

Community structure of crustacean bycatch of blue swimming crab (*Portunus pelagicus*) fisheries in Kendari Bay, Southeast Sulawesi, Indonesia

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Abstract. Catch data is essential for the management of ecosystem-based blue swimming crab (*Portunus pelagicus*) fisheries, but its availability is still limited. This study aims to determine the community structure of crustacean bycatch of *P. pelagicus* fisheries in the Kendari Bay, Southeast Sulawesi, Indonesia, determined in accordance with catch data. This research was conducted from March to October 2019. Sampling of crustacean bycatch was conducted monthly on a purposively selective fishing with trap and gillnet. The data obtained are presented spatially-temporally, then the family level composition of catches was analyzed, as well as the Shannon-Wiener diversity index, the evenness index, the Simpson's dominance index, and the Sorensen similarity index to determine ecological status of the community structure of crustacean bycatch of *P. pelagicus* fisheries. The results found were 37 species and 14 families of crustacean bycatch of *P. pelagicus* from the fisheries, consisting of 25 valuable species and 12 discarded species. The main *P. pelagicus* bycatch species were *Thalamita crenata*, *T. danae* and *Charybdis anisodon*. Spatial-temporal community structure of crustacean bycatch of crab fisheries has a low diversity and a moderate dominance, evenness and stability. The similarity of the crustacean bycatch community was temporally higher than spatially. Collected data of crustacean bycatch of *P. pelagicus* fisheries is expected to be able to support their management planning in Southeast Sulawesi and Indonesia.

Key Words: bay fisheries, biological indices, ecological status, fisheries management, species richness.

Introduction. Blue swimming crab (*Portunus pelagicus*) is one of Indonesia's main fishery export commodities and its market demand continues to increase. To meet the demand, crab fishing was done intensively, determining an overfished crab stock condition in Indonesia, including in Southeast Sulawesi (Suman et al 2016). To maintain the sustainability of crab stocks in nature, it is necessary to well-manage the crab fisheries. Crab management in Indonesia, according to the Management Plan for Blue Swimming Crab Fisheries 2016, is ecosystem-based (MMAF 2016). One of the data categories needed in the management approach is the crab fishery bycatch (Kalayci & Yeşilçiçek 2014; Budiarto et al 2015; Fazrul et al 2015). *P. pelagicus* is also a type of marine food commodity that was highly prioritized to get certification from the Marine Stewardship Council (Kembaren et al 2012), and the crab fishery bycatch data is one of the requirements (Sai Global 2014).

Bycatch is defined as the total catch of non-target animals (Kelleher 2005), and is a serious problem in capture fisheries, including crab fisheries, specifically related to the sustainability of aquatic biodiversity because bycatch can reduce the abundance and number of aquatic biota species (Alverson & Hughes 1996; Samanta et al 2018).

Fishery bycatches are composed of 2 categories: non-valuable bycatch or discarded and valuable or retained bycatch (Alverson et al 1994), which include groups of

fish, crustaceans, mollusks, and echinoderms (Batista et al 2009; Pillai et al 2014; Fazrul et al 2015; Samanta et al 2018). The community structure of the crab fishery bycatch includes the abundance and composition of species usually influenced by habitat and season (Kalayci & Yeşilçiçek 2014; Fazrul et al 2015), type and design of fishing gear (Campbell & Sumpton 2009; Shester & Micheli 2011; Leland et al 2013; Broadhurst et al 2014; Kalayci & Yeşilçiçek 2014).

Research on crustacean bycatch of crab fisheries was relatively limited: Kumar et al (2013) investigated the standardization of gillnet related bycatch, and Fazrul et al (2015) conducted a study on the composition of gillnet bycatch species and the influencing factors. Studies on trap bycatch were conducted by Campbell & Sumpton (2009), Leland et al (2013), Kunsook & Dumrongrojwathana (2017), and Prakosa et al (2017), but most of them focused on the construction of the trap. Studies of crustacean bycatch of crab fisheries in Indonesia were sporadic and more focused on crustacean biodiversity, like the study conducted by Hamid & Wardiatno (2018) in Lasongko Bay, Southeast Sulawesi, Indonesia.

P. pelagicus fishing in Kendari Bay is usually carried out by small fishermen with fishing grounds scattered inside and outside the Kendari Bay area. The *P. pelagicus* fishers also caught several other crustacean species as bycatch, but the community structure has never been reported. This study aims to elucidate the community structure of crustacean bycatch of *P. pelagicus* fisheries in the Kendari Bay Kendari, Southeast Sulawesi, Indonesia.

Material and Method

Research site. This research was conducted in the Kendari Bay, Southeast Sulawesi, Indonesia from March to October 2019. Crustacean bycatch data collection was carried out at five fishing crab landing fisheries (Figure 1), namely Lapulu (inside the bay), Leppe, Purirano, Bungkutoko, Lallowaru (outside the bay).

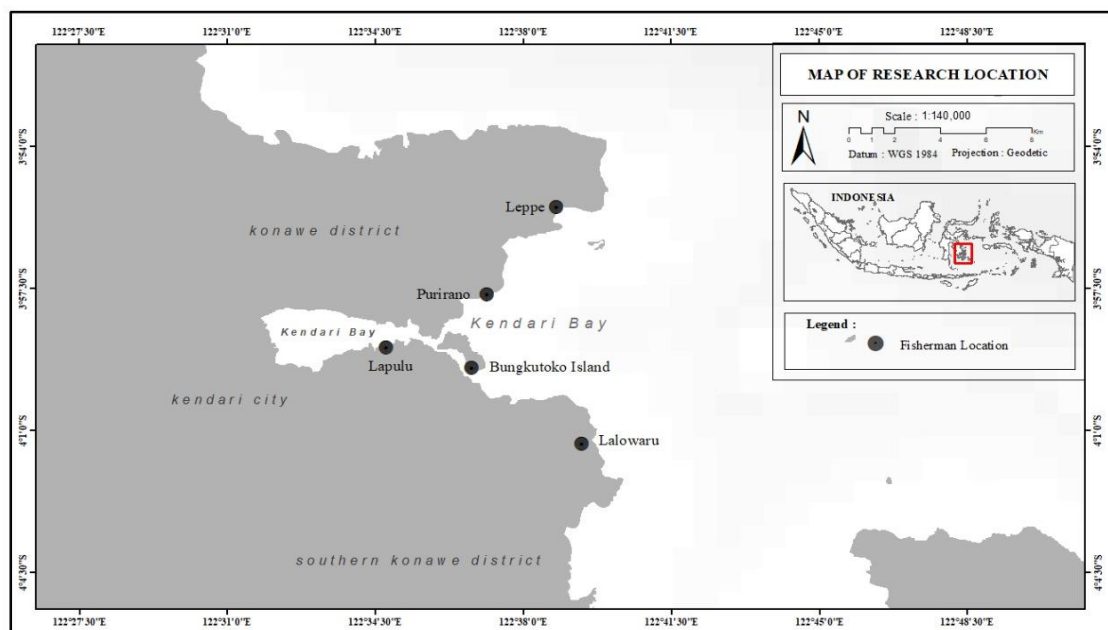


Figure 1. Map of research and location of the fish landing of *Portunus pelagicus* fisheries (black circles) in Kendari Bay, Southeast Sulawesi, Indonesia.

Sampling protocols and data analysis. The crustacean bycatch data collection was conducted purposively on crab fishing with trap and gillnet, on a monthly basis, at each location. Collected samples were identified following Wee & Ng (1995), Ng (1998), Chan (1998), Ng et al (2008) and Khvorov (2012), and were counted. The crustacean bycatch data was presented spatially-temporally and was classified as valuable or retained

bycatch or no-valuable or discarded bycatch, based on the perception of local fishermen (Alverson et al 1994). The data analysis consisted of species composition, Shannon-Wiener diversity index, evenness index, Simpson's dominance index and Sorensen similarity index (Brower et al 1990) to determine the ecological status of the community structure of crustacean bycatch of *P. pelagicus* fisheries in Kendari Bay, Southeast Sulawesi, Indonesia.

Results

Spatial community structure of crustacean bycatch. The community structure of crustacean bycatch of *P. pelagicus* fisheries in Kendari Bay composed 14 families and 37 species. Crustacean bycatch of the crab group (Brachyura) composed 11 families and 33 species, while the shrimp group (Macrura) consisted of only three families and four species (Table 1). The crustacean bycatch community of crab fisheries in Kendari Bay categorized as retained were 25 species, and the discarded were 12 species (Table 1). There was 17 species of portunid crabs (*Portunidae*) as dominant crustacean bycatch family of *P. pelagicus* fisheries in Kendari Bay (86.76%), followed by Matutidae and Xanthidae with proportions of 8.67% and 1.41%, respectively (Figure 2).

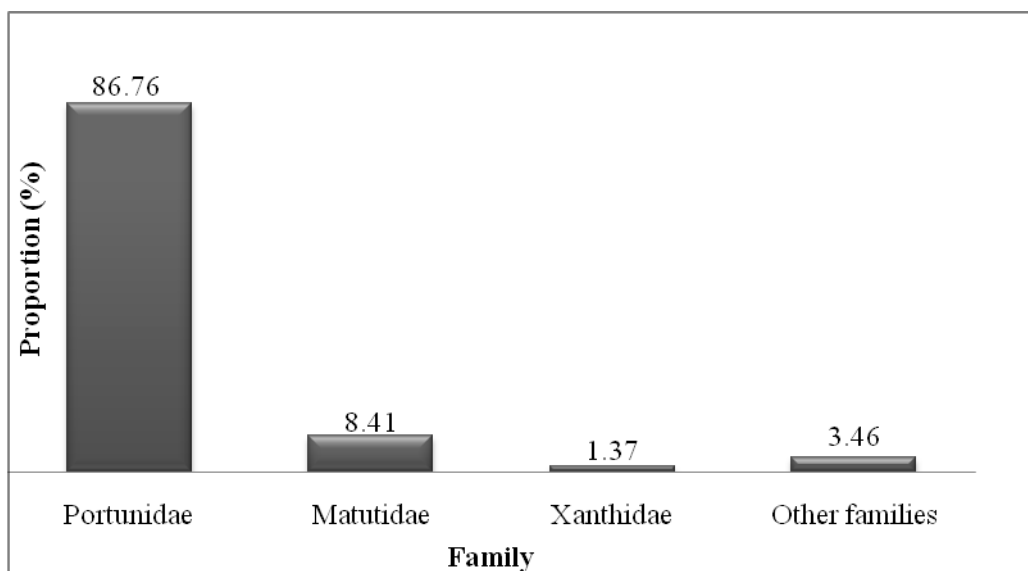


Figure 2. The proportion of dominant family of crustacean bycatch of *Portunus pelagicus* fisheries in Kendari Bay, Southeast Sulawesi, Indonesia.

The species diversity of crustacean bycatch of *P. pelagicus* in each location ranges from 12-24 species with abundance ranging from 520-1,108 individuals. The highest species diversity and abundance of crustacean bycatch were found in Lapulu, and the lowest species diversity found in Bungkutoko and Lalowaru, and the lowest abundance found in Purirano (Table 1). The Shannon-Wiener diversity index of crustacean bycatch at each location ranged from 0.555-0.801 with evenness and Simpson's dominance indices ranging between 0.514-0.628 and 0.061-0.402, respectively.

Table 1

Community spatial structure of crustacean bycatch of *Portunus pelagicus* fisheries in Kendari Bay, Southeast Sulawesi, Indonesia

No.	Family	Species	Abundance (individual)/location					Status
			LE	PR	LP	BT	LL	
1	Calappidae	<i>Calappa calappa</i>	1				1	R
		<i>Calappa hepatica</i>	8	3			2	D
2	Carpiliidae	<i>Carpilus convexus</i>	1					D
3	Eriphiidae	<i>Myomenippe hardwickii</i>			43	4		R
4	Euryplacidae	<i>Eucrate</i> sp.			23			D
5	Grapsidae	<i>Grapsus</i> sp.			1			D
6	Majidae	<i>Schyzophys aspera</i>	15	6	11	1	2	D
		<i>Schyzophys dama</i>		1			1	D
7	Matutidae	<i>Ashtoret lunaris</i>	142	96	8	17	63	D
8	Palinuridae	<i>Panulirus versicolor</i>			3			R
9	Parthenopidae	<i>Daldorfia horrida</i>	1					D
10	Penaeidae	<i>Penaeus monodon</i>			1			R
		<i>Penaeus merguensis</i>				2		R
11	Pilumnidae	<i>Pilumnus</i> sp.			2			D
		<i>Charybdis anisodon</i>	26	8	467	144	72	R
		<i>Charybdis hellerii</i>	15	17	205	27		R
		<i>Charybdis truncata</i>			2			R
		<i>Charybdis natator</i>	3					R
		<i>Gonioinfradens</i> sp.	1	2	5		4	R
		<i>Podothalmus vigil</i>		1	121	2		R
		<i>Portunus sanguinolentus</i>	36				12	R
		<i>Portunus</i> sp.	1					R
12	Portunidae	<i>Scylla Serrata</i>			11	2		R
		<i>Thalamita admete</i>	2	5				R
		<i>Thalamita danae</i>	281	229	3	129	122	R
		<i>Thalamita crenata</i>	151	69	145	430	417	R
		<i>Thalamita coeruleipes</i>					4	R
		<i>Thalamita sima</i>		9	13	3	0	R
		<i>Thalamita spinimana</i>	58	36	11	5	25	R
		<i>Thalamita prymna</i>	1					R
		<i>Thalamita</i> sp.		31				R
13	Scyllaridae	<i>Thenus orientalis</i>			1			R
		<i>Atergatis integerrimus</i>	1		3			D
		<i>Etitus laevimanus</i>		1	22			R
14	Xanthidae	<i>Etitus laevimanus</i>		1	22			R
		<i>Liomera</i> sp.			4			D
		<i>Lophozozymus pictor</i>	11	5	3			D
		<i>Liagore</i> sp.	2	1				D
Number of species (taxa)			20	17	24	12	12	
Abundance (individual)			760	520	1108	766	725	
Shannon-Wiener index (H')			0.798	0.773	0.801	0.555	0.560	
Evenness index (E)			0.613	0.628	0.588	0.514	0.518	
Simpson's dominance index (C)			0.221	0.061	0.243	0.402	0.224	

LE-Leppe ; PR-Purirano; LP-Lapulu; BT-Bungkutoko; LL-Lalowaru; R-retained; D-discarded.

The Sorensen similarity index of crustacean bycatch community of crab fisheries ranged from 0.400-0.649, the highest was found between Leppe and Purirano, and the lowest between Lapulu and Lalowaru (Table 2). The number of same species of crustacean bycatch were found in Leppe and Purirano by 12 species, while between Lapulu and Lalowaru were 7 species.

Temporal crustacean bycatch community structure. The temporal community structure of crustacean bycatch of *P. pelagicus* fisheries in the Kendari Bay ranges from 13-18 species with abundance ranging from 269-704 individuals (Table 3). The highest species diversity and abundance of crustacean bycatch community were found in May and October, respectively, while the lowest were found in June and March, respectively (Table 2). Six species were found every month in the crustacean bycatch, with a high abundance: *T. crenata*, *T. danae*, *C. anisodon*, *C. helleri*, and *A. lunaris*. *Thalamita spinimana* was also found every month, but its abundance was relatively low.

Table 2

The spatial matrix of Sorensen similarity index of crustacean bycatch community of *Portunus pelagicus* fisheries in Kendari Bay, Southeast Sulawesi, Indonesia

Location	Sorensen similarity index at each location				
	Leppe	Purirano	Lapulu	Bungkutoko	Lalowaru
Leppe	-	0.649	0.419	0.438	0.625
Purirano		-	0.500	0.621	0.621
Lapulu			-	0.621	0.400
Bungkutoko				-	0.500
Lalowaru					-

Shannon-Wiener diversity index of crustacean bycatch of *P. pelagicus* fisheries of temporally ranged from 0.751-0.874 with evenness index ranging from 0.627-0.736 and Simpson's dominance index ranged from 0.189-0.256 (Table 3).

Table 3

Temporal community structure of crustacean bycatch of *Portunus pelagicus* fisheries in Kendari Bay, Southeast Sulawesi, Indonesia

Month	Number of species	Abundance (individual)	Indices		
			Shannon-Wiener	Evenness	Simpson's dominance
March	14	269	0.843	0.736	0.189
April	14	421	0.768	0.670	0.218
May	18	579	0.814	0.648	0.216
June	13	349	0.751	0.674	0.256
July	16	455	0.755	0.627	0.239
August	16	598	0.826	0.686	0.206
September	14	495	0.776	0.677	0.213
October	17	704	0.874	0.710	0.178

Table 4

The temporal matrix of Sorensen similarity index of crustacean bycatch community of *Portunus pelagicus* fisheries in Kendari Bay, Southeast Sulawesi, Indonesia

Sampling period	Sorensen similarity index at each sampling period							
	March	April	May	June	July	August	September	October
March	-	0.786	0.688	0.667	0.733	0.733	0.667	0.710
April		-	0.750	0.667	0.667	0.667	0.593	0.645
May			-	0.581	0.647	0.647	0.581	0.686
June				-	0.690	0.552	0.538	0.467
July					-	0.625	0.552	0.606
August						-	0.828	0.727
September							-	0.667
October								-

Temporal Sorensen similarity index of crustacean bycatch community of crab fisheries in Kendari Bay ranged between 0.467-0.828, the highest was found between August and September, while the lowest was found between June and October (Table 4). The number of same species of crustacean bycatch was found in August and September of 12 species, while in June and October only 7 species were found.

Discussion

Diversity of the crustacean bycatch community. Species diversity and abundance of crustaceans bycatch community of *P. pelagicus* fisheries in Lapulu are higher than at the four other locations (Table 1). This shows that the diversity of the crustacean community in the inner side of Kendari Bay is higher than outside of it. The results of this study were identical to those found in Lasongko Bay (Hamid & Wardiatno 2018), but contrary to the pattern reported by Fazrul et al (2015), related to the diversity of crustacean bycatch the inner Pattani Bay, Thailand (Table 5).

Table 5
Diversity of crustacean bycatch of *Portunus pelagicus* fisheries in several waters

Location	No of species	Shannon-Wiener diversity index (H')	Source
		Trawl	
Kerala Coast, India	43	2.135-1.948*	Kumar et al (2007)
Chennai Coast, India	37	0.942- 1.664**	Pillai et al (2014)
		Gillnet	
Thoothukudi Coast, India	6		Kumar et al (2013)
Pattani Bay, Thailand	26		Fazrul et al (2015)
Pattani Coast, Thailand	29		
Krung Krabaen Bay,Thailand	17		Kunsook & Dumrongrojwaththana (2017)
Lasongko Bay, Indonesia	38	0.812-0.893	Hamid & Wardiatno (2018)
		Trap	
Moreton Bay, Australia	3		Campbell & Sumpton (2009)
Jepara Coast, Indonesia	1		Prakosa et al (2017)
Pati Coast, Indonesia	4		Ernawati (2013)
Kendari Bay, Indonesia	37***	0.555-0.801	This study

*converted from ln to log₁₀ ; **converted from log₂ to log₁₀ ; ***trap as dominant fishing gear.

The diversity of crustacean bycatch community of *P. pelagicus* fisheries in this study was higher than that found in some other waters (Table 5), except in Lasongko Bay (Hamid & Wardiatno 2018). The species diversity of crustacean bycatch of *P. pelagicus* fisheries in Kendari Bay was the same as that found in trawl fisheries in the Chennai Coast, India (Pillai et al 2014), but lower than that found in the Kerala Coast, India (Kumar et al 2007). Species diversity and abundance of crustacean bycatch community of *P. pelagicus* fisheries might be influenced by habitat, season, type of fishing gear, as well as frequency and scope of the sampling area (Shester & Micheli 2011; Kalayci & Yeşilçiçek 2014; Fazrul et al 2015).

Portunidae is the dominant family of crustacean bycatch of crab fisheries in terms of species diversity and abundance (Table 1 and Figure 2), as found by the observation of relevant sites: Kerala Coast, India (Kumar et al 2007), Chennai Coast, India (Pillai et al 2014), Pattani Beach, Thailand (Fazrul et al 2015) and Lasongko Bay, Indonesia (Hamid & Wardiatno 2018). In several crustacean biodiversity studies (Pratiwi & Wijaya 2013; Varadharajan et al 2013; Kumaralingam et al 2013; Anggorowati 2014; Sruthi et al 2014; Anggraeni et al 2015) it was also reported that Portunidae was the dominant family. The number of species from the Portunidae family found in several biodiversity studies in Indonesia ranged from 5-6 species (Pratiwi & Wijaya 2013; Anggorowati 2014; Anggraeni et al 2015), and in India ranged from 10-23 species (Varadharajan et

al 2013; Kumaralingam et al 2013; Sruthi et al 2014).

Species richness of Portunidae, *P. pelagicus* fisheries bycatch in Kendari Bay were higher than trawl fishery bycatch in Kerala Beach, India, 16 species (Kumar et al 2007) and Chennai Beach, India, 16 species (Pillai et al 2014), and crab gillnet bycatch in Coast and Bay of Pattani, Thailand, 9 and 8 species, respectively (Fazrul et al 2015) and Lasongko Bay, Indonesia, 12 species (Hamid & Wardiatno 2018). The proportion of Portunidae abundance in this study was higher than in Lasongko Bay, Indonesia, 78% (Hamid & Wardiatno 2018). Species richness of the *Thalamita* genus in Kendari Bay was higher than in Lasongko Bay, which counted five species (Hamid et al 2019). The value of Portunidae species' diversity and abundance variation was probably caused by differences in the condition of aquatic habitats and in the sampling method.

The crustacean bycatch species of *P. pelagicus* fisheries found in each sampling period were *T. crenata*, *T. danae*, *T. spimana*, *C. anisodon*, *C. hellerii*, *A. lunaris* and *S. aspera*. All of these species were also found in almost all locations, with a variable abundance, except for *C. hellerii*, which was not found in Lalowaru (Table 1). The abundance of *T. crenata*, *T. danae* and *C. anisodon* was higher than the abundance of the other four species. Therefore, the three species were considered as the main bycatch of *P. pelagicus* fisheries in Kendari Bay, for the crustacean group. The crab gillnet bycatch on Pattani Coast, Thailand was dominated by *C. bilineatu*, *C. philargiu* and *P. vigil*, and in Pattani Bay, Thailand it was dominated by *Carcinoscorpius rotundicauda*, *S. serrata* and *Miyakea nepa* (Fazrul et al 2015), but in Lasongko Bay, Indonesia it was dominated by *C. anisodon* and *P. vigil* (Hamid & Wardiatno 2018). The crab trap bycatch in Indonesia was dominated by *P. vigil* and *T. crenata*, and the crab gillnet was dominated by *T. orientalis* (IMACS 2015). Crustacean of trawl bycatch on the Chennai Coast, India was dominated by *Callapa* spp. and *Portunus* spp. (Pillai et al 2014). *P. vigil* was almost found in each sampling period and was commonly found in Lapulu (Table 1). The *P. pelagicus* fishing ground in Lapulu was situated in the inner Kendari Bay, generally characterized by fine sand and mud substrates, which are the preferred substrate of *P. vigil* (Hamid 2019). Based on the description above, the dominant crustacean bycatch species vary between locations, habitats, and types of fishing gear.

Ecological status of the crustacean bycatch community. In general, the Shannon-Wiener diversity index, evenness index, and Simpson dominance index of crustacean bycatch community of *P. pelagicus* fishery were temporally higher and stable than spatially (Tables 1 and 3). The three biological indices above were influenced by the number of species and the abundance of each species (Brower et al 1990). Variations in species diversity and abundance of crustacean in waters could probably be influenced by substrate type and seagrass density (Huang et al 2011; Anggorowati 2014; Hamid 2015) as well as by physical and chemical parameters like: temperature, salinity, oxygen, turbidity and water depth (Ndoro et al 2014; Andrade et al 2015; Hamid 2015; Kunsook & Dumrongrojwatthana 2017).

The spatial-temporal Shannon-Wiener diversity index of crustacean bycatch community of *P. pelagicus* fisheries was less than 1 (Tables 1 and 3), indicating that the diversity level of the crustacean bycatch community in Kendari Bay was low. The condition might be related to the high intensity of crab fishing in this area. The Shannon-Wiener diversity index value of the crustacean bycatch community in this study was lower than the values found by Kumar et al (2007), Pillai et al (2014), and Hamid & Wardiatno (2018), and also from several crustacean biodiversity studies in Indonesia (Pratiwi & Astuti 2012; Pratiwi & Wijaya 2013; Anggorowati 2014), but higher than those found by Pratiwi (2010) and Widyastuti (2007 & 2016). The Shannon-Weiner diversity index value of crustacean bycatch of *P. pelagicus* fisheries and biodiversity studies show a variation between locations, because it depends on the number of species and abundance found at each location.

Spatially and temporally, the evenness index of the crustacean bycatch community of crab fisheries in Kendari Bay was categorized as moderate. The Simpson's dominance index of crustacean bycatch community of *P. pelagicus* fisheries was also low (Tables 1 and 3), which indicates that every species in the crustacean bycatch community was

relatively evenly distributed and no species was dominant in terms of number. The evenness and Simpson dominance index of the crustacean bycatch community of crab fisheries in Kendari Bay were in line with some previous studies (Kumar et al 2007; Pillai et al 2014; Hamid & Wardiatno 2018), ranging from 0.592 to 0.993 and from 0.024 to 0.313, and with several studies of crustacean biodiversity (Pratiwi 2010; Pratiwi & Astuti 2012; Pratiwi & Wijaya 2013; Anggorowati 2014), ranging from 0.360 to 0.970 and from 0.070 to 0.620, respectively. Based on these studies, the crustacean community evenness index was in the moderate to high category, and the Simpson's dominance index was in the low to moderate category, and both are related to the number of species and the abundance of crustaceans at each location.

Spatial-temporal Sorensen similarity index of crustacean bycatch community of *P. pelagicus* fisheries in the Kendari Bay of tended to vary. Spatial similarity index of crustacean bycatch community was lower than the temporal similarity index (Table 2 and Table 4), and the latter was generally relatively elevated, i.e. >0.61 (Anggorowati 2014). The similarity index in this study was higher than in West Lombok, Indonesia, where it ranged 0.314-0.612 (Anggorowati 2014), and lower than in Lasongko Bay, Indonesia, where it ranged 0.560-0.809 (Hamid & Wardiatno 2018). The number of same species of crustacean bycatch which was found across locations and along sampling periods ranged from 7 to 12 species. The similarity index value of the crustacean community was varying, and differences between these locations were thought to be related to habitat conditions at each location.

Crustacean bycatch species with economic value. Crustacean bycatch species found in this study are classified as non-valuable or discarded at 32.43% (12 species), and valuable or retained at 67.57% (25 species) of the total species found (Table 1). The proportion of discarded crustacean species was lower than the value found by Fazrul et al (2015) and Kunsook & Dumrongrojwatthana (2017).

In Kendari Bay fisheries, crustacean bycatch species of crab with high economic value were *P. versicolor*, *P. monodon*, *P. merguensis*, *S. serrata* and *T. orientalis*. The five crustacean bycatch species were found with low abundance (1-13 individuals) and the total number was 20 individuals (Table 1), and their size was not categorized as traded size category. The number of species of valuable crustacean bycatch community found in this study was greater than in previous studies (Fazrul et al 2015; Kunsook & Dumrongrojwatthana 2017; Hamid & Wardiatno 2018). Crustacean bycatch of *P. pelagicus* fisheries counted also species that occasionally traded in the Kendari Bay region, from the genera *Thalamita* and *Charybdis*.

Conclusions. The community structure of crustacean bycatch of *P. pelagicus* fisheries in Kendari Bay consisted of 37 species and 14 families with the main bycatch composed of *T. crenata*, *T. danae* and *C. anisodon*. The proportion of valuable crustacean species is 67.57% and discarded by 32.43%. Species diversity and abundance of crustacean bycatch of crab fisheries in the inner side of Kendari Bay were higher than that in the outside. The ecological status of crustacean bycatch community of *P. pelagicus* fisheries based on diversity is classified as low with moderate evenness and low dominance, and temporally community similarity is higher than spatially and both of them vary. This data of crustacean bycatch of *P. pelagicus* fisheries is expected to be able to support the management planning of *P. pelagicus* fisheries in Southeast Sulawesi and Indonesia.

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References

- Andrade L. S., Frameschi I. F., Costa R. C., Castilho A. L., Fransozo A., 2015 The assemblage composition and structure of swimming crabs (*Portunoidea*) in continental shelf waters of southeastern Brazil. *Continental Shelf Research* 94:8-16.
- Anggorowati D. A., 2014 [Community structure of crustacean fauna at the intertidal zone of West Lombok]. *Zoo Indonesia* 23(2):92-100. [In Indonesian].
- Anggraeni P., Elfidasari D., Pratiwi R., 2015 [Brachyuran crab distribution in Tikus Island, Pari Island group, Seribu Islands]. *Proceedings of the National Seminar on the Indonesian Biodiversity Society* 1(2):213-221. [In Indonesian].
- Alverson D. L., Freeberg M. G., Murawski S. A., Pope J. G., 1994 A global assessment of fisheries bycatch and discards. *FAO Fisheries Technical Paper No. 339*, Rome, 233 p.
- Alverson D. L., Hughes S. E., 1996 Bycatch: From emotion to effective natural resource management. *Review Fish Biology and Fisheries* 6:443-462.
- Batista M. I., Célia M. T., Henrique N. C., 2009 Catches of target species and bycatches of an artisanal fishery: The case study of a trammel net fishery in the Portuguese coast. *Fisheries Research* 100:167-177.
- Broadhurst M. K., Butcher P. A., Cullis B. R., 2014 Effects of mesh size and escape gaps on discarding in an Australian giant mud crab (*Scylla serrata*) trap fishery. *PLoS ONE* 9(9):e106414.
- Brower J., Jerrold H. Z., Ende N. V. E., 1990 *Field and laboratory methods for general ecology*. Wm. C. Brown Publishers, Dubuque, Iowa, USA, 220 p.
- Budiarto A., Adrianto L., Kamal M. M., 2015 [The status of ecosystem approach to fishery management for blue swimming crab (*Portunus pelagicus*) at Java Sea waters (FMA 712)]. *Journal Kebijakan Perikanan Indonesia* 7(1):9-24. [In Indonesian].
- Campbell M. J., Sumpton W. D., 2009 Ghost fishing in the pot fishery for blue swimmer crabs *Portunus pelagicus* in Queensland, Australia. *Fisheries Research* 95:246-253.
- Chan T. Y., 1998 Shrimps and prawns. In: *The living marine resources of the Western Central Pacific*. Carpenter K. E., Niem V. H. (eds), pp. 851-971, *FAO Species Identification Guide for Fishery Purposes*, FAO, Rome.
- Ernawati T., 2013 [Population dynamics and stock assessment of blue swimmer crab (*Portunus pelagicus* Linnaeus) resource in Pati and the adjacent waters]. MSc Thesis. Bogor Agricultural University, Indonesia, 80 p. [In Indonesian].
- Fazrul H., Hajisamae S., Ikhwanuddin M., Pradit S., 2015 Assessing impact of crab gill net fishery to bycatch population in the lower Gulf of Thailand. *Turkish Journal of Fisheries and Aquatic Sciences* 15:761-771.
- Hamid A., 2015 [Habitat, reproductive biology and population dynamic of the blue swimming crab (*Portunus pelagicus* Linnaeus 1758) as a basic of its management at Lasongko Bay, Southeast Sulawesi]. PhD Dissertation, Graduate School, Bogor Agricultural University, Bogor, 160 p. [In Indonesian].
- Hamid A., Wardiatno Y., 2018 Diversity of decapod crustacean in Lasongko Bay, Southeast Sulawesi, Indonesia. *Biodiversity Journal* 9(3):303-311.
- Hamid A., 2019 [Habitat and biological aspects of sentinel crab, *Podophthalmus vigil* (Fabricius 1798) in Lasongko Bay, Southeast Sulawesi]. *Journal Ilmu Pertanian Indonesia* 24(1):1-11. [In Indonesian].
- Hamid A., Wardiatno Y., Irawati N., 2019 Biological aspects of genus *Thalamita* Latreille, 1829 (Decapoda: Portunidae) in Lasongko Bay, Southeast Sulawesi, Indonesia. *AAFL Bioflux* 12(4):1335-1348.
- Huang J. R., Brown C. L., Yang T. B., 2011 Spatio-temporal patterns of crab fisheries in the main bays of Guangdong Province, China. *Iranian Journal of Fisheries Science* 10(3):425-436.
- Kalayci F., Yeşilçiçek T., 2014 Effects of depth, season and mesh size on the catch and discards of whiting (*Merlangius merlangus euxinus*) gillnet fishery in the Southern Black Sea, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences* 14:449-456.
- Kelleher K., 2005 Discards in the world's marine fisheries. An update. *FAO Fisheries Technical Paper No. 470*, FAO, Rome, 131 p.

- Kembaren D. D., Ernawati T., Suprpto, 2012 [Biology and population parameters of blue swimming crab (*Portunus pelagicus*) in the Bone Bay and the adjacent waters]. *Journal Penelitian Perikanan Indonesia* 18(4):273-281. [In Indonesian].
- Khvorov S., 2012 Crabs of Sultanate of Oman. Marine Science Fisheries Centre, Ministry of Agriculture and Fisheries Wealth, Muscat, Oman, 60 p.
- Kumaralingam S., Sivaperuman C., Raghunathan C., 2013 Diversity and community structure of brachyuran crabs in North Andaman, In: Ecology and conservation. Venkataraman K., Sivaperuman C., Raghunathan C. (eds), pp. 171-182, Springer-Verlag Berlin Heidelberg.
- Kumar A. B., Kumar M. S., Raffi S. M., Khan S. A., 2007 Diversity of brachyuran crabs associated with trawl by-catch in Kerala coast, India. *Indian Journal of Fisheries* 54(3):283-290.
- Kumar A., Sundaramoorthy B., Jakhar J. K., 2013 Standardization of crab bottom set gillnet for reduction of bycatch at Thoothukudi coast, Tamilnadu, India. *Archives of Applied Science Research* 5(6):74-81.
- Kunsook C., Dumrongrojwatthana P., 2017 Species diversity and abundance of marine crabs (Portunidae: Decapoda) from collapsible crab trap fishery at Kung Krabaen Bay, Chanthaburi Province, Thailand. *Tropical Life Sciences Research* 28(1):45-67.
- Leland J., Butcher P., Broadhurst M. K., Paterson B. D., Mayer D. G., 2013 Relative trap efficiency for recreationally caught eastern Australia blue swimmer crab (*Portunus pelagicus*) and associated injury and mortality discard. *Fisheries Research* 147: 304-311.
- Ndoro C. K., Kaunda-Arara B., Munga C. N., Ruwa R., 2014 Influence of seasonality and bathymetry on decapod crustacean community structure in Malindi-Ungwana Bay, Kenya. *Western Indian Ocean Journal of Marine Science* 13(1):31-46.
- Ng P. K. L., 1998 Crabs. In: The living marine resources of the Western Central Pacific. Carpenter K. E., Niem V. H. (eds), pp. 1046-1155, FAO species identification guide for fishery purposes, FAO, Rome.
- Ng P. K. L., Guinot D., Davie P. J. F., 2008 Systema brachyurorum: part I. An annotated checklist of extant brachyuran crabs of the world. *The Raffles Bulletin of Zoology* 17:1-286.
- Pillai S. L., Kizhakudan S. J., Radhakrishnan E. V., Thirumilu P., 2014 Crustacean bycatch from trawl fishery along north Tamil Nadu coast. *Indian Journal of Fishery* 61(2):7-13.
- Prakosa E. F., Fitri A. D. P., Kurohman F., 2017 [Analysis of escape gap on dome trap to catch blue swimming crab (*Portunus pelagicus*) at TPI Demaan Jepara District]. *Journal of Fisheries Resources Utilization Management and Technology* 6(4):103-109. [In Indonesian].
- Pratiwi R., 2010 [Crustaceans association in seagrass ecosystems Lampung Bay waters]. *Ilmu Kelautan Indonesian Journal of Marine Sciences* 15(2):66-76. [In Indonesian].
- Pratiwi R., Astuti O., 2012 [Biodiversity of crustacean (Decapod, Brachyura, Macrura) from Kendari waters expedition 2011]. *Ilmu Kelautan: Indonesian Journal of Marine Sciences* 17(1):8-14. [In Indonesian].
- Pratiwi R., Wijaya N. I., 2013 [The community diversity of crustacean in Matasiri Islands, South Kalimantan]. *Berita Biologi* 12:127-140. [In Indonesian].
- Samanta R., Chakraborty S. K., Sheroy L., Nagesh T. S., Behera S., Bhoomik T. S., 2018 Bycatch characterization and relationship between trawl catch and lunar cycle in single day shrimp trawls from Mumbai Coast of India. *Regional Studies in Marine Science* 17:47-58.
- Shester G. G., Micheli F., 2011 Conservation challenges for small-scale fisheries: Bycatch and habitat impacts of traps and gillnets. *Biological Conservation* 144:1673-1681.
- Sruthi A., Nansimole A., Devi G. T. V., Radhakrishnan T., 2014 Diversity of brachyuran crabs of Kanyakumari area, South West Coasts of India. *International Journal of Scientific Research* 3:126-128.
- Suman A., Irianto H. E., Satria F., Amri K., 2016 [Potency and exploitation level of fish resources 2015 in fisheries management area of Indonesian Republic (FMAs) and its

- management option]. *Journal Kebijakan Perikanan Indonesia* 8(2):97-110. [In Indonesian].
- Varadharajan D., Soundarapandian P., Pushparajan N., 2013 The global science of crab biodiversity from Puducherry coast, Southeast coast of India. *Arthropods* 2:26-35.
- Wee D. P. C., Ng P. K. L., 1995 Swimming crabs of the genera *Charybdis* De Haan, 1833, and *Thalamita* Latreille, 1829 (Crustacea: Decapoda: Brachyura: Portunidae) from peninsular Malaysia and Singapore. *The Raffles Bulletin of Zoology* 1:1-128.
- Widyastuti E., 2007 [Fauna of crustacean in Anambas waters, Riau Islands Province]. *Biosfera* 24(1):10-16. [In Indonesian].
- Widyastuti E., 2016 [Crabs diversity at mangrove ecosystem in Lingga waters and adjacent area, Riau Islands]. *Zoo Indonesia* 25(1):22-32. [In Indonesian].
- *** IMACS (Indonesia Marine and Climate Support), 2015 [Fishery data collection protocol blue swimming crab (*Portunus pelagicus*), Indonesia]. USAID Indonesia, Jakarta, 29 p. [In Indonesian].
- *** MMAF (Ministry of Marine Affairs and Fisheries), 2016 Decree of the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia No. 70/Kepmen-KP/2016 concerning the management plan for blue swimming crab fisheries in fisheries management area of Indonesian Republic. Jakarta, Indonesia, 47 p. [In Indonesian].
- *** Sai Global, 2014 Marine stewardship council pre-assessment report for the Asosiasi Pengelolaan Rajungan Indonesia (APRI) Tiworo Strait, Southeast Sulawesi blue swimming crab trap and gillnet fisheries. Indonesia Marine and Climate Support (IMACS), Jakarta, 57 p.

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