International Journal of Agricultural Technology 2022Vol. 18(6):2523-2534
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Species diversity and population structure of fishes in the Khanom Estuary, Nakhon Si Thammarat Province, Southern of Thailand

Petsut, N.[1*], Petsut, J.[1] and Kulabtong S.[2,3]

[1]Department of Agricultural Technology, Faculty of Science, Ramkhamhaeng University, Bangkok, Thailand; [2]Faculty of Agro-Industrial Technology, Rajamangala University of Technology Tawan-ok Chanthaburi Campus, Khao Khitchakut, Chanthaburi, Thailand; [3]Save Wildlife Thailand Society, Thanyaburi, Pathum Thani Province, Thailand.

Petsut, N., Petsut, J. and Kulabtong, S. (2022). Species diversity and population structure of fishes in the Khanom Estuary, Nakhon Si Thammarat Province, Southern of Thailand. International Journal of Agricultural Technology 18(6):2523-2534.

Abstract The research finding was investigated the species diversity and population structure of fishes in the Khanom Estuary, Khanom District, Nakhon Si Thammarat Province carried out in November 2016 (the northeast monsoon) and July 2017 (the southwest monsoon) at ten sampling stations. The fish specimens were collected using beach seine and dip-net. A total of 1,406 individuals representing 37 species from 27 families were found. The most dominant family was Gobiidae [5 species (13.5%)], e.g., *Acentrogobius viridipunctatus*, *Acentrogobius caninus*, *Glossogobius* sp., *Brachygobius doriae* and *Gobiopterus chuno* followed by Ambassidae with three species (8.1%) and other families with one or two species each. *Ambassis kopsii* and *Gerres filamentosus* were mostly distributed in the study area. They were found in brackish water canal ecosystems, estuary ecosystems, and the coastal marine ecosystem. The population structure corrected in November 2016 revealed that the average abundance of the fish population was between 0.43–1.34 individuals/m^2 and in July 2017, the average abundance of the fish population was between 0.87–3.76 individuals/m^2. The highest average fish product in the southwest monsoon season (July 2017) was about 3.46 Kilograms/Rai. The data of diversity, evenness and dominance indices of fish specimens showed that the fish specimens in the collecting sites that showed low to medium diversity (H′; 0.73–1.73). The distribution of fish specimens in the northeast monsoon and the southwest monsoon seasons was not even, and some fish specimens were more dominant than the other specimens in each collecting sites.

Keywords: Diversity, Population structure, Khanom Estuary, Nakhon Si Thammarat Province

Introduction

Khanom is a small district located in the northern region of the province of Nakhon Si Thammarat in Thailand. The city is positioned about 100 kilometers away from Mueang District, with an area of 358.39 square kilometers. There are areas on the north and east adjacent to the Gulf of

[*] **Corresponding Author:** Petsut, N.; **Email:** nidsaraporn@rumail.ru.ac.th

Thailand. Moreover, the area to the west is a reserved area and a conservation area for natural resources and watershed forests. There is also Bang-Mod Canal that connects the marine ecosystem and the swamp ecosystem (Khanom District Office, 2019). The western area of Khanom District is in contact with Don Sak District, the province of Surat Thani and the southern area is contact with Sichon District in Nakhon Sri Thammarat. The topography of Khanom District is different: the eastern coastal plain area is in Khanom Subdistrict, the central plains area is in Khuan Thong Subdistrict. The area to the west of the hill slope is in Khuan Thong Subdistrict, and the mountain area spans from north to south, west, and northeast (Cheablam, 2010). The majority of the population in Khanom works in agriculture, with the next most common work being fisheries and general employment.

Since Khanom district is an area adjacent to the sea, it results in many marine attractions. It is also an area that has resource availability for tourism, and tourists also want to travel for relaxation and to experience the natural attractions. Khanom has been a popular tourist destination since 2002, with popular tourist attractions from eco-tourists in the Khanom Estuary (Cheablam, 2010). It is an area surrounded by two massive mountains with Khanom Canal along the edge of the hill on the southern side. This area is the location of Khanom Power Plant and Khanom Gas Separation Plant. Also nearby is the location of resorts and local shops. Consequently, there is an imbalance in the use of natural resources for economic activities. The problem effects changes in economic activities of the area that are more tourism focused (Tantiwat, 2011). The effects change natural resources in the area, especially the resources in the Khanom Estuary area and aquatic animals. These resources are affected by the activities, especially fishing resources.

Fishing resources are an essential resource because it is an important income for local fisheries and the economy. However, the environment, ecology of the water source, and the use of the area has changed, resulting in many types of fishery resources being changed, reduced, or lost from the water source. Continuous surveying and data preparation of aquatic animal resources are essential and important. Prominently, fish resources are essential for economic activity in primary water sources such as Khanom Estuary. Therefore, the study investigated species diversity and the population structure of fish in the Khanom Estuary, Khanom District, Nakhon Si Thammarat province.

Materials and methods

Study area

The observation of fish diversity was carried out at the Khanom Estuary. Data were collected at 10 different stations and were arranged at five interval distances away from estuary. The first interval distance, ST1a, and ST1b, was categorized by a one-kilometer radius away from Khanom Estuary. Both sites are partially a part of the Gulf of Thailand and not far from Khanom Power Plant and Khanom Gas Separation Plant. The solid substrate of ST1a (9 ° 14.178'N, 99 ° 51.910'E) is estuary whereas ST1b (9 ° 14.456'N, 99 ° 51.847'E) represents the sand beach area with a dune. The second interval distance, ST2a (9 ° 13.935'N, 99 ° 51.616'E) and ST2b (9 ° 13.848'N, 99 ° 51.565'E), was categorized by a two-kilometer radius away from Khanom Estuary. These sites are in a brackish water canal and are located on the upper zone of a mangrove forest, which is always influenced by the tide. The third interval distance, ST3a and ST3b, was categorized by a three-kilometer radius away from Khanom Estuary. Both sites are situated at 9 ° 13.066'N, 99 ° 51.924'E and 9 ° 13.035'N, 99 ° 51.736'E respectively. Their areas are a small brackish water canal and in a mangrove forest. Also, there are fishery communities. The fourth interval distance, ST4a (9 ° 12.751'N, 99 ° 51.699'E) and ST4b (9 ° 12.547'N, 99 ° 51.909'E), was categorized by a four-kilometer radius away from Khanom Estuary. Sites are on a small brackish water canal and a mangrove forest. The fifth interval distance, ST5a and ST5b, was categorized by a five-kilometer radius away from Khanom Estuary. ST5a (9 ° 12.832'N, 99 ° 49.860'E) is on a small brackish water canal and a mangrove forest. ST5b (9 ° 16.934'N, 99 ° 50.608'E) is in a sandy habitat with dunes of the Gulf of Thailand, which is frequently influenced by the tide.

Sample collection and laboratory analysis

The fish specimens were collected in November 2016 (the northeast monsoon) and July 2017 (the southwest monsoon) at ten sampling stations in Khanom Estuary (ST1a-ST5b), using beach seines with a mesh size of 1 ×1 mm, 10 m width and 1.2 m depth. Fish samples were preserved in 10 percent formalin-freshwater solution and were preserved after that for 7 days using 75 percent ethyl alcohol as permanent preservation for identification in the laboratory. The species was identified following Smith (1945); Rainboth and Kottelat (1987); Kottelat *et al*. (1993); Rainboth (1996); Doi (1997); Kottelat (2001) and Liao *et al*. (2010). After identification of all species, the number of specimens of each species were calculated, as well as each collecting site and each collecting time to explain the distribution of fish in these areas. The community structure of fish specimens in study areas was analyzed by five ecological indexes as follows: average density (individual/m^2), average fish product (Kilograms/Rai; 1,600 m^2), diversity index (Washington, 1984),

evenness index (Clarke and Warwick, 1994), and dominance index (Clarke and Warwick, 1994).

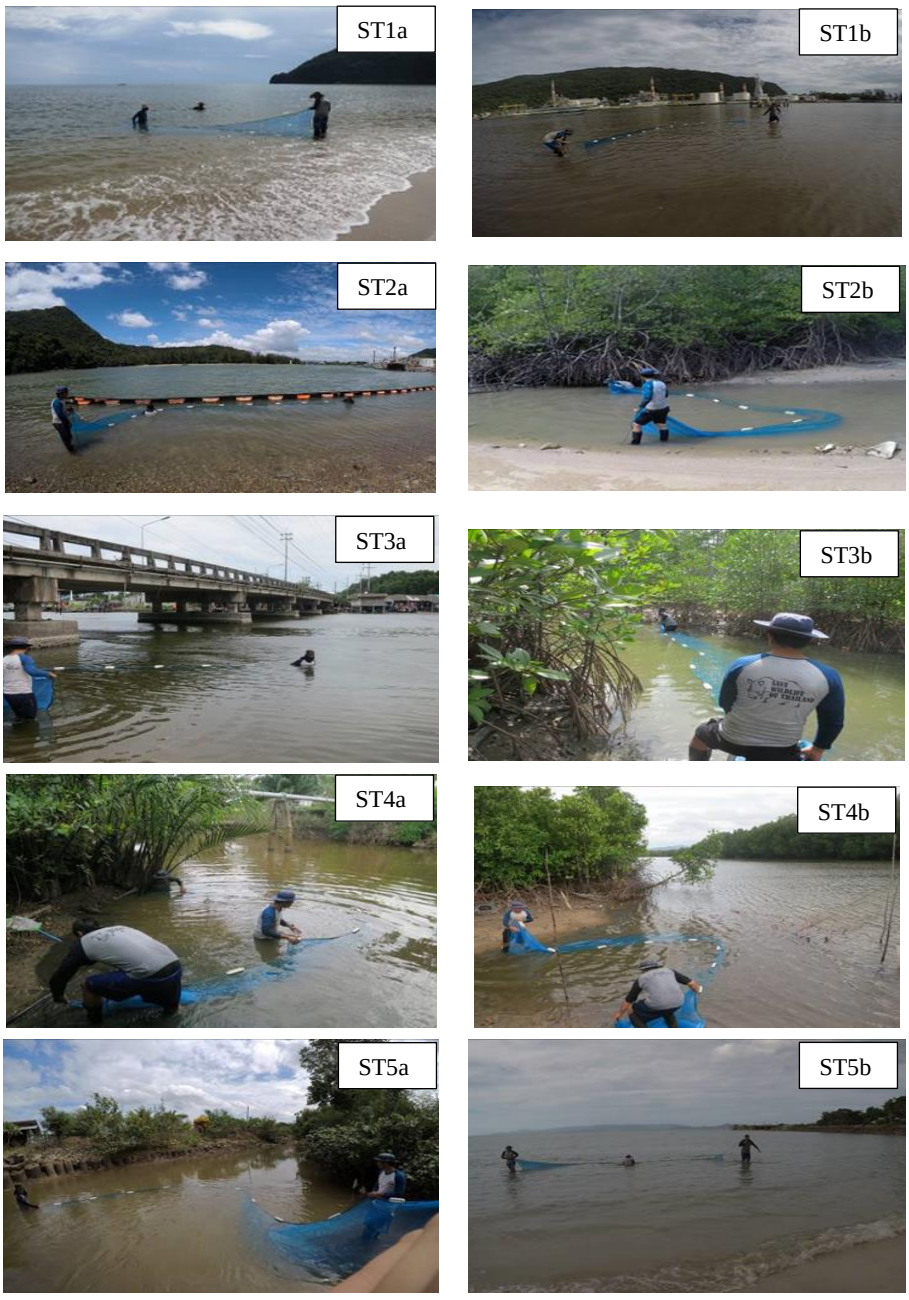

Figure 1. Cllecting sites in Khanom District, Nakhon Si Thammart Province

Results

Species diversity and distribution

A total of 37 species belonging to 27 families of species were found during survey. Most of these species were found to be ecologically euryhaline and generally representatives of mangrove areas, estuarine and coastal marine habitats. The most dominant family was Gobiidae [5 species (13.5%)], e.g., *Acentrogobius viridipunctatus, Acentrogobius caninus, Glossogobius* sp., *Brachygobius doriae* and *Gobiopterus chuno*. The minor dominant species was Ambassidae with three species (8.1%), e.g, *Ambassis kopsii*, *Ambassis vachellii* and *Parambassis siamensis*. For other families, namely Clupeidae, Engraulidae, Cyprinidae, Atherinidae, Hemiramphidae, Belonidae, Phallostethidae, Adrianichthyidae, Syngnathidae, Scatophagidae, Holocentridae, Sillaginidae, Siganidae, Gerreidae, Terapontidae, Lutjanidae, Leiognathidae, Mugilidae, Cichlidae, Scorpaenidae, Platycephalidae, Osphronemidae, Blenniidae, Eleotridae and Tetraodontidae only 1or 2species were identified.

Community structure of fish specimens in study areas

Resukt showed in November 2016 (the northeast monsoon) (Table 2), 7–15 species of fish specimens were found in each collecting site. In the collecting site which was a 5 kilometer radius away from Khanom Estuary, the highest number of species of fish specimens were found, with a total of 15 species. It was inferior to the collecting site with 2 kilometer radius away from Khanom Estuary, where 13 species were found, and lastly collecting sites were 1 and 3 kilometer radiuses away from Khanom Estuary, where 7 species were found to be the lowest species number of fish specimens in this area. The collecting site of 2 kilometer radius away from Khanom Estuary had the highest average fish product (1.9 Kilograms/Rai) and the highest average density was found at the collecting site of 1 kilometer radius away from Khanom Estuary (1.34 individuals/m^2).

The data of diversity index, evenness index and dominance index of fish specimens are shown in Table 2. The diversity of fish specimens in all collecting sites was low to medium (H′; 0.73–1.52). The collecting site of 2 kilometer radius away from Khanom Estuary had the highest diversity index (H′=1.52). The evenness indexes of fish specimens in all collecting sites were low (0.21–0.51) but the dominance index of fish specimens in all collecting sites was quite high (0.49–0.79).

Table 1. Fishes species distribution in the Khanom Estuary, Khanom District, Nakhon Si Thammarat Province, Southern of Thailand

Family	Scientific name	Study areas										Frequency	Percentage (%)
		1a	1b	2a	2b	3a	3b	4a	4b	5a	5b		
Clupeidae	*Sardinella gibbosa*	X	X									17	1.209
Engraulidae	*Stolephorus commersonnii*	X	X									26	1.849
Cyprinidae	*Osteochilus hasselti*							X				1	0.071
Atherinidae	*Atherinomorus lacunosus*				X		X		X	X		30	2.134
Hemiramphidae	*Hyporhamphus limbatus*	X				X	X		X	X	X	34	2.418
	Dermogenys siamensis							X				7	0.498
Belonidae	*Strongylura leiura*	X		X	X							17	1.209
Phallostethidae	*Neostethus lankesteri*						X	X	X	X		165	11.74
Adrianichthyidae	*Oryzias javanicus*							X				1	0.071
Syngnathidae	*Ichthyocampus carce*					X					X	2	0.142
Scatophagidae	*Scatophagus argus*								X		X	2	0.142
Holocentridae	*Sargocentron rubrum*			X	X							3	0.213
Sillaginidae	*Sillago sihama*	X	X	X	X				X	X		321	22.83
Siganidae	*Siganus fuscescens*			X	X		X		X	X	X	37	2.632
	Siganus javus		X	X	X	X	X				X	55	3.912
Gerreidae	*Gerres filamentosus*	X	X	X	X		X	X		X	X	22	1.565
Terapontidae	*Terapon jarbua*										X	22	1.565
Lutjanidae	*Lutjanus monostigma*			X	X							5	0.356
Leiognathidae	*Leiognathus equulus*			X	X	X	X		X		X	47	3.343
	Nuchequula gerreoides	X	X									18	1.28
Mugilidae	*Moolgarda cunnesius*	X	X									11	0.782

Family	Scientific name	Study areas										Frequency	Percentage (%)
		1a	1b	2a	2b	3a	3b	4a	4b	5a	5b		
Ambassidae	*Ambassis kopsii*		X	X	X	X	X		X	X	X	265	18.85
	Ambassis vachellii							X				8	0.569
	Parambassis siamensis							X				42	2.987
Cichlidae	*Oreochromis mossambicus*						X	X				2	0.142
Scorpaenidae	*Scorpaenopsis sp. (Juvenile)*								X			1	0.071
Platycephalidae	*Grammoplites knappi*					X				X		4	0.284
Osphronemidae	*Trichopsis vittata*							X		X		132	9.388
Blenniidae	*Omobranchus ferox*			X								1	0.071
Eleotridae	*Butis butis*					X		X	X		X	7	0.498
	Butis koilomatodon			X								1	0.071
Gobiidae	*Acentrogobius caninus*				X				X		X	35	2.489
	Acentrogobius viridipunctatus			X			X					11	0.782
	Glossogobius sp.							X	X			18	1.28
	Brachygobius doriae								X			8	0.569
	Gobiopterus chuno							X			X	9	0.64
Tetraodontidae	*Tetraodon nigroviridis*					X				X	X	19	1.351
Total	27 *families* 37 *species*	8	8	12	11	8	10	12	13	9	12	1,406	100

Remarks: ST1a–ST5b = Sampling stations for collecting fishes in the Khanom Estuary, ST1a, ST1b Sampling stations 1 kilometer radius away from Khanom Estuary, ST2a, ST2b Sampling stations 2 kilometer radius away from Khanom Estuary, ST3a, ST3b Sampling stations 3 kilometer radius away from Khanom Estuary, ST4a, ST4b Sampling stations 4 kilometer radius away from Khanom Estuary and ST5a, ST5b Sampling stations 5 kilometer radius away from Khanom Estuary

Table 2. Community structure of fish specimens from each collecting site in November 2016 (the northeast monsoon)

Community structure of fish specimens	Radius away from Khanom Estuary (kilometers)				
	1	2	3	4	5
Species number	7	13	7	12	15
Average density (individual/m2)	1.34	0.59	1.04	0.43	0.72
Average fish product (Kg/Rai)	0.32	1.90	0.93	0.77	1.04
Diversity index	0.75	1.52	0.73	1.28	1.39
Evenness index	0.23	0.47	0.21	0.51	0.42
Dominance index	0.77	0.53	0.79	0.49	0.58

Moreover, in July 2017 (the southwest monsoon), 10–16 species of fish specimens were found in each collecting site (Table 3). In the collecting site with 4 kilometer radius away from Khanom Estuary, the highest number of species of fish specimens were found, with a total of 16 species. It was inferior to the collecting site with of 5 kilometer radius away from Khanom Estuary where 13 species were found, and lastly collecting sites that were 1, 2 and 3 kilometer radius away from Khanom Estuary which had the lowest species number of fish specimens in this area with 10 species found. The collecting site of 3 kilometer radius away from Khanom Estuary had the highest average fish product (3.46 Kilograms/Rai) and the highest average density was found at the collecting site of 4 kilometer radius away from Khanom Estuary (3.76 individuals/m^2). The data of diversity index, evenness index, and dominance index of fish specimens are shown in Table 3. The diversity of fish specimens in all collecting sites was low to medium (H′; 0.97–1.73). The collecting site of 5 kilometer radius away from Khanom Estuary had the highest diversity index (H′=1.73). The evenness indexes of fish specimens in all collecting sites were low (0.19–0.46), but the dominance index of fish specimens in all collecting sites was high (0.54–0.81).

Table 3. Community structure of fish specimens from each collecting site in July 2017 (the southwest monsoon)

Community structure of fish specimens	Radius away from Khanom Estuary (kilometers)				
	1	2	3	4	5
Species number	10	10	10	16	13
Average density (individual/m2)	1.97	1.64	0.95	3.76	0.87
Average fish product (Kg/Rai)	1.29	1.95	3.46	3.34	2.29
Diversity index	1.43	1.2	1.47	0.97	1.73
Evenness index	0.32	0.28	0.38	0.19	0.46
Dominance index	0.68	0.72	0.62	0.81	0.54

Discussion

A total of 37 species belonging to 27 families of species were found during this survey. The most dominant family was Gobiidae. Fish in the Gobiidae family were dominantly found in mangrove forests, small brackish water canals, muddy benthic substrates, and shallow coastal areas. Similarly, Allen (1991) reported that family inhabits shallow coastal water and rivers as well as fresh to brackish water and muddy habitats of estuary ecosystems (Talwar and Jhingran, 1991; Tongnunui *et al*., 2002; Gulshan *et al*., 2015). In this study, the dominantly discovered species were fish in the Gobiidae family, which had the highest number. It corresponded with studies of fish population structure and fish larvae living in mangrove ecosystems at various estuaries, located in southeastern and southwestern parts of Thailand as results showed that Gobiidae was found to have the highest number for both species number and quantity (Tongnunui *et al*., 2002; Ikejima *et al*., 2003; Ratmuangkhwang *et a*l., 2014; Petsut *et al*., 2017). According to Blaber and Milton (1990), the Gobiidae family dominated samples from mangrove estuaries with a soft substratum on the Solomon Islands. It is suspected that species of these families are permanent or temporal residents in mangrove waters (Wahyudewantoro, 2018).

Among the 28 species studied so far, *Ambassis kopsii* and *Gerres filamentosus* were widely distributed in the study area (8 collecting sites). In Thailand, both species, *Ambassis kopsii* and *Gerres filamentosus* have high economic value. They are found in brackish water canal ecosystems, estuary ecosystems, and the coastal marine ecosystem. The results of research conducted by Rainboth (1996) found *Ambassis kopsii* in coastal and brackish waters sometimes ascends freshwater. Similarly, on Lombok Island, Indonesia, the species of *Ambassis* spp. are more common in marine areas, estuaries and mangroves (Wahyudewantoro, 2018). *Gerres filamentosus* lives mostly in shallow water, muddy bottom coastal sand, and estuaries in Vietnam, and this fish species has high economic value (Vo *et al*., 2014). *Hyporhamphus limbatus, Sillago sihama, Siganus fuscescens* and *Siganus javus* are found in 6 collecting sites. Other fish species were strictly distributed and were found from only 1 to 4 collecting sites.

The monsoon influenced changes in fish population structure as shown in tables 2 and table 3. As the monsoon creates strong waves and wind as well as turbulent water currents, these conditions can affect natural habitats and feeding grounds for several fish species (Abesamis and Russ, 2010). Regarding the recent study, the numbers of different fish types and density ranged from 7 to 16 species and 0.43 to 3.76 individuals/m^2, respectively. The maximum

numbers of both were noted when the southwest monsoon hit the study sites in July 2017. During this period, fish productivity ranged from 1.29 to 3.46 Kilograms/Rai, which was higher than those (0.32–1.90 Kilograms/Rai) reported when influenced by the southeast monsoon. Naturally, at Khanom Estuary in November it was the rainy season and the site was annually affected by the heaviest precipitation and the lowest temperature. Furthermore, the environmental factors of coastal lines fluctuated due to the stronger waves when compared with those in July. Consequently, this area derived its influences from an amount of heavy precipitation and rising seawater levels. Moreover, a massive amount of freshwater run-off from the mainland flows to mix with seawater at Khanom Estuary and the small brackish canal, leading to low salinity. Thus, this condition was one of the critical factors, affecting the type and distribution of fish species existing at the estuary. Variations in physical and environmental conditions of seawater can affect the diversity of existing fish species and influence the structural heterogeneity of juvenile fish (Nanjo *et al*., 2014; Nip and Wong, 2010). In July, the influence of the southwest monsoon caused rising temperatures stimulating the metabolism of aquatic animals. It resulted in high fish productivity in water resources (Climatological Group, 2015; Hajisamae, 2008).

Tudorance *et al*. (1975) reported that a diversity index that ranged from 1 to 3 could indicate suitable water conditions for aquatic animal to exist but if less than 1, it means that the natural water quality is not suitable. While if this index is more than 3, it indicates that water quality is in optimal condition for the growth of aquatic animals. Similarly, in a recent study, the fish diversity index ranged from 0.73 to 1.73, and obtained a maximum (H'=1.73) that was noted when the southwest monsoon-influenced study sites. Therefore, data implied that the environmental condition of Khanom Estuary was still suitable for the existence of aquatic animals. Also, the evenness index was consistently and steadily low although the sites were affected by the southwest monsoon in July and the northeast monsoon in November. Furthermore, the dominant index was at a high level, indicating that at Khanom Estuary the distribution of fish specimens was not eveness and some fish specimens dominated more than other specimens in each collecting site, namely *Ambassis kopsii*, *Sillago sihama*, *Neostethus lankesteri* and *Trichopsis vittata*. Importantly, they are considered as economic species thanks to their high demand for domestic consumption and as famous ornamental fish.

Acknowledgements

We wish to thank anonymous reviewers for their invaluable editorial advice. A very special thanks to the Save Wildlife Volunteer Thailand Team for collecting some specimens

employed in this study, and to the Bird Conservation Society of Thailand and PTT Public Company Limited for providing help during the field survey and financial support. Finally, we are grateful to all partners for their support.

References

Abesamis, R. A and Russ, G. R. (2010). Patterns of recruitment of coral reef fishes in a monsoonal Environment. Coral Reefs, 29:911-921.

Allen, M. J. (1991). Beam-trawl survey of bay and nearshore fishes of the soft-bottom habitat of southern California in 1989. California Cooperative Oceanic Fisheries Investigations Report, 32:112-127.

Blaber, S. J. M. and Milton, D. A. (1990). Species composition, community structure and zoogeography of fishes of mangrove estuaries in the Solomon Islands. Marine Biology (Berlin), 105:259-267.

Cheablam, O. (2010). Application of Geographical Information System to Ecotourism Opportunity Spectrum Zoning in Khanom District Nakhon Si Thammarat Province. Songklanakarin J. of Social Sciences & Humanities, 16:365-382.

Clarke, K. R. and Warwick, R. M. (1994). Change in marine community: an approach to statistical analysis and interpretation. Plymouth Marine Laboratory. Plymouth, UK.

Climatological Group. (2015). The Climate of Thailand. Meteorological Development Bureau Meteorological Department, Bangkok.

Doi, A. (1997). A review of taxonomic studies of cypriniform fishes in Southeast Asia. Japanese Journal of Ichthyology, 44:1-33.

Gulshan, A. L., Abu, T. A., Sagir, A., Mizanur, A. M., Asaduzzaman, M., Abu, O. M., Muzammel, H. M. and Aparna, R. B. (2015). Fishes of Gobiidae Family, Recorded from the Rivers and Estyaries of Bangladesh: Some Morphomeyric and Meristic Studies. Bangladesh Journal of Zoology, 43:157-171.

Hajisamae, S. (2008). Fish ecology: theory and application. Faculty of Science and Technology, Prince of Songkla University, Pattani Campus. (in Thai).

Ikejima, K., Tongnunui, P., Medej, T. and Taniuchi, T. (2003). Juvenile and small fishes in a mangrove estuary in Trang Province, Thailand: seasonal and habitat differences. Estuarine, Coastal and Shelf Science, 56:447-457.

Khanom District Office (2019). General information about Khanom District. (Online) http://pokkrongnakhon.org, February 22 2019.

Kottelat, M. (2001). Fishes of Laos. Wildlife Heritage Trust, Colombo.

Kottelat, M, Whitten A. J, Kartikasari, S. N. and Wirjoatmodjo, S. (1993). Freshwater fishes of Western Indonesia and Sulawesi. Periplus Editions, Hong Kong.

Liao, T. Y., Kullander, S. O. and Fang, F. (2010). Phylogenetic analysis of the genus *Rasbora* (Teleostei: Cyprinidae). Zoologica Scripta, 39:155-176.

Nanjo, K., Kohno, H., Nakamura, Y., Horinouchi, M. and Sano, M. (2014). Differences in fish assemblage structure between vegetated and unvegetated habitats in relation to food abundance patterns in a mangrove creek. Fisheries science, 80:21-41.

Nip, T. H. M. and Wong, C. K. (2010). Juvenile fish assemblages in mangrove and non-mangrove soft-shore habitats in Eastern Hongkong. Zoological Studies, 49:760-778.

Petsut, N., Kulabtong, S. and Petsut, J. (2017). Species diversity and distribution of fishes in Pranburi river, Phetchaburi province and Prachuap Khirikhan province. International Journal of Agricultural Technology, 13:671-682.

Rainboth, W. J. (1996). Fishes of Cambodian Mekong. FAO Species Identification Field Guide for Fisheries Purpose. Mekong River Commission, FAO and DANIDA. XXVII pls.
Rainboth, W. J. and Kottelat, M. (1987). *Rasbora spilocerca*, a new cyprinid from the Mekong River. Copeia, 2:417-423.
Ratmuangkhwang, S., Kongkaew, W., Samnak, T., Intan, T. and Kraiwichai, P. (2014). Preliminary Survey of Species Diversity of Fishes in Kampuan Mangrove, Suksamran District, Ranong Province. Proceeding of 52nd Kasetsart University Annual Conference, 173-180.
Smith, H. M. (1945). The freshwater fishes of Siam, or Thailand. Bulletin of the United States National Museum, 188:1-622.
Talwar, P. K. and Jhingran, A. G. (1991). Inland Fishes of India and Adjacent Countries. Vol. 1 & 2. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
Tantiwat, W. (2011). Economic Evaluation of Humpback Dolphin and Adaptation of the Local People from Tourism Activity: A Case Study Of Khanom District, Nakhon Si Thammmmarat Province. (Master's thesis). Kasetsart University.
Tongnunui, P., Ikejima, K., Yamane, T., Horinouchi, M., Medeji, T., Sano, M., Kurokura, H. and Taniuchi, T. (2002). Fish fauna of the Sikao Creek Mangrove estuary, Trang, Thailand. Fisheries Science, 68:10-17.
Tudorance, C., Green, R. H. and Huebner, J. (1975). Structure, Dynamics and Production of the Benthic Fauna in Lake Monitoba, Hydrobiologia, 64:59-9.
Vo, V. T., Tran, T. Y., Nguyen, T. H. B. and Huynh, N. T. (2014). Growth characteristics of fish species *Gerres filamentosus* (Cuvier, 1829) in coastal zone, Quang Binh province. Journal of Vietnamese Environment, 6:184-187.
Wahyudewantoro, G. (2018). The fish diversity of mangrove waters in Lombok Island, West Nusa Tenggara, Indonesia. Biodiversitas, 19:71-76.
Washington, H. G. (1984). Review of diversity, biotic and similarity indices. Water resources, 18(6).

(Received: 9 June 2022, accepted: 30 October 2022)