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Local Community's Knowledge and Perception towards Freshwater Turtle Conservation in Southern Sumatra, Indonesia

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Abstract

The conservation of freshwater turtles relies on local knowledge and perceptions. This phenomenon is especially significant for communities located near turtle habitats. This study aims to investigate the influence of local communities' knowledge and perceptions of freshwater turtles on their attitudes, behaviors, and the resulting conservation outcomes for these species. Knowledge encompasses the empirical understanding of turtle species, their ecological roles, and conservation statuses. Perceptions encompass the subjective beliefs, attitudes, and values influenced by culture that communities hold regarding these species. The research was carried out in three river systems of southern Sumatra, involving interviews with 133 participants through a semi-structured approach that included closed and semi-open questionnaires, alongside a recollection method utilizing photographs as a tool. Identification was successful for only 8 of the 12 depicted turtle species, and merely one-third of the freshwater turtle eggs were identifiable. The most widely recognized species include the ambiona box turtle (*Cuora amboinensis*)*, Malaysian giant turtle* (*Orlitia borneensis*)*, soft-shelled turtle* (*Amyda cartilaginea*)*, and black marsh turtle* (*Siebenrockiella crassicollis*)*. While most perceptions indicated a favorable attitude towards freshwater turtle conservation, negative behaviors persist that may adversely affect turtle populations.*

Keywords: *attitude, behavior, traditional belief, preservation*

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Introduction

Previous research has recognized the significant role of local and indigenous knowledge systems in biodiversity conservation (Ens et al., 2015; Mistry & Berardi, 2016; Sterling et al., 2017; Fernández-Llamazares & Cabeza, 2018; Díaz et al., 2019). This recognition is significant, as local ecological knowledge and traditional practices offer essential insights for sustainable resource utilization and conservation efforts. The interactions among knowledge, beliefs, and practices are complex. Idu (2020) conducted a study in Nigeria that revealed the intricate influence of local ecological knowledge, cultural beliefs, and traditional practices on community-based natural resource management. Pranyoto et al. (2024) emphasized the significance of comprehending the interaction among social, cultural, and institutional factors in the formulation of effective conservation strategies for Indonesia's forest landscape.

Theories from environmental psychology, social-ecological systems, and traditional ecological knowledge provide a comprehensive analytical framework for understanding the relationships among knowledge, perceptions, and conservation behaviors (Gould et al., 2015; Tengö et al., 2017; Nadasdy, 2020; Reyes-García et al., 2020). Interdisciplinary approaches are essential for comprehending the intricate human-nature relationships that influence forest management outcomes. The interconnectedness of ecosystems has important implications for species conservation, particularly for those residing in forested and adjacent non-forested environments, where they may fulfill critical ecological functions.

Research on wildlife conservation perspectives in Sumatra has primarily focused on large, conflict-prone mammals (Berliani et al., 2016), as well as broader species conservation and bats (Gandiwa et al., 2014; Shafie et al., 2017; Kato et al., 2019). In contrast, studies on reptiles, particularly turtles, are limited. Sunyoto (2012) conducted research on public perceptions of *Amyda cartilaginea* in Indonesia, while Rahayu et al. (2021) and Vallejo-Betancur et al. (2018) explored similar themes in various other regions.

Turtles have significantly contributed to global ecosystems for over 220 million years and have influenced human culture for at least 400,000 years (Stanford et al., 2020), serving as sources of sustenance, medicine, and companionship (Lee et al., 2014; Mardiastuti et al., 2021;

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Dufour et al., 2022). However, extensive exploitation, particularly through illicit harvesting, has contributed to species extinctions (Kusrini et al., 2014; Sigouin et al., 2017; Lovich et al., 2018; Fauzi et al., 2020a; 2020b; Hu et al., 2022), with over fifty percent of the 360 extant species at risk of extinction (Stanford et al., 2020). Luiselli et al. (2021) report that 92% of known freshwater turtles and tortoises are classified as data-deficient, reflecting the current status of freshwater turtles in Indonesia. Notable exceptions are studies on the Asiatic softshell turtle (*A. cartilagenea*) (Kusrini et al., 2014), the Amboina box turtle (*Cuora amboinensis*) (Ives et al., 2008; Schoppe, 2009; Fauzi et al., 2020a), and the pig-nosed turtle (*Carretochelys insculpta*) (Burgess & Lilley, 2014; Triantoro, 2016; Triantoro & Tuharea, 2017; Triantoro et al., 2017).

Since the 1990s, Indonesia has categorized freshwater turtles as a fishery commodity (Oktaviani et al., 2006), with few documented accounts of their harvests. Sumatra Island serves as a primary habitat for turtles in Indonesia (Table 1), with provinces like Riau and North Sumatra recognized as significant areas for turtle trade (Shepherd, 2000). The turtles traded were obtained from these provinces and the neighboring South Sumatra Province, resulting in a total of 77 tonnes of freshwater turtles over a 16-year period (1990 to 2005), with an annual average of 4.8 tonnes (Oktaviani et al., 2008; Fauzi et al., 2021).

Research conducted in Sumatra on turtles primarily emphasizes biological and commercial dimensions, encompassing population characteristics, genetics, species utilization, and turtle diversity (Widagti, 2007; Sentosa et al., 2013; Pasaribu et al., 2019; Guntoro et al., 2020; Fauzi et al., 2020b, 2021). Studies examining local populations' attitudes toward freshwater turtles are less comprehensive than those focused on sea turtles. Two studies investigate local residents' perceptions of specific freshwater turtle species: one in the Philippines (Regodos & Schoppe, 2005) and another in Kalimantan, Indonesia (Rahayu et al., 2021). Conversely, studies on sea turtles have been conducted across various countries (Awabdi et al., 2018).

The perceptions and behaviors of communities regarding a species significantly impact its sustainability within the natural environment. This study explores a notable gap in our understanding of the conservation of freshwater turtles in Southern Sumatra. It is essential for comprehending local knowledge and perceptions regarding conservation initiatives for freshwater turtles. Such outcomes may result in misaligned conservation initiatives, population decreases, ongoing detrimental practices, erosion of traditional ecological knowledge, and postponed policy actions. Bridging the gap between scientific conservation methods and local realities is crucial for implementing culturally appropriate and locally supported conservation actions, thereby ensuring the long-term survival of these species and potentially informing future conservation efforts. This study has the objective to 1) identify community knowledge regarding freshwater turtles and 2) assess community perceptions and behaviors related to the conservation of freshwater turtles.

Methods

Study area The research was carried out in three main river basins located in Southern Sumatra: the Indragiri River in

Table 1 List of freshwater turtles in Sumatra. Conservation status of each species is based IUCN red list (International Union for Conservation of Nature, 2022), appendix CITES (Convention on International Trade in Endangered Species, 2017), and protected list from Indonesia Government (Departemen Kehutanan, 1999; Menteri Kehutanan, 2008; Kementerian Lingkungan Hidup dan Kehutanan, 2018)

No	Species (Scientific name and local name)	Distribution in Indonesia	Conservation status (IUCN red list/ appendix CITES/protected species (PP))
1	*Amyda cartilaginea* (*Labi-labi*)	Kalimantan, Sumatra, Java, Bali, Lombok,	(VU/Appendix II/-)
2	*Batagur affinis* (*Tuntong sungai*/*biuku*)	Sumatra	(CR/Apendix I/DEPHUT 1999, KLHK 2018)
3	*Batagur borneoensis* (*Tuntong laut*)	Sumatra	(CR/Appendix II/ MENHUT 2008, KLHK 2018)
4	*Cuora amboinensis* (*Kuya batok*)	Sumatra, Java, Nusa Tenggara	(EN/Appendix II/-)
5	*Cyclemys dentata* (*Kura-kura bergerigi*)	Sumatra, Kalimantan, Java, Bali	(NT/Appendix II/-)
6	*Cyclemys oldhamii* (*Kura-kura garis hitam*)	Sumatra, Kalimantan, Java	(EN/Appendix II/-)
7	*Heosemys spinosa* (*Kura-kura duri*)	Sumatra, Kalimantan, Bangka	(EN/Appendix II/-)
8	*Malayemys subtrijuga* (*Kura-kura pemakan siput*)	Sumatra, Java	(NT/Appendix II/-)
9	*Notochelys platynota* (*Beiyogo*)	Sumatra, Bangka, Kalimantan, Java	(VU/Appendix II/-)
10	*Orlitia borneensis* (*Bajuku*/*kura-kura gading*)	Sumatra, Kalimantan	(CR/Appendix II/DEPHUT 1999, KLHK 2018)
11	*Siebenrockiella crassicollis* (*Kura-kura pipi putih*)	Sumatra, Kalimantan, Java	(EN/Appendix II/-)

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Riau Province, the Pasir Darat River in South Sumatra Province, and the Sekampung River in Lampung Province (Figure 1). The Indragiri River, extending approximately 550 km, has depths varying from 2 to 36 m and is in Riau Province. The research concentrated on the watersheds of Indragiri Hulu Regency and Indragiri Hilir Regency. *Sungai Pasir*, also known as Pasir River, has a width ranging from 20 to 40 m and is located in the Ogan Komering Ilir (OKI) Regency of South Sumatra Province. Sungai Pasir Darat, a sub-watershed of Jeruju, is situated along the eastern coastline. The majority of participants lived in the village of Sungai Pasir Darat, located in Cengal District.

The Sekampung Watershed in Lampung encompasses more than 484,000 ha and includes eight autonomous regions or districts/cities, such as Sekampung Hulu in Tanggamus Regency, Sekampung Tengah in Central Lampung Regency, and Sekampung Hilir in East Lampung Regency. The primary watershed in Lampung Province is essential for the production of staple foods, export commodities, and fisheries goods (Arifin et al., 2018). Respondents from the Sekampung River were chosen from Lampung Regency, specifically Labuan Ratu Village in Pasir Sakti District and Mekar Jaya Village in Jabung District, as well as South Lampung Regency, including Palas Jaya Village in Palas District and Sukagenah Village in Sragi District.

Site selection The selection of subdistricts and villages for surveying within the three watersheds (Indragiri, Pasir, and Sekampung) was based on information provided by key informants regarding turtle habitats and the frequency of turtle sightings. During high water events, residents frequently observe numerous turtles in the vicinity of their homes. The typical residences in these areas are elevated permanent or semi-permanent structures built on wooden stilts, raised approximately 50–200 cm above the water level. This design serves to prevent inundation during high tides or floods while allowing residents to observe local turtle populations.

Figure 1 Map of the studied watersheds: (a) Indragiri (Riau), (b) Pasir Darat (South Sumatra), and (c) Sekampung (Lampung).

Selection of informants and respondents Researchers developed a thorough understanding of the conservation challenges and opportunities for freshwater turtles in the study area through the engagement of key informants and respondents. This knowledge can guide future management and protection strategies. Informants are subject matter experts offering detailed, qualitative insights, whereas respondents are community members supplying broader, generalized data derived from their personal experiences and interactions.

Altogether, this study involved four key informants, selected for their direct involvement and expertise in conservation efforts relevant to the study areas. The key informants comprised conservation officers actively working in the field from the regional BKSDA offices located in the Provinces of Riau, South Sumatra, and Lampung, and a naturalist guide from the SatuCita Lestari Indonesia Foundation. The informants from the three BKSDA office held the position of Heads of Conservation Section located in the Provinces of Riau, Lampung, and South Sumatra. The BKSDA officials were selected for their essential roles in managing and executing conservation strategies at the provincial level. According to the conservation regulation in Indonesia, any protected species found outside protected areas will be under the responsibility of BKSDA. Importantly, the selected BKSDA officials are also local individuals from the respective study sites, which equipped them with a profound understanding of the local context, culture, and ecological challenges. Their roles provide extensive knowledge of local conservation issues, policy execution, and practical realities, while their local backgrounds enable them to offer insights that connect official viewpoints with community perspectives. As for the fourth key informants, the SatuCita Lestari Indonesia Foundation was also strategically significant. SatuCita is a registered not-for-profit organization dedicated to wildlife conservation, particularly the preservation of freshwater turtles, tortoises, and terrapins in Indonesia, with a focus on Northern Sumatra. The specialized focus of the SatuCita representative renders them an essential source of expertise regarding the specific species and conservation challenges pertinent to this study. The naturalist guide, possessing extensive field experience, offered significant insights into the practical dimensions of conservation efforts, community engagement, and the specific conservation requirements of various species.

The selection of these four key informants was considered adequate for this study based on their senior positions, extensive experience and area oversight, local origins, and specialized expertise, which enhance the validity of the findings despite the small sample size. Hence,

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this facilitated a thorough understanding of the conservation landscape across the three provinces. The BKSDA officials embody the governmental stance on conservation alongside local perspectives, whereas the SatuCita guide provides a concentrated, non-governmental viewpoint on freshwater turtle conservation, thereby ensuring a balanced representation of essential stakeholders. The primary stakeholders in freshwater turtle conservation in these regions include government agencies, specialized conservation organizations, and local communities. Therefore, in addition to the key informants, this study also engaged a wider group of respondents to gather comprehensive data on local perceptions and knowledge. The respondents comprised individuals living near freshwater habitats or those actively engaged in activities pertaining to freshwater ecosystems. They provided insights into the local perceptions, experiences, and interactions with freshwater turtles, which were essential for comprehending the sociocultural context and potential threats to these species. The study involved 133 respondents, consisting of 31 women and 102 men, across three watersheds: 62 participants from the Indragiri Riau watershed, 33 from the Pasir Darat South Sumatra watershed, and 38 from the Sekampung Lampung watershed. The ages of the respondents were categorized based on criteria set forth by the Indonesian Ministry of Health (Departemen Kesehatan, 2009). Data gathered from key informants and respondents encompassed the distribution and abundance of freshwater turtle species, traditional beliefs and practices associated with the turtles, threats to the turtle populations (including pet trade, egg consumption, and habitat destruction), and the potential for community-based conservation initiatives.

Data collection methods Prior to commencing the study, the questionnaire and interview process were carefully designed to comply with the protocol and local authority standard operating procedures to ensure adherence to the ethical principles outlined in the Declaration of Helsinki. The questionnaires and interview process include respect for participant privacy, informed consent, and minimizing potential risks.

This study utilized a mixed-methods approach, combining both quantitative and qualitative techniques, which are well-established and validated in conservation social science research (Kinnebrew et al., 2021; Stevens & Norrins, 2022). This method facilitates a thorough understanding of the knowledge and perceptions held by local communities concerning freshwater turtles. Interviews were conducted after obtaining written consent from each respondent, occurring between 17 January and 18 February 2020. The closed questionnaire included three categories of inquiries: self-identification, community knowledge, and perceptions of freshwater turtle species. The self-identification category included five inquiries related to name, age, gender, education, and livelihoods, adhering to established demographic data collection methodologies in social surveys (McCormick, 2017). In contrast, the community knowledge category comprised eight questions evaluating respondents' awareness of freshwater turtles, encompassing species recognition, identification of freshwater turtle eggs, awareness of their presence, and understanding of their habitats and occurrences. This method for evaluating local ecological knowledge has been corroborated by prior research (Rai & Dhayani, 2023).

Photo elicitation techniques, demonstrated to be effective in ecological knowledge assessments (Clark-Ibáñez, 2004; Kong et al., 2015), were utilized. Images of 11 freshwater turtle species and one sea turtle species (Figure 2) were provided to assist respondents in recalling species they had previously observed. Respondents were requested to identify and name the species based on their knowledge. A comparative image featuring green sea turtles (*Chelonia mydas*) was presented alongside four types of eggs: freshwater turtle, sea turtle, chicken, and quail eggs. Respondents were instructed to identify freshwater turtle eggs from the provided images. Chicken eggs and quail eggs feature a hard calcium shell, distinguishing them from turtle eggs. Turtle eggs are generally characterized by a round or oval shape and feature a delicate, flexible shell. Images of *Batagur borneoensis* eggs were utilized; these eggs are oval-shaped and resemble those of other freshwater turtles, including *C. amboinensis*. The application of visual aids for evaluating species recognition has been effectively implemented in various studies (Owen-Smith et al., 2012; Hamzaoui et al., 2023).

This study employed a nuanced methodology to assess environmental knowledge and its correlation with conservation attitudes. The assessment of turtle species and egg identification served as a fundamental measure of basic ecological awareness, rather than a direct indicator of conservation orientation. The aim was to create a foundational understanding of respondents' familiarity with the focal taxa, which could subsequently be expanded to investigate more profound conservation perceptions and behaviors.

The study included semi-structured questionnaires on the local community's perceptions of freshwater turtle conservation. This enabled a thorough assessment, going beyond simple species identification to encompass cultural values, awareness of conservation issues, and personal attitudes towards wildlife factors that can significantly influence an individual's likelihood to support conservation efforts. This multifaceted approach seeks to enhance understanding of the intricate relationship among ecological knowledge, cultural contexts, and conservation behaviors as shown by prior studies (Drew, 2005; Sunkar et al., 2020).

Data analysis Data on perception and behavior were evaluated using a Likert scale, with scores from 0 to 3: strongly disagree (SD, 0), disagree (DS, 1), agree (AG, 2), and strongly agree (SA, 3). The semi-open questionnaire results were analyzed by converting the data into tables and graphs to improve clarity and aid interpretation. Chi-square analysis was conducted at a 0.05 significance level to assess the differences in species commonly observed across various locations. The individual scores derived from the Likert scale were computed by dividing the total score from seven questions by the maximum achievable score of 28, subsequently multiplying the result by 100. The individual scores were averaged for each watershed area to derive an overall score, and variations in perception levels were analyzed across watersheds. The constraints of utilizing

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Figure 2 Pictures of turtles and eggs for assessing local people's knowledge in South Sumatra. 1) *Batagur affinis);* 2) *Callagur borneoensis;* 3) *Cyclemys dentata;* 4) *Malayemys subtrijuga;* 5) *Cuora amboinensis*; 6) *Sienbenrockiella crassicollis*; 7) *Amyda cartilagenea*; 8) *Orlitia borneensis*; 9) *Chelonia mydas*; 10) *Heosemys spinosa*; 11) *Notochelys platynotan;* 12) *Cyclemys oldhamii*; 13) chicken eggs; 14) *C. borneoensis* eggs; 15) quail eggs; 16) *C. mydas* eggs. Pictures: 1 and 2 by Joko Guntoro; 3, 5, 13, and 14 by Nathan Rusli; 4 by Đỗ Kỳ Minh Hiền; 6, 7, and 8 by Alma Tiara; 9 by Ruchira Somaweera; 10 by Francis Seow Choen; 11 by Andri I. S. Martamenggala; 12 by Satu Cita Foundation; 14 by Yusratul Aini.

species identification and encounter time as direct indicators of pro-conservation knowledge and behavior necessitate a more nuanced approach in assessing conservation perceptions in this study. The survey included a series of semi-structured questions to evaluate respondents' attitudes, beliefs, and stated intentions concerning freshwater turtle conservation, rather than depending exclusively on species identification scores. The attitudinal measures offered a more comprehensive indicator of conservation orientation, extending beyond mere ecological knowledge to encompass the intricate sociocultural factors influencing environmental behaviors.

The data analysis classified respondents into distinct categories based on attitudinal responses, rather than relying solely on species identification for direct inferences. A "high score" generally indicated favorable perceptions of turtle conservation, whereas an "intermediate score" suggested a mixed outlook, with positive conservation sentiments coexisting alongside concerns regarding potential conflicts between community priorities and turtle protection. A "low score" signifies predominantly negative perceptions and insufficient support for turtle conservation efforts. This typology facilitated a contextual understanding of the relationship among knowledge, perceptions, and conservation behaviors, avoiding simplistic assumptions.

We employed analysis of variance (ANOVA) at a significance level of 0.05 to evaluate the differences in respondents' opinions on conservation across various locations. This approach to data analysis facilitated a detailed understanding of the quantitative and qualitative dimensions of respondents' knowledge, perceptions, and behaviors concerning freshwater turtle conservation in the study areas.

Results

The majority of respondents were within the productive age range of 25 to 65 years, with the largest age group being 36 to 55 years old. The data collected during this study suggested that, despite varying experiences, both older and younger respondents exhibited similar levels of awareness and engagement with turtle conservation practices. Moreover, our analysis did not reveal statistically significant differences in knowledge or conservation behaviors across age groups.

The Indragiri watershed is primarily inhabited by the traditional Muslim Riau Malay ethnic group; however, in Indragiri Hulu, the indigenous Talang Mamak tribe coexists with various other ethnic groups, despite differences in religion and culture. The population of the Pasir Darat

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watershed is primarily made up of the Palembang tribe, who speak the Palembang language. The inhabitants of the Sekampung watershed included the Lampung ethnic group and transmigrant settlers from Java and Sunda. The residents of the Sekampung watershed utilize the Lampung language, specifically the Api dialect, for communication. The respondents predominantly attained primary education (grades 16), with the majority employed as fishermen, while a smaller group participated in rice farming and other occupations, including housewives.

This study identifies the respondents' knowledge and familiarity with local freshwater turtle species as a significant finding. The findings indicate that participants accurately identified only 8 of the 12 turtle species presented, with specific species such as *Cyclemys oldhamii*, *Heosemys spinosa*, *Malayemys subtrijuga*, and *Notochelys platynota* (Figure 3) being largely unrecognised. Respondents who identified *B. borneoensis* were exclusively from Lampung, whereas those identifying *Cyclemys dentata* were solely from South Sumatra. The species most commonly identified included *C. amboinensis, Orlitia borneensis, A. cartilaginea*, and *Siebenrockiella crassicollis*. Another important finding is the respondents' knowledge of turtle eggs. The research indicated that although respondents were knowledgeable about chicken and quail eggs, their understanding of freshwater turtle eggs was significantly lacking, as only 28% were able to identify them correctly (Figure 4). More than 50% of respondents in the Pasir Darat and Sekampung watersheds incorrectly identified freshwater turtle eggs as sea turtle eggs.

The findings indicate the predominant freshwater turtle species observed, namely *C. amboinensis* (25%), *O. borneensis* (23%), *S. crassicollis* (20%), and *A. cartilaginea* (16%), which were typically recorded biweekly (Figure 5). Chi-square analysis indicated significant differences in observed species among the three watersheds ($\chi^2_{14,\ 389}$ = 118.33, p-value < 0.05). Respondents predominantly observed freshwater turtles during the daytime (56%) or in the afternoon while walking (23%). Freshwater turtles observed at the roadside included S. *crassicollis* (31%), *C. dentata* (26%), and *C. amboinensis* (23%). Women sometimes observe freshwater turtles in the morning, accounting for 20% of observations, with an additional 5% noting sightings while washing in the river. Respondents reported observing *C. amboinensis* in fishponds (43%), *O. borneensis* in swamps while fishing (48%), *C. amboinensis* in rice fields (48%), and *A. cartilaginea* in rivers (59%) (Figure 6). Respondents also reported the presence of *Chelonia mydas* (26%) in marine environments, with the majority (76%) of sightings occurring during fishing activities, typically more than 2 km from the respondents' residences (66%). In contrast, locations for domestic activities such as washing and bathing are found within 2 km.

Species frequently recorded in the study area consist of *C. amboinensis* (28%) and *O. borneensis* (24%). In the rainy season, *A. cartilaginea* was the predominant species identified in the river, comprising 36% of the total, while the overall species composition was 35%. *O. borneensis, C. dentata, C. amboinensis*, and *A. cartilaginea* were consistently observable from the day before the interview to five years prior. Despite both *B. borneoensis* and *B. affinis* being classified as critically endangered, sightings of *B. borneoensis* are more frequent. One individual reported observing *B. affinis* in South Sumatra one week prior to the interview, after multiple sightings occurred over the past 20 years.

The proportion of turtle species recognized by the majority of the community (67%) corresponded with the frequency of turtle sightings. *C. amboinensis, O. borneensis, S. crassicollis*, and *A. cartilaginea* were commonly observed by respondents within a 2-km radius of their residences during the past five years. Despite their conservation statuses—*C. amboinensis* and *S. crassicollis* classified as Endangered, *A. cartilaginea* as Vulnerable, and *O. borneensis* as Critically Endangered—these species were consistently detected across the three watersheds.

Respondents were unfamiliar with several turtle species, including the snail-eating turtle (*M. subtrijuga*), Malayan flat-shelled turtle (*N. platynota*), black striped turtle (*C. oldhamii*), and the spiny turtle (*H. spinosa*). Respondents demonstrated a lack of understanding regarding the distinctions between chicken/quail eggs and freshwater turtle eggs. The consumption of *B. borneoensis* eggs in the Indragiri watershed enhanced egg recognition, whereas respondents from the Pasir Darat and Sekampung watersheds frequently misidentified freshwater turtle eggs as sea turtle

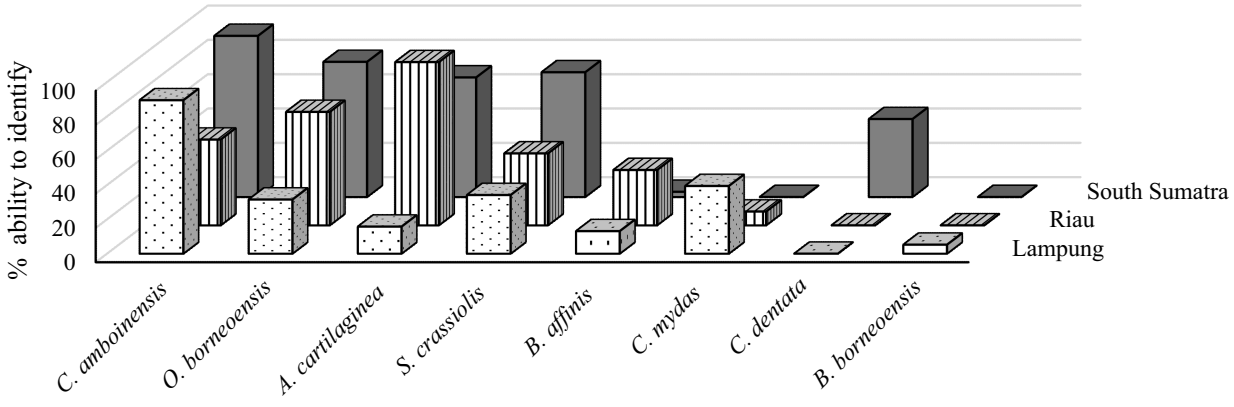

Figure 3 Percentage of respondents able to identify freshwater turtle's species.

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eggs, with a misidentification rate of 59%. Respondents predominantly encountered turtles that were unintentionally caught in fishing gear. Some fishermen kept bycatch turtles as pets or sold them to minor collectors for IDR7,000–10,000 kg^{-1}.

In total, 62% of respondents considered freshwater turtles to be unremarkable; however, all respondents (100%) indicated that they had encountered turtles during their activities, with 90% categorizing turtle sightings as commonplace. In all three watersheds, there was unanimous agreement among communities (100%) on the necessity of preserving the habitat of freshwater turtles. In the Indragiri watershed, a significant majority of respondents (82%) ignored the presence of turtles when observed and agreed (82%) that turtles should not be captured. A small percentage of respondents reported capturing freshwater turtles for sale to collectors (10%), for personal companionship (6%), or for the purpose of killing the turtles (2%). In the Pasir Darat watershed (South Sumatra), 52% of respondents found turtles appealing, while only 55% expressed a willingness to release any turtles they encounter, consistent with the belief that turtles should not be collected (55%). In this watershed, respondents captured freshwater turtles for sale (21%) or for personal companionship (21%). Lastly, in the Sekampung watershed (Lampung), 50% of respondents expressed interest in turtles, while 82% indicated a willingness to release any captured turtles. Sixteen percent of respondents reported keeping freshwater turtles as pets; however, none were involved in commercial activities. In this watershed, 98% of respondents indicated that the shooting and selling of freshwater turtles can reduce their populations in the wild, while 79% expressed the view that freshwater turtles should not be kept as pets (Table 2). No significant difference was observed in respondents' conservation perceptions among the three watersheds, with the mean value categorized as moderate (Table 3).

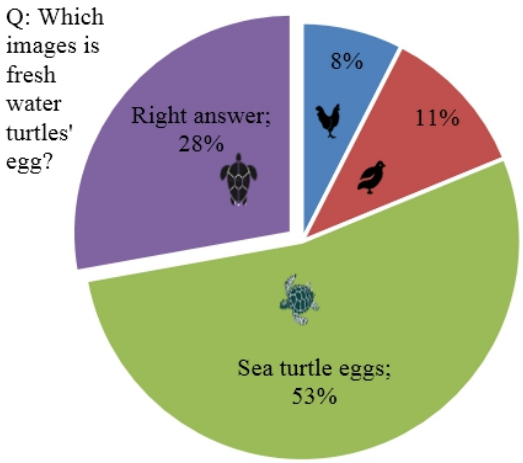

Figure 4 Respondent knowledge of freshwater turtle eggs.

The decline in freshwater turtle populations may be ascribed to several potential factors. A small group of fishermen in the Indragiri and Pasir Darat basins reported that bycatch of *B. affinis* and *C. amboinensis* was considered

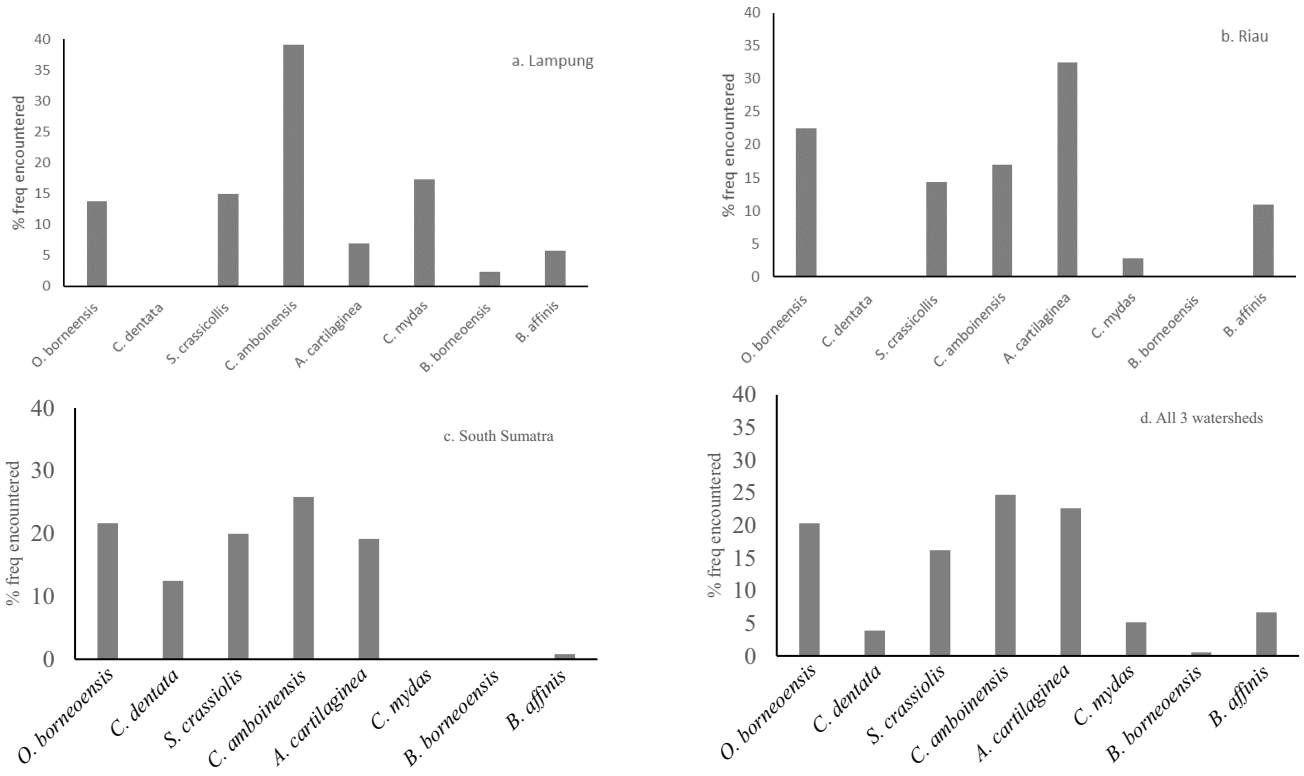

Figure 5 Percentage of species frequently encountered (a) Sekampung (Lampung), (b) Indragiri (Riau), (c) Pasir Darat (South Sumatra), and (d) average of three watershed.

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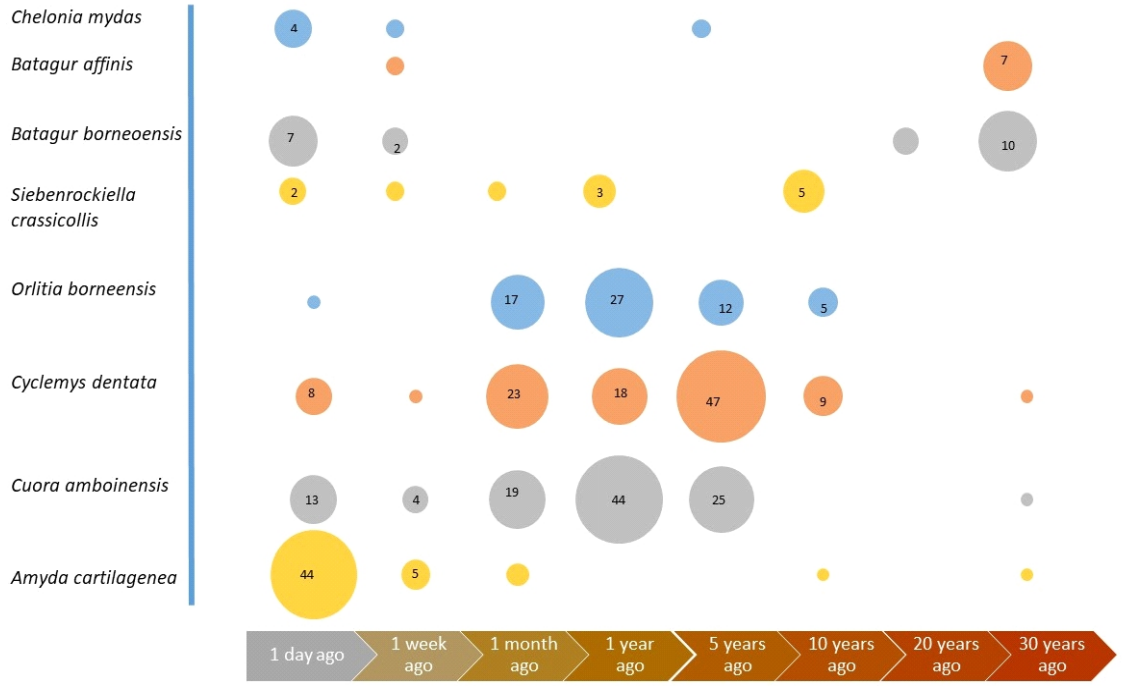

Figure 6 Respondent most recent encounter with freshwater turtles (JanuaryFebruary 2020 interview); the size of the bubble indicates the number of respondents (see numbers inside)

Table 2 Statements used to study public perception of freshwater turtles' conservation

No	Statement
1	Freshwater turtle should not be captured
2	The habitat of freshwater turtles should not be damaged
3	Freshwater turtle should not be eaten
4	Freshwater turtles should not be kept as pet
5	Eggs of freshwater turtle should not be eaten
6	Freshwater turtle should not be disturbed or killed
7	Hunting and selling of freshwater turtles can reduce the number of freshwater turtles in the wild

Table 3 Average perceived conservation value for freshwater turtles in the three watersheds

Location	N	Mean	Std. deviation	Min	Max
Indragiri watershed (Riau)	62	67.63	8.340	46	75
Pasir watershed (South Sumatra)	33	66.73	9.866	46	75
Sekampung watershed (Lampung)	38	70.08	8.165	43	75
Total	133	68.11	8.725	43	75

pests, leading to their elimination and subsequent use as fish bait (Moll et al., 2015). Additionally, participants from the Indragiri watershed reported that the consumption of *B. affinis* eggs was common prior to 1990. Interviews indicated that between 1990 and 2000, the acquisition of *B. affinis* eggs in the wild was highly difficult. The decline of *B. affinis* was due to overharvesting and the degradation of nesting habitats caused by sand mining (Moll et al., 2015). Interviews revealed that the eggs of *B. borneoensis* turtles and sea turtles (*Chelonia mydas*) are still being consumed.

A small number of individuals in the Indragiri and Pasir Darat watersheds persist in capturing turtles for commercial purposes, while lesser collectors remain engaged in the trade of turtles. The species involved in trade included *C. amboinensis, A. cartilaginea, S. crassicollis,* and *M. emys*. The interviews indicated that prior to 2019, the primary freshwater turtle trade consisted of three species: *C. amboinensis, A. cartilaginea, and S. crassicollis*. Species like

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C. amboinensis and *S. crassiolis* were primarily kept as pets, leading to a preference for a reduced size of 410 cm in length. *A. cartilaginea* was marketed for consumption in the three watersheds, leading to an increase in pricing attributed to its size (Sunyoto, 2012; Vallejo-Betancur et al., 2018; Rahayu et al., 2021). By the end of 2019, most collectors stopped selling turtles, with only a few illicit collectors continuing their activities. The interview revealed that this resulted from government restrictions that prohibited the sale and acquisition of protected species, leading to the termination of legal trade.

Discussions

Factors influencing turtle conservation awareness

Demographic and socio-demographic factors play a significant role in shaping awareness of wildlife conservation and influencing local community behavior (Buta et al., 2013; Kato et al., 2019; Katuwal et al., 2021; Rahayu et al., 2021). Although previous studies have highlighted the importance of intergenerational knowledge transfer for maintaining traditional environmental knowledge (Cristancho & Vining, 2009; Mota et al., 2023), our data indicates that factors such as community exposure to conservation initiatives, individual motivations, and environmental education are more central to understanding respondents' attitudes and behaviors (Gurung & Thapa, 2023) than age alone, as was also found by Buta et al. (2013). Additionally, while older generations may possess traditional ecological knowledge, younger generations bring modern perspectives. This dynamic indicates that knowledge and attitudes about conservation are not solely linked to age but rather influenced by a combination of personal experiences, cultural context, and active community engagement. Hence, while age may be a relevant factor in certain contexts, our study's findings support the conclusion that age does not significantly influence the variables under investigation. Research indicates that male respondents demonstrate a higher level of knowledge regarding turtles, potentially attributable to their involvement in fishing and sand mining activities (Mutalib et al., 2013). The present study may introduce bias due to a predominance of male respondents. In contrast, other studies suggest that women frequently exhibit higher levels of engagement and concern regarding natural resource conservation (Gökmen, 2021; Dhenge et al., 2022).

Regular interactions with frequently observed species have probably enhanced local communities' understanding. The persistent identification of endangered and critically endangered species throughout all watersheds indicates that their populations could be more numerous than presently recorded, underscoring the necessity for standardized monitoring practices. *Orlitia borneensis* is protected under Indonesian Law (Kementerian Lingkungan Hidup dan Kehutanan, 2018), and all four commonly observed species are listed in CITES Appendix II.

The findings indicate that local communities might possess a restricted comprehension of the complete diversity of freshwater turtles present in their surroundings. Respondents identified only 8 of the 12 presented species, indicating that several species were largely unrecognised. The regional variations in species identification, exemplified by *B. borneoensis* being recognized solely in Lampung and *C. dentata* exclusively in South Sumatra, suggest potential disparities in species distribution or local knowledge across watersheds. The low percentage of respondents, at 28%, accurately identifying freshwater turtle eggs indicates a significant gap in the understanding of turtle life cycles. Respondents in the Indragiri watershed exhibited superior knowledge of freshwater turtle eggs, likely attributable to increased consumption rates in the region. The misunderstanding of freshwater turtle eggs as sea turtle eggs by over 50% of respondents in the Pasir Darat and Sekampung watersheds underscores the necessity for focused educational initiatives. The observed species frequency may reflect their relative abundance or visibility in local habitats, while significant variations across watersheds indicate the impact of local environmental factors and human activities on turtle populations. The patterns of turtle observations, encompassing temporal factors and specific locations, yield significant insights into turtle behavior and habitat utilization. The occurrence of *Chelonia mydas* in marine ecosystems, primarily noted during fishing activities, suggests the likelihood of human-sea turtle interactions extending beyond the immediate areas surrounding settlements. The variations in species observed among watersheds highlight the necessity of customizing conservation strategies to align with the unique ecological and sociocultural contexts of each region while considering local knowledge, practices, and environmental conditions.

The lack of familiarity with specific turtle species indicates a disconnect between the community and these less frequently observed species, likely attributable to their elusive characteristics or their remoteness from community interactions. Species including *M. subtrijuga, N. platynota, C. oldhamii, H. spinosa*, and *C. dentata* are generally found hidden within forested areas (As-singkily et al., 2021; Horne et al., 2021; Timmins et al., 2021). The limited understanding of turtle eggs indicates a broader lack of awareness regarding turtles, with regional differences shaped by local consumption habits and the closeness to coastal regions.

The bycatch of freshwater turtles in Indonesia is rarely documented, except for *C. amboinensis*, which was captured in the Rawa Aopa swamp in Sulawesi (Nurazizah et al., 2022). The retention of bycatch turtles as pets or their sale to minor collectors poses significant concerns regarding the effects on turtle populations, underscoring the necessity for enhanced awareness and regulatory measures. Variations in attitudes towards turtle conservation and their implications for management strategies.

The findings indicate a multifaceted relationship between local communities and freshwater turtles within the three examined watersheds. Although most respondents view turtles as unremarkable, there is a consensus on their presence and a collective acknowledgment of the necessity to preserve their habitats. This indicates a fundamental awareness of the ecological importance of these species. The differences in attitudes and behaviors regarding turtles among various watersheds underscore the impact of local context on conservation viewpoints. The significant proportion of respondents in the Indragiri watershed who oppose the capture of turtles suggests a preference for a non-interventionist strategy in turtle conservation. The small

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percentage of respondents capturing turtles for various purposes indicates that threats to turtle populations persist.

The Pasir Darat watershed exhibits a more intricate situation, characterized by an increased valuation of turtles alongside a heightened propensity for their capture for commercial or companionship purposes. The distinction between appreciation and exploitation highlights potential conflicts in conservation initiatives and underscores the necessity for focused educational programmes. The resumption of commerce will negatively impact the freshwater turtle population, as responses indicated multiple requests and offers from various parties for specific species (Uyeda et al., 2016; Sunkar et al., 2020).

The Sekampung watershed exhibits favorable attitudes towards turtle conservation, as evidenced by a significant proportion of respondents expressing willingness to release captured turtles and acknowledging the detrimental effects of hunting and the pet trade on wild populations. This indicates that conservation messages might have been communicated or received more effectively in this region. All watersheds have moderate conservation attitudes, indicating that conservation awareness and actions can be enhanced. The little disparities within watersheds indicate that analogous characteristics may be influencing perceptions, potentially guiding region-wide conservation strategies. Understanding local attitudes and behaviors is essential for developing effective freshwater turtle conservation projects. Enhancing local conservation perspectives and practices in these watersheds necessitates ongoing education and awareness.

Role of local knowledge and perceptions in freshwater turtle conservation The study found that the populations in the three watersheds did not possess traditional beliefs or indigenous knowledge regarding freshwater turtles. The respondents' limited knowledge regarding specific turtle species and their eggs may contribute to the diminished cultural and social value attributed to these species, subsequently affecting the degree of conservation concern and initiatives within local communities. This may contribute to the ongoing threats to these species, such as capture for the pet trade, commercial exploitation, and habitat degradation.

Research indicates that knowledge and perceptions significantly influence conservation behavior (Kellert, 1980; Barkes, 2007). In the context of freshwater turtle conservation, understanding both local and scientific perspectives is crucial for effective management. The absence of traditional ecological knowledge related to turtles suggests a disconnect between the community and their environment, leading to insufficient conservation actions. Moreover, studies have shown that negative experiences and lack of awareness can shape community attitudes towards wildlife, often resulting in detrimental practices (LaHart, 1978; Batt, 2009). Without incorporating local perspectives into conservation strategies, interventions may lack community support, thereby limiting their effectiveness. This concept is further supported by studies examining how knowledge can shape risk perception and precautionary behaviors. For example, Permatasari et al. (2024) explored how knowledge about heat exposure mitigation strategies can influence risk perception and precautionary behaviors among individuals. Similarly, Putra et al. (2024) investigated the relationships between heat-related knowledge, risk perception, and precautionary behaviors among Indonesian pine forest workers. These studies demonstrate that an individual's level of knowledge about a particular environmental issue or risk can be a key factor in shaping their perceptions, attitudes, and behaviors towards that issue. These studies suggest that the limited knowledge and appreciation expressed by local communities may be contributing to diminished conservation concern and initiatives.

In Indonesia, where traditional beliefs have shaped community attitudes towards reptile conservation. In Banten province, local taboos restrict the harvesting of *V. salvator* and *M. reticulatus* (Uyeda et al., 2016). In Komodo village, located within Komodo National Park, the villagers' perception of kinship with the Komodo dragon, despite its formidable reputation, positively influences their views (Sunkar et al., 2020). Conversely, in Belawa village, Cirebon (West Java), the community's belief in the sacredness of *A. cartilaginea* has strengthened its protection (Sunyoto, 2012).

In contrast, the populations within the three watersheds did not possess traditional beliefs concerning reptiles, including freshwater turtles. Individuals in all three watersheds frequently observe turtles. However, a comprehensive assessment of the community indicated that detrimental activities persistently endanger the turtle population, such as turtle captures, pet ownership, egg consumption, and the trafficking of freshwater turtles, persistently endanger the turtle population. This highlights the significance of acknowledging negative perceptions of species within conservation efforts (Sunkar et al., 2020).

The absence of local knowledge and culturally informed conservation practices in the examined areas highlights the importance of incorporating community engagement and education in future freshwater turtle conservation efforts. Local communities can actively safeguard freshwater turtles and their habitats by developing a deep understanding and appreciation of the ecological and cultural importance of these animals.

The relationship between perceived cultural and social value and conservation behavior is more complex than initially proposed. Assuming that freshwater turtles lacking significant cultural importance will be subject to exploitation and neglect is an oversimplification. Elevated cultural valuation may result in overexploitation in the absence of adequate economic incentives or governance structures (Courchamp et al., 2006). Due to the potential decline of turtle populations from certain activities, it is essential to increase awareness and enhance conservation practices. Communities across the three watersheds should receive education on turtle conservation through the distribution of information customized to the unique attributes of each community. Proposed actions encompass outreach initiatives aimed at educating fishermen regarding the ecological importance of turtles, training on the use of sustainable fishing gear, and the dissemination of information on the diversity of freshwater turtles. The outreach initiative must engage various stakeholders across all age groups, including

youth. Furthermore, consistent governmental oversight and enforcement of trade regulations should be implemented regularly, incorporating community involvement in conservation initiatives.

Conclusion

The residents of the Pasir Darat, Sekampung, and Indragiri watersheds, who primarily rely on fishing and live adjacent to freshwater ecosystems, frequently encounter freshwater turtles. The four most commonly observed species are *C. amboinensis* (25%), *O. borneensis* (23%), *S. crassicollis* (20%), and *A. cartilaginea* (16%). The analysis indicates that despite the lack of significant economic or cultural importance of freshwater turtles in the study communities, one should not assume the situation leads to apathy or indifference regarding conservation efforts. The lack of established cultural practices and traditional ecological knowledge may facilitate the continuation of detrimental activities such as egg harvesting, pet trade, and trafficking. Additionally, contextual factors including economic incentives, institutional frameworks, and levels of environmental awareness significantly influence conservation behaviors. A multi-pronged approach is necessary to address this complexity, involving the cultivation of a deeper understanding and appreciation of the ecological and cultural significance of these turtle species within local communities through diverse outreach and education initiatives. Long-term turtle conservation requires effective governmental regulation and enforcement, alongside significant community involvement in conservation initiatives. This integrated approach is more effective in promoting positive conservation behaviors compared to relying exclusively on the presence or absence of cultural values.

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