

Evaluation of the local ecological knowledge and conservation attitudes of fishermen toward blue swimming crab fisheries management

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Abstract. This study provides a comprehensive analysis of the local ecological knowledge (LEK) and attitudes of 245 crab fishermen in the Eastern Philippines, shedding light on their demographics and their perspectives on the conservation of the Philippine blue swimming crab (BSC), *Portunus pelagicus*. The findings suggest that the fishermen's LEK regarding the BSC is, on average, moderate, aligning with previous studies in different contexts. This demonstrates their understanding of the species' behavior and ecological aspects, which can contribute to more effective fishing strategies. The study highlights the moderate knowledge about existing rules and regulations concerning BSC conservation, with age, experience, income, and the types of fishing gear used influencing their understanding. This finding underscores the need for targeted education awareness campaigns to ensure compliance with conservation measures. Remarkably the fishermen displayed a positive attitude toward conserving the BSC, with none showing a negative attitude. This may stem from their recognition of BSC as a vital source of livelihood. The correlation between knowledge and conservation attitudes suggests that increasing awareness and knowledge can lead to more ecologically responsible behavior. Furthermore, the study reveals regional differences in LEK and conservation attitudes, reflecting the complex interplay of natural, social, and cultural factors in archipelagic island settings. This underscores the need for contextualized conservation strategies in such regions. In conclusion, this research emphasizes the importance of LEK and attitudes in the conservation of vital marine resources. It highlights the potential for targeted education and awareness programs to enhance understanding and promote more sustainable resource management practices among local fishermen.

Key Words: crab fishery, LEK, blue swimming crab, Philippines.

Introduction. The blue swimming crab (BSC), *Portunus pelagicus* (Crustacea: Decapoda: Brachyura: Portunidae), also known as the sand crab, is a species found in large numbers in shallow bays with sandy bottoms and widely distributed in coastal and estuarine waters of the Indo-West Pacific region (Stephenson 1962; Williams 1982; Kailola et al 1993). The male crabs are colored with blue markings, while the females are dull green. It is characterized by a rough to granulose carapace with regions discernible in the carapace; a front with 4 acutely triangular teeth; and 9 teeth on each anterolateral margin.

In the Philippines, BSC is one of the most important species of crustaceans found in major fishing grounds. This species is captured through a variety of artisanal fishing gears used in shallow areas such as gill nets, crab pots, crab lift nets, push nets, and trawl (Romero 2009; dela Cruz et al 2018; Mesa et al 2018). The crab fishery is a source of livelihood in the coastal areas of the countryside. It occupies a significant place in the fishing industry due to its high nutritive value, and good market price. It is among the well-traded marine commodities both for the local and international markets with high economic value that supports a multi-million dollar fishery industry (PSA 2020). In support of the conservation of the BSC for sustainable fisheries in the country, the Blue Swimming Crab Management Plan (BSCMP) was created in 2011 through the

collaboration of crab industry stakeholders and government agencies. In addition, a joint administrative order of the Department of Agriculture (DA) and the Department of Interior and Local Government (DILG) entitled "Regulation for the Conservation of Blue Swimming Crab (*Portunus pelagicus*)" was enacted in 2014. Despite the implementation of policies and regulations, studies on BCS stock assessment showed a decline in a catch over the years, while market demand for the products is consistently high and even increasing (de la Cruz et al 2015; Mesa et al 2018). It was also brought to light that resource management regulations are not effectively implemented, enforced, or followed. Moreover, ecological issues also pose serious threats needing management action. These issues include habitat degradation, growth, and recruitment overfishing, and the aggravating effects of climate change (Pauly & Zeller 2016; Yap et al 2017). The majority of the problems in the BSC industry can be accounted for by human activities. However, studies on the stakeholders' perception of the government's fishery regulations, attitudes toward cooperation with BSC fishery management, and level of BSC local ecological knowledge (LEK) are rather rare. Understanding these concepts for resource management is important since stakeholder engagement provides benefits to environmental management projects (Reed 2008; Sterling et al 2017).

Achieving sustainable resource utilization necessitates a comprehensive grasp of the interconnected aspects encompassing the economics of fisheries, the environment, and the community reliant on these resources (Mitchell et al 2007). This strategy was instigated to support the environmentalist agenda and incorporate the often neglected social dimension of sustainability (Elkington 1994; Anderson et al 2015). Even in certain ecosystem-based fisheries management approaches, this perspective tends to be overlooked (Hilborn 2011; Doyen et al 2012). Furthermore, this approach aligns with the current global shift in environmental resource management policies, emphasizing an imperative shift in paradigms to include a more explicit human perspective on the environment.

Studies in the social dimension are significant in filling the gaps for inclusive planning for resource use and management. Therefore, the main goal of this study was to evaluate the local ecological knowledge, conservation perception, and attitudes to obtain supportive data to help understand and recommend technical rules for the rational use and management of the Philippine BSC resource.

Material and Method

Description of the study sites. This study was conducted in four selected sites in the eastern Philippines (Figure 1): Ormoc City, Leyte; Catbalogan City, Samar; Guiuan, E. Samar; and Rapu-rapu, Albay. The survey was conducted from June 2022 to March 2023. The existence of crab stock and crab fishery is well known in these areas. The Bicol and Eastern Visayas regions are among the top producers of BSC in the country (PSA 2019, 2020; Yap et al 2020).

Ethical considerations. During the conduct of the study, it was ensured that the moral and legal rights of the respondent were protected. Before the research was conducted the survey instrument underwent a thorough review from the University of San Carlos - Ethics Committee for approval. The privacy of the respondents of this undertaking was not invaded without their formal consent. The purpose, relevance of the study, and the respondent's rights to join and withdraw from the study were thoroughly discussed. All information derived from this survey is confidential and anonymity of all respondents was taken into account. An "Informed Consent Form" was given to the interviewees, providing information about the study, the researcher, and the institution to which the researcher is affiliated.

Data collection. To evaluate the LEK and conservation attitude and perception concerning the BSC fisheries, 245 randomly chosen individuals from 670 registered fishermen were interviewed. Thirty-five (35) were from Guiuan, 99 from Catbalogan City, 33 from Rapu-rapu, and 78 from Ormoc City.

Individual interviews were conducted using structured interview guides with three main points adapted with modification from the study of Braga et al (2017) and DA-DILG JAO No. 1 series of 2014 (Regulation for the Conservation of Blue Swimming Crab; Supreme Court of the Philippines 2014). The parts of the survey questionnaire are (1) respondents' profile and fishing structure; (2) fishermen's LEK; (3) knowledge of the current policies and regulations; and (4) attitude towards conservation.

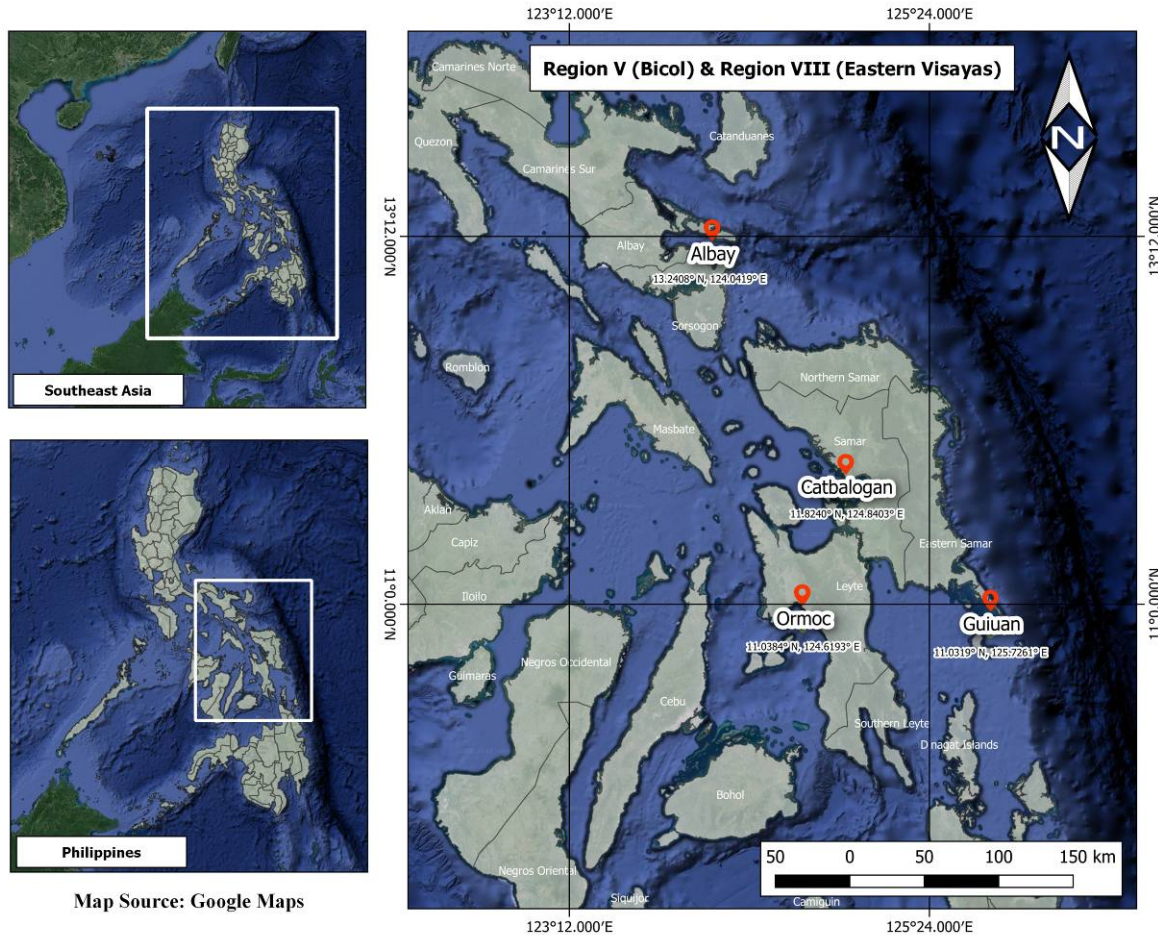


Figure 1. Map of study site.

Data analysis. Quantitative analysis was performed for the data on LEK and the attitude of fishermen towards BSC conservation. To analyze the level of LEK on the biology and fishery regulation of BSC a three-point Likert scale with values ranging between 0 and 1 was used (Likert 1932). Scientifically sound answers were scored with a value equal to 1, the partly correct answer will be 0.5 and incorrect or no response with 0. The five-point Likert scale was employed to measure the attitude towards conservation. LEK and the attitudes of interviewees were compared through additive indicators (Braga & Schiavetti 2013; Castilho et al 2013). Indicators were computed by dividing the maximum possible score by the summation of the individual score of each interviewee. After this, the LEK and attitude indicator for each site were computed from the average of all the individual values. The overall LEK indicators were classified into three categories (0-0.33 below average; 0.34-0.66 average; and 0.67-1 above average). Attitude on the other hand was categorized into negative (1.00-2.33), moderate (2.34-3.66), and positive (3.67-5.00).

Prior to testing for the relationships of variables Shapiro-Wilk procedure was used to test the normality of data. The correlation between LEK and attitudes to the respondents' profile and fishing structure was analyzed using Spearman's Rho, Rank-Biserial, and Contingency Coefficient C procedure. Comparison across study sites was tested using the Kruskal-Wallis test and Dunn's test for the post-hoc analysis. The R program version 4.0.2 was utilized in all statistical analyses.

Results

Fishermen's interview profile. Interviews were conducted with 245 crab fishermen in the three islands of the eastern Philippines, through a structured questionnaire. This sample represents approximately 36% of the total registered fishermen by the Local Agriculture Office. Respondents are classified as 92.59% male and 7.41% female. Their age ranges from 17 to 80, with a mean age of 46.140 (sd = 13.037). The respondents' years of fishing experience varied from 1 to 63, with a mean year of 20.987 (sd = 14.081). The educational attainment of the fishermen is 38.91% elementary level, 24.27% high school level, 20.92% elementary graduate, 8.79% high school graduate, 8.86% college level, and 1.26% college graduate. The minimum monthly income from crab fishing of both full-time and part-time fishermen ranges from \$4.32 to \$270.00, with an average of 71.33 (sd = 2,481.1, at 0.018 PhP to USD exchange rate). Among the interviewed respondent 67.22% are full-time and 32.78% are part-time and/or seasonal fishermen. The top three fishing gear used in crab fishing are entangling net (45.87%), crab lift net (28.10%), and gill net (15.29%). Other fishing gear and practices used are gleaning, sweeping nets, and crab pots.

LEK and attitude indices towards conservation of the Philippine blue swimming crab. The average LEK indicator for the BSC for the fishermen of the selected sites of Eastern Philippines was 0.480. The minimum indicator calculated was 0.091 and the maximum was 0.952. The LEK of the fishermen is categorized as average based on the computed knowledge indicator. Respondents from Albay have the highest LEK of 0.590 while Ormoc at 0.353 was the lowest. For overall all levels of ecological knowledge 79.18% scored average, 8.98% above average, and 11.84% below average when compared to scientific literature. Among the study sites, only Ormoc and Catbalogan respondents registered to have below-average ecological knowledge scores (Table 1). Regarding knowledge of policies and regulations of the BSC fisheries overall mean was 0.501, with a minimum of 0.036 and a maximum of 0.864. Based on the knowledge indicator obtained, crab fishers are considered moderately knowledgeable of the existing rules and regulations of the Philippine government on the conservation of BSC. A sum of 82.45% of the fishermen scored average, 10.61% below average, and 6.94% above average.

Table 1
Knowledge indices of crab fishers in selected sites of Eastern Philippines

Site	Mean	Max	Min	SD
<i>Ecological knowledge</i>				
Ormoc	0.353	0.700	0.100	0.161
Guiuan	0.500	0.700	0.400	0.065
Albay	0.590	0.830	0.430	0.100
Catbalogan	0.530	0.950	0.170	0.150
Overall	0.480	0.952	0.091	0.166
<i>Knowledge on policies and regulations</i>				
Ormoc	0.547	0.800	0.200	0.093
Guiuan	0.500	0.800	0.300	0.084
Albay	0.350	0.550	0.000	0.110
Catbalogan	0.520	0.860	0.180	0.130
Overall	0.501	0.864	0.036	0.129

Note: 0.00-0.33 below average; 0.34-0.66 average; 0.67-1.00 above average.

On the attitude towards conservation, the overall average indicator was 4.244. The minimum observed index was 3.100 and the maximum was 5.000 (SD = 0.492; Table 2). The attitude towards BSC conservation is positive. Among the study sites, Catbalogan registered to have the highest index at 4.604. None of the responses registered under negative classification, 8.57% were moderate and 91.43% had positive attitudes.

Table 2

Attitude index of crab fishers toward blue swimming crab management

<i>Site</i>	<i>Mean</i>	<i>Min</i>	<i>Max</i>	<i>SD</i>
Ormoc	3.897	3.100	5.000	0.374
Guiuan	4.172	3.600	5.000	0.272
Albay	4.066	3.889	4.800	0.206
Catbalogan	4.604	3.200	5.000	0.462
Overall	4.244	3.100	5.000	0.492

Range: 1.00-2.33 negative; 2.34-3.66 moderate; 3.76-5:00 positive.

LEK and attitudes: correlation and comparison analysis. The Spearman's Rho, Rank-Biserial, and Contingency Coefficient C correlations were utilized between the LEK, knowledge of policies, attitude indices, and demographic profiles of the respondents (age, years in fishing, educational attainment, and fishing gear used) as presented in Table 3. The index of LEK had a positive and significant correlation to both the index of conservation attitude and the type of fishing gear used. Fishermen with more correct knowledge of BSC tend to have a more positive attitude towards conservation and management.

The index of the knowledge on policies and regulation was positive and significantly correlated with the following demographic variables: fishermen's age, years in fishing, income, fishing status, and fishing gear used. Knowledge of BSC policies and regulations tends to be associated more with variables related to respondents' experience.

Attitude towards conservation and management was calculated to be positive and significantly correlated to local ecological knowledge. The result also showed a negative and significant correlation between educational attainment and the index of attitude toward the conservation and management of BSC. It can be said that more educated fishermen tend to have a negative attitude towards species conservation.

Table 3

Correlation analysis results between variables

<i>Variable</i>	<i>(1)</i>	<i>(2)</i>	<i>(3)</i>
(1) Ecological knowledge ^a	1.0000	0.0395	0.1545*
(2) Knowledge on policies and regulations ^a	0.0395	1.0000	0.0714
(3) Attitude towards conservation and management ^a	0.1545*	0.0714	1.0000
Sex ^b	-0.0630	0.0625	-0.0612
Age ^a	-0.0648	0.1888**	0.0550
Number of years in fishing ^a	0.0474	0.1437*	0.0212
Educational attainment ^a	0.0528	-0.0363	-0.1367*
Income ^a	0.0628	0.1859**	-0.2050
Status ^c	0.0659	0.2394**	0.0207
Fishing gear ^c	0.3212*	0.4228***	0.1511

a - correlation coefficient estimated using Spearman's Rho procedure; b - correlation coefficient estimated using Rank-Biserial procedure; c - correlation coefficient estimated using Contingency Coefficient C procedure; * significant at 5% level; ** significant at 1% level; *** significant at 0.1% level.

The Kruskal-Wallis test was made to compare the indices between sites. The result showed that there were significant differences in the average level of local ecological knowledge ($H(3) = 40.4590$; $p < 0.001$); knowledge of policies and regulations ($H(3) = 57.8920$; $p < 0.001$) and attitude towards conservation and management ($H(3) = 83.5610$; $p < 0.001$). To validate and understand the behavior of the comparisons Dunn's test for post-hoc analyses was conducted (Table 4). For local ecological knowledge and knowledge of policies and regulations, Catbalogan and Guiuan were statistically different from the rest of the test sites. On the fishermen's attitude towards conservation, all four crabbing locations are significantly different at a 5% level from one another.

Table 4

Comparison of indices across different crabbing sites of Eastern Philippines

Site	Mean	SD	Test statistic value	p-value
<i>Ecological knowledge</i>				
Albay	0.5939 ^a	0.0965	40.4590 ^{***}	< 0.001
Catbalogan	0.5251 ^b	0.1495		
Guiuan	0.5401 ^b	0.0668		
Ormoc	0.4444 ^c	0.1061		
<i>Knowledge on policies and regulations</i>				
Albay	0.3523 ^c	0.1118	57.8920 ^{***}	< 0.001
Catbalogan	0.5211 ^b	0.1276		
Guiuan	0.5013 ^b	0.0857		
Ormoc	0.5571 ^a	0.1050		
<i>Attitude toward conservation and management</i>				
Albay	4.0758 ^c	0.2077	83.5610 ^{***}	< 0.001
Catbalogan	4.6036 ^a	0.4641		
Guiuan	4.1898 ^b	0.2806		
Ormoc	3.8974 ^c	0.3769		

Note: Means with the same letter assignment are not statistically different at 5% level following Dunn's test procedure; *** significant at 0.1% level.

Discussion. The results are in accordance with the previous studies that implied that socio-demographic attributes like age, income, and experience among others influence the ecological knowledge, regulation, and attitudes of the communities towards conservation. The local ecological knowledge of fishermen in the fishing communities of the Eastern Philippines was average compared to the literature (Kangas 2000; Germano & Melgo 2003; Lai et al 2010; Yap et al 2020). This result corresponds to other studies showing a moderately positive comparison of fishermen's LEK to scientific literature. In Itanhaém River Estuary, São Paulo, Brazil, traditional knowledge of mangrove crab (*Ucides cordatus*) fishermen was confirmed in the literature (De Souza & Pinheiro 2021). European sardine (*Sardina pilchardus*) fishermen in Peniche Portugal and edible cockle (*Cerastoderma edule*) shellfishers in the Ria de Aveiro lagoon, Western Iberia also showed moderate LEK in comparison to related scientific findings (Braga et al 2017, 2022). Even in the higher ecological aspect fishers' LEK is comparable to scientific data, Silvano & Begossi (2012) reported that fishermen's LEK on habitat use and trophic interactions for the studied fishes conforms to the scientific literature.

The BSC is an open-source fishery that contributes significantly to local fisheries and comes with several fishing gear types operated mostly by marginal fishers of the community (De la Cruz et al 2015, 2018). The substantial informal knowledge found in the current work reveals that fishermen seek for better understanding of the biology and ecology of BSC. The result demonstrates a cumulative body of knowledge to better understand the species' behavioral pattern for more effective fishing strategies. The importance of this resource may have contributed to local fishermen's pursuit to better understand it through practical observation, regular interaction with the environment (Berkes et al 2000; Murray et al 2006), and horizontal transmission of information (Ruddle 1994) by more experienced crabbers.

The moderate level of knowledge of BSC regulations speaks of the fishermen's awareness of the existing resource management policies. However, a lack of in-depth understanding of the policies and their provisions was observed in the majority of the respondents. The result manifests weak information dissemination or ambiguity of management initiatives. The study of Thomas et al (2015) also suggests that the level of awareness of rules could be due to the complexity of the regulations, straightforward and common legislation that applies to general fishers tends to have a high level of understanding and compliance. The correlation of knowledge of policies and regulations with age, experience, income status, and fishing gear used is an indication that the older, the more experienced, and multiple gear users the better the understanding of the

resource management imposed by the government. It is observed that a diversified fishing portfolio leads to a more comprehensive understanding of the marine environment and its dynamics (Farr et al 2018) and appears to be more likely to follow fishery laws and recognize the value of the environment to the fishing resource (Musiello-Fernandes et al 2021). On the other hand, the positive correlation of age with knowledge of policies and regulations contradicts other studies where younger fishers were more knowledgeable and adaptive than their older counterparts (Marshall & Marshall 2007; Seara et al 2016).

The attitude indices on BSC conservation of all respondents showed a moderate to positive trend. This is in congruence with previous studies showing a positive attitude toward the conservation of different marine species like *Xiphopenaeus kroyeri* shrimp (Musiello-Fernandes et al 2021), Brazilian sardine, *Sardinella brasiliensis* (Braga et al 2018); cetaceans (Naylor & Parsons 2018); European sardine, *Sardina pilchardus* (Braga et al 2017); shark (O'Bryhim et al 2016; Neves et al 2021); and sea turtles (Reptilia: Testudines; Braga & Schiavetti 2013). The studies on terrestrial organisms, the elephant population in the Northern Congo (Nsonsi et al 2017), the primate species in Southwest China (Ellwanger et al 2015), and the wildlife in Southern Mozambique (de Boer & Baquete 1998) all exhibit a similar pattern.

Respondents view BSC fishing as an important source of livelihood and, hence, present a behavior that is supportive of the preservation of this fishery resource. The fishers' individual personal circumstances and ecosystem conditions like the declining biomass of marine resources according to Bernos et al (2021) influence fishing and conservation behavior providing motivation to improve ecological health. The positive correlation between knowledge and conservation attitude in the current study is consistent with Naylor & Parsons (2018) and Barney et al (2005) findings. With age and educational exposure, people's understanding rose and their likelihood of having an eco-friendly, ecoscientific opinion of resource conservation increased. Researchers believe that knowledge and attitude are closely related, and attitude is further linked to behavior (Flamm 2006). In this regard, Hoehn & Thapa (2009) and Tonin & Lucaroni (2017) found that knowing the variables influencing people's attitudes and behaviors in the exploitation of marine resources can help management approaches be more effective.

Archipelagic islands often have diverse natural resources (Primavera 2006) and archipelagic communities possess localized ecological knowledge (Huntington 2000). This localization of LEK and attitude towards conservation is evident in the current study where respondents of Albay (Luzon), Samar, and Leyte islands are statistically different from each other. As corroborated in the study of Steinmetz et al (2006), the cumulative accumulation and transmission of knowledge through generations produces spatial-temporal insights into the ecological role of intermittent processes important for biodiversity conservation (Baker & Constant 2020). The effects of the archipelagic island system on LEK and conservation attitudes are complex and multifaceted, shaped by a combination of natural, social, and cultural factors reflective of the local conditions (Savaresi & Chiarolla 2016). Hence, research and conservation efforts in archipelagic regions such as the current study area should consider these factors to develop effective and context-specific sustainable environmental management and protection strategies.

Conclusions. The findings from this study align with previous researches that emphasizes the significant influence of socio-demographic factors, such as age, income, and experience, on ecological knowledge, regulations, and attitudes toward conservation within the fishing communities. It is evident that local ecological knowledge (LEK) of the fishermen in the Eastern Philippines is relatively average when compared to existing scientific literature, indicating a moderate understanding of the blue swimming crab (BSC) and its ecological dynamics. These findings are consistent with studies in various global contexts, further emphasizing the value of their experience and insights in resource management. The positive factors between knowledge and conservation attitudes underscore the interconnectedness of these factors, suggesting that better understanding leads to more eco-friendly and conservation-minded behavior. The differences observed across islands within the archipelagic system highlight the complex

and multifaceted nature of the relationship between knowledge and attitudes towards conservation, shaped by both natural and sociocultural factors, highlighting the need for context-specific conservation and management strategies in archipelagic regions like the Eastern Philippines.

Acknowledgements. The authors are grateful to the crab fishers of Albay, Samar, and Leyte for their participation. Big thanks to LGU-Ormoc Fisheries Section, SSU-EVCCRD, staff of SSU-CFARRD, and Ms Ana Marie Magallanes of BFAR-Guiaun for their assistance during fieldwork and data gathering. This study was partly funded by the Philippine Commission on Higher Education K-12 Transition Program and Samar State University.

Conflict of interest. The authors declare that there is no conflict of interest.

References

- Anderson J., Anderson C., Chu J., Meredith J., Asche F., Sylvia G., Smith M., Anggraeni D., Arthur R., Guttormsen A., McCluney J., Ward T., Akpalu W., Eggert H., Flores J., Freeman M., Holland D., Knapp G., Kobayashi M., Larkin S., MacLauchlin K., Schnier K., Soboil M., Tvetaras S., Uchida H., Valderrama D., 2015 The fishery performance indicators: a management tool for triple bottom line outcomes. *PLoS ONE* 10(5): e0122809.
- Baker S., Constant N. L., 2020 Epistemic justice and the integration of local ecological knowledge for marine conservation: lessons from the Seychelles. *Marine Policy* 117: 103921.
- Barney E. C., Mintzes J. J., Yen C. F., 2005 Assessing knowledge, attitudes and behavior toward charismatic megafauna: the case of dolphins. *Journal of Environmental Education* 36(2):41-55.
- Berkes F., Colding J., Folke C., 2000 Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* 10(5):1251-1262.
- Bernos T. A., Travouck C., Ramasinoro N., Fraser D. J., Mathevon B., 2021 What can be learned from fishers' perceptions for fishery management planning? Case study insights from Sainte-Marie, Madagascar. *PLoS ONE* 16(11):e0259792.
- Braga H. O., Schiavetti A., 2013 Attitudes and local ecological knowledge of experts fishermen in relation to conservation and bycatch of sea turtles (Reptilia: Testudines), Southern Bahia, Brazil. *Journal of Ethnobiology and Ethnomedicine* 9: 15.
- Braga H. O., Azeiteiro U. M., Oliveira H. M. F., Pardal M. A., 2017 Evaluating fishermen's conservation attitudes and local ecological knowledge of the European sardine (*Sardina pilchardus*), Peniche, Portugal. *Journal of Ethnobiology and Ethnomedicine* 13:25.
- Braga H. O., Azeiteiro U. M., Oliveira H. M. F., Pardal M. A., 2018 Conserving Brazilian sardine: fisher's attitudes and knowledge in the marine extractive reserve of Arraial do Cabo, Rio de Janeiro State, Brazil. *Fisheries Research* 204:402-411.
- Braga H. O., Azeiteiro U. M., Magalhães L., 2022 A case study of local ecological knowledge of shellfishers about edible cockle (*Cerastoderma edule*) in the Ria de Aveiro lagoon, Western Iberia. *Journal of Ethnobiology and Ethnomedicine* 18:11.
- Castilho L. C., Martinez R. A., Giné G. A., Ribeiro G. C., Schiavetti A., 2013 The thin-spined porcupine, *Chaetomys subspinosus* (Rodentia: Erethizontidae), within protected areas in the Atlantic Forest, Brazil: local knowledge and threats. *Tropical Conservation Science* 6(6):796-810.
- De Boer W. F., Baquete D. S., 1998 Natural resource use, crop damage and attitudes of rural people in the vicinity of the Maputo Elephant Reserve, Mozambique. *Environmental Conservation* 25(3):208-218.
- De la Cruz M. T., De la Cruz J. O., Tan I. L., Ruizo E. K. C., 2015 The blue swimming crab (*Portunus pelagicus*) fishery of Eastern Visayas, Philippines. *Philippines Journal of Natural Science* 20(1):25-45.

- De la Cruz M. T., De la Cruz J. O., Ruizo E. K. C., Tan I. L., 2018 The blue swimming crab fishers and fishing practices in Leyte and Samar, Philippines. *The Philippine Journal of Fisheries* 25(2):1-15.
- De Souza F. V. B., Pinheiro M. A. A., 2021 Local ecological knowledge (LEK) on the mangrove crab *Ucides cordatus* (Linnaeus, 1763): fishery profile of mangrove areas in Itanhaém (Southeast Brazil). *Ethnoscintia* 6(3):15-42.
- Doyen L., Thébaud O., Béné C., Martinet V., Gourguet S., Bertignac M., Fifas S., Blanchard F., 2012 A stochastic viability approach to ecosystem-based fisheries management. *Ecological Economics* 75:32-42.
- Elkington J., 1994 Towards the sustainable corporation: win-win-win business strategies for sustainable development. *California Management Review* 36(2):90-100.
- Ellwanger A. L., Riley E. P., Niu K., Tan C. L., 2015 Local people's knowledge and attitudes matter for the future conservation of the endangered Guizhou snub-nosed monkey (*Rhinopithecus brelichi*) in Fanjingshan National Nature Reserve, China. *International Journal of Primatology* 36(1):33-54.
- Farr E. R., Stoll J. S., Beitzl C. M., 2018 Effects of fisheries management on local ecological knowledge. *Ecology and Society* 23(3):15.
- Flamm B. J., 2006 Environmental knowledge, environmental attitudes, and vehicle ownership and use. Dissertation, University of California, Berkeley, 197 pp.
- Germano B. P., Melgo J. L. F., 2003 Population, reproductive and fishery biology of the blue crab, *Portunus pelagicus*, in Leyte and Samar and management implications. *UPV Journal of Natural Sciences* 8:63-82.
- Hilborn R., 2011 Future directions in ecosystem based fisheries management: a personal perspective. *Fisheries Research* 108(2-3):235-239.
- Hoehn S., Thapa B., 2009 Attitudes and perceptions of indigenous fishermen towards marine resource management in Kuna Yala, Panama. *International Journal of Sustainable Development and World Ecology* 16(6):427-437.
- Huntington H. P., 2000 Using traditional ecological knowledge in science: methods and applications. *Ecological Applications* 10(5):1270-1274.
- Kailola P. J., Williamson M. J., Stewart P. C., Reichelt R. E., McNee A., Grieve C., 1993 Australian fisheries resources. Bureau of Resource Sciences, Canberra, 422 pp.
- Kangas M. I., 2000 Synopsis of the biology and exploitation of the blue swimmer crab, *Portunus pelagicus* Linnaeus, in Western Australia. Fisheries Research Report No. 121, Fisheries Research Division, WA Marine Research Laboratories, Australia, 22 pp.
- Lai J. C. Y., Ng P. K. L., Davie P. J. F., 2010 A revision of the *Portunus pelagicus* (Linnaeus, 1758) species complex (Crustacea: Brachyura: Portunidae), with the recognition of four species. *The Raffles Bulletin of Zoology* 58(2):199-237.
- Likert R., 1932 A technique for the measurement of attitudes. *Archives of Psychology* 22(140):55.
- Marshall N., Marshall P., 2007 Conceptualizing and operationalizing social resilience within commercial fisheries in northern Australia. *Ecology and Society* 12(1):1.
- Mesa S. V., Bayate D. E. E., Guanaco M. R., 2018 Blue swimming crab stock assessment in the Western Visayan Sea. *The Philippine Journal of Fisheries* 25(1):77-94.
- Mitchell M., Curtis A., Davidson P., 2007 Can the "triple bottom line" concept help organizations respond to sustainability issues? Proceedings in 5th Australian Stream Management Conference, pp. 271-275.
- Murray G., Neis B., Johnsen J. P., 2006 Lessons learned from reconstructing interactions between local ecological knowledge, fisheries science, and fisheries management in the commercial fisheries of Newfoundland and Labrador, Canada. *Human Ecology* 34:549-571.
- Musiello-Fernandes J., Zappes C. A., Braga H. O., Hostim-Silva M., 2021 Artisanal fishers' local ecological knowledge and attitudes toward conservation about the shrimp (*Xiphopenaeus kroyeri*) on the Brazilian central coast. *Anais de Academia Brasileira Ciências* 93:e20191047.

- Naylor W., Parsons E. C. M., 2018 An online survey of public knowledge, attitudes, and perceptions toward whales and dolphins, and their conservation. *Frontiers in Marine Science* 5:153.
- Neves J., Giger J. C., Piçarra N., Alves V., Almeida J., 2021 Social representations of sharks, perceived communality, and attitudinal and behavioral tendencies towards their conservation: an exploratory sequential mixed approach. *Marine Policy* 132: 104660.
- Nsonsi F., Heymans J. C., Diamouangana J., Breuer T., 2017 Attitudes towards forest elephant conservation around a protected area in northern Congo. *Conservation and Society* 15(1):59-73.
- O'Bryhim J. R., Parsons E. C. M., Gilmore M. P., Lance S. L., 2016 Evaluating support for shark conservation among artisanal fishing communities in Costa Rica. *Marine Policy* 71:1-9.
- Pauly D., Zeller D., 2016 Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining. *Nature Communications* 7:10244.
- Philippine Statistical Authority (PSA), 2019 Per capita: gross national income, gross domestic product and household final consumption expenditure. Available at: <http://psa.gov.ph/nap-press-release/sector3/Per%20Capita%20GNI>. Accessed: April, 2018.
- Philippine Statistical Authority (PSA), 2020 Fisheries situation report for January to December 2020. Available at: <https://psa.gov.ph/sites/default/files/Fisheries%20Situation%20Report%2C%20January%20to%20December%202020>. Accessed: February, 2023.
- Primavera J. H., 2006 Overcoming the impacts of aquaculture on the coastal zone. *Ocean and Coastal Management* 49:531-545.
- Reed M. S., 2008 Stakeholder participation for environmental management: a literature review. *Biological Conservation* 141(10):2417-2431.
- Romero F. G., 2009 Population structure of the blue crabs, *Portunus pelagicus* (L.) in the Visayan Sea: implications to fisheries management. PhD dissertation, University of the Philippines, Diliman, Philippines.
- Ruddle K., 1994 Local knowledge in the folk management of fisheries and coastal marine environments. In: *Folk management in the world's fisheries: lessons for modern fisheries management*. Dyer C. L., McGoodwin J. R. (eds), University Press of Colorado, Niwot, CO, pp. 161-206.
- Savaresi A., Chiarolla C., 2016 Indigenous challenges under the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) – embracing indigenous knowledge and beyond. *The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES): Meeting the Challenge of Biodiversity Conservation and Governance*, Routledge, 28 pp.
- Seara T., Clay P. M., Colburn L. L., 2016 Perceived adaptive capacity and natural disasters: a fisheries case study. *Global Environmental Change* 38:49-57.
- Silvano R. A. M., Begossi A., 2012 Fishermen's local ecological knowledge on Southeastern Brazilian coastal fishes: contributions to research, conservation, and management. *Neotropical Ichthyology* 10(1):133-147.
- Steinmetz R., Chutipong W., Seaturien N., 2006 Collaborating to conserve large mammals in Southeast Asia. *Conservation Biology* 20(5):1391-1401.
- Stephenson W., 1962 Evolution and ecology of portunid crabs, with special reference to Australian species. In: *The evolution of living organisms*. Leeper G. W (ed), Melbourne University Press, Melbourne, pp. 311-327.
- Sterling E. J., Betley E., Sigouin A., Gomez A., Toomey A., Cullman G., Malone C., Pekor A., Arengo F., Blair M., Filardi C., Landrigan K., Porzecanski A. L., 2017 Assessing the evidence for stakeholder engagement in biodiversity conservation. *Biological Conservation* 209:159-171.
- Supreme Court of the Philippines, 2014 BFAR Joint DA-DILG Administrative Order No. 01, S. 2014 - Regulation for the Conservation Of Blue Swimming Crab (*Portunus Pelagicus*) - Supreme Court E-Library (judiciary.gov.ph). Available at: <https://elibrary.judiciary.gov.ph/thebookshelf/showdocs/10/71729>.

- Thomas A. S., Milfont T. L., Gavin M. C., 2015 What determines fishers' knowledge of and attitudes towards regulations? A case study from the Marlborough Sounds, New Zealand. *Marine Policy* 51:547-554.
- Tonin S., Lucaroni G., 2017 Understanding social knowledge, attitudes and perceptions towards marine biodiversity: the case of tegnùe in Italy. *Ocean and Coastal Management* 140:68-78.
- Williams M. J., 1982 Natural food and feeding in the commercial sand crab *Portunus pelagicus* Linnaeus, 1766 (Crustacea: Decapoda: Portunidae) in Moreton Bay, Queensland. *Journal of Experimental Marine Biology and Ecology* 59(2-3):165-176.
- Yap E. E., Mesa S., Napata R., Ledesma A. B., 2020 The Philippines' blue swimming crab (*Portunus pelagicus*) fishery root cause analysis report. United Nations Development Programme and Bureau of Fisheries and Aquatic Resources, Philippines, 49 pp.

Received: 15 November 2023. Accepted: 10 December 2023. Published online: 08 January 2024.

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How to cite this article:

Balindo D. S. A., Otadoy J. B., 2024 Evaluation of the local ecological knowledge and conservation attitudes of fishermen toward blue swimming crab fisheries management . *AAFL Bioflux* 17(1):30-40.