conducted by Barrios-Garrido et al. (2019), researchers assessed conflict severity using a scale ranging from minor disagreements (1) to physical violence (5). According to their findings, past conflicts in Corozalito reached a severity level of 4. However, our respondents observed a decrease in both conflicts and nest extraction over time.

The prevailing sentiment among the respondents was that sea turtle egg extraction in Corozalito had diminished over time, a trend that aligns with the monitoring data (CREMA, unpublished). Most respondents expressed their belief that local egg extraction rates are low and not a significant concern. According to respondents, only a small number of locals are currently directly involved in sea turtle egg extraction, often linked to alcohol abuse (see Table 1). Previous studies have linked sea turtle and egg extraction to substance abuse (Barrios-Garrido et al., 2019; Mejías-Balsalobre et al., 2021; Rojas-Cañizales et al., 2022a). However, respondents expressed concerns regarding egg extraction for commercial purposes, an issue still prevalent in the area (Pheasey et al., 2020). Our findings also revealed

that the youngest generation of respondents unanimously opposed sea turtle egg extraction, consistent with research indicating a non-consumptive approach among younger demographics (Abd Mutalib et al., 2013; Campbell, 2007).

It is important to remark that many of the respondents who were in favor of extracting sea turtle eggs in Corozalito, alluded to the excess of nesting turtles given the dimensions of the beach, and specified that there should be a “controlled extraction”. Aligned with this mindset, Ostional was frequently mentioned as a model where the extraction of sea turtle eggs for commercial purposes is legal (Valverde et al., 2012). Ostional is a community-based conservation model, not free of controversy. Among its criticisms is that it facilitates a nationwide market for eggs illegally extracted outside of Ostional (Pheasey et al., 2021), though a recent study found no evidence that Ostional is being used as a cover to sell eggs from other turtle species (Pheasey et al., 2024). Another criticism is that it may encourage other communities with arribada nesting events to pursue this system, as the present study confirms. However, Ostional stands as a recognized success story in community-based conservation (Campbell, 1998). The trade of sea turtle eggs sustains the community of Ostional, where residents actively engage in sea turtle conservation efforts by regulating tourist numbers during arribada events, cleaning the beaches of debris, safeguarding hatchlings on their journey to the sea, and defending nests from illegal extraction (Campbell et al., 2007). Central to the Ostional model, with its attendant advantages and disadvantages, is the unwavering support of the local community (Campbell, 1998; Sardeshpande and MacMillan, 2019). In contrast, our findings in Corozalito reveal a community divided over sea turtle egg extraction, with some members taking proactive steps to protect sea turtles, even creating the ADI of Corozalito. Given past intra-community conflicts and a majority opposed to commercial egg extraction, a system akin to Ostional is discouraged for the time being.

4.2.3. Tourism

Corozalito's economy is currently geared towards tourism, as evidenced in the present study. Ecotourism has been proven as an alternative livelihood that may change locals' attitudes towards the consumptive use of sea turtles and their products (Tröeng and Drews, 2004; Senko et al., 2011; Hart et al., 2013), even though it may not necessarily imply a change on their consumptive behavior (Hancock et al., 2017; Mejías-Balsalobre et al., 2021). However, poorly handled ecotourism can have detrimental effects on both sea turtles and local communities (Meletis and Harrison, 2010; McGovern et al., 2020). Corozalito is a small town with limited infrastructure and employment opportunities; the support for increased tourism with regulations (use of red lights, reduced groups, timetables, etc.), reflects the community's desire for additional economic activity that is respectful of sea turtles. In fact, the community counts with an established Environmental Committee (CREMA, personal communication). Moreover, participants complained about the lack of local employment since 2013. To this point, outside tour operators from larger towns like Punta Islita or Samara, have brought tourists to witness sea turtles nesting at Corozalito, barely involving local residents directly. Local benefit from ecotourism is essential as previous studies found contrasting perceptions between neighboring communities with different rewards from ecotourism, with the highest levels of awareness where tourism was a main source of income (Hart et al., 2013; Mejías-Balsalobre et al., 2021). Multiple strategies can be implemented to ensure sustainable ecotourism in rural areas (Gutiérrez-Lince et al., 2021), yet community participation in decision-making is key to ensure that benefits reach local residents, while supporting sea turtle conservation (Campbell, 1992).

This study was conducted in a pre-pandemic context (2018). We acknowledge that the perceptions and attitudes reflected in this study might differ due to the new realities at regional, national, and worldwide levels. The outbreak of the COVID-19 pandemic at the start of 2020 led to a dramatic reduction and alteration of human activity (Quesada-Rodríguez et al., 2021). In Costa Rica, the pandemic prompted widespread changes across various sectors, particularly those reliant on tourism (Espinoza-Cisneros et al., 2022). Therefore, this study should be regarded as an initial exploration of social research in Corozalito, aimed at comprehending the historical significance of the arribada and its socio-economic impacts on the community. Further research is imperative to grasp the evolving dynamics and new realities brought forth by the pandemic.

5. Conclusions

Arribadas have been studied by the scientific community since the 1960s (Hildebrand, 1963). Nevertheless, there are still many enigmas surrounding these events and their study is usually complicated by a lack of sound historic records. According to LEK, Corozalito arribadas started in the late 1990s early 2000s, setting a new date of first occurrence as the first official report dates back to 2007. In agreement with monitoring data (available since 2008), our results show that since its onset arribadas have increased in size, frequency, and number of months of occurrence during the year. There is no clear answer about Corozalito arribada's formation; nevertheless, for future studies we encourage assessing Camaronal's nesting trends and its potential relation with Corozalito, using LEK if scientific data is scarce. Overall, the results of this study shed some light onto the establishment of the Corozalito arribada and its evolution, which along with the current monitoring effort, can help assess the status of the population and enhance current knowledge about arribada events along the Eastern Pacific.

The present study exposes some of the impacts a coastal community may be subject to due to its proximity to an arribada nesting beach, which tend to be located in isolated and rural regions. With the exception of Ostional, little research has been carried out to assess the impact of arribada beaches on neighboring rural coastal communities. The village of Corozalito is a good example of the benefits and costs that a mass nesting event, or arribada, can bring to a rural community. The massive nesting numbers can evoke a wide range of feelings and perceptions about sea turtles and their ecology, use, and conservation. Certainly, while the abundance of sea turtles in Corozalito and the existence of arribadas, has moved part of the community towards the non-consumptive use of sea turtles, it has resulted in intra-community conflicts along the way.

The rising ecotourism, encouraged by the community, needs to be regulated to benefit more local entrepreneurs. Corozalito has the

potential to be a model of community-based conservation, with many community members conscious of the importance of conserving the natural resource available to them. These individuals are already taking steps to manage this resource in a responsible way, while simultaneously improving their economic well-being through non-consumptive use of sea turtles, such as tour guiding. Further social research is needed in the upcoming years, when arribadas are expected to be larger and more frequent, to assess the community's perceptions over time, particularly in the aftermath of the COVID-19 pandemic, and to identify potential challenges. Currently, Corozalito does not enjoy a conservation status. Rojas-Cañizales et al. (2022b) suggested that the area could benefit with the designation of a National Wildlife Refuge at the site, although recently consulted officers feel more inclined towards the creation of a "Other Effective Area-Based Conservation Measure", or OECM, which are sites outside of protected areas that are governed and managed in ways that deliver the long-term *in situ* conservation of biodiversity. We recommend that this and other future conservation management strategies in Corozalito, be decided taking into account its history, the best available sound scientific data (based on long-term monitoring) and acknowledging the needs of the local community.

CRedit authorship contribution statement

Carmen Mejías-Balsalobre: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Daniela Rojas-Cañizales:** Writing – review & editing, Visualization, Supervision, Investigation, Conceptualization. **Roger Fusté:** Writing – review & editing, Methodology, Investigation, Data curation. **Roldán A. Valverde:** Writing – review & editing, Validation, Supervision. **Randall Arauz:** Writing – review & editing, Supervision. **Isabel Naranjo:** Writing – review & editing, Supervision. **Héctor Barrios-Garrido:** Writing – review & editing, Visualization, Supervision, Resources, Methodology, Conceptualization.

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.

Data availability

The data that has been used is confidential.

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Appendix A. Supplementary data

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