Threat of small scale capture fisheries on the fish biodiversity in seagrass beds of Bontang, East Kalimantan, Indonesia

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Abstract. Small-scale fishing (SSF) activities have a significant role in supporting the fishermen along Indonesian coasts and, in particular, from the coastal areas of Bontang, East Kalimantan, Indonesia. The availability of fishing trap nets (local name "belat") in the coastal city of Bontang has reached 800 pieces. The aim of this study is to reveal threats affecting fish biodiversity in seagrass beds because of the use of trap nets. This study was conducted from December 2016 to November 2017. The data in this study was collected from 6 sampling stations (ST). These 6 seagrass observation stations were spread from the North to the South area of Bontang coastal waters. ST1, ST3 and ST5 were seagrasses connected to coral reefs, while ST2, ST4 and ST6 were seagrasses connected with mangroves. Observations on seagrass density along with observations regarding fish, crustaceans and molluscs collected using trap nets were conducted in each station. The results showed that there were 5 species of seagrass (*Enhalus acoroides*, *Thalassia hemprichii*, *Halophila minor, Cymodocea ratundata* and *Halodule pinifolia*). In addition, the use of trap nets negatively affected 79 fish species in seagrass beds. Furthermore, the loss of seagrass in Bontang coastal areas is estimated at around 5.17 ha. In conclusion, trap nets have damaged marine biodiversity, especially fish from seagrass beds.
Key Words: mangrove, marine biota, seagrass, trap net gear.

Introduction. Small-scale fisheries (SSF) have an important role in supporting fishermen (Purcell & Pomeroy 2015), in maintaining food security, as well as in reducing poverty (Barnes-Mauthe et al 2013). In Indonesia, SSF are the source of livelihood for fishermen in the coastal areas (Nababan et al 2008; Koeshendrajana et al 2012; Triarso 2012; Rahmi et al 2013; Nazmar 2014; Samosir et al 2014; Vibriyanti 2014). In addition, SSF facilitate the fulfilment of fish consumption for the community (FAO 2016; Wahyono 2016). Small scale fishermen apply traditional fishing strategies and patterns to improve their resilience in facing and responding to climate and fishing season constraints (Prihandoko et al 2011; Wiyono 2013; Siwat et al 2016).

Threats degrading coastal fishery resources can be driven by various sources, not only from the industrial sector, but also from SSF activities (Begossi 2013; Prabhakaran et al 2013). These various activities reduce and destroy the habitat and the biodiversity of marine resources, including the genetic diversity of fish (Jackson et al 2014). In the worst case scenario, degradation can lead to species extinction (Yusuf et al 2009; Ambariyanto 2017). SSF activities in Indonesian coastal areas tend to encourage overfishing, usually followed by a decrease in catches and disturbances in coastal ecosystems (Adam & Surya 2013; Nurhayati 2013; Yulianto et al 2016). These conditions were triggered by the limited skills of fishermen in selecting fishing gears (Wiyono 2009) and poor implementation of science and technology in fisheries (National Legal Development Agency of Ministry of Justice and Human Rights of Indonesia 2015). Regarding to those aforementioned conditions, it is important to optimize the implementation and development of comprehensive SSF policies (Koeshendrajana et al2012; Arief et al 2014; Romadhon 2014; Listriani & Roesa 2015; Purcell & Pomeroy 2015; Yulianto et al 2016).

Small scale fishing activities in Bontang coastal areas can be performed by the use of trap net gear (local name: "belat") (Agustina et al 2014). Trap net gear numbers have reached 800 units. Trap nets block fish and other biota (Fisheries, Maritime and Agriculture Affairs Office of Bontang City 2015) crossing the seagrass beds to other ecosystems, or biota that use seagrass beds as spawning grounds (Polte & Asmus 2006), nursery grounds (Erftemeijer & Allen 1993; Carroll & Peterson 2013) or feeding grounds (Hantanirina & Benbow 2013; Blandon & zu Ermgassen 2014). SSF fishermen seem to possess a low ability in selecting appropriate fishing gears. Usually, a mesh size of the chamber net (crib) of only 1 inch is used, encouraging increased ecological pressure on fish resources. For example, *Siganus canaliculatus* tends to be caught in small sizes, 10.2 cm in length and 13.8 g in weight (Agustina et al 2014; Mahardika et al 2015). The utilization of trap net gears in SSF has threatened both resources and biodiversity of fish in seagrass beds (Unsworth et al 2014) and in other coastal ecosystems (Hutchinson et al 2013; Irawan et al 2018). The purpose of this study is to examine the threat of trap net gear operations on fish biodiversity in the seagrass beds of Bontang, East Kalimantan, Indonesia.

Material and Method

Description of the study sites. This research was conducted in the coastal waters of Bontang City, East Kalimantan, Indonesia, from December 2016 to November 2017. There were six seagrass observation stations spreading out from the North to the South area of Bontang coastal waters (ST1: 0°11'38.26"N, 117°31'44.26"E; ST2: 0°9'55.58"N, 117°30'8.35"E; ST3: 0°8'56.13"N, 117°33'3.82"E; ST4: 0°8'20.70"N, 117°31'46.20"E; ST5: 0°5'44.50"N, 117°31'46.22"E; ST6: 0°4'22.99"N, 117°31'32.59"E). ST1, ST3 and ST5 were seagrass beds connected with coral reefs and found during the highest tide at a depth of 1-2 m and during the lowest tide at 0.3-0.5 m depth. The other stations, ST2, ST4 and ST6, were seagrass beds connected with mangroves and found during the highest tide at depths between 0.5 and 1 m and during the lowest tide they experienced temporal exposure.

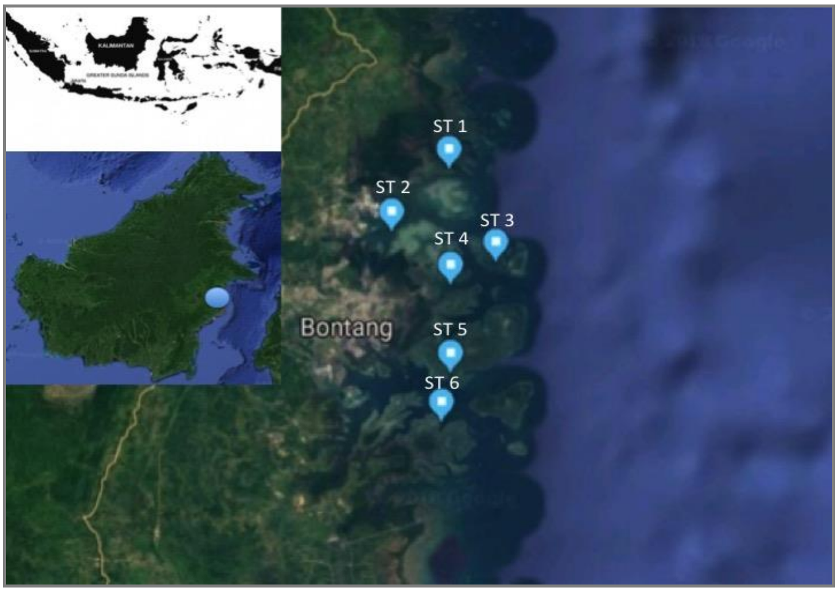

Figure 1. Research sites of trap net gear use in Bontang City, Indonesia.

Sampling stations. There were six sampling stations with trap net gears. In each station, fish, crustaceans, molluscs and seagrass were collected (Figure 1). Fishermen used the trap net gear to catch fish, crustaceans and molluscs, which were identified, counted, measured (total length) and weighed. Fish collection using trap net gears was conducted at the lowest tide, three times during a three-month interval. Fish species identification was conducted based on available scientific literature (Lovett 1981; Allen 1999; Verhoef 2009; Bergbauer & Kirschner 2011; Jones et al 2011; Wood & Michael 2011; Suyatna et al 2016).

Seagrass sampling. For seagrass sampling, each station had three line transects, and each transect consisted of 3 quadrant plots, sized 0.5x0.5 m (English et al 1994). Seagrass species were determined (Prasetya et al 2017; Riniatsih et al 2019). The identification of seagrass species was done according to existent scientific literature (den Hartog 1970; Kuo & McComb 1989; Fortes 1993; Tomascik et al 1997; Seagrass Watch 2010).

Description of the trap net gear. Although trap net gears operated in Bontang coastal waters are similar to the Nomura set nets, the trap net gear used has no buoys and anchors to hold up its main fence, wing and chamberpoles (Figure 2). A number of poles made of stems or branches were properly set to stretch the nets. One unit of trap net gears requires 175 poles, and covers 64.61 m^2 (Table 1). The trap net gear components and component sizes used in the sampling points can be observed in Table 1.

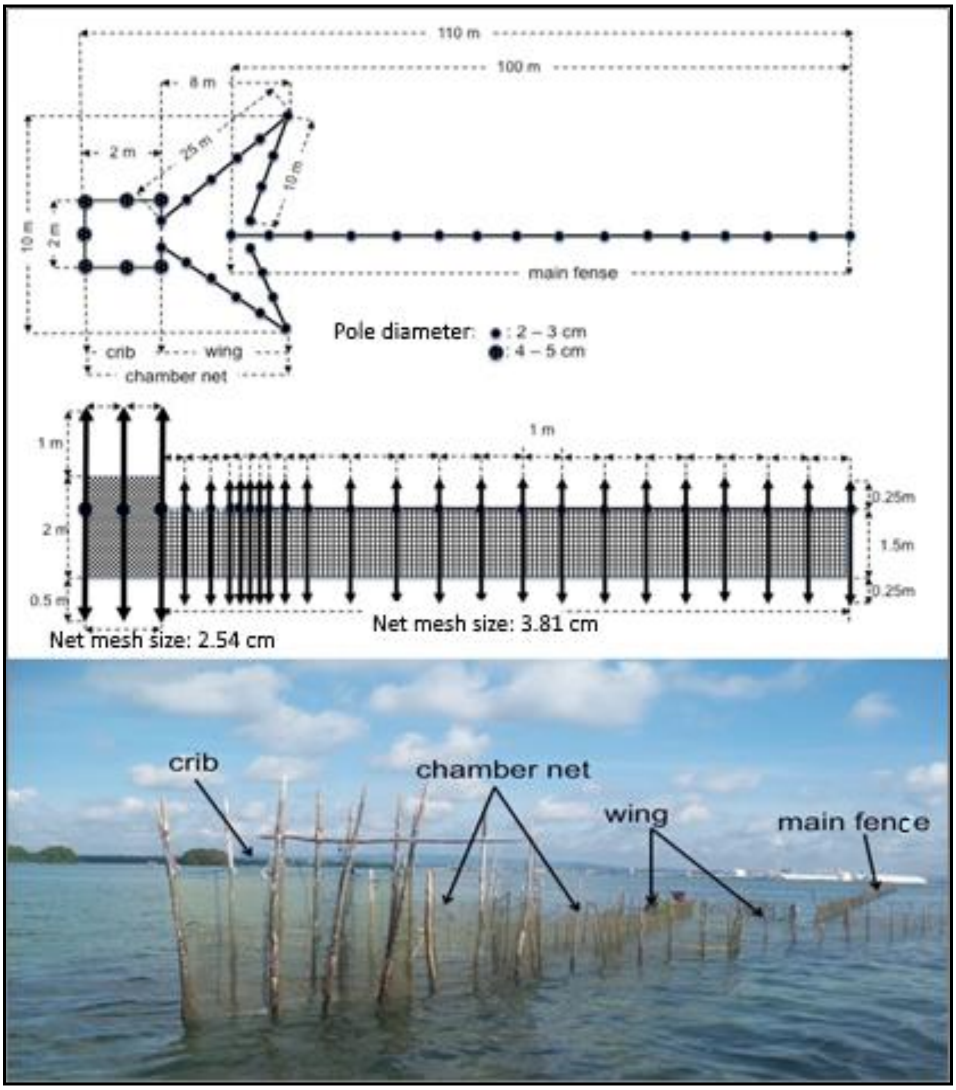

Figure 2. Characteristics of trap net gear from the Bontang City area.

Table 1

Trap net gear components and dimensions in Bontang coastal waters

No	*Component*	*Number*	*Length (m)*	*Width (m)*	*Diameter (cm)*	*Size (m^2)*	*800 unit set net (m^2)*
1	Chamber crib	1	2	2	-	4.	3200
2	Chamber wing	2	35	-	-	46.76	37408
3	Main fence	1	100	-	-	-	-
4	Chamber crib poles	7	3.5	-	6	1.98	1584
5	Right wing poles	34	2	-	3	2.40	1920
6	Left wing poles	34	2	-	3	2.40	1920
7	Main fence poles	100	2	-	3	7.07	5656
	Total Number					64.61	51688
		Crib		Wing		Main fence	
8	Net mesh size (cm)	2.54		3.81		3.81	

Statistical analysis. The data obtained from the study was analyzed using descriptive approach, tabulation, graph and correspondence analysis by statistical and quantitative approach and product–moment correlation (α=5%). Fish data was analysed regarding species composition, diversity index (H'), similarity index (E) and dominance index (C). Seagrass data was analysed based on density (D) (English et al 1994).

Results and Discussion

Seagrass. The study identified five species of seagrass, *Enhalus acoroides*, *Thalassia hemprichii*, *Halophila minor, Cymodocea ratundata* and *Halodule pinifolia*. These five species were found in ST1, where seagrasses connected with coral reefs, while ST4 was found to be the station with the highest density associated with mangroves (Figure 2a) for only one species, *Cymodocea ratundata* (Figure 2b).

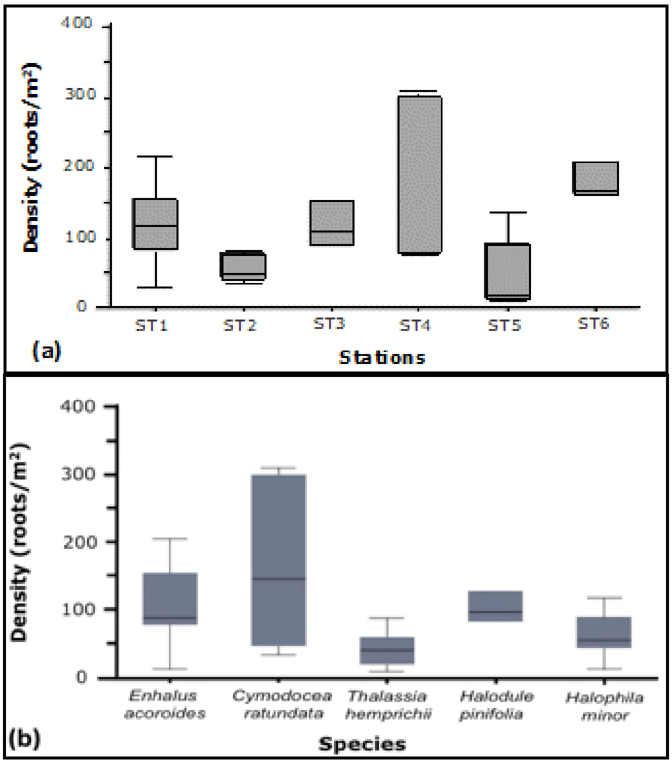

Figure 2. a - seagrass density based on stations; b - seagrass density based on seagrass species.

Fish, crustaceans and molluscs. The largest number of species caught in the trap net gear was found at ST4. There were 3386 individuals from 79 fish species belonging to 42 genera, 2 species of crustaceans belonging to 2 genera and 2 species of molluscs belonging to 2 genera (Table 2). Table 3 shows the analysis of both the diversity index value and the similarity index value. The diversity index is characterized by a moderate level, while the similarity index value is equal, as it reveals no domination among species. Based on the analysis of the correlation between fish and seagrasss density, a r value of +0.69 was determined, with a positive correlation.

Table 2

Species, length, weight and number of individuals

No	*Species*	*Total length (cm)*		*Weight (g unit^{-1}day^{-1})*		*Density (indv unit^{-1}day^{-1})*		
		range	mean	range	mean	Range	Mean±SD	%
	Fish							
1	*Abudefduf sexfasciatus*	5.5	5.5	3	3	5-7	6±1.2	0.18
2	*Aeoliscus strigatus*	7.5-10.5	9.8	4-9	5.3	37-53	46±8.3	1.36
3	*Alectes ciliaris*	12.5	12.5	39	39	2-7	4±2.5	0.12
4	*Apogonfuscus*	13.5-15	14.3	33-45	39	11-17	13±3.2	0.38
5	*Apogon kallopterus*	7-8	7.5	6-7	6.8	14-17	15±1.7	0.44
6	*Arothron hispindus*	16-23	19.3	108-312	175.6	18-24	22±3.2	0.65
7	*Arothron mappa*	21.5-29	25.3	226-582	404	0-12	7±6.2	0.21
8	*Arothron manillensis*	15-30	18.7	32-667	253.7	3-12	7±4.5	0.21
9	*Arothron nigropunctatus*	15	15.5	94	94	0-8	3±4.4	0.09
10	*Arothron immaculatus*	15.5	15.5	8.5	8.5	2-4	3±1.2	0.09
11	*Arothron reticularis*	18	18	185	185	3-9	6±3.1	0.18
12	*Arothron stellatus*	18.5-19	18.8	212-231	221.5	5-7	6±1.2	0.18
13	*Balistodes viridescens*	15.8	15.8	206	206	2-6	4±2.1	0.12
14	*Carangoides dinema*	18	18	85	85	7-8	8±0.6	0.24
15	*Carangoides ferdau*	15	15	52	52	2-4	3±1.2	0.09
16	*Carangoides caerulaurea*	7.5-13	10.4	5-96	20.2	91-119	106±14.1	3.13
17	*Caesio lunaris*	9-11	10	8-14	11	0-16	6±8.5	0.18
18	*Centriscus scutatus*	16.5	16.5	7	7	0-7	3±3.8	0.09
19	*Cheilodipterus intermedius*	11	11	18	18	5-12	8±3.6	0.24
20	*Chromis xanthura*	12-15	13.7	19-38	30.3	13-34	24±10.5	0.71
21	*Colurodontis paxmani*	18.5	18.5	92	92	2-5	3±1.5	0.09
22	*Ctenochaetus striatus*	10.7-25	17.9	21-277	149	0-6	3±3.1	0.09
23	*Cymbacephalus beauforti*	21.5	21.5	29.9	29	2-4	3±1.2	0.09
24	*Epinephelus caeruleopunctatus*	13	13	29	29	1-11	5±5.3	0.15
25	*Epinephelus polylepis*	28	28	286	286	0-16	6±8.5	0.18
26	*Epinephelus quoyanus*	22.5	22.5	157	157	5-7	6±1.2	0.18
27	*Epinephelus tukula*	12.2-15	13.4	36-58	45.7	17-22	20±2.6	0.59
28	*Fistularia petimba*	70	70	148	148	4-9	6±2.6	0.18
29	*Gazza*sp.	6.5	6.5	5	5	1-7	3±3.5	0.09
30	*Gazza minuta*	6-8	6.7	3-9	5.4	31-39	36±4.2	1.06
31	*Gerres abbreviates*	10-13	11.5	21-45	33	1-6	3±2.5	0.09
32	*Gerres flamentous*	8.5-15.5	12	6.7-156	30.2	194-211	202±8.5	5.97
33	*Lactoria cornuta*	23	23	151	151	2-4	3±1.2	0.09
34	*Leiognathus equulus*	5.5-10.5	7.2	2.0-21	6	433-811	663±202.1	19.58
35	*Leiognathus smithursti*	10	10	18	18	0-6	3±3.1	0.09
36	*Leiognathus fasciatus*	7-7.5	7.3	6-80	43	43-61	51±9.2	1.51
37	*Lethrinus lentjan*	12-18.5	15.4	21-97	57.7	29-54	38±14.2	1.12
38	*Lethrinus miniatus*	18	18	97	97	0-24	11±12.1	0.32
39	*Lethrinus semicinctus*	11.7	11.7	19	19	1-6	4±2.5	0.12
40	*Liza subviridis*	31	31	377	377	3-11	7±4.0	0.21
41	*Lutjanus* sp.	6.5-8.5	7.3	3-7	4.5	0-13	4±7.5	0.12
42	*Lutjanus lutjanus*	9.5-15	12.3	10-38	23.6	35-41	39±3.2	1.15
43	*Lutjanus decussates*	12-14.2	13	25-48	34.5	3-9	7±3.5	0.21
44	*Lutjanus ehrenbergi*	17	17	94	94	3-4	4±0.6	0.12
45	*Lutjanus fulviflamma*	13-18.5	15.8	16.5-85	58.8	19-27	22±4.4	0.65
46	*Lutjanus quinquelineatus*	5-15.5	12.7	2-65	38.1	22-34	29±6,1	0.86
47	*Lutjanus rasselli*	8-19.8	13	6-122	48.5	3-16	7±7.5	0.21
48	*Monacanthus chinensis*	5.7-19	11.7	6-82	30	15-39	28±12.1	0.83
49	*Pantolobus radiates*	15	15	29	29	1-9	3±4.9	0.09

Table 2 (continuation)

Species, length, weight and number of individuals

No	Species	*Total length (cm)*		*Weight (g unit^{-1} day^{-1})*		*Density (indv unit^{-1} day^{-1})*		
		range	mean	range	mean	Range	Mean±SD	%
50	*Parachaetodon ocellatus*	7.5-10.2	9.2	8-3	25.9	53-76	63±11.9	1.86
51	*Paramonacanthus choirochephalus*	13	13	25	25	4-5	6±2.6	0.18
52	*Paraplotosus albilabris*	12-13	12.8	10-15.6	13.5	667-825	768±88	22.68
53	*Parascolopsis eriomma*	20.5-26.5	22.7	117-267	173.3	7-12	9±2.9	0.27
54	*Pardachirus pavoninus*	17-18.5	17.4	64-112	82.8	25-29	26±2.3	0.77
55	*Pelates quadrilineatus*	11.2-13	12.3	19-243	108.5	97-121	105±13.6	3.10
56	*Pentapondus bifasciatus*	9.5-17	13.5	10-53	36.6	28-35	31±3.8	0.92
57	*Phyllichthys punctatus*	29	29	318	318	0-7	4±3.6	0.12
58	*Platax batavianus*	5.5	5.5	6	6	0-7	3±3.5	0.09
59	*Platax teira*	5-15.5	9.3	18-18	20.5	8-14	12±3.2	0.35
60	*Pseudomonacanthus macrrurus*	8-9.5	8.6	9-18	15.5	2-6	4±2.1	0.12
61	*Pseudorhombus arsius*	15	15	42	42	1-12	5±5.9	0.15
62	*Pseudorhombus* sp.	15	15	42	42	1-9	4±4.6	0.12
63	*Rastrelliger brachysoma*	16	16	41	41	0-11	4±5.9	0.12
64	*Selar boops*	12-14	13.2	9.5-30.4	23.5	221-253	241±17.2	7.12
65	*Scolopsis ciliates*	10-16.5	13.2	16-67	37.1	66-87	75±10.8	2.22
66	*Scomberoides tala*	7.5-22	22.6	3-59	37.2	15-23	20±4.6	0.59
67	*Siganus canaliculatus*	9.2-18	12.7	11-89	29.4	227-244	235±8.6	6.94
68	*Siganus doliatus*	11.2	11.2	21	21	5-9	6±2.3	0.18
69	*Siganus guttatus*	24	24	274-255	264.5	3-13	7±5.1	0.21
70	*Siganus spinus*	9.5	9.5	19	19	0-8	3±4.4	0.09
71	*Scarus chameleon*	26-27	26.5	223-270	246.5	4-11	7±3.8	0.21
72	*Siganus ghobban*	13	13	45	45	0-7	3±3.5	0.09
73	*Sphyraena jello*	16-24	20.3	21-69	45.7	11-15	13±2.1	0.38
74	*Spratelloides robustus*	8.5-9.5	9	5-7	6	6-15	14±7.5	0.41
75	*Stolephorus indicus*	9.3-10.7	9.9	7-10	8.3	9-15	13±3.2	0.38
76	*Strongylura lieura*	42.5-46	44.8	110-162	129	14-19	17±2.9	0.50
77	*Tylosurus gavialoides*	46.5-51	48.8	162-225	193.5	11-17	13±3.2	0.38
78	*Upenus tragula*	12-16.7	14.3	20-48	32.2	2-32	16±15.1	0.47
79	*Xenojulis margaritaceous*	10-13.7	12.2	21-53	40.3	8-14	10±3.5	0.30
	Crustaceans							
80	*Portunus* sp.	10-16.5	12.1	41-219	115.7	32-39	35±3.8	1.03
81	*Scylla* sp.	2.5-21.5	10.1	2-85	48	11-17	15±3.2	0.44
	Molluscs							
82	*Loligo vulgaris*	22-33	26.3	36-198	66.6	24-37	31±6.5	0.92
83	*Sepia* sp.	16-35	25.3	13-108	54	44-58	49±7.8	1.45

Note: SD – standard deviation; indv – individuals.

Fish, crustaceans and molluscs in seagrass beds. Five types of seagrass species were found in the six stations. *C. rotundata* and *E. acoroides* were species with the highest density (Figure 2). Seagrass beds are fundamentally important for the 79 identified fish species (Table 2). The presence of fish species had a positive correlation with the density level of seagrass beds (r=0.69). As shown in Table 2, most fish species were found in seagrassbeds, generally small in size and particularly in their juvenile stages, except *Apogon fuscus*, *Centriscus scutatus*, *Cheilodipterus intermedius, Colurodontis paxmani*, *Ctenochaetus striatus*, *Liza subviridis*, *Phyllichthys punctatus* and *Spratelloides robustus*. A group of crustaceans and some mollusc species were also found. The species of molluscs captured were *Loligo vulgaris* and *Sepia* sp. with the approximate length of 26.3 cm and 25.3 cm, respectively.

Table 3

Number of species, density of fish, diversity index (H'), similarity index (E), and dominance index (C)

Station	*Number of Species*	*Fish Density (%)*	*Diversity Index (H')*		*Similarity Index (E)*		*Dominance Index (C)*	
			range	Mean	range	mean	range	mean
ST1	29	45.4±3.1	1.4-1.8	1.6±0.2	0.5-0.6	0.5±0.04	0.4-0.5	0.4±0.06
ST2	26	12.4±1.9	2.1-2.5	2.3±0.2	0.7-0.8	0.7±0.06	0.1-0.2	0.2±0.05
ST3	22	8.3±1.3	2.0-2.2	2.1±0.1	0.7-0.8	0.8±0.01	0.1-0.2	0.2±0.03
ST4	38	16.4±1.8	2.1-2.2	2.1±0.1	0.6-0.7	0.6±0.02	0.1-0.2	0.3±0.01
ST5	23	7.5±0.9	2.3-2.5	2.4±0.1	0.8-0.9	0.8±0.03	0.1-0.2	0.1±0.02
ST6	22	9.9±2.4	1.7-1.9	1.9±0.2	0.6-0.7	0.7±0.06	0.2-0.3	0.3±0.06

The percentage of the number of species found in seagrass beds connected with coral reefs (ST1, ST3 and ST5) was 61.3%. This result is much higher than that found in seagrass beds connected with mangroves (ST2, ST4 and ST6), of 38.7%. Meanwhile, the value of the diversity index was relatively similar, ranging between 2.03 and 2.10, on average. It indicates that the spread of fish species is characterized by the interaction between seagrass beds and other ecosystems (mangroves and coral reefs), the existence of seagrass species being part of the life cycle of the ecosystems (Erftemeijer & Allen 1993; Polte & Asmus 2006; Carroll & Peterson 2013; Hantanirina & Benbow 2013; Blandon & zu Ermgassen 2014).

Based on the average number of fish species caught in seagrass beds, there were 10 dominant species. The total percentage of these 10 caught species was 74.10%. 4 of these species, *Paraplotosus albilabris, Leiognathus equulus, Parachaetodon ocellatus* and *Leiognathus fasciatus* tended to inhabit coral reefs during their adult phase. Meanwhile, 3 species, *Gerres flamentous, Carangoides caerulaurea* and *Pelates quadrilineatus* tended to live in coastal water and estuarines in adult phase. Furthermore, *Scolopsis ciliatus* tends to inhabit mud-sand bottom in adult phase, and both *Selar boops* and *Siganus canaliculatus* tend to live in seagrass beds, weedy areas, in their adult phase (Allen 1999). This shows that seagrass beds are nursery grounds, feeding grounds and also provide shelter (spatial and temporal patterns) for some species, before heading to the adult habitat in other coastal ecosystems (Irawan et al 2018).

The result of the correspondence analysis based on the total length of fish species found at each station (Figure 3) showed that the fish species originating from *Leiognathus* and *Platax* genera were inextricably linked with ST1 (19.28%). This station was also a habitat for *Loligo* spp. and *Siganus canaliculatus*. Moreover, fish species *Lethrinus semicinctus*, *Lutjanus quinquelineatus* and *Selar boops* were also associated with their seagrass beds, especially in ST2 (3.62%). Meanwhile, *Siganus* and *Sepia* genera were closely associated with ST3 (10.84%). 24.10% of the fish species distribution was represented by *Epinephelus* and *Arothron* genera, with a close relationship with ST4. At last, at ST5 and ST6, *Lutjanus* and *Gerres* genera were represented in each station by 8.43% and 9.64%, respectively.

Threat of the trap net gears. The operation of trap net gears caused harm to the seagrass beds. Each unit is 64.61 m^2 wide, and, therefore, 800 units reach up to 51688 m^2 (5.17 ha) (Table 1). The large loss of seagrass bed areas contribute to the decline of the fauna in seagrass beds (Irawan 2011; Irawan 2014). Another consequence was spatial competition among species, which is considerably high, as well as the declining number of fish species (Ambo-Rappe et al 2013; Schaffler et al 2013; McCloskey & Unsworth 2015).

Trap net gear is operated throughout the year in Bontang coastal waters. Time selection in operating trap net gear is usually not applied properly and becomes the main reason for the harm of various fish species from seagrass beds (Torre-Castro et al 2008). Moreover, there is a tendency of a lower average value of the diversity index in ST1 and ST6 than that found in other stations (Table 3). This result is associated with a higher number of trap net gears operated in those areas. It can be stated that the seagrass beds from this study were not a good fishing ground for fish species with a high economic value.

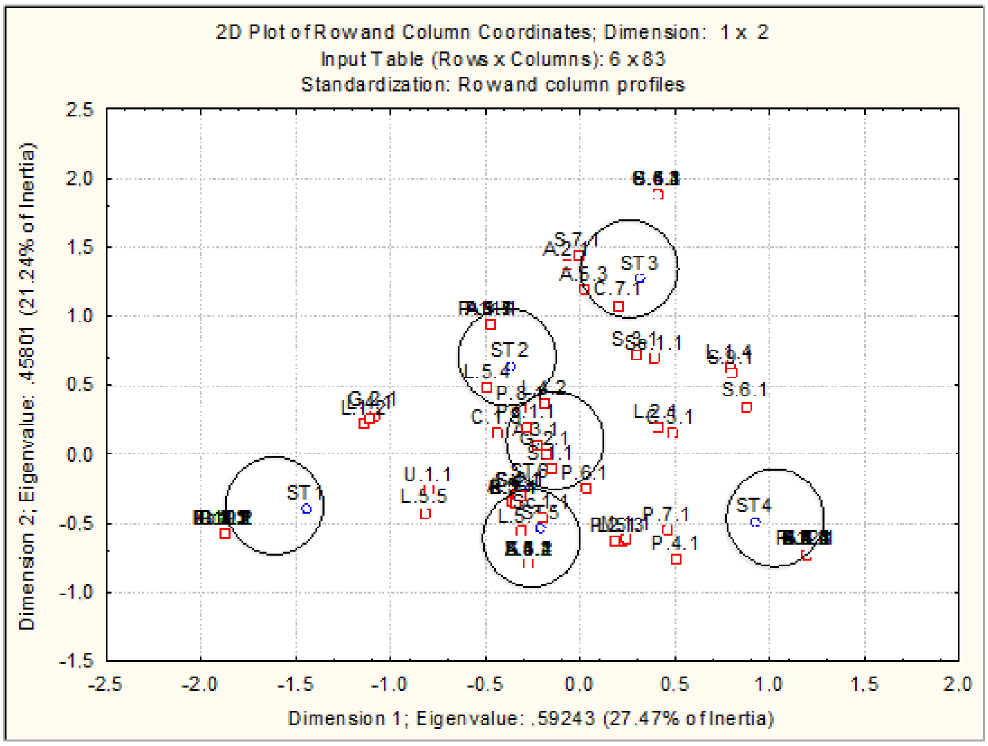

Figure 3. Correspondence analysis with 100% of inertia based onthe total length of fish, crustacean and mollusc species.

Fish capture activities with trap net gears made by fisherman along Bontang coastal waters greatly affected other ecosystems, especially mangroves (Erwiantono et al 2016). In addition, the number of poles per unit was 175 (Table 1). Thus, there were 140000 poles required for 800 units. Both right-wing and left-wing poles, as well as main fence poles are able to endure about six months and have to be replaced afterwards. Meanwhile, chamber-crib poles can last for a year and it is estimated that the stems and branches used yearly sum up to approximately 274400 for 800 units. In 5 years, the operation of trap net gears requires more or less 1372000 stems. Consequently, at least 1 million trees are cut down yearly for this operation.

The fluctuations in fish catch results eventually affect the income of fishermen. Some fishermen are encouraged to work on new strategies to deal with these fluctuations. They usually select traditional methods and add more units and fishing gear coverage in terms of width (lengthening the wing and main fence) and height of the trap. However, these strategies lead to more serious problems, like overfishing and the utilization of seagrass beds, mangrove stems and branches for fishing.

Conclusions. Although small-scale fisheries can be considered as significant income sources for fishermen, the operation of trap net gear in seagrass beds tends to bring negative impacts on the ecosystem. It does not only directly threat seagrass, but it also damages marine fish biodiversity and density, especially the marine fish populations in seagrass beds. It even leads to biodiversity loss in the surrounding ecosystems. The more operations of trap net gears exist, the higher damage to mangroves will be. The damage on seagrass and mangrove ecosystems ultimately reduces the water productivity and cause the loss of ecosystems (seagrass and mangrove). Consequently, it is necessary to create and implement a comprehensive management plan for the operation of the trap net gears in seagrass beds.

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