

Knowledge, attitudes and practices for Asian horseshoe crab conservation in Pangutaran Island, Sulu, Philippines

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Abstract. The decreasing global population of horseshoe crabs highlights the need for conservation in areas where remaining populations persist. However, a limited understanding of community perceptions and behaviors can hinder the development of effective conservation strategies. Thus, this study measures knowledge, attitude, and practices (KAP) of the locals in Pangutaran Island, Sulu Province, Philippines, that can be integrated into future interventions and conservation strategies for horseshoe crabs in the area. A cross-sectional survey was conducted across 357 local coastal residents in three barangays of Pangutaran Island about their ecological knowledge of the horseshoe crabs in their locality, their attitude towards their population and conservation, and their current practices influencing the horseshoe crab population status. Findings showed that while ecological knowledge about the species remained limited ($\leq 42\%$), majority expressed strong positive attitudes toward willingness to support conservation (55%). Active and bycatch capture of horseshoe crabs was reported by only a small proportion of respondents. However, the species continues to be utilized for traditional medicinal, cultural, and consumption purposes. KAP was significantly associated with sociodemographic factors, including occupation, educational attainment, and income ($p < 0.001$), and among its components. These findings highlight the importance of integrating ecological education with value-based community engagement to strengthen local participation in horseshoe crab conservation in Pangutaran Island.

Keywords: *Carcinoscorpius rotundicauda*, SDG 14, sociodemographic factors, *Tachypleus tridentatus*, wildlife conservation.

Introduction. Horseshoe crabs are considered ecologically (Botton, 2009; Liao et al., 2025) and economically significant species, especially with their strong recognition from the medicinal field (Kumar et al., 2016). However, only four species of horseshoe crabs remain worldwide (Baylon & Alcantara-Creencia, 2022; Xie et al., 2022), two of which can be found in the Philippines: tri-spine horseshoe crab, *Tachypleus tridentatus* (Leach 1819), and mangrove horseshoe crab, *Carcinoscorpius rotundicauda* (Latreille 1802) (Almendral & Schoppe 2005; Baylon & Alcantara-Creencia 2022). The former is currently categorized as 'Endangered (EN)' on the International Union for Conservation of Nature (IUCN) Red List (Laurie et al., 2019), while the status of the latter is 'data deficient', although recent studies indicate a declining population trend (Wang et al., 2020; Fauziyah et al., 2023). Their decreasing population status calls for effective conservation efforts.

Despite a declining trend in their global population, documentation of horseshoe crab presence remains limited (Wang et al., 2020). In the Philippines, horseshoe crabs exhibit observable geographic patterns in the Sulu Sea (Laurie et al., 2019). Baseline data on horseshoe crabs are primarily derived from field records in Palawan (Almendral & Schoppe, 2005; Baylon & Alcantara-Creencia, 2022; Pedrosa-Gerasmio et al., 2025) and Tawi-Tawi (Omno et al., 2026), as well as from local knowledge in Panay and Negros Oriental (Schoppe, 2002). The most recent national survey was conducted in 2012 (Laurie et al., 2019). These studies have focused on ecological aspects of horseshoe crabs, including morphology and population structure (Baylon & Alcantara-Creencia, 2022; Pedrosa-Gerasmio et al., 2025; Omno et al., 2026). Although horseshoe crabs

exhibit observable geographic patterns around the Sulu Sea (Laurie et al., 2019), their status in some coastal areas remains understudied.

This apparent absence of records is often attributed to constraints in monitoring rather than true species absence. Similar challenges have been observed in Taiwan, where horseshoe crab populations were previously thought to be extinct until scientific investigations confirmed their continued occurrence (Shih et al., 2025). In the Sulu Sea region, the horseshoe crab population remains undocumented in the Municipality of Pangutaran Island, despite its suitable coastal environment for horseshoe crab habituation. Pangutaran Island has the largest mangrove and seagrass areas among the municipalities of Sulu Province (Bureau of Fisheries and Aquatic Resources, 2020), supporting diverse coastal and marine ecosystems, while also supporting aquaculture and human settlements (Fauziyah et al., 2023). Assessing knowledge, attitude, and practices (KAP) of the locals can help understand underlying socioeconomic factors contributing to horseshoe crab conservation in the area. For example, the study of Pati et al., (2020) found that assessing knowledge and attitude provided a basis for implementing awareness and compassion-building projects among fisherfolk in coastal communities of India, where fishing practices were contributing to the unintentional mortality of horseshoe crabs. Furthermore, incorporating public KAP into conservation planning promotes inclusivity in the decision-making process that empowers responsibility among community members in wildlife management (Shawon et al., 2025).

Thus, this study aims to (1) determine the level of knowledge, attitudes, and practices of residents towards the existing horseshoe crab population and its conservation, and (2) to assess what factors are involved in these current levels by examining significant differences of KAP across sociodemographic groups, and the relationship among KAP components. The findings of this study will provide baseline information that can guide future interventions and conservation strategies for horseshoe crabs in Pangutaran Island, where efforts to protect these species are needed. This study also contributes to UN SDG 14 by providing scientific evidence to inform the conservation of coastal and marine resources (Target 14.5) and the sustainable management and restoration of ecosystems impacted by anthropogenic pressures (Target 14.2).

Material and Method

Description of the study sites. Pangutaran Islands, or the Municipality of Pangutaran, is a municipality island within the Province of Sulu, Philippines, at the south of the Sulu Sea, at 6.3113° N, 120.5624° E coordinates (Figure 1). This island has dense vegetation of mangrove, seagrass, and coral cover, and is abundant in reef fishes. Consisting of 16 rural barangays, the island has a population density of 36,374 (PhilAtlas, nd), and a household population density of 2,810 (Bureau of Fisheries and Aquatic Resources, 2020). This study was conducted along three of its coastal barangays, namely Barangay Kihi Niog, Barangay Lantong Babag, and Barangay Simbahan; selected based on their relatively high population densities, as indicated by municipal records for 2025, and anecdotal evidence suggesting that local key informants possess knowledge of horseshoe crab utilization. Fishing serves as the primary source of livelihood for residents in these communities (Bureau of Fisheries and Aquatic Resources, 2020).

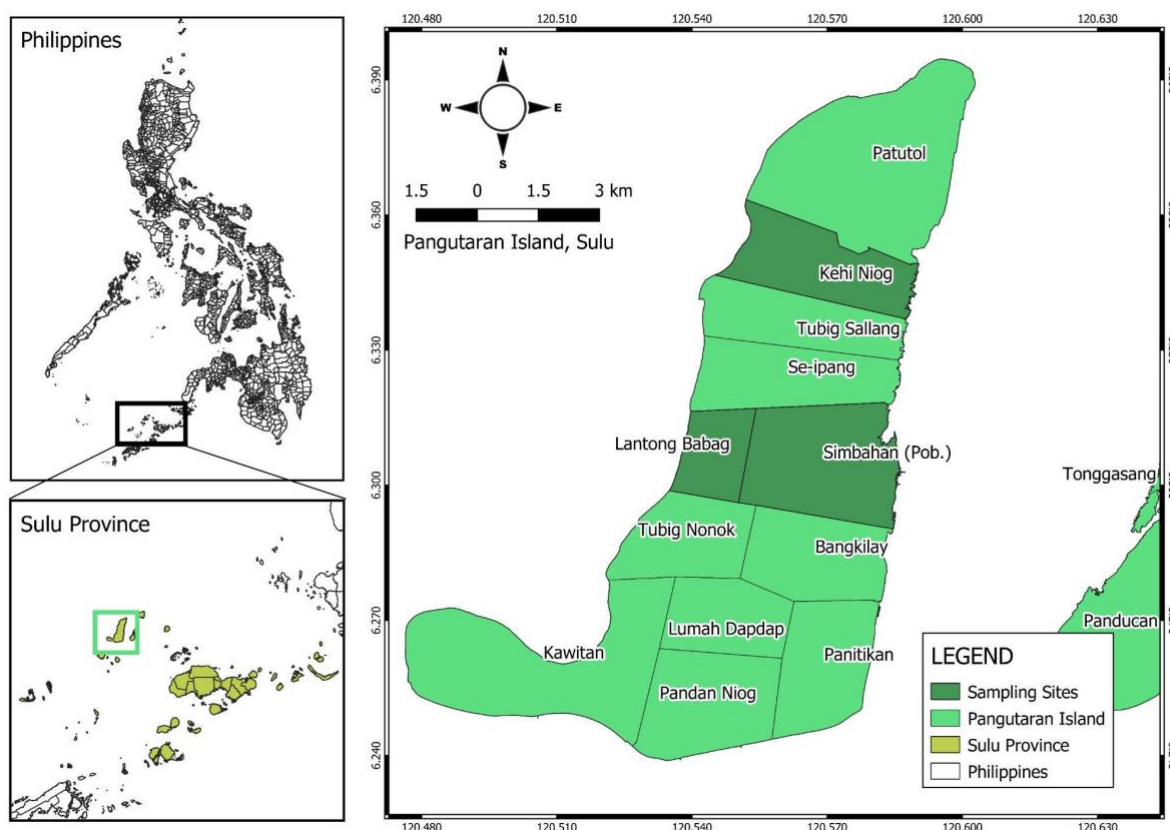


Figure 1. Map showing the three sampling sites at Pangutaran Island, Sulu Province, Philippines.

Entry permits and ethical considerations. Before the sampling, ethical clearance (UERB-2025-00367) for the survey methodologies was obtained from the Research Integrity and Compliance Office of MSU-IIT to ensure compliance with research ethical standards and protocol. Permits from the mayor of Pangutaran Island and chairpersons of Barangay Simbahan, Kih Niog, and Lantong Babag were secured. Only participants aged 18 or older were included. During the collection, informed consent was provided detailing the purpose of the study, the voluntary nature of participation, the right to withdraw at any time without penalty, and the minor time inconvenience associated with the interviews. Only individuals who provided written informed consent were included. To ensure full comprehension prior to consent, the interview questions were translated into the local dialects of the respondents, namely Sama-Pangutaran and Tagalog. Participant confidentiality was ensured through the use of coded identifiers in all research notes and documents.

Research design. This study utilized a quantitative cross-sectional survey method using a structured questionnaire to assess the knowledge, attitudes, and practices of community members regarding horseshoe crab conservation.

Sample size and sampling method. The 2025 household density of the selected barangays was retrieved from the municipal office of Pangutaran Island (Table 1). Sample size was calculated using the Slovin's formula (Slovin 1960, as cited in Valdehueza et al., 2026) as follows:

$$n = N/(1+N \cdot e^2)$$

where:

n - the sample size;

N - the total population size;

e - the margin of error.

Using the total household population size ($N = 2,035$) from the three barangays and a confidence level of 95% with a margin of error (e) of 0.05, the total sample size (n) is 334. The three barangays were treated as strata, and samples were proportionately obtained depending on the number of households between the sampling areas, allowing the results to be generalized (Ahmed, 2024). Using the ratio 13:20:67 between the population of the sampling sites, the sampling sizes were 43, 67, and 224 for Barangay Kih Niog, Barangay Lantong Babag, and Barangay Simbahan, respectively.

Table 1

Household density and sample size of the sampling sites

<i>Sampling site</i>	<i>Household density</i>	<i>Sample size</i>
Barangay Simbahan	1,358	224
Barangay Lantong Babag	403	67
Barangay Kih Niog	274	43

Purposive sampling method was used considering the time constraints of the field sampling schedule. Data obtained were from coastal areas whose residents live in close proximity to horseshoe crab habitats allowing interaction, affecting or affected by horseshoe crab population. Data were collected through face-to-face interview using pen and paper.

Survey questionnaire. A structured questionnaire was used, which was divided into parts such as: the sociodemographic information of the respondents (i.e. address, sex, age, years of residency in the area, educational attainment, ethnic group, occupation, and monthly income), KAP questions towards horseshoe crabs in their locality. Questions were adapted from the study of Kwan et al., (2017) and Mustopa et al., (2023) assessing knowledge, attitudes and behaviors on horseshoe crabs among secondary school students in Hong Kong. Respondents answered questions with either “yes” or “no” and some elaboration, or rate a statement on a 5-point Likert-type scale (1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree). To ensure validity, the questionnaire was translated to local dialects through backward-forward translation method (Kaderi et al., 2024), and face validity was reviewed by experts. To ensure reliability, the questionnaire was pre-tested with 50 respondents, and results were used to remove ambiguous, redundant, or items demonstrating poor performance in item-total correlation. The final version of the questionnaire consisted of 6 items for knowledge, 10 items for attitudes, and 3 items for practices, with a Cronbach’s alpha of 0.895, 0.837, and 0.753, respectively, ensuring the internal consistency of the items in each KAP component.

Data analysis. Responses were encoded and descriptive statistics and graphical presentations were generated using Microsoft Excel 2021. Frequency and percentage were used to present sociodemographic profile of respondents, and percentages and graphs for descriptive statistics of KAP components.

Knowledge and Practice items were treated as binary variables (present/absent). Thus, an equivalent of 1 point was given to every ‘yes’ choice. The Knowledge component yields a maximum score of 14 points, whereas the Practice component yields a maximum score of 6 points. On the other hand, data from Attitude items were treated as interval variables, and scores were averaged, yielding values ranging from 1 to 5. A scoring system for KPP levels adapted from Shawon et al., (2025) was used, wherein scores below half of the total possible score were classified as low.

For inferential statistics, the Shapiro-Wilk test showed non-normality of KAP score distributions. Thus, nonparametric tests were used. Independent Samples T-test/Mann-Whitney U test and one-way ANOVA/Kruskal-Wallis analyses were applied for bicategorical (i.e., sex and ethnic group) and multi-categorical sociodemographic variables, respectively. Dwass-Steel-Critchlow-Fligner (DSCF) pairwise comparisons were then used to identify categories that significantly differed. Lastly, Spearman correlation analysis assessed relationships between KAP components.

Results and Discussion

Socioeconomic profile of the respondents. A total of 357 respondents across three barangays in Pangutaran Island had participated in the survey: 238 from Barangay Simbahan, 69 from Barangay Lantong Babag, and 50 from Barangay Kihi Niog (Table 2). Females comprised the majority (56%), while males accounted for 44%, indicating a relatively balanced sex representation. Respondents were aged between 18-96 years. About 24% had lived in the locality for ≤ 15 years, 31% for 16-31 years, 22% for 32-47 years, and the remainder for ≥ 48 years.

Table 2
Socioeconomic profile of respondents

Variable	Category	Frequency (n = 357)	Percentage (%)
Address	Simbahan	238	66.67
	Lantong Babag	69	19.33
	Kihi Niog	50	14.01
Sex	Female	201	56.30
	Male	156	43.70
Age	18 - 30 years old	130	36.41
	31 - 43 years old	106	29.69
	44 - 56 years old	72	20.17
	57 - 69 years old	35	9.80
	70 years old and above	14	3.92
Years of residency	15 years and less	87	24.37
	16 - 31 years	112	31.37
	32 - 47 years	79	22.13
	48 - 63 years	51	14.29
	64 - 79 years	25	7.00
	80 years and above	3	0.84
Educational attainment	Elementary	165	46.22
	High School	106	29.69
	College	50	14.01
	No formal education	36	10.08
Ethnic group	Sama Pangutaran	351	98.32
	Tausug	6	1.68
Occupation	Self-employed/Unemployed	106	29.69
	Fisherfolks/Seafarers/ Divers	74	20.73
	Housewives/Housekeepers	73	20.45
	Vendors	36	10.08
	Students	30	8.40
	Farmers	23	6.44
	Government employees	15	4.20
Family monthly income*	USD 17.39 and below	52	14.57
	USD 17.40 - 121.73	223	62.46
	USD 121.74 - 226.07	59	16.53
	USD 226.08 - 330.41	11	3.08
	USD 330.42 - 434.74	3	0.84
	USD 434.74 above	9	2.52

Note: *conversion is based on the overall average Philippine peso-to-USD exchange rate for the year 2025, as reported by the Bangko Sentral ng Pilipinas (n.d.).

In terms of educational attainment, most respondents had attained elementary (46%), secondary (30%), or tertiary education (14%), while only a small proportion had no formal schooling (10%). This suggests a population with the capacity to comprehend basic scientific concepts and form biological and ecological perspectives (Pati et al., 2020). All of the respondents are practicing Islam, and are either part of Sama-Pangutaran (98%) or Tausug (2%) groups.

One third (30%) were self-employed or unemployed, including business owners, construction workers, drivers, healers, laborers, and dress makers; 21% were housewives or housekeepers; and a total of 37% are relying on fisheries-related source of income such as fishing, fish vending, and seaweed farming. This distribution indicates the presence of both fishing and non-fishing income sources within the community, reflecting some degree of economic diversification.

Nevertheless, income levels remained generally low, with majority (62%) earning USD 17.40 to USD 121.73 monthly, and 15% are earning below USD 17.39 per month. These income patterns suggest that many households fall below the poverty threshold of Sulu Province of USD 241.25 monthly for an average family size of five (Philippine Statistics Authority, 2024), which may increase dependence on readily accessible coastal and marine resources. Low income has been identified as a significant factor influencing fisherfolk to sell horseshoe crabs (Pati et al., 2020) or depend on coastal resources to address health-related needs (Ahsan et al., 2023; Tahluddin et al., 2025).

Knowledge of the locals of horseshoe crabs and their ecology. Almost all respondents (93%) know horseshoe crabs based on their local names, and 56% were aware of their existence in Pangutaran Island (Figure 2). These findings indicate that most of the respondents were familiar with the horseshoe crabs and several were aware of their local existence. Horseshoe crabs are commonly known as 'balangkas' in Pangutaran Island, while 'barangkas' (Palawan) and 'bangkas' (Tawi-Tawi) in other Philippine islands surrounding the Sulu Sea (Pedrosa-Gerasmio et al., 2025; Omnos et al., 2026).

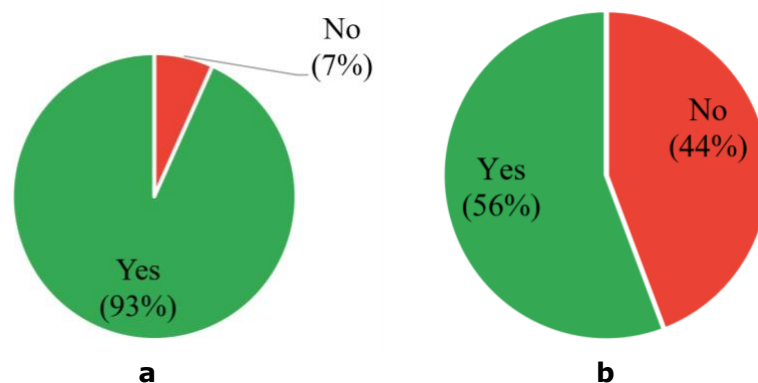
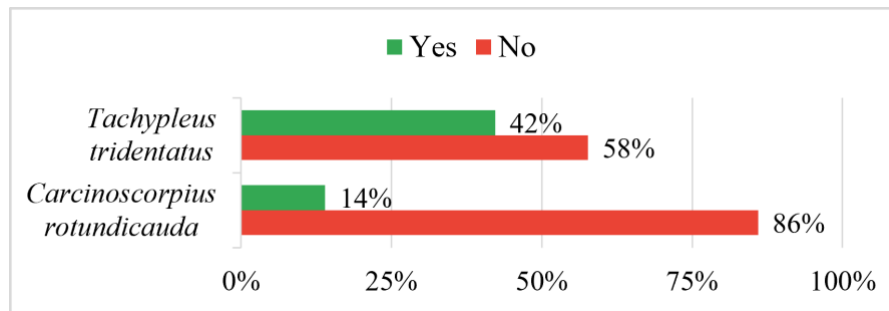
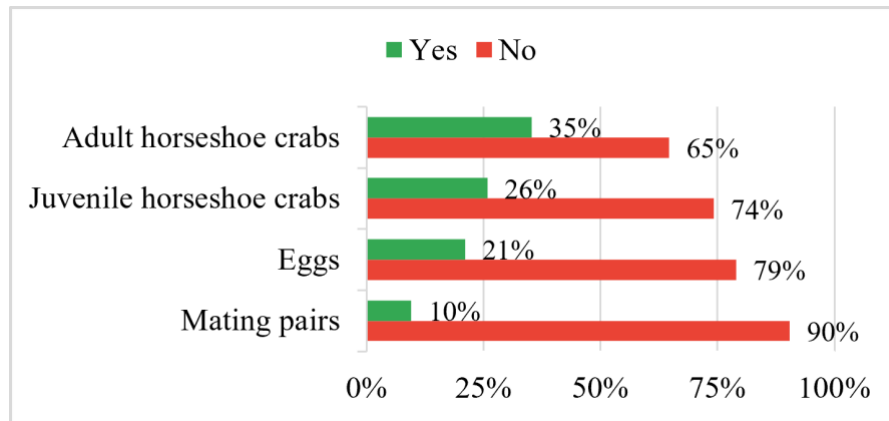


Figure 2. Distribution of responses about whether they know (a) animals called horseshoe crabs (balangkas, tatus, mangkas, pamah, sangbaw, or katos in Sama), and (b) horseshoe crabs exist in Pangutaran Island.

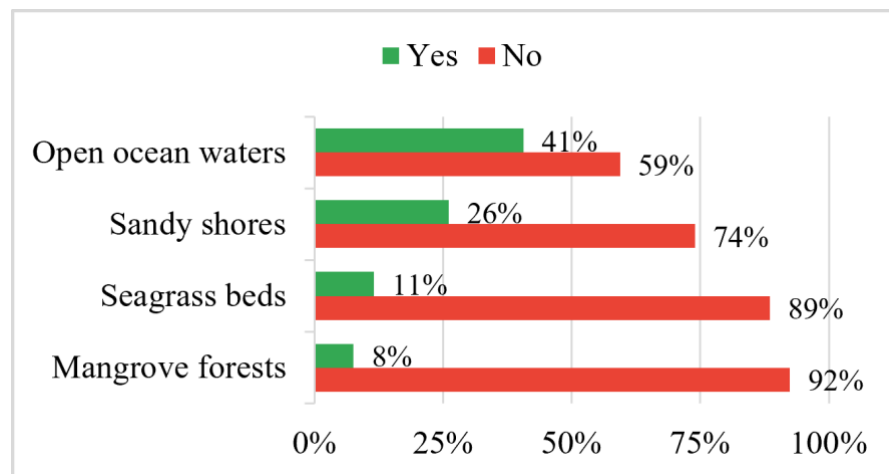
Figures 3a-3d summarize respondents' knowledge of horseshoe crab species, life stages, habitats, and feeding behavior, highlighting generally low awareness across categories. Majority were unaware of the specific species occurring in their area (Figure 3a), recognized horseshoe crabs at different life stages (Figure 3b), nor identify their habitat type (Figure 3c), and their feeding behavior (Figure 3d). Consequently, low awareness of species ecology may lead to habitat degradation or contribute to continued bycatch and harvesting, as observed in other regions (Tang et al., 2025).



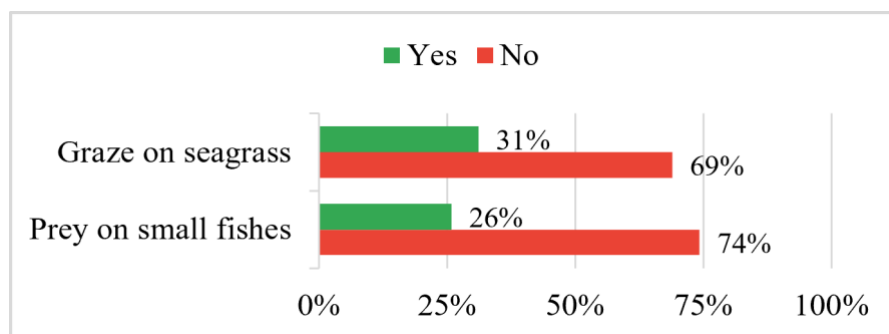
a



b



c



d

Figure 3. Distribution of responses about whether they know which (a) species, (b) life stage, (c) type of habitat, and (d) feeding behavior of horseshoe crabs can be found in their area.

Table 3

Mean of knowledge, attitude, and practice scores of respondents across sociodemographic factors

<i>Category</i>	<i>Knowledge</i>	<i>Category</i>	<i>Attitude</i>	<i>Category</i>	<i>Practice</i>	<i>Category</i>
Location / Address						
Simbahan	5.65	Low	3.97	High	1.51	Low
Lantong Babag	1.68	Low	4.64	High	0.33	Low
Kihi Niog	2.18	Low	3.99	High	0.88	Low
Sex						
Female	4.99	Low	4.10	High	1.24	Low
Male	3.63	Low	4.11	High	1.13	Low
Age						
18 - 30 years old	6.16	Low	4.00	High	1.48	Low
31 - 43 years old	3.46	Low	4.15	High	1.10	Low
44 - 56 years old	3.57	Low	4.18	High	0.97	Low
57 - 69 years old	3.06	Low	4.21	High	0.89	Low
70 years old and above	2.64	Low	4.09	High	1.14	Low
Years of residency						
15 years and less	7.03	High	4.05	High	1.62	Low
16 - 31 years	4.79	Low	4.13	High	1.14	Low
32 - 47 years	2.39	Low	4.08	High	1.09	Low
48 - 63 years	3.14	Low	4.16	High	0.82	Low
64 - 79 years	2.60	Low	4.11	High	0.96	Low
80 years and above	2.33	Low	4.17	High	1.67	Low
Educational attainment						
Elementary	3.15	Low	4.15	High	0.96	Low
High School	6.50	Low	4.06	High	1.51	Low
College	5.98	Low	3.94	High	1.56	Low
No formal education	1.69	Low	4.27	High	0.83	Low
Ethnic group						
Sama Pangutaran	4.35	Low	4.10	High	1.19	Low
Tausug	6.83	Low	4.43	High	1.50	Low
Occupation						
Self-employed/ Unemployed	3.89	Low	4.08	High	1.19	Low
Fisherfolks/ Seafarers/Divers	2.64	Low	4.18	High	0.88	Low
Housewives/ Housekeepers	4.21	Low	4.25	High	0.85	Low
Vendors	5.94	Low	4.05	High	1.33	Low
Students	9.10	High	3.94	High	2.23	Low
Farmers	3.35	Low	4.00	High	1.39	Low
Government employees	6.07	Low	3.86	High	1.73	Low
Family monthly income						
USD 17.39 and below	3.40	Low	3.96	High	1.21	Low
USD 17.40 - 121.73	4.14	Low	4.17	High	1.10	Low
USD 121.74 - 226.07	5.69	Low	4.05	High	1.31	Low
USD 226.08 - 330.41	6.27	Low	3.67	High	1.82	Low
USD 330.42 - 434.74	6.67	Low	4.47	High	1.00	Low
USD 434.74 above	4.78	Low	4.11	High	1.89	Low

Table 3 presents the aggregated KAP scores of respondents according to sociodemographic factors. While knowledge was low across sociodemographics, this level of knowledge improved across all sociodemographic variables except ethnic group (Table 4). Knowledge levels were significantly higher among females and respondents from Barangay Simbahan (Table 5). Thus, males and residents of Barangay Lantong Babag and Barangay Kihi Niog must be prioritized as target respondents for knowledge-based interventions. Higher knowledge was also observed among those with higher educational attainment (i.e., high school and college) and higher monthly family income of USD

121.74 - 226.07, reflecting knowledge derived from access to environmental information (Eriksson et al., 2019). On the other hand, fisherfolk and older and long-term residents exhibited comparatively lower knowledge levels. Nonetheless, their experiential knowledge from frequent habitat interactions can serve as a valuable learning resource for non-formal literacy programs.

Table 4

Association between sociodemographic factors and knowledge scores toward horseshoe crabs

<i>Sociodemographic factor</i>	χ^2	<i>df</i>	<i>U-Statistic</i>	<i>p</i>	<i>Interpretation</i>
Location/ Address	69.5	2	12,205	< 0.001	Significant
Sex				< 0.001	Significant
Age	39.8	4		< 0.001	Significant
Years of residency	74.1	5		< 0.001	Significant
Educational Attainment	73.3	3		< 0.001	Significant
Ethnic Group			596	0.06	Not significant
Occupation	69.5	6		< 0.001	Significant
Income	14.7	5		0.012	Significant

Table 5

Differences in knowledge scores across sociodemographic groups

<i>Category</i>	<i>W</i>	<i>p</i>
Location/Address		
Kihi Niog – Simbahan	-7.61	< 0.001
Lantong Babag – Simbahan	-10.08	< 0.001
Age		
18 - 30 years old – 31 - 43 years old	7.2544	< 0.001
18 - 30 years old – 44 - 56 years old	6.2944	< 0.001
18 - 30 years old – 57 - 69 years old	5.2895	0.002
18 - 30 years old – 70 years old and above	4.1655	0.027
Years of residency		
64 - 79 years – 15 years and less	-6.93	< 0.001
48 - 63 years – 15 years and less	-8.016	< 0.001
32 - 47 years – 16 - 31 years	-6.14	< 0.001
32 - 47 years – 15 years and less	-10.704	< 0.001
16 - 31 years – 15 years and less	-5.644	< 0.001
Educational attainment		
College – Elementary	6.17	< 0.001
College – No formal education	6.76	< 0.001
High School – Elementary	9.83	< 0.001
High School – No formal education	8.64	0.014
Elementary – No formal education	4.26	< 0.001
Occupation		
Self-employed/Unemployed – Students	-8.88	< 0.001
Fisherfolks/Seafarers/Divers – Vendors	-5.854	< 0.001
Fisherfolks/Seafarers/Divers – Students	-10.645	< 0.001
Fisherfolks/Seafarers/Divers – Government employees	-4.444	0.028
Housewives/Housekeepers – Students	-8.457	< 0.001
Vendors – Students	-4.998	0.007
Students – Farmers	6.43	< 0.001
Monthly family income		
USD 121.74 - 226.07 – USD 17.39 and below	4.512	0.018

Note: W - Wilcoxon rank-sum test statistic used in DSCF pairwise comparisons; p - significance level.

Attitude of the locals towards the horseshoe crab population and its conservation. Levels of attitude found were generally positive in favor of horseshoe crab conservation in Pangutaran Island (Figure 4). Specifically, 43% of respondents strongly agreed that horseshoe crabs contribute to the health of other marine animals and local communities, and that they have a meaningful role to play in conserving the species (community responsibility), but have a neutral level of perception regarding the declining

population of horseshoe crabs. These results reflect recognition of their ecological and economic importance, consistent with previous perception studies in regions where horseshoe crabs have medicinal significance but can damage fish nets (Pati et al., 2020). However, uncertainty about their current population status suggests limited encounters that may be due to low occurrence of the species in the area (Löki et al., 2023). Nonetheless, 44% agreed that horseshoe crabs have a positive overall benefit to coastal ecosystems and communities.

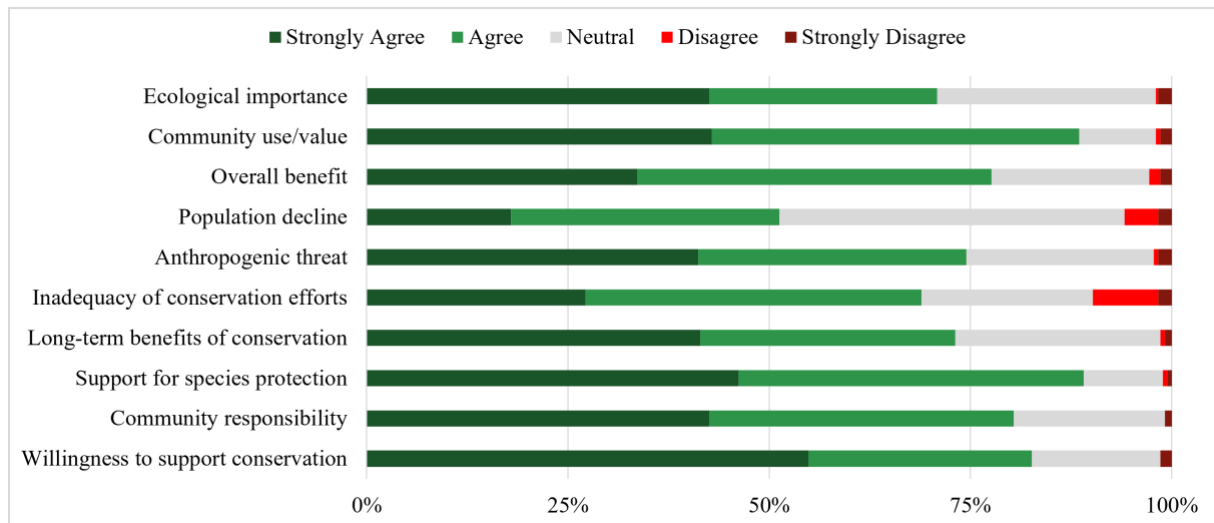


Figure 4. Distribution of responses about respondents' perception and attitude towards the horseshoe crab population and conservation.

In terms of perception of anthropogenic pressures, 41% strongly agreed that community coastal activities such as mass harvesting can negatively affect horseshoe crab populations. Some (42%) agreed that no strong efforts to conserve horseshoe crabs in the community have been made, but strongly agreed that conservation initiatives can provide long-term ecological and economic benefits. Almost half (46%) of the respondents strongly favored protecting these species, and 55% expressed a strong willingness to support conservation efforts. These findings suggest that while general awareness of threats exists, greater dissemination of information on population trends and conservation status may be necessary to strengthen community understanding of the species' conservation needs.

Attitude scores significantly varied by location, age, educational attainment, occupation, and income (Table 6). Older residents, fisherfolk, and housewives or housekeepers of coastal communities exhibited higher conservation attitudes (Table 7), likely due to experiential knowledge (Mustopa et al., 2023). Similarly, respondents with no formal education had significantly higher attitude scores than those with high school ($p = 0.033$) or college education ($p = 0.028$), supporting that ethnic groups have more protective attitudes towards wildlife management despite less access to academic or professional roles (Werdel et al., 2024). Households with lower income also showed stronger attitudes ($p = 0.015$). This result suggests that community-based monitoring can be actively participated by these coastal households, as their involvement may also translate to direct benefits given their greater dependence on coastal resources. With lower-income groups making up the majority of the population, the municipality has a strong potential for locally-owned conservation governance. Meanwhile, sex is not significantly associated with attitude scores ($p = 0.488$), indicating that local residents maintain positive attitudes toward horseshoe crab conservation regardless of sex.

Table 6

Association between sociodemographic factors and attitude scores toward horseshoe crab conservation

<i>Sociodemographic factor</i>	χ^2	<i>df</i>	<i>U-Statistic</i>	<i>p</i>	<i>Interpretation</i>
Address	103	2	15,010	< 0.001	Significant
Sex				0.488	Not significant
Age	12.5	4		0.014	Significant
Years of residency	4.1	5		0.535	Not significant
Educational Attainment	14.9	3		0.002	Significant
Ethnic Group			639	0.098	Not significant
Occupation	28	6		< 0.001	Significant
Income	14.1	5		0.015	Significant

Table 7

Differences in attitude scores across sociodemographic groups

<i>Category</i>	<i>W</i>	<i>p</i>
Address		
Kihi Niog – Lantong Babag	-12.12	< 0.001
Lantong Babag – Simbahan	13.44	< 0.001
Age		
18 - 30 years old – 44 - 56 years old	-4.084	0.032
Educational attainment		
College – No formal education	-3.92	0.028
High School – No formal education	-3.85	0.033
Occupation		
Fisherfolks/Seafarers/Divers – Students	5.425	0.002
Housewives/Housekeepers – Students	5.887	< 0.001
Housewives/Housekeepers – Farmers	4.824	0.012
Income		
USD 226.08 - 330.41 – USD 17.40 - 121.73	-4.4171	0.022

Note: W - the Wilcoxon rank-sum test statistic used in DSCF pairwise comparisons; p - the significance level.

Practices towards the horseshoe crab population. Most respondents do not catch horseshoe crabs (82%), while a small proportion actively catch (13%) or retain bycatch (5%) (Figure 5a). Catch methods include fishnets and handpicking (Figure 5b). Utilization is primarily medicinal (74%) and for food (19%) or cultural purposes (9%) (Figure 6). Medicinal utilization of these species is for treatment of *kabus* or premature infants commonly administered by 66% of the households surveyed. The practice of boiling horseshoe crab body parts, with the cooled extract used for bathing infants, was believed to help them survive from their condition. Similar use has been documented in Tawi-Tawi (Omnos et al., 2026), a neighboring island province of Sulu and shares Sulu Sea where horseshoe crabs were also recently documented. Other medical illnesses that horseshoe crabs are used for treatment include asthma (8%). Shell is the part most often utilized by boiling for treatment of illnesses (88%), while meat (22%) and eggs (13%) are consumed by some (Figure 6b).

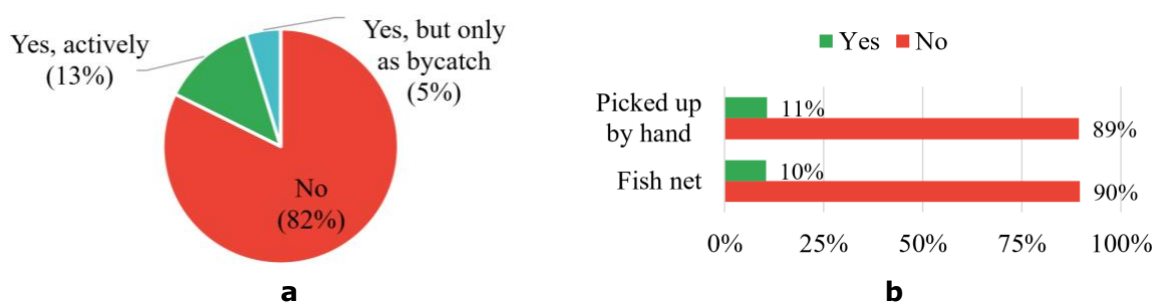
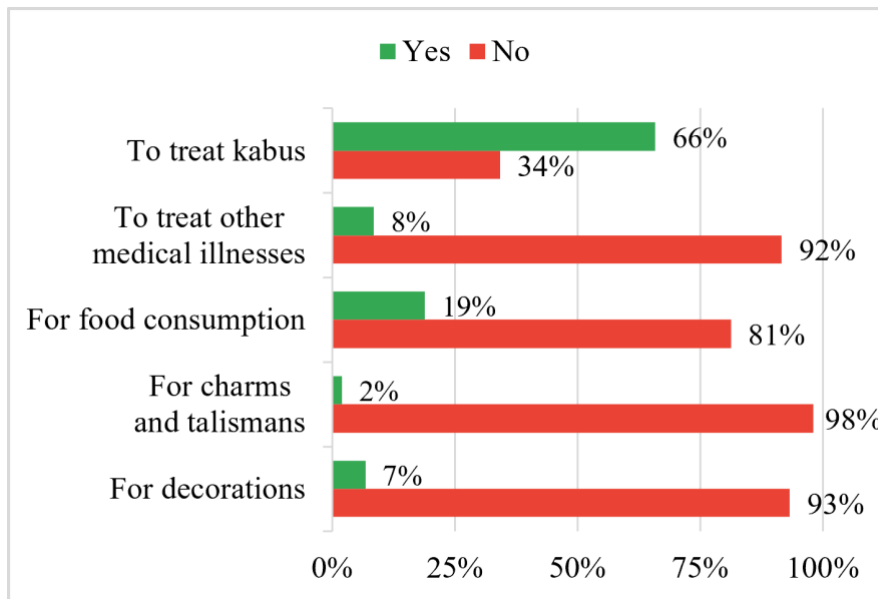
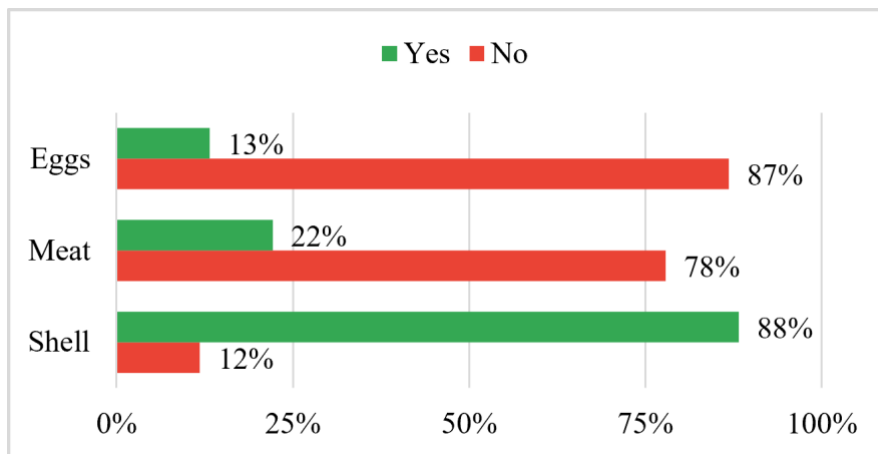


Figure 5. Distribution of responses about (a) whether they catch horseshoe crabs, and (b) the tools they use.



a



b

Figure 6. Distribution of responses about respondents' (a) utilities of horseshoe crabs, and (b) the horseshoe crab parts they use.

Practice significantly differed across sociodemographic factors (Table 8). Practice scores were higher among younger, more educated respondents, and those with shorter residency (Table 9), while these groups were found to have weaker positive attitudes, supporting the results of Tsoi et al., (2016) that there is reduced wildlife consumption for those who perceived their ecological significance and conservation status. Occupation also influenced practice, with students and government employees scoring higher than housewives or fishermen. Income showed mixed effects; lower-income households tended to rely more on marine resources. Sex is not significantly associated with practices, showing that consumptive and captive behavior is low for both male and female residents.

Table 8

Association between sociodemographic factors and practice scores toward horseshoe crabs

<i>Sociodemographic factor</i>	χ^2	<i>df</i>	<i>U-Statistic</i>	<i>p</i>	<i>Interpretation</i>
Address	83.9	2	14,229	< 0.001	Significant
Sex				0.111	Not significant
Age	13.4	4		0.009	Significant
Years of residency	20.2	5		0.001	Significant
Educational attainment	28.7	3	816	< 0.001	Significant
Ethnic group				0.315	Not significant
Occupation	41.9	6		< 0.001	Significant
Income	13.3	5		0.021	Significant

Table 9

Differences in practice scores across sociodemographic groups

<i>Category</i>	<i>W</i>	<i>p</i>
Address		
Simbahan – Kihi Niog	5.39	< 0.001
Simbahan – Lantong Babag	12.01	< 0.001
Kihi Niog – Lantong Babag	8.04	< 0.001
Age		
18 - 30 years old – 44 - 56 years old	4.07	0.033
Years of residency		
48 - 63 years – 15 years and less	-5.566	0.001
32 - 47 years – 15 years and less	-4.031	0.05
16 - 31 years – 15 years and less	-4.174	0.037
Educational Attainment		
College – Elementary	5.046	0.002
College – No formal education	4.442	0.009
High School – Elementary	6.046	< 0.001
High School – No formal education	4.681	0.005
Occupation		
Self-employed/Unemployed – Students	-5.5938	0.001
Fisherfolks/Seafarers/Divers – Students	-7.634	< 0.001
Fisherfolks/Seafarers/Divers – Government employees	-4.5254	0.023
Housewives/Housekeepers – Students	-7.3782	< 0.001
Housewives/Housekeepers – Government employees	-4.2991	0.038
Vendors – Students	-4.4086	0.03

Note: W = the Wilcoxon rank-sum test statistic used in DSCF pairwise comparisons; p = the significance level.

Correlation between knowledge, attitude and practice components. Pearson correlation analysis showed that practice of catching and utilization are significantly correlated with knowledge of horseshoe crabs and attitude towards their conservation (Table 10). This finding indicates that promoting behavioral change should rely on both awareness-based campaigns and programs incorporating value formation that strengthen positive attitudes toward wildlife conservation. Practice was positively correlated with knowledge ($r = 0.317$, $p < 0.001$) but negatively correlated with attitude ($r = -0.305$, $p < 0.001$), indicating that while awareness facilitates utilization, positive conservation attitudes reduce exploitative behavior. Knowledge and attitude were not significantly correlated ($r = 0.028$, $p = 0.593$), suggesting cognitive and affective components should be addressed separately in conservation programs.

Table 10

Pearson correlation analysis between knowledge, attitude and practice scores

<i>Variable</i>	<i>Statistic</i>	<i>Knowledge</i>	<i>Attitudes</i>	<i>Practices</i>
Knowledge	Spearman's rho	—		
	df	—		
	p-value	—		
Attitudes	Spearman's rho	0.028	—	
	df	355	—	
	p-value	0.593	—	
Practices	Spearman's rho	0.317	-0.305	—
	df	355	355	—
	p-value	< 0.001	< 0.001	—

Conclusions. This study shows that local communities in Pangutaran Island have moderate familiarity with horseshoe crabs, but ecological knowledge remains limited, particularly regarding species identification, life stages, and habitat requirements. Knowledge levels significantly vary across sociodemographic factors, with higher education, younger age, and higher income associated with better awareness.

Attitudes toward horseshoe crab conservation are generally positive across respondents, with stronger conservation-oriented attitudes observed in older, less formally educated, and lower-income groups. However, uncertainty regarding population status indicates limited awareness of conservation concerns.

Utilization of horseshoe crabs for traditional and subsistence purposes is present but relatively low, suggesting ongoing anthropogenic pressure on local populations.

The results indicate that knowledge, attitudes, and practices are not strongly aligned: knowledge is moderately associated with utilization, while positive attitudes are less moderately linked to reduced exploitative practices, but knowledge and attitudes are not significantly related. This suggests that knowledge alone is insufficient to ensure conservation-oriented behavior.

Overall, the findings highlight the need for targeted ecological education and community-based conservation programs, particularly for fisherfolk and resource-dependent households, to support sustainable management of horseshoe crab populations in Pangutaran Island.

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Data Availability. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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