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Local people perception on *Carcinoscorpius rotundicauda* and *Tachypleus* spp. in Banyuasin, Sumatera, Indonesia

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ABSTRACT

The population decline in horseshoe crabs was increasingly revealed by various researchers in Asian countries, but there are still gaps in information regarding their population and ecological status. In data-poor situations, especially in the Banyuasin peninsula, collecting local knowledge was required because this approach was an easy, wide-scale, inexpensive, and rapid way to obtain data. This work aimed to assess the contributing local knowledge regarding the horseshoe crab's distribution, use, and threats to the existence of horseshoe crabs in the Banyuasin peninsula. Interviews using a questionnaire were conducted in five villages and one hamlet by visiting randomly selected households. The result revealed that most respondents (94%; n = 115) could correctly identify the species and shape between *Carcinoscorpius rotundicauda* and *Tachypleus* spp. Most respondents stated easily recognized *C. rotundicauda* by their rounded telson and smooth (without spines) whereas *Tachypleus* spp. was also easily recognized by their triangular telson with spines. The respondents avowed that Sembilang National Park Waters, especially Sembilang River (80%; n = 98), Cabe Island (71%; n = 87), Benawang River (56%; n = 68), and Sapi Island (52%; n = 64) were the most widespread location of horseshoe crabs. The *C. rotundicauda* was discovered more frequently than *Tachypleus* spp. in almost every distributing location around December (80%; n = 97), November (70%; n = 86), and October (57%; n = 69). The most horseshoe crabs benefit was for food (63%, n = 73). The main factors encouraged a decline in the horseshoe crab population, i.e. entangled in fishing nets (92%, n = 106). Respondents acknowledged that the Indonesian Government established the horseshoe crab as a protected animal. Fishermen's consciousness to reduce the horseshoe crab's bycatch and ensure it returned to the sea alive and safe was much needed to address the serious threat to its population decline.

1. Introduction

South Sumatra is one of the provinces in Indonesia with large mangroves and Banyuasin Peninsula is an area in South Sumatra with the largest mangrove forest (Basuki and Putri, 2019). Mangroves provide various valuable services and one of them is an ideal habitat (spawning, breeding, and nursery) for most fish, shellfish, crabs, and shrimps (Brander et al., 2012; Vo et al., 2012). Mangrove forests along the Banyuasin Peninsula are a potential habitat for horseshoe crabs, especially *Tachypleus gigas* and *Carcinoscorpius rotundicauda* as well as possibly *Tachypleus tridentatus* (Fauziyah et al., 2019a, 2019b, 2021; Sari et al., 2020). These species are most famous as "living fossils" due to their bodies changing very little since the Ordovician period (ie. over about 440 Million years) when the first representatives of this group appear and also since the Triassic when the modern family of Limulidae could be recorded (Cartwright-Taylor et al., 2009; Størmer, 1952).

Horseshoe crabs in Indonesia can be found and spread across Java, Sumatra, Sulawesi, and Kalimantan Island (Meilana and Fang, 2020). Horseshoe crab or *'kepiting tapal kuda'* (Indonesia name) is known as *'mimi lan mintuno'* (Java Island), 'belangkas' (Kalimantan and Sumatra Island) or '*bungkak*' (local name in Banyuasin, South Sumatra). The status of the species *T. gigas* and *C. rotundicauda* in the IUCN Red List is 'data deficient' (World Conservation Monitoring Centre, 1996a, 1996b), and there has been no further update. However, the *T. tridentatus* species

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underwent a status update (Laurie et al., 2019) to become "endangered". In Indonesia, the status of horseshoe crabs is categorized as a protected animal based on the Decree of the Minister of Forestry No.12/KPS-II/1987 and renewed by the regulation of the Minister of Environment and Forestry of the Republic of Indonesia number P20/MENLHK/SETJEN/KUM.1/6/2018. Even though there has been a renewal of regulations by the government regarding horseshoe crabs, until now (for 36 years), there has been no conservation area with the target of conserving horseshoe crabs species in Indonesia.

Based on data from the Directorate General of Marine Spatial Management of the Republic of Indonesia 2022, 79 conservation areas have been designated until 2022. Based on The Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia Number 1 of 2021 concerning Protected Fish Species, 20 types of fish are conservation priorities, such as turtles, dugongs, sharks, rays, and dolphins. Thus, horseshoe crabs are not a conservation priority fish species even though they are protected animals based on government regulations. Consequently, none of the conservation areas includes horseshoe crabs as a conservation target. This is the challenge that must be faced to make horseshoe crabs a priority fish species for conservation. Baseline data on ecologies, such as population conditions, potential distribution, population status, and threats related to horseshoe crabs, have not yet been collected (John et al., 2018). Besides the lack of ecological information, the lack of funding for research or publication of horseshoe crabs in Indonesia (Meilana and Fang, 2020) makes the gap even bigger.

Developing physical infrastructure in the vicinity inflicts a threat to species spawning grounds and accordingly, conservation and management are required (Fairuz-Fozi et al., 2018). All efforts to protect these crabs are inadequate when the ecological knowledge gained from the local people's engagements is not well documented (Pati et al., 2020). Thus, the local people play a significant role in conservation. Their knowledge of horseshoe crabs species and understanding of potential threats to their survival is an effort to introduce to the government that horseshoe crabs can be included as conservation priority fish species. Pati et al. (2020) proposed bottom-up suggestions that call for management decisions.

One of the efforts that can be conducted to reduce the horseshoe crabs population is local knowledge-based conservation activities. Therefore, experience-based knowledge is a crucial information source in this research. Some researchers called it Traditional Ecological Knowledge (TEK), Local Ecological Knowledge (LEK), Rural Peoples' Knowledge, or Farmer Knowledge (Berkes et al., 2000; Brook and Mclachlan, 2008; Franzini et al., 2013; Kothari, 2002; Mauro and McLachlan, 2008). The TEK represents culturally generated knowledge delivered through generations (Costa and Nunez, 2011) and can even be considered a key source of information regarding the migration and distribution of species, including reproduction and feeding habits (Franzini et al., 2013). In this context, information obtained from the local people about the horseshoe crabs was used as primary data for this research. Therefore, this study aimed to document contributing local knowledge regarding the horseshoe crab's distribution, use, and threats to the existence of these crabs in the Banyuasin peninsula. Through this LEK assessment, baseline data will be obtained to make the living fossils a priority fish species for conservation in Indonesia. These local perspectives are also needed by related stakeholders, especially in efforts to make the National Sembilang Park a horseshoe crabs conservation area. It should be noted that this local knowledge does not diminish scientific knowledge when formulating governmental regulations for the protection of these species, but it helps to plan investigations in details for the future.

2. Material and methods

2.1. Study sites and samples

The research was carried out in the Banyuasin Peninsula (Fig. 1),

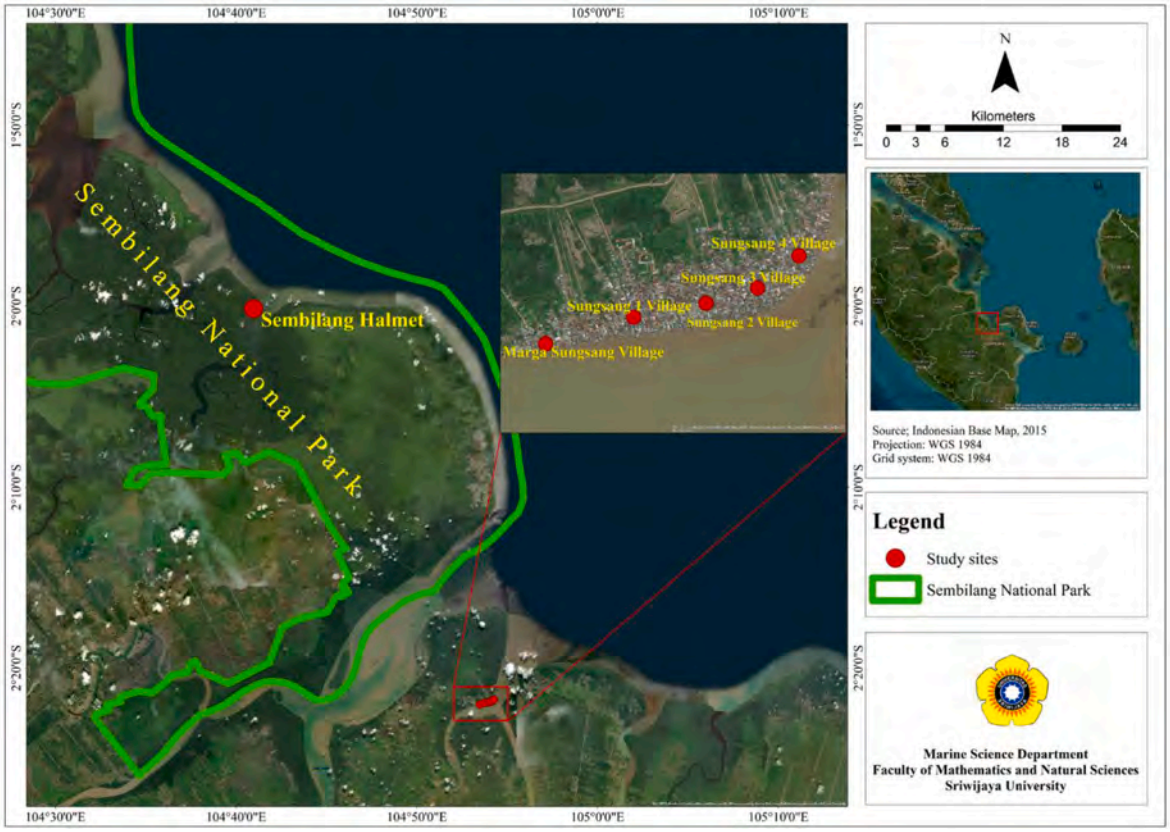

Fig. 1. Map of the study sites in Banyuasin peninsula, South Sumatra, Indonesia.

located in the Banyuasin Coastal Villages (Sungsang I, Sungsang II, Sungsang III, Sungsang IV, and Marga Sungsang Village) and the Sembilang hamlet in the Sembilang National Park (SNP). The villages of Sungsang I, Sungsang II, Sungsang III, Sungsang IV, and Marga Sungsang are located in the Banyuasin II sub-district with an area of 32.93 km^2, 340.08 km^2, 12.26 km^2, 1651.99 km^2, and 28.51 km^2 respectively, the population density of these villages was 179, 17, 288, 3, and 122 people per km^2 (BPS, 2022). Administratively, the Sembilang hamlet is part of the Sungsang IV Village.

Individual interviews with the local people from the six sites were conducted from June to August 2021. The interviews were conducted by visiting randomly selected households. The three parameters used to select respondents were (1) residents who have a lot of experience or are familiar with horseshoe crabs, (2) represented the social status in the local community such as fishermen, housewives, traders, village apparatus, teachers, and others (the sea and air police, SNP manager, security guard, and speedboat driver), and (3) one respondent represented one household. The photographs were always shown after respondents had described the horseshoe crabs, and responses regarding the photo to ensure that they could correctly identify the species of horseshoe crabs.

There were a total of 6942 households in the surveyed sites. Statistically, the determination of sample size in this study used Slovin's Formula with a 10% margin of error. The formula was written as follows (Tejada and Punzalan, 2012):

$$n = \frac{N}{1 + Ne^2} \quad (1)$$

where n is the total number of surveyed households, N is the total number of households in the study sites, and e is a specified margin of error. Accordingly, the sample size in this survey was 99 households (adjusted to 122 respondents) and represented the sample sites proportionally.

The respondent's information was declared eligible for the questionnaire validation test if the respondent answered at least 80% of the questionnaire questions. Thus, the final samples that appropriate all of these criteria were 122 respondents scattered in Sembilang (14 respondents), Marga Sungsang (15 respondents), Sungsang 1 (22 respondents), Sungsang 2 (29 respondents), Sungsang 3 (19 respondents), and Sungsang 4 (24 respondents).

2.2. Questionnaire design

The survey was carried out through personal interviews, consequently, a survey instrument (questionnaire) was to be prepared. The initial questionnaire from the previous research (Meilana and Fang, 2020) was applied for pre-testing with limited respondents (20 respondents) to examine their reactions and understanding of the questions before the actual survey. Their feedback was used to modify the initial questionnaire to become the final questionnaire with a 95% confidence level. This questionnaire was structured into six sections: the first section aimed to collect socio-demographic data of the respondents (5 items), the second section purposed to collect data on the general knowledge about horseshoe crabs (6 items), the third section was designed to explore the respondent's knowledge about their distribution (2 items), the fourth section aimed to detect the respondents' perceptions about the benefits of horseshoe crabs (4 items), the fifth section aimed to explore the horseshoe crabs population (7 items), and the sixth section aimed to reveal the conservation actions (2 items). The questionnaire used both open-ended and close-ended formats to elicit respondent preferences (see Appendix A).

Before conducting a survey, the interviewers were trained. The interviewers should be able to communicate the questionnaire using the local language. Thus, the respondents could easily understand all questions and ensured that all questions were answered according to the respondent's perception.

2.3. Data collection

An ethnographic method was adopted for collecting data on the local people's perception of the ecological horseshoe crabs. Hence, observation techniques and individual interviews were applied. For ethnographic observation, passive observation only observed and recorded their daily activities to get the people's perspective. This observation was used to verify the horseshoe crab species revealed by the respondents. Meanwhile, the final questionnaires were used in the structured interviews as a guide for asking questions to respondents in a predetermined order. Lambert and Loiselle (2008) highlighted that the respondents' expressions regarding their experiences would represent their reality when questions were correctly structured. In addition, secondary data available in the village monograph was also collected.

In order to complete the information about the horseshoe crabs distribution, a participatory mapping method (PMM) was also adopted. The PMM was developed using information obtained from the respondent's knowledge and perceptions, based on the laminated map of study sites (De Souza and Pinheiro, 2021). The maps were presented to each respondent for marking information about distribution locations using an overhead projection marker. The maps were digitized for further analysis using the ArcGIS software.

2.4. Data analysis

Before further analysis, all respondents' answers were grouped into similar categories and input in Microsoft Excel 2016. The validity test of Pearson's product-moment correlation and the corrected item-total correlation was applied for questionnaire validation. This validity test used the principle of correlating each question item score with the overall score of the questionnaire (Ernawati et al., 2020). In this case, the socio-demographic questions were excluded from the validity test. Questions with answers "yes" or "no" was scored 1 and 0, respectively. For the open-ended questions, if the respondent answered or did not answer the question also transformed into 1 and 0, respectively. Questionnaire items of respondents' perceptions were grouped into five aspects (general knowledge, distribution, benefits, threats, and conservation actions). The total value of each aspect was then transformed into a Likert scale (1–5) scaling the respondents' responses to the questionnaire aspects. The questionnaire item (question) was considered valid (Coradini et al., 2022; Purwanto, 2018) when the p-value was less than 0.05 and the value of the corrected item-total correlation (r-count) was greater than the Pearson table coefficient (r-table).

In addition, the reliability test was performed to analyze the internal consistency among questions on the questionnaire. The most commonly used method to evaluate internal consistency is by computing the Cronbach Alpha coefficient (Adamson and Prion, 2013). The Cronbach alpha score of 0.7 indicated acceptable internal consistency (Barbera et al., 2021; Torkian et al., 2020).

Principal component analysis (PCA) was applied to visualize the socio-demographic characteristics associated with the perception categories of horseshoe crabs. The PCA was performed using the XLSTAT statistical software. Spatial distributions of horseshoe crabs were visualized using ArcGIS 10.8. IBM SPSS Statistics V21.0 has also been used for the validity and reliability tests and the *t*-test (Mann-Whitney *U* test) with statistical significance established at $p < 0.05$.

3. Results

The results of this study revealed the validity and reliability tests of the questionnaire, social-demographics characteristics, and respondents' perceptions regarding horseshoe crabs (general knowledge, distribution, benefits, threats, and conservation actions). Therefore, the analysis results of ethnographic material (field notes, photographs, recordings, and transcriptions) were obtained during fieldwork (interviews and observation).

3.1. Reliability and validity measures of the questionnaire

The statistical tests of reliability and validity are summarized in Table 1. Table 1 presents 21 items scattered into the five questionnaire constructs. Based on the validity test results, the Corrected Item-Total Correlation and Pearson's correlation coefficient were obtained for each item. The r-table value with a degree of freedom (df) of 120 was 0.150 obtained. Overall scores of the Corrected Item-Total Correlation (ranging from 0.254 to 0.766) were greater than the r-table and overall scores of the Pearson's correlation coefficient (ranging from 0.476 to 0.889) were also greater than 0,4 and significant at the 0.01 level. Therefore, overall items of the questionnaire could be declared valid. This instrument also produced a reliable questionnaire with a Cronbach's alpha value (0.707–0.756) greater than 0.7. Accordingly, the questionnaire constructs have fulfilled the reliability and validity criteria. Thus, the questionnaire results could be used for further analysis needs.

3.2. Sociodemographic characteristics of the respondents and their perceptions

According to the sociodemographic characteristics of the respondents (Table 2), males (80.3%; n = 98) were more represented than females (19.7%; n = 24), and 59.8% (n = 73) of age groups aged over 39 years (A4 = 29.5%; A5 = 30.3%). In addition, most of the respondents (54.1%; n = 66) graduated from elementary school (E2), and more than half (59.8%; n = 73) were fishermen (O7). Most of the respondents' perceptions included good and excellent categories regarding aspects of general knowledge (94.3%; n = 115), distribution (81.1%; n = 99), benefits (62.3%; n = 76), and threats (98.4%, n = 120), on the contrary for the conservation action aspect, their perception included fair to very poor categories (59%; n = 72). Among the respondents who had good to excellent perceptions, most (more than 80%) were over 29 years old with more than half graduating from elementary school, and working as fishermen.

Table 1
The validation test of the questionnaire used the Corrected Item-Total Correlation, Cronbach's Alpha, and Pearson's product-moment correlation.

Constructed Questionnaire	The Statistics tests of the questionnaire		
	The validity		Reliability
	Corrected Item-Total Correlation	Pearson's correlation coefficient	Cronbach's Alpha
General Knowledge (GK)			0.756
GK1	0.766	0.822**	
GK2	0.766	0.822**	
GK3	0.524	0.700**	
GK4	0.766	0.822**	
GK5	0.58	0.740**	
GK6	0.305	0.657**	
Distribution (D)			0.707
D1	0.548	0.870**	
D2	0.548	0.889**	
Benefits (B)			0.704
B1	0.467	0.675**	
B2	0.254	0.570**	
B3	0.636	0.833**	
B4	0.655	0.832**	
Threats (T)			0.711
T1	0.579	0.651**	
T2	0.403	0.681**	
T3	0.654	0.846**	
T4	0.305	0.476**	
T5	0.579	0.651**	
T6	0.583	0.683**	
T7	0.391	0.521**	
Conservation Actions (CA)			0.708
CA1	0.55	0.872**	
CA2	0.55	0.889**	
The r-table (db = 120)	0.150		

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

In Fig. 2A, PC1 and PC2 explained 78.23% and 14.99% of the data variation, respectively. Referring to the PCA results, each observation and variable have the largest values in squared cosine at PC1. Age (A), education (E), gender (G), and occupation (O) have different characteristics which are indicated by different quadrants. Both occupation and gender have a negative correlation with benefits (B), threats (T), general knowledge (GK), conservation actions (CA), and distribution variables (D). Education has a strong positive correlation with general knowledge, conservation actions, distribution, and threat, while age has a strong positive correlation with threat, benefit, general knowledge, and conservation action variables. The variables of general knowledge, conservation action, threat, education, and distribution have a strong positive correlation with each other. In contrast, the benefit variable has a weak positive correlation with the distribution variable (the angle between the two lines is close to 90°). The distribution variable has the largest variance values (the longest vector line), while the general knowledge variable has the smallest (the shortest vector line).

In Fig. 2B, PC1 and PC2 explained 69.95% and 12.56% of the data variation respectively. Based on the values of the squared cosines from the PCA results, PC1 consists of A1, A2, A3, A3, A4, A5, G1, G2, E1, E2, E4, O2, O3, O4, O5, O6, and O7, while E3, E5, and O1 were included in PC2. Based on the angle between socio-demographic groups toward the observed perception variables, they could be regrouped into four groups. Group 1 represented respondents aged over 29 years (A2, A3, A4, A5), male (G2), educated below secondary or high school (E1, E2, E4), and work as fishermen (O7), traders (O5) or village apparatus (O4). Group 2 represented respondents educated in upper high school (E5) and working in other fields (O1). Group 3 represented respondents aged under 20 years (A1), female (G1)) and work as students (O2), teachers (O3), or housewives (O6). Group 4 represented respondents educated in secondary school (E3). Group 1 has a strong positive correlation with distribution, threat, general knowledge, benefit, and conservation action variables. Group 2 has a strong negative correlation with general knowledge, and benefit and conservation action variables. Group 3 has a strong negative correlation with distribution, threat, general knowledge, benefit, and conservation action variables. Meanwhile, group 4 has a strong positive correlation with the threat, general knowledge, benefit, and conservation action variables.

3.3. General knowledge of horseshoe crabs species

Ethnographic results regarding horseshoe crabs revealed that most of the respondents (94%; n = 115) could correctly identify the species and shape. The main characteristic was identified with a smooth and rounded telson for *C. rotundicauda,* while the telson was triangular for *Tachypleus* spp. The local people did not distinguish between *Tachypleus gigas* and *Tachypleus tridentatus* because the morphometrics of both species had a high similarity. Horseshoe crabs are known by the local people (98%; n = 120) as "Bungkak", although Java people generally call them "mimi" or "belangkas" by Sumatra people. They also called "bungkak jantan" for *Tachypleus* species and "bungkak betina" for *C. rotundicauda*. In addition, they called the "bungkak betina" for *C. rotundicauda* due to this species often co-occurrence with *Tachypleus* species and was found in a smaller size with eggs stuck within her body. Morphometrics, morphology, and form were used for species identification especially to identify the main characteristics of each species. Ethnographic results also revealed the distribution (Table 3-6), benefits (Fig. 6), and threats (Table 7).

Most respondents (98%; n = 115) admitted that they had seen eggs/larvae/juveniles of horseshoe crabs. Based on their morphometrics

Table 2
Socio-demographic characteristics of the respondents and their perception categories on the ecological knowledge of horseshoe crabs in the Banyuasin Peninsula, South Sumatra.

Local Perception	Age						Gender			Educational Attainment						Occupation							
	A1	A2	A3	A4	A5	Σ	G1	G2	Σ	E1	E2	E3	E4	E5	Σ	O1	O2	O3	O4	O5	O6	O7	Σ
General Knowledge	5	15	29	36	37	122	24	98	122	14	66	19	14	9	122	5	4	4	8	13	15	73	122
• Excellent	3	13	25	26	30	97	11	86	97	9	57	14	12	5	97	4	2	2	6	10	7	66	97
• Good	1	1	3	8	5	18	7	11	18	5	4	4	2	3	18	1	1	1	2	2	4	7	18
• Fair	1	0	1	2	1	5	4	1	5	0	4	1	0	0	5	0	1	0	0	1	3	0	5
• Poor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
• Very Poor	0	1	0	0	1	2	2	0	2	0	1	0	0	1	2	0	0	1	0	0	1	0	2
Distribution	5	15	29	36	37	122	24	98	122	14	66	19	14	9	122	5	4	4	8	13	15	73	122
• Excellent	3	13	23	29	31	99	17	82	99	13	52	14	12	8	99	5	2	3	8	9	12	60	99
• Good	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
• Fair	1	1	2	5	4	13	2	11	13	0	8	3	2	0	13	0	1	0	0	3	0	9	13
• Poor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
• Very Poor	1	1	4	2	2	10	5	5	10	1	6	2	0	1	10	0	1	1	0	1	3	4	10
Benefits	5	15	29	36	37	122	24	98	122	14	66	19	14	9	122	5	4	4	8	13	15	73	122
• Excellent	1	5	13	12	20	51	5	46	51	4	32	7	5	3	51	2	0	0	3	9	3	34	51
• Good	0	5	5	8	7	25	4	21	25	2	14	6	3	0	25	0	0	0	1	1	3	20	25
• Fair	3	2	2	10	5	22	6	16	22	5	9	3	2	3	22	1	3	2	3	2	3	8	22
• Poor	0	2	6	3	3	14	5	9	14	2	9	1	0	2	14	0	0	1	1	0	4	8	14
• Very Poor	1	1	3	3	2	10	4	6	10	1	2	2	4	1	10	2	1	1	0	1	2	3	10
Threats	5	15	29	36	37	122	24	98	122	14	66	19	14	9	122	5	4	4	8	13	15	73	122
• Excellent	3	14	27	32	35	111	16	95	111	12	64	16	12	7	111	3	2	3	7	12	11	73	111
• Good	1	1	2	4	1	9	6	3	9	2	2	2	2	1	9	2	1	0	1	1	4	0	9
• Fair	0	0	0	0	1	1	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1
• Poor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
• Very Poor	1	0	0	0	0	1	1	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	1
Conservation Actions	5	15	29	36	37	122	24	98	122	14	66	19	14	9	122	5	4	4	8	13	15	73	122
• Excellent	1	4	14	13	18	50	2	48	50	4	32	6	4	4	50	0	0	0	6	2	1	41	50
• Good	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
• Fair	1	3	9	10	12	35	4	31	35	5	13	8	6	3	35	0	1	2	2	6	1	23	35
• Poor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
• Very Poor	3	8	6	13	7	37	18	19	37	5	21	5	4	2	37	5	3	2	0	5	13	9	37

Notes: A1 = < 20 years, A2 = 20–29 years, A3 = 30–39 years, A4 = 40–49 years, A5 = 49 > years; G1 = female, G2 = male, E1 = below the elementary school, E2 = elementary school, E3 = secondary school, E4 = high school, E5 = upper high school, O1 = others, O2 = students, O3 = teachers, O4 = village apparatus, O5 = traders, O6 = housewives, O7 = fishermen, and Σ = total number of respondents.

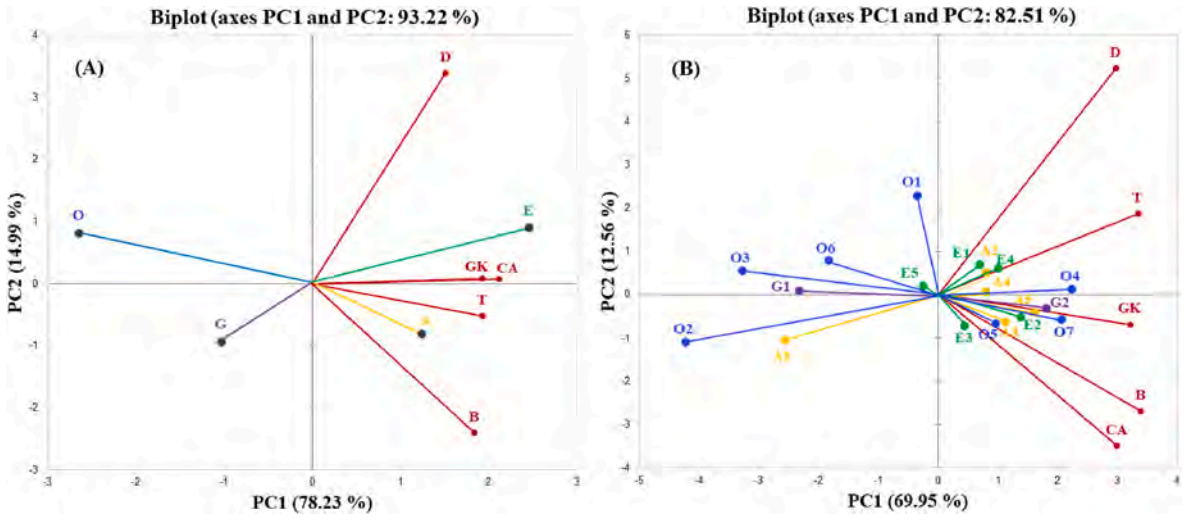

Fig. 2. PCA biplot to visualize the interaction between socio-demographic characteristics of the respondents and their perception categories regarding the horseshoe crab's existence in the Banyuasin peninsula, South Sumatra, Indonesia. Abbreviations A1 = age group <20, A2 = age group 20–29 years, A3 = age group 30–39 years, A4 = age group 40–49 years, and A5 = age group 49 > years. Gender was represented by G1 = female and G2 = male respondents. Education was denoted with E1 = below the elementary school, E2 = elementary school, E3 = secondary school, E4 = high school, and E5 = upper high school. Occupation was represented by O1 = others, O2 = students, O3 = teachers, O4 = village apparatus, O5 = traders, O6 = housewives; and O7 = fishermen. The perception was denoted with GK = general knowledge, D = distribution, B = Benefits, Threats = T, and CA = conservation actions.

Table 3
Ethnographic spatial distribution of horseshoe crabs recognized by the local communities in the Banyuasin Peninsula, South Sumatra.

Spatial Distribution	Number of Respondent Opinion											
	Fishermen (N = 73)		Non-Fishermen (N = 49)								Overall (N = 122)	
	N	%	O1	O2	O3	O4	O5	O6	Σ	%	N	%
A. SNP Area												
1. Sembilang River	62	85	5	1	3	8	7	12	36	73	98	80
2. Cabe Island	57	78	5	0	3	7	5	10	30	61	87	71
3. Benawang River	48	66	4	0	3	6	3	4	20	41	68	56
4. Sapi Island	42	58	5	0	2	4	5	6	22	45	64	52
5. Nibung River	34	47	2	0	1	5	4	5	17	35	51	42
6. Tulu River	30	41	1	0	0	5	5	4	15	31	45	37
7. Barong River	30	41	1	0	1	4	2	2	10	20	40	33
8. Alang Gantang	26	36	4	0	0	3	2	1	10	20	36	30
9. Bungin River	18	25	0	0	0	5	4	3	12	24	30	25
10. Birik Kecil River	17	23	4	0	0	2	2	1	9	18	26	21
11. Bangka Kecil River	16	22	3	0	0	1	1	1	6	12	22	18
12. Apung River	13	18	1	0	0	3	2	1	7	14	20	16
13. Kacangparang River	17	23	2	0	0	1	0	0	3	6	20	16
14. Tepingaram River	3	4	0	0	0	1	0	1	2	4	5	4
15. Bogem Besar River	1	1	0	0	0	1	0	1	2	4	3	2
16. Terusan Dalam	2	3	0	0	0	1	0	0	1	2	3	2
17. Tanjung Medi	0	–	0	0	0	1	0	0	1	2	1	1
18. Tiram River	0	–	0	0	0	1	0	0	1	2	1	1
B. Non-SNP Area												
19. Sungsang	22	30	1	4	1	4	6	6	22	45	44	36
20. Carat Cape	17	23	0	1	0	1	4	2	8	16	25	20
21. Legon	13	18	0	0	1	1	4	4	10	20	23	19
22. Payung Island	4	5	0	1	1	1	1	1	5	10	9	7
23. Upang estuary	2	3	0	0	0	0	0	0	0	–	2	2
24. Musi estuary	1	1	0	0	0	0	0	0	0	–	1	1

Notes: SNP = Sembilang National Park, O1 = others, O2 = students, O3 = teachers, O4 = village apparatus, O5 = traders, O6 = housewives, N = number, and Σ = total number.

knowledge, among the 115 respondents claimed sighting larvae without tail (telson) in small sizes (53%; n = 65), juveniles with telson in medium sizes (49%; n = 60), and adult sizes (84%; n = 102). According to the people's opinions, adult horseshoe crabs and juveniles (Fig. 3) were present around the Banyuasin coastal waters, specifically around the Sembilang River. In addition, most respondents (84%; n = 102) have found horseshoe crabs in pairs, and more than ten respondents sighted mating pairs in Sembilang River, Cabe Island, Sapi Island, Benawan River, Carat Cape, Alang Gantang and Sungsang.

3.4. Spatial and temporal distribution

Concerning local people's knowledge, 24 locations in Banyuasin Peninsula waters amount to the distribution area of horseshoe crabs (Table 3 and Fig. 4). These locations were distributed in 18 locations in the SNP area and the remaining (6 locations) were outside the SNP area.

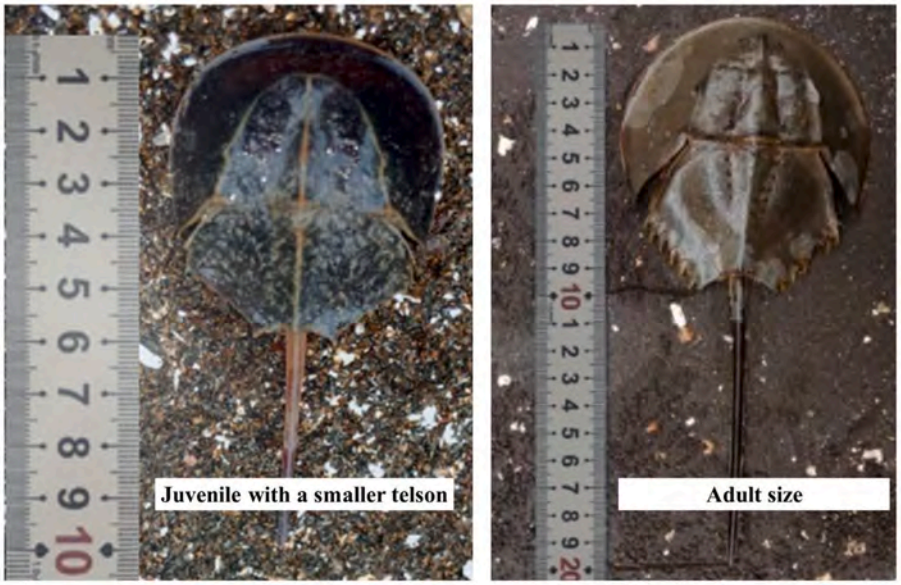

Fig. 3. Juvenile and adult size of horseshoe crabs found in the Banyuasin coastal waters.

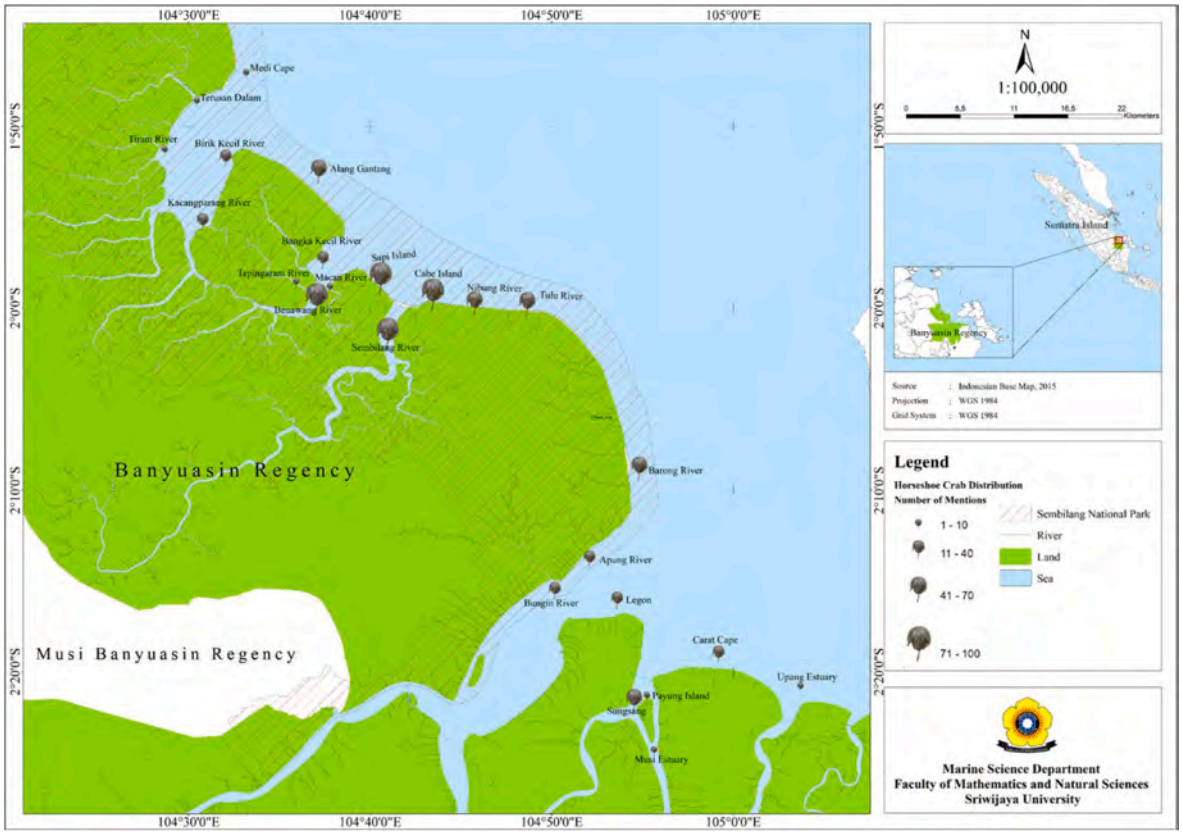

Fig. 4. The spatial distribution map of horseshoe crabs according to local knowledge around the Banyuasin Peninsula, South Sumatra, Indonesia.

More than half of the respondents mentioned the four locations where horseshoe crabs were most commonly found, namely the Sembilang River (80%; n = 98), Cabe Island (71%; n = 87), Benawang River (56%; n = 68), and Sapi Island (52%; n = 64).

Regarding their temporal distribution (Table 4), these crabs were most commonly found during the wet season covering December (80%; n = 97), November (70%; n = 86), and October (57%; n = 69), especially around the Sembilang River in the SNP area. Meanwhile, from March to June, these crabs were still found in small quantities (less than 15% mentioned that they had found these crabs). According to the respondent's perception, these crabs congregated along the coastal zone for mating and spawning activities from November to December (the highest tides period). Accordingly, the respondents assumed that the period was the mating season.

In Table 5, all respondents mentioned that both *C. rotundicauda* (61%; n = 74) and *Tachypleus* spp. (57%; n = 70) were frequently found

Table 4
Ethnographic temporal distribution of individual horseshoe crabs recognized by the local communities in the Banyuasin Peninsula, South Sumatra.

Temporal Distribution	Number of respondent opinion											
	Fishermen (N = 73)		Non-Fishermen (N = 49)								Overall (N = 122)	
	Σ	%	O1	O2	O3	O4	O5	O6	Σ	%	Σ	%
January	23	32	2	1	2	1	7	4	17	11	40	33
February	16	22	1	1	2	0	5	2	11	7	27	22
March	9	12	1	1	1	0	2	2	7	5	16	13
April	5	7	1	1	1	0	1	2	6	4	11	9
May	6	8	0	1	1	1	1	2	6	4	12	10
June	8	11	0	2	1	1	2	2	8	5	16	13
July	14	19	0	1	1	1	2	4	9	6	23	19
August	19	26	1	1	1	2	3	6	14	9	33	27
September	29	40	1	2	1	4	4	6	18	12	47	39
October	43	59	3	4	2	5	3	9	26	17	69	57
November	51	70	4	4	3	7	6	11	35	23	86	70
December	60	82	4	4	3	6	10	10	37	25	97	80

Notes: N = number, O1 = others, O2 = students, O3 = teachers, O4 = village apparatus, O5 = traders, O6 = housewives, and Σ = total number.

Table 5
Ethnographic species distribution of horseshoe crabs recognized by the local communities in the Banyuasin Peninsula, South Sumatra.

Spatial Distribution	Number of Respondent Opinion											
	Fishermen (N = 73)				Non-Fishermen (N = 49)				Overall (N = 122)			
	Cr		T		Cr		T		Cr		T	
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
A. SNP Area												
1. Sembilang River	53	73	50	68	21	43	20	41	74	61	70	57
2. Cabe Island	50	68	36	49	15	31	9	18	65	53	45	37
3. Benawang River	41	56	26	36	11	22	4	8	52	43	30	25
4. Sapi Island	38	52	25	34	12	24	6	12	50	41	31	25
5. Nibung River	28	38	7	10	8	16	2	4	36	30	9	7
6. Tulu River	25	34	4	5	7	14	1	2	32	26	5	4
7. Barong River	24	33	6	8	6	12	3	6	30	25	9	7
8. Alang Gantang	23	32	16	22	5	10	1	2	28	23	17	14
9. Bungin River	17	23	6	8	0	–	2	4	17	14	8	7
10. Birik Kecil River	16	22	7	10	5	10	3	6	21	17	10	8
11. Bangka Kecil River	16	22	9	12	7	14	2	4	23	19	11	9
12. Apung River	14	19	0	–	7	14	2	4	21	17	2	2
13. Kacangparang River	12	16	5	7	5	10	1	2	17	14	6	5
14. Tepingaram River	3	4	0	–	0	–	0	–	3	2	0	–
15. Bogem Besar River	1	1	0	–	1	2	0	–	2	2	0	–
16. Terusan Dalam	1	1	0	–	1	2	1	2	2	2	1	1
17. Tanjung Medi	0	–	0	–	1	2	1	2	1	1	1	1
18. Tiram River	0	–	1	1	1	2	1	2	1	1	2	2
B. Non-SNP Area												
19. Sungsang	20	27	1	1	11	22	10	20	31	25	11	9
20. Carat Cape	15	21	17	23	4	8	6	12	19	16	23	19
21. Legon	10	14	2	3	4	8	4	8	14	11	6	5
22. Payung Island	4	5	0	–	3	6	2	4	7	6	2	2
23. Upang estuary	2	3	0	–	0	–	1	2	2	2	1	1
24. Musi estuary	1	1	0	–	0	–	0	–	1	1	0	–

Notes: Cr = *C. rotundicauda*, T = *Tachypleus* spp., N = number, and Σ = total number.

in the Sembilang River (SNP area), similar to the distribution locations in Table 3. According to the respondent's opinion, spatial distribution for both *C. rotundicauda* and *Tachypleus* spp. were more evenly distributed in the Sembilang River. The species of *C. rotundicauda* was discovered more frequently than *Tachypleus* spp. in almost every distributing location. In general, the co-occurrence between *C. rotundicauda* and *Tachypleus* spp. in the same habitat was also revealed through their local knowledge (Fig. 5). This co-occurrence was most commonly found in the Sembilang River, Cabe Island, Benawang River, and Sapi Island.

3.5. Benefits, threats, and conservation actions

In Fig. 6, almost all respondents (86%; n = 99) stated that the horseshoe crab has various benefits, such as food (63%; n = 73), medicine (23%; n = 27), ornament (28%; n = 32), pet (21%; n = 24) and catfish bait (18%; n = 21). During the survey, the horseshoe crabs were not found sold in local markets, restaurants, or roadside. In a few incidents, the horseshoe crabs were found at fishermen's houses as children's toys due o they had not been returned to their habitat. For fishermen, the horseshoe crabs are considered to damage nets, as a discarded species, and these crabs are recognized as an illegal commodity to be caught.

In this interview, questions regarding problems and threats were also asked. Among 115 respondents, most (59%; n = 68) realized that there had been a decrease in the horseshoe crabs population, although 30% (n = 35) mentioned an increase and the remaining 10% claimed no change in their population. Some respondents claimed that the horseshoe crabs population had increased due to fishermen's awareness of the ban on capturing horseshoe crabs. Also, they still found horseshoe crabs in large

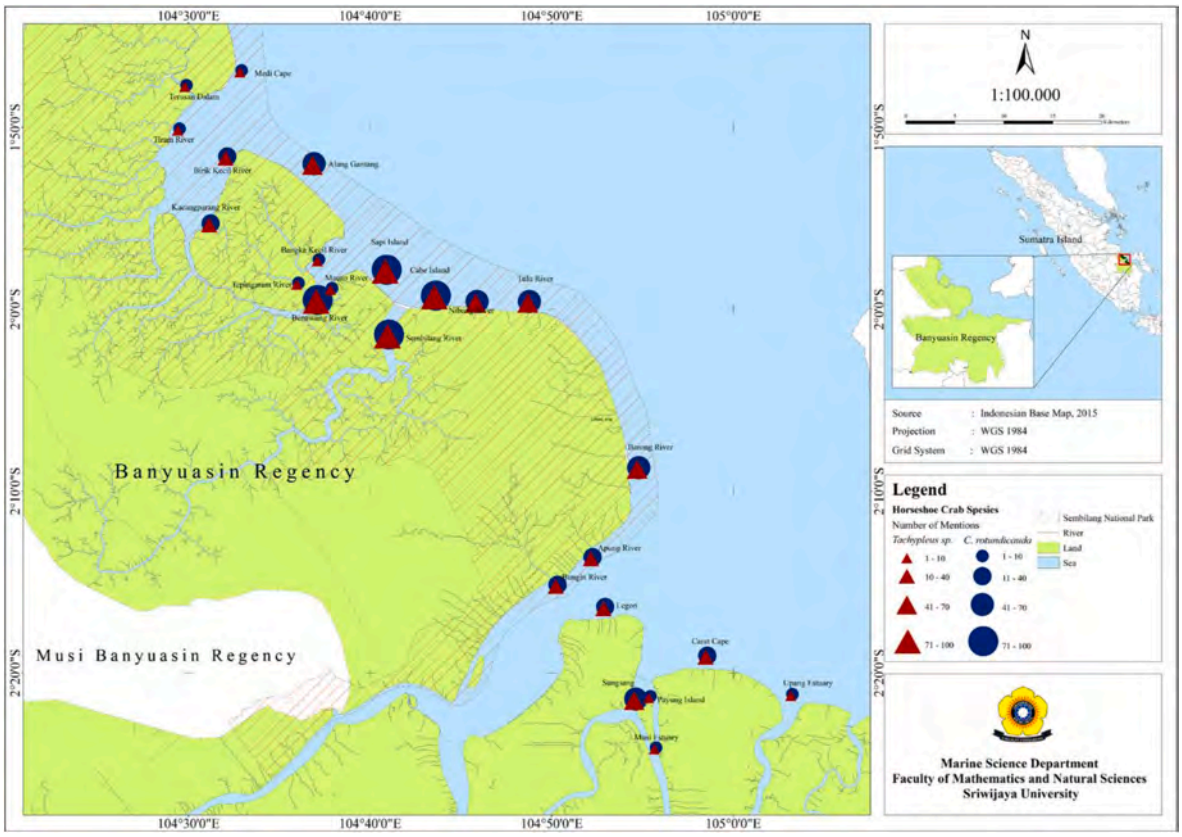

Fig. 5. The spatial distribution map of two horseshoe crabs according to local knowledge around the Banyuasin Peninsula, South Sumatra, Indonesia.

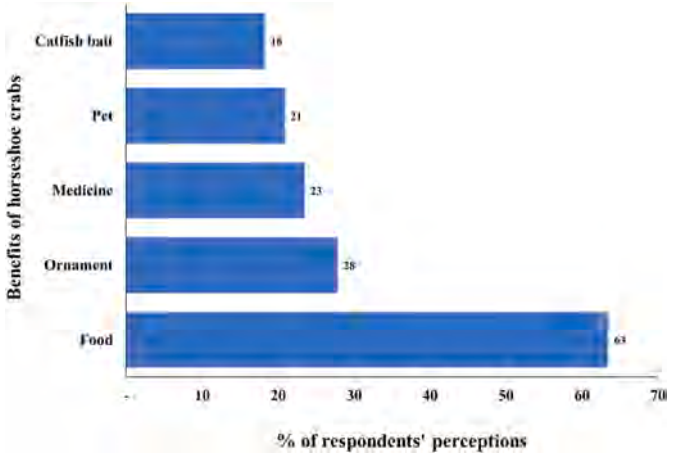

Fig. 6. The benefits of horseshoe crabs according to local knowledge around the Banyuasin Peninsula, South Sumatra, Indonesia.

numbers around the Banyuasin coastal waters, especially the Sembilang River area.

Information concerning locations where horseshoe crabs were found in the past but not found nowadays or otherwise is presented in Table 6. This table revealed the trend of declining horseshoe crabs population in several locations such as Sungsang, Payung Island, Upang Estuary, Bangka Kecil River, Sebalik River, and Tepingaram River. Meanwhile, an inclining horseshoe crabs population occurred in Lagon, Carat Cape, Tulu River, Bungin River, Sapi Island, Cabe Island, Barong River, Nibung River, Sembilang River, Alang Gantang, Apung River, and Musi Estuary. Historically, horseshoe crabs were not found in Benawang River, Kacangparang River, Birik Kecil River, Sarang Lang, Tanjung Medi, and Terusan Dalam. On the contrary, these crabs were currently found in those locations.

Table 6
The locations where horseshoe crabs were found in the past and nowadays according to respondents' perception.

No.	Locations	The existence of horseshoe crab		Change	
		Past	Nowadays	%	Trend
1	Sungsang	79	3	−96	decline
2	Legon	15	18	20	incline
3	Payung Island	14	6	−57	decline
4	Carat Cape	7	15	114	incline
5	Tulu River	5	11	120	incline
6	Bungin River	4	7	75	incline
7	Upang Estuary	4	3	−25	decline
8	Sapi Island	3	41	1267	incline
9	Bangka Kecil River	3	2	−33	decline
10	Cabe Island	2	34	1600	incline
11	Barong River	2	8	300	incline
12	Nibung River	2	8	300	incline
13	Sembilang River	1	58	5700	incline
14	Alang Gantang	1	12	1100	incline
15	Apung River	1	6	500	incline
16	Musi Estuary	1	2	100	incline
17	Sebalik River	1	0	−100	decline
18	Tepingaram River	1	0	−100	decline
19	Benawang River	0	32	∞	incline
20	Kacangparang River	0	17	∞	incline
21	Birik Kecil River	0	4	∞	incline
22	Sarang Lang	0	1	∞	incline
23	Tanjung Medi	0	1	∞	incline
24	Terusan Dalam	0	1	∞	incline

The surveyed respondents stated that many factors encouraged a decline in the horseshoe crab population (Table 7), such as being entangled in fishing nets (92%; n = 106), commercialized demand

Table 7
The factors encouraged a decline in the horseshoe crab population according to respondents' perception.

No	Factors	Opinions						The M-W test (p-value)
		Fishermen (72)		Non-Fishermen (43)		Overall (115)		
		N	%	N	%	N	%	
1	Entangled in fishing nets (Y_1)	64	89	42	98	106	92	0.091 ^{NS}
2	Commercialized demand (Y_2)	27	38	10	23	37	32	0.115 ^{NS}
3	Consumed demand (Y_3)	15	21	9	21	24	21	0.99 ^{NS}
4	Coastal Waste[a] (Y_4)	11	15	9	21	20	17	0.441 ^{NS}
5	Others (Y_5)	3	4	5	12	8	7	0.13 ^{NS}
	Overall (Y)		0.933^{NS}					

[a] a waste material (plastics, metal, glassware, rubber processed wood, paper, and cardboard) that is discarded and left in the coastal environment. Note: N = number, % = percentage, NS = No significant.

(32%, n = 37), consumed demand (21%; n = 24), coastal waste (17%; n = 20), and others (7%; n = 8). The non-parametric test results indicated that there was no significant difference (Mann-Whitney; $p = 0.933 > 0.05$) between fishermen's and non-fishermen opinions regarding overall factors causing the decline in the horseshoe crabs population. Crabs gillnet, trammel nets, and scope nets were fishing gears commonly capturing horseshoe crabs as bycatch.

Various opinions concerning the horseshoe crab's condition before being returned to the sea. Over half of the interviewees (66%; n = 76) claimed that all horseshoe crabs returned to the sea were alive. However, several respondents (33%; n = 38) stated that only a few crabs were returned alive, and a minority of the interviewees (5%; n = 6) stated all the crabs returned were not alive.

Regarding the commercialized demand issue (illegal market), the respondents stated that the selling price of horseshoe crabs varies depending on the size, which was approximately IDR 2000 for a small, IDR 15,000 for a medium, and IDR 25,000 for a large size. While the selling price of horseshoe crabs eggs was approximately IDR 70,000 per kilogram. Furthermore, those crabs were sold to the middlemen to be sent to other cities such as Bangka, Jambi, Medan, and Aceh. And then would be exporting to Malaysia, Thailand, and Japan.

Another threat also revealed that several local communities captured the female horseshoe crabs and consumed their eggs. Among the 115 respondents, 86 claimed that they had noticed people consumed horseshoe crabs and over half of the respondents (59%; n = 68) admitted that they had consumed them.

According to the respondent's knowledge, most of them (70%; n = 85) acknowledged that the Indonesian Government had established the horseshoe crabs as a protected animal. The respondent's knowledge concerning these protected animals was obtained from the Government's role in providing direct socialization to several fishermen respecting the prohibition of capturing these crabs. However, the interview results indicated that a few respondents (41%; n = 50) were aware of this socialization program. As a result, most of the respondents (70%; n = 85) were aware of the ban after several fishermen were arrested by the authorities for capturing and selling those crabs for export demand.

4. Discussion

This study covered 14 respondents from the Sembilang Hamlet, 14 respondents from Marga Sungsang Village, 22 respondents from Sungsang 1 Village, 29 respondents from Sungsang 2 Village, 17 respondents from Sungsang 3 Village and 24 respondents from Sungsang 4 Village. Selected respondents (122 respondents in total) were household representatives who have lived in the study sites and have knowledge of the horseshoe crab's existence. The sample locations only investigated 5 of the 7 coastal villages in the Banyuasin Peninsula with a 10% margin of error in determining the number of respondents. This might be one of the limitations of this study due to the respondents did not represent all coastal villages. Additionally, the local wisdom and beliefs have not been explored in more detail in the questionnaire. For further research, it would be better if the respondent could represent all coastal villages with a 5% margin of error and a confidence level of as low as 95%.

4.1. Sociodemographic characteristics and perceptions

This study revealed how local perceptions toward horseshoe crabs are associated with socio-demographic characteristics (Table 2 and Fig. 2). Their sociodemographic characteristics indicated that males were more represented than females, the majority of age groups aged over 39 years, mostly graduated from elementary school, and their works were mostly as a fisherman. Males, seniors, elementary school graduates, and occupations directly related to coastal resources generally, have a better perception regarding the general knowledge of horseshoe crabs. Education is closely associated with scientific logic when considering biological-ecological opinions (Pati et al., 2020). On the other hand, males, old age, and fishermen are sociodemographic characteristics that are closely correlated with their personalities, motivations, and experiences (internal factors), which ultimately affect their perception of horseshoe crabs. These findings are evidence regarding the importance of revealing sociodemographic characteristics when exploring local people's perceptions.

In general (Table 2), most respondents have at least a good perception of general knowledge, distribution, benefits, and threats. On the contrary, their perception included fair to very poor categories for the conservation action aspects. These results indicated that the sociodemographic characteristics of the respondents influenced their perceptions. These results were also evidenced by the PCA results (Fig. 2) which were the education, gender, occupation, and age attributes were correlated with the perceptions variables. These PCA results were relevant to study results on the Northeast Coast of India (Pati et al., 2020) that gender, age, and education are closely related to local people's perceptions of the threat of horseshoe crabs due to bycatch.

4.2. Local knowledge of species and distribution

By collecting local knowledge from coastal village communities, 20 potential habitats distributed along the Banyuasin peninsula were identified. Among the 20 locations, four locations were claimed to be commonly found horseshoe crabs namely the Sembilang River, Cabe Island, Benawang River, and Sapi Island (close to Sembilang National Park). Waters around Sungsang, Carat Cape, and Lagon (outside of Sembilang National Park) were potential habitats, although these crabs were found in smaller quantities. Their perception regarding the spatial distribution of horseshoe crabs is relevant to the investigations assessment conducted in the Banyuasin coastal waters in 2019 (Fauziyah et al., 2019a, 2019b, 2021). In the investigation's report, the main location distribution was found (Sembilang National Park, Makarti Jaya, and Carat Cape), carried out by following trammel net and bottom gillnet fishing with the target species of blue swimming crab. Therefore, their local knowledge described a broad range of spatial distribution compared to the results of the first investigation. Similar to the local knowledge from fishing communities in Beibu Gulf, China which revealed that potential nursery/spawning grounds for *T. tridentatus* and *C. rotundicauda* were distributed along these shores, and accordingly, this proved that local knowledge was useful and effective in identifying the distribution of potential habitats for these horseshoe crabs (Liao et al., 2019). This finding was also relevant to local knowledge from Bintan Island, which revealed the presence of horseshoe crab and its

distribution (Anggraini and Karlina, 2023).

Fauziyah et al. (2019a) reported two horseshoe crabs (*C. rotundicauda* and *T. gigas*) found in the Banyuasin estuarine based on their morphological characteristics, and these records were also relevant to this study results. According to DNA barcoding, *T. tridentatus* was also found in these waters (Fatimah et al., 2023). In this study, most respondents stated they easily recognized *C. rotundicauda* by their rounded telson and smooth (without spines), on the other hand, *Tachypleus* spp. were recognized by their triangular telson with tiny spines. This knowledge is similar to most respondents in Sulawesi, Kalimantan, Sumatra, and Java Island (Meilana and Fang, 2020). Accordingly, the results of this residents' perception-based study could be a starting point for a comprehensive survey in future scientific research, especially regarding the horseshoe crab's existence in the Banyuasin Peninsula.

Generally, *C. rotundicauda* prefers brackish and muddy habitats near mangroves (Meilana and Fang, 2020; Robert et al., 2014) whereas *T. gigas* prefers muddy to sandy habitats (Tan et al., 2012). The species of *T. gigas* can be discovered in the mangrove area by crossing the sandy beach nearby. Otherwise, *C. rotundicauda* can route to the muddy habitat by crossing the sandy beach (Jawahir et al., 2017). Co-occurrence in the same habitat for both species was also found in Singapore (Cartwright-Taylor et al., 2011), China (Chen et al., 2015), Peninsular Malaysia (Jawahir et al., 2017), and Hong Kong (Shin et al., 2009). According to local knowledge, horseshoe crabs are well-known species in the Banyuasin peninsula. However, respondents are not distinguishing between the two species of Tachypleus due to both species having a high similarity.

The temporal distribution for these crabs seems to be clearly revealed by locals. The horseshoe crabs were found chiefly during October–December (rainy season). The distribution pattern for the horseshoe crabs juvenile in East Kalimantan (Indonesia) occurred from August to October (Meilana et al., 2021). In the northern Beibu Gulf of China, the peak spawning for *C. rotundicauda* and *T. tridentatus* occurred from June to July (Yue et al., 2022). The occurrence of horseshoe crabs in shallow water was not affected by the season (Pati et al., 2020).

4.3. Perception of benefits, threats, and conservation actions

The people's perception from the Banyuasin peninsula clearly stated that the horseshoe crabs have been used by the local community as a food source, ornaments, and pets, as well as used as bait for capturing the White-lipped eel catfish. The tangible benefits of horseshoe crabs were also revealed by most respondents on the Northeast Coast of India (Pati et al., 2020). However, it is important to note that those various benefits possibly threaten the horseshoe crabs population. Therefore, most respondents believed that the horseshoe crabs are decreasing due to threats from overharvesting for commercialized use, bait for catfish, food, and waste in coastal waters. Commercialization attracts people to the exploitation of horseshoe crabs (Bolden et al., 2016; Pati et al., 2020). The fishermen's habit of returning discarded horseshoe crabs to unsuitable habitats impacted the horseshoe crab's survival (Meilana and Fang, 2020). Recent evidence suggests that these horseshoe crabs face serious threats such as overexploitation, habitat and spawning grounds degradation, environmental pollution, and biomedical bleeding practices (John et al., 2018).

Consistent with the threats faced by horseshoe crabs, the local knowledge pointed out the decline of these crabs in the Banyuasin peninsula. Declining in their populations was also revealed by the fishing community in Beibu Gulf, China (Liao et al., 2019). Scientific research on horseshoe crabs reported that their population was declining in Malaysia Waters (Halim et al., 2021), Hong Kong (John et al., 2021; Kwan et al., 2016), Japan (Shinji et al., 2022; Wada et al., 2016), Taiwan (Hsieh and Chen, 2015), and Vietnam (Laurie et al., 2019).

The study results highlighted no significant difference in opinions between fishermen and non-fishermen concerning the factors that encouraged declining the horseshoe crab in the Banyuasin peninsula. The fishermen's knowledge has spread widely to other community groups. In addition, this information extracted the interviewees' perceptions and the knowledge passed down from generation to generation (Franzini et al., 2013). Similarly, the fishermen's knowledge possibly has passed to the next generation (Pati et al., 2020).

The case of the horseshoe crabs entangled in the nets is a major issue for fishermen in the Banyuasin peninsula. A similar case also occurred on the Indian coast (Pati et al., 2020; Pramanik et al., 2021), the north coast of Singapore (Cartwright-Taylor et al., 2012), Peninsular Malaysia (Tan et al., 2011), and the Indonesian coast (Fauziyah et al., 2018; Meilana, 2015). Most local knowledge admitted that the horseshoe crabs had been established as a protected animal by the Indonesian Government. Thus, if these crabs were entangled in the nets, they would be returned to the sea alive. It's relevant to the claim of the Odia people that they do not harm horseshoe crabs, even though they were entangled in the fishing nets (Pati et al., 2020). Pati et al. (2020) also highlighted that the Odia community carefully removed the horseshoe crabs bycatch from the nets and released them into the sea. Horseshoe crabs are legally protected in Indonesia, India, Singapore, Bangladesh, Vietnam, and certain regions/provinces in mainland Japan and China (John et al., 2021). However, law enforcement is intricate and inconsistent (John et al., 2018).

For local fishermen, horseshoe crabs are not a target species but a discarded catch. In addition, the entangled horseshoe crabs in the nets are also considered to damage the fishing gear. Most fishermen cut their nets to return the entangled crabs due to the difficulty of disentangling them (Meilana and Fang, 2020). Unfortunately, few fishermen still capture the female horseshoe crabs, which lays eggs and are consumed by local people. Moreover, most respondents claimed to have consumed horseshoe crab. These findings are consistent with the previous study in China (Liao et al., 2019), and Indonesia (Anggraini and Karlina, 2023; John et al., 2018; Meilana and Fang, 2020), which reported that most people in the region consumed adult horseshoe crabs, despite these crabs being listed as Protected Aquatic Wildlife. Compared to Hong Kong, horseshoe crabs are not commonly consumed by local people but these crab dishes are only served in a few restaurants (John et al., 2018). In Viet Nam, horseshoe crabs are recognized as a legally exploitable resource, consumed by locals and supplied for market demand in China (Laurie et al., 2019).

Fortunately, most fishermen in the Banyuasin peninsula are aware of the prohibition on capturing these crabs. Although accidently fishing for these crabs can not be avoided, the local fishermen have conservation awareness concerning the sustainability of fishing practices for the horseshoe crabs species in this region. This is strong evidence regarding conservation awareness among local people in the study sites, especially regarding the released bycatch of the horseshoe crabs into the sea to avoid high mortality. However, local people should raise awareness of the urgency to protect horseshoe crabs and their breeding grounds. Additionally, an event of coastal waste cleaning can be a solution to safeguard horseshoe crabs along the Banyuasin coastal waters.

Overall, the local people's perception obtained in this survey has revealed essential lessons learned concerning the Spatio-temporal distribution, benefits, threats, and conservation actions including causes of the decrease in the horseshoe crabs population in the Banyuasin peninsula. These findings are a strength of this study which successfully extracts local people's perceptions toward the horseshoe crab species. In addition, public awareness was also revealed in this study.

This research was slightly different from the research on the Northeast Coast of India (Pati et al., 2020), where the Banyuasin people's beliefs toward horseshoe crabs have not been revealed. These study results were similar to the local knowledge in Sulawesi, Kalimantan, Sumatra, and Java Island (Meilana and Fang, 2020). Therefore, the novelty of this research resided in the first extracted people's perception regarding *C. rotundicauda* and *Tachypleus* spp. in the Banyuasin peninsula of South Sumatra (Indonesia) using the ethnographic approach as

illustrated.

The fisherman's knowledge was successfully used to identify the decrease in fish species over the years (Lima et al., 2016). In the last few years, the value of local environmental knowledge has been approved as a valuable ecological information source (Franzini et al., 2013). In addition, the LEK could be called the intellectual twin of science and should be realized as a stakeholder collaboration to manage better and protect the natural resources and environment (Kimmerer, 2002; Orario et al., 2021; Whyte, 2013). The local knowledge represented vital information to be considered for planning management strategies (Mani-Peres et al., 2016).

The findings of this study certainly have implications for developing horseshoe crab research in the future, as well as the design of better horseshoe crabs conservation strategies and action plans. Further research can be directed at mapping feeding, spawning, and breading areas to determine potential locations for horseshoe crabs conservation areas. Raising public awareness can be one of the strategic initiatives. Fishermen's awareness to reduce the horseshoe crab bycatch and ensure that the horseshoe crabs bycatch is returned to the sea alive and survived is urgently needed to address the serious threat to the horseshoe crabs population decline. In addition, supervision by the competent authorities regarding illegal activities (fishing and trading of horseshoe crabs) also needs to be improved.

5. Conclusion

This present study revealed that the experienced local people admittedly have significant local knowledge of the horseshoe crabs, especially regarding the distribution, benefits, threats, and conservation actions as well as the main factors that caused the decline in their populations. The waters of the Sembilang National Park, especially the Sembilang River, Cabe Island, Benawang River, and Sapi Island were the most distributed locations of horseshoe crabs according to local knowledge from the Basyuasin Peninsula. The horseshoe crabs were a well-known species in this area, although the local people were not distinguished between the two species of the Tachypleus genus. They claimed that these crabs were most found during the wet season. Various benefits, threats, and conservation actions of horseshoe crabs were also revealed in the study results. The main factor that threatened the decrease in the horseshoe crabs population was incidental entangled crabs in the nets. Nonetheless, this bycatch is returned to the sea alive to avoid high mortality. This local knowledge is expected to complement the lack of scientific information in protecting and conserving the horseshoe crabs for small-scale fisheries in this region.

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

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ocecoaman.2023.106597.

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