Study on the effect of ghost fishing on uncountable fishery mortality of BSC in Surat Thani Province

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Ghost fishing is a fishing gear that has been lost and lost control of the fishery where it is still able to catch fish, causing continued death by lost fishing gear from normal fishing (Way, 1976) because when fishing gear is lost Such an apparatus can continue to catch fish for a period until it loses its catch condition, which varies according to the type and material of the fishing gear. When a fishing gear is lost to nature, its catch is not only the target fish being caught but also other fish being caught and lost without exploitation. In addition, the ghost gear could damage the bottom water environment (Brown and Macfadyen, 2007), and affect vulnerable ecosystems such as seagrass ecosystems. coral ecosystems, etc. It may also affect rare marine species (protected marine species) such as whales, dolphins, turtles, and dugongs. Most modern fishing gear is often made up of durable materials that do not decompose in nature. When this fishing gear is lost to the sea, it tends to remain in the environment for a long time and can continue to catch fish for long periods of time and causing significant environmental and economic losses. As a result, the issue of uncountable fishery mortality due to various types of fishing gears has become an issue of fisheries scientists and scientific studies. In the past, Thailand's BSC fishery, the fishing gear includes crab trap and crab gill nets (Sonthaya et al., 2017), which have been lost. As can be seen from the BSC fishing, ghost fisheries in the crab trap are found at a high rate while the occurrence of ghost fisheries in crab gill nets was secondary (Putsa et al., 2016), this was one of the main concerns for the assessment of BSC improvement projects 2018 (Assessment Document for BSC Fisheries Improvement Project, 19-20 April 2018, Department of Fisheries, Bangkok). Therefore, the objectives of a study to assess ghost fishing mortality of fishing gear Crab trap and crab gill nets of BSC fishing in Surat Thani Province was to analyze the catching efficiency of crab trap and crab gill nets and the impact of crab trap and crab gill nets on aquatic resources in order to propose guidelines and measures for sustainable BSC fishery resources management.

Methodology

1. Study area

Conducting an experimental study and collecting data in Surat Thani Province by selecting the experimental station (Quasi-experiment) at 3 stations, namely

1. Ban Hat Somboon, Tha Chana District,

2. Ban Takrob, Chaiya District, and

3. Nang Kam Beach, Don Sak District (Figure 1).

The experimental study area was the area where local fishermen of BSC fishing is operated.

Figure 1 shows the experimental and sampling station

2. Study process

In the present study, each station used crab trap and gill nets in the same way that fishermen used to fish. Each station will consist of 20 sets of crab traps (1 set consisting of 9 traps, size 36 x 54 x 19 cm. Each trap will be tied with a rope, each 10 meters long) and crab gill nets (size 60 x 1.5 m.) of 20 pieces (Figure 2). The crab trap and the crab gill net will be placed approximately 1 kilometer apart. For the crab trap experiment will use the bait on the first day of experiment.

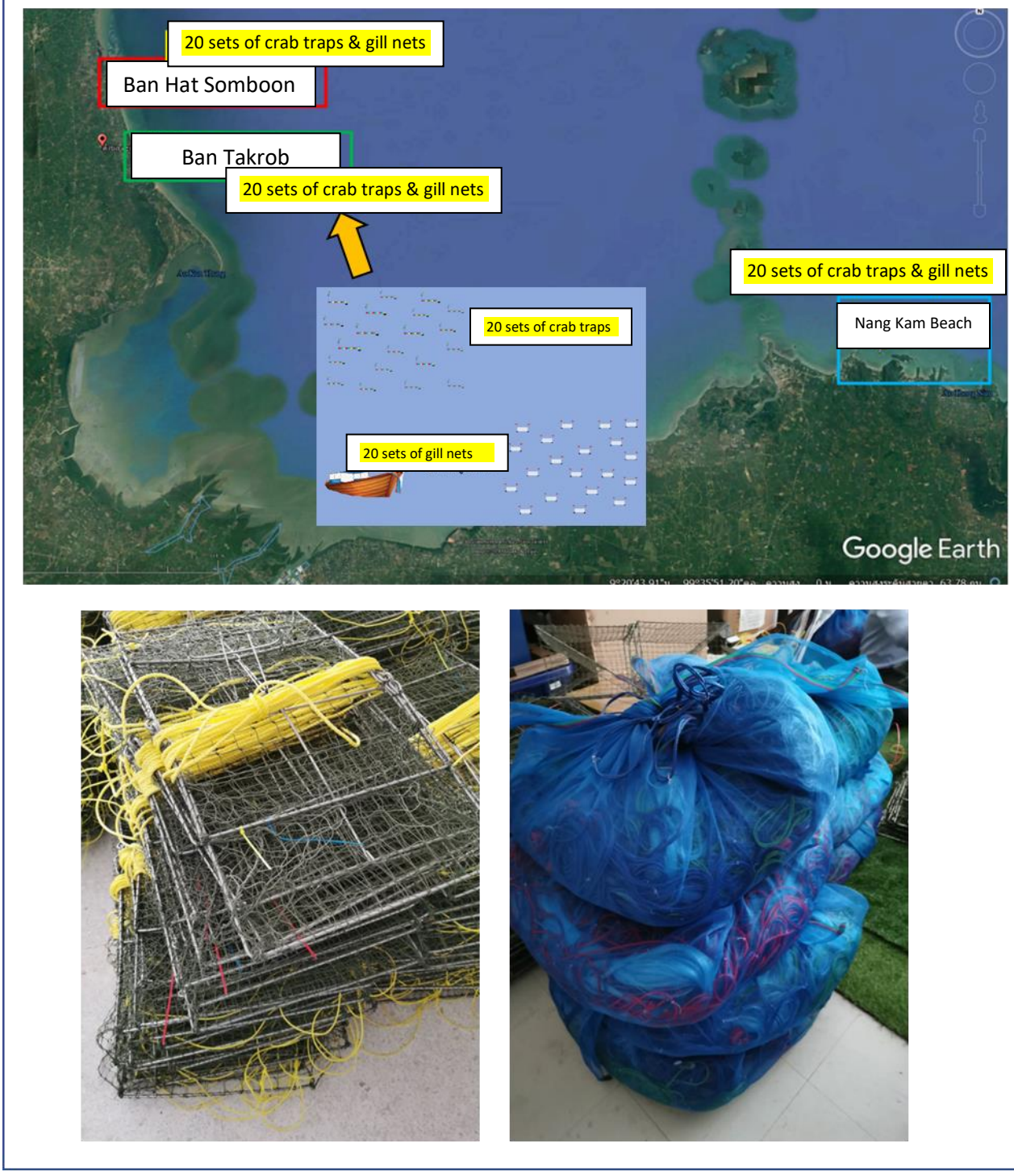

Figure 2 shows a set of crab traps and crab gill nets at each station.

Surveying and data collection at each station will collect traps and gill nets 1 set at a time (1 set of traps and 1 gill net) without returning to the sea. Trap and gill net are collected for the first month every 3 days, the second and third months are every 15 days, and the fourth and subsequent months are collected once a

month until it is ineffective for catching fish. In addition, SCUBA diving will be surveyed and recorded to help record images and assess the catching effectiveness of fishing gear.

3. Data Analysis

Data from the sample collection included catch composition, species classification and count, and the condition of each type of fishing gear.

4. Results

From the study of the effect of ghost fishing on uncountable fishery mortality during September 2021 to April 2022, catch results of fisheries at each station can be divided as follows:

Ban Hat Somboon Station

The samples were collected by 13 sets of 117 crab traps. A total of 124 individuals from 18 species of aquatic animal were entrapped by 13 sets. A total of 43 BSCs (34.68%) which was target species were trapped. While 81 individuals (65.2%) from 17 species of non-Target species were also trapped. Moreover, the Swimming Crab (*Charybdis anisodon*) was the most abundant species in non-Target species in this study. A total of 21 individuals (25.93%) were trapped (Table 1).

Table 1 shows the species and number of non-target species from crab traps fishery gear, Ban Hat Somboon fishing area.

Common name	Species name	Number	%
Screw turret	*Turritella terebra*	1	1.23
Melongena	*Hemifusus* sp.	1	1.23
Shouldered castor bean	*Drupella margariticola*	2	2.47
Blood Cockle	*Tegillarca nodifera*	8	9.88
Hermit crab	*Clibanarius infraspinatus*	3	3.70
Swimming crab	*Charybdis feriata*	1	1.23
Swimming crab	*Charybdis affinis*	6	7.41
Swimming crab	*Charybdis anisodon*	21	25.93
crab	*Sphaerozius* sp.	8	9.88
appendage of crab	Unidentified	1	1.23
Egg capsules of the cuttlefish	Unidentified	4	4.94
Striped eel catfish	*Plotosus linneatus*	4	4.94

Common name	Species name	Number	%
Orange-spotted grouper	*Epinephelus coioides*	4	4.94
Largescaled terapon	*Terapon theraps*	4	4.94
Jarbua terapon	*Therapon jarbua*	7	8.64
Spotted scat	*Scatophagus argus*	1	1.23
Streaked spinefoot	*Siganus javus*	5	6.17
Total		81	100.00

The Sample collection by gill nets, total of 13 pieces. A total of 151 individuals from 22 species of aquatic animal were caught by 13 pieces. A total of 84 BSCs (55.63%) which was target species were caught from gill nets. While 67 individuals (44.37%) from 21 species of non-Target species were also trapped. Moreover, the Spined murex Conchs (*Murex* sp.) and Rare spined murex (*Murex trapa)* were abundant species in non-Target species in this study which they were caught for 22 (32.84%) individuals and 20 (29.85%) individuals, respectively (Table 2).

Table 2 shows the species and number of non-target species from gill nets fishery gear, Ban Hat Somboon fishing area.

Common name	Species name	Number	%
Screw turret	*Turritella terebra*	1	1.49
Spiral melongena	*Pugilina* sp.	1	1.49
Rock snail	*Indothais* sp.	1	1.49
Rare spined murex	*Murex trapa*	20	29.85
Spined murex	*Murex* sp.	22	32.84
Melongena	*Hemifusus* sp.	1	1.49
Blood Cockle	*Tegillarca nodifera*	1	1.49
Swimming crab	*Charybdis anisodon*	4	5.97
Swimming crab	*Charybdis feriata*	1	1.49
Spiny claw swimming crab	*Thalamita spinimana*	1	1.49
crab	*Sphaerozius* sp.	1	1.49
Peregrine crab	*Varuna litterata*	1	1.49
Mangrove stone crab	*Myomenippe hardwickii*	1	1.49
appendage of crab	Unidentified	1	1.49

Common name	Species name	Number	%
Mantis shrimp	*Oratosquilla nepa*	2	2.99
Indo-Pacific horseshoe crab	*Tachypleus gigas*	3	4.48
Mangrove horseshoe crab	*Carcinoscorpius rotundicauda*	1	1.49
Octopus	*Octopus* sp.	1	1.49
Egg capsules of the cuttlefish	Unidentified	1	1.49
Veined catfish	*Arius venosus*	1	1.49
Shortfin lizardfish	*Saurida micropectoralis*	1	1.49
Total		67	100.00

Ban Ta Krob Station

The samples were collected by 13 sets of 117 crab traps. A total of 164 individuals from 18 species of aquatic animal were entrapped by 13 sets. A total of 32 BSCs (19.51%) which was target species were trapped. While 132 individuals (80.49%) from 17 species of non-Target species were also trapped. Moreover, the Swimming Crab (*Charybdis anisodon*) and Rabbitfishes (*Siganus canaliculatus)* were abundant species in non-Target species in this study which they were trapped for 54 (40.91%) individuals and 43 (32.58%) individuals, respectively (Table 3).

Table 3 shows the species and number of non-target species from crab traps fishery gear, Ban Ta Krob fishing area.

Common name	Species name	Number	%
Ternate false fusus	*Brunneifusus ternatanus*	1	0.76
Rare spined murex	*Murex trapa*	1	0.76
Short necked clam	*Paphia undulata*	5	3.79
Blood Cockle	*Tegillarca nodifera*	1	0.76
Swimming crab	*Charybdis anisodon*	54	40.91
Octopus	*Octopus* sp.	1	0.76
Cuttlefish	*Sepia* sp.	1	0.76
Egg capsules of the cuttlefish	Unidentified	1	0.76
Gray eel-catfish	*Plotosus canius*	2	1.52
Orange-spotted grouper	*Epinephelus coioides*	5	3.79
Sixbar grouper	*Epinephelus sexfasciatus*	2	1.52

Common name	Species name	Number	%
Largescaled terapon	*Terapon theraps*	3	2.27
Jarbua terapon	*Therapon jarbua*	5	3.79
Broadbanded cardinalfish	*Ostorhinchus fasciatus*	3	2.27
Streaked spinefoot	*Siganus javus*	3	2.27
White-spotted spinefoot	*Siganus canaliculatus*	43	32.58
Pig faced leather jacket	*Paramonacanthus choirocephalus*	1	0.76
Total		132	100.00

The Sample collection by gill nets, total of 13 pieces. A total of 191 individuals from 22 species of aquatic animal were caught by 13 pieces. A total of 140 BSCs (73.30%) which was target species were caught from gill nets. While 51 individuals (26.70%) from 21 species of non-Target species were also trapped. Moreover, the Spiral melongena (*Brunneifusus ternatanus*) was the most abundant species in non-Target species in this study. A total of 12 individuals (23.53%) were trapped (Table 4).

Table 4 shows the species and number of non-target species from gill nets fishery gear, Ban Ta Krob fishing area.

Common name	Species name	Number	%
Ternate false fusus	*Brunneifusus ternatanus*	12	23.53
Dog conch	*Laevistrombus canarium*	1	1.96
Common frog shell	*Bufonaria rana*	1	1.96
Rare spined murex	*Murex trapa*	4	7.84
Blood Cockle	*Tegillarca nodifera*	1	1.96
Orange-striped hermit crab	*Clibanarius infraspinatus*	3	5.88
Swimming crab	*Charybdis anisodon*	1	1.96
Spider crab	*Doclea armata*	1	1.96
Sentinel crab	*Macrophthalmus* sp.	1	1.96
Spotted moon crab	*Matuta victor*	1	1.96
Mangrove stone crab	*Myomenippe hardwickii*	5	9.80
Peregrine crab	*Varuna litterata*	1	1.96
Mantis shrimp	*Oratosquilla nepa*	1	1.96

Common name	Species name	Number	%
Mangrove horseshoe crab	*Carcinoscorpius rotundicauda*	3	5.88
Starfish	Asteroidea	7	13.73
Bengal whipray	*Himantura imbricata*	1	1.96
Daggertooth pike conger	*Muraenesox cinereus*	1	1.96
Striped eel catfish	*Plotosus linneatus*	1	1.96
Bartail flathead	*Platycephalus indicus*	1	1.96
Macau sole	*Cynoglossus trulla*	2	3.92
White-spotted spinefoot	*Siganus canaliculatus*	2	3.92
Total		51	100.00

Hat Nang Kam Station

The samples were collected by 12 sets of 108 crab traps. A total of 123 individuals from 29 species of aquatic animal were entrapped by 12 sets. A total of 13 BSCs (10.57%) which was target species were trapped. While 110 individuals (89.43%) from 28 species of non-Target species were also trapped. Moreover, the Swimming Crab (*Charybdis anisodon*) and Sea Urchins (*Temnopleurus toreumaticus)* were abundant species in non-Target species in this study which they were trapped for 25 (22.73%) individuals and 13 (11.82%) individuals, respectively (Table 5).

Table 5 shows the species and number of non-target species from crab traps fishery gear, Hat Nang Kam fishing area.

Common name	Species name	Number	%
Sea anemone	Unidentified	7	6.36
Rock snail	*Indothais* sp.	2	1.82
Spiral melongena	*Pugilina* sp.	1	0.91
Spined murex	*Murex* sp.	3	2.73
White Phos	*Nassaria pusilla*	1	0.91
Fawn Sand Snail	*Natica vitellus*	1	0.91
Orange-striped hermit crab	*Clibanarius infraspinatus*	4	3.64
Hermit crab	*Diogenes* sp.	1	0.91
Swimming crab	*Charybdis affinis*	25	22.73
Swimming crab	*Charybdis feriata*	2	1.82

Common name	Species name	Number	%
Spider crab	*Doclea armata*	4	3.64
Mangrove stone crab	*Myomenippe hardwickii*	2	1.82
Green Tiger Prawn	*Penaeus semisulcatus*	1	0.91
Egg capsules of the cuttlefish	Unidentified	6	5.45
Sea uchin	*Temnopleurus toreumaticus*	13	11.82
Brittle star	*Ophiocnemis* sp.	10	9.09
Ball sea cucumbers	*Phyllophorella kohkutiensis*	2	1.82
Sea cucumber	*Mensamaria* sp.	5	4.55
Sea cucumber	Cucumariidae	1	0.91
-	Unidentified	4	3.64
Striped eel catfish	*Plotosus linneatus*	1	0.91
Threespine Frogfish	*Batrachomoeus trispinosus*	2	1.82
Orange-spotted grouper	*Epinephelus coioides*	1	0.91
Sixbar grouper	*Epinephelus sexfasciatus*	2	1.82
Broadbanded cardinalfish	*Ostorhinchus fasciatus*	4	3.64
Tropical sand goby	*Acentrogobius caninus*	3	2.73
White-spotted spinefoot	*Siganus canaliculatus*	1	0.91
Pufferfishes	*Chelonodon* sp.	1	0.91
Total		110	100.00

The Sample collection by gill nets, total of 12 pieces. A total of 222 individuals from 31 species of aquatic animal were caught by 12 pieces. A total of 28 BSCs (12.61%) which was target species were caught from gill nets. While 194 individuals (87.39%) from 30 species of non-Target species were also trapped. Moreover, the Spined murex Conchs (*Murex* sp.) and Rare spined murex (*Murex trapa)* were abundant species in non-Target species in this study which they were caught for 87 (44.85%) individuals and 30 (15.46%) individuals, respectively (Table 6).

Table 6 shows the species and number of non-target species from gill nets fishery gear, Hat Nang Kam fishing area.

Common name	Species name	Number	%
Sea anemone	Sea anemone	10	5.15

Common name	Species name	Number	%
Rock snail	*Indothais* sp.	2	1.03
Spiral melongena	*Pugilina* sp.	1	0.52
Melongena	*Hemifusus* sp.	1	0.52
Rare spined murex	*Murex trapa*	30	15.46
Spined murex	*Murex* sp.	87	44.85
Noble volute	*Cymbiola nobilis*	2	1.03
Orange-striped hermit crab	*Clibanarius infraspinatus*	2	1.03
Hermit crab	*Diogenes* sp.	3	1.55
Swimming crab	*Charybdis affinis*	7	3.61
Swimming crab	*Charybdis anisodon*	1	0.52
Spiny claw swimming crab	*Thalamita spinimana*	1	0.52
Spider crab	*Doclea armata*	3	1.55
Mangrove stone crab	*Myomenippe hardwickii*	3	1.55
Mud crab	*Scylla* sp.	1	0.52
Mantis shrimp	*Oratosquilla nepa*	1	0.52
Mantis shrimp	*Oratosquillina interrupta*	1	0.52
Egg capsules of the cuttlefish	Unidentified	8	4.12
Indo-Pacific horseshoe crab	*Tachypleus gigas*	3	1.55
Sea uchin	*Temnopleurus toreumaticus*	2	1.03
Brittle star	*Ophiocnemis* sp.	3	1.55
Ball sea cucumbers	*Phyllophorella kohkutiensis*	6	3.09
Thorny sea cucumber	*Colochirus quadrangularis*	1	0.52
Sea cucumber	*Mensamaria* sp.	5	2.58
-	Unidentified	2	1.03
Sagor catfish	*Hexanematichthys sagor*	3	1.55
Sixbar grouper	*Epinephelus sexfasciatus*	2	1.03
Tigertooth croaker	*Otolithes ruber*	1	0.52
Largescaled terapon	*Terapon theraps*	1	0.52
White-spotted spinefoot	*Siganus canaliculatus*	1	0.52

Common name	Species name	Number	%
Total		194	100.00

From collecting samples and surveying crab traps and crab gill nets at all 3 stations, it was not found that both types of fishing gear were attached to aquatic animals; Endangered, Threatened and Protected Species (ETP Species). As well as from asking fishermen who fish nearby, it was not found that any fishing gear was slip through or lost to attached rare aquatic animals or protected marine animals such as Sea Turtle, Dolphin, dugon and Sea Horse.

From the analysis of the catch efficiency of Crab Traps, it was found that crab traps were effective in catching aquatic animals during the first month and will reduce the fishing efficiency in the 2nd month with the eyes of the crab trap's nets began to break and creatures began to cling the traps such as seaweed, barnacles and there is sediment on the crab trap's nets. In the 3rd month, the crab traps begin to sink in the sediment, some traps are folded that they can't catch any fish, there is a large amount of sediment covering the nets, there are any seaweed and barnacles growing around the rope. As well as the catches of the species and numbers of fish began to stabilize, indicating that the trap fishing gear had begun to lose its effectiveness in the 3rd month. In addition, the fishing area is characterized by the seafloor with a large percentage of sediment. Causing the trap lay on the sea floor and sediment caught at the netting area, preventing aquatic animals from entering, as shown in Figure 3.

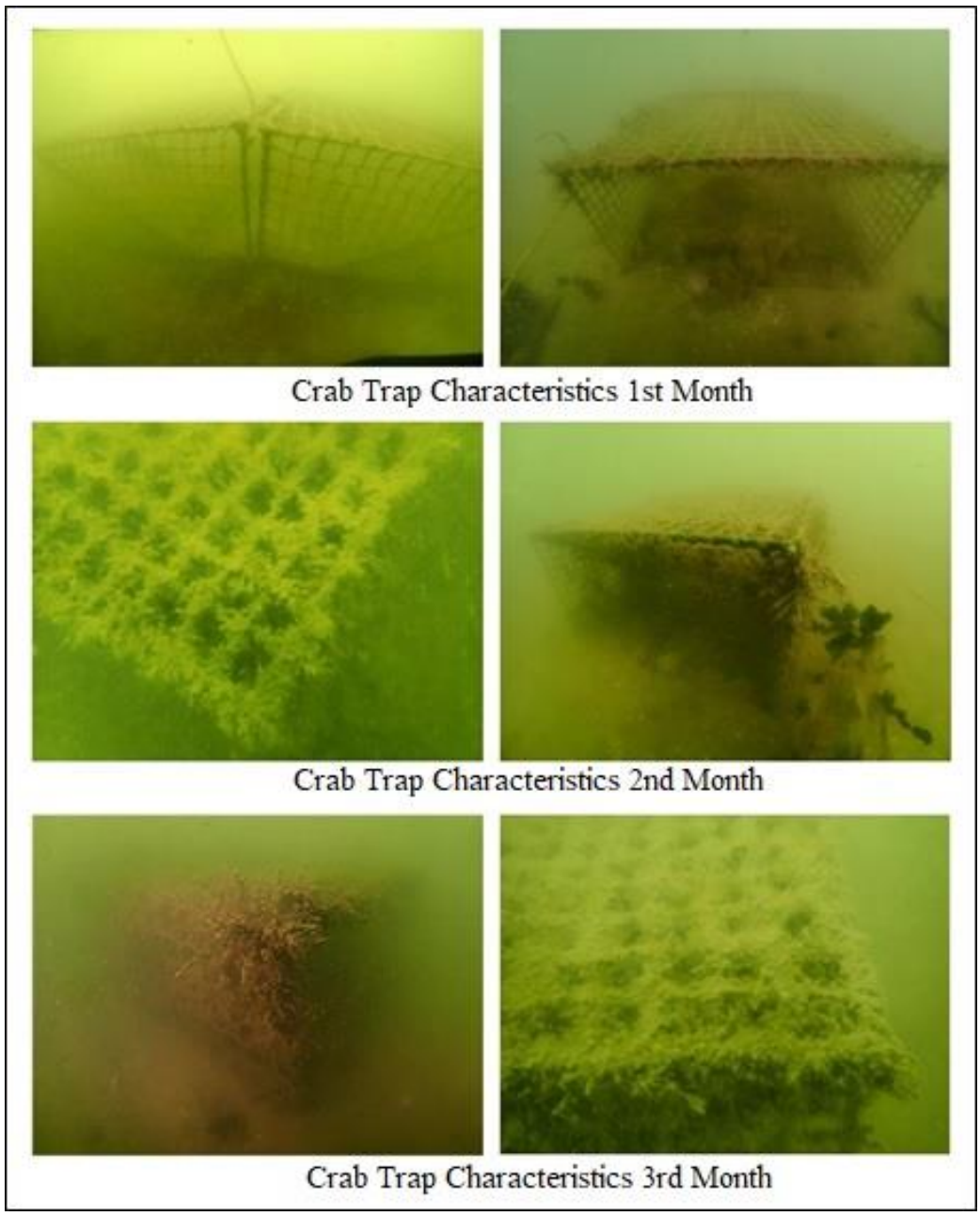

Figure 3 shows characteristics of crab traps in each month.

Moreover, from the analysis of fish catch efficiency with Crab Gill Nets, it was found that crab gill nets are effective in catching aquatic animals during the 1-2 months. By the 2nd month, the net will begin to break and have a coil, there is some seaweed on the buoy area which reduces the efficiency of catching fish. In the 3rd month, the nets have a coiled shape and began to sink to the sea floor, there are a lot of seaweed and barnacles on the buoys which aquatic species are still caught or attach in semi-floating, semi-sunk nets, so there should be further follow-up. Figure4

Figure 4 shows characteristics of crab gill nets in each month.

Due to the monsoon season, the experimental fishing gear was moved by the wind and loss and after the end of the monsoon, the wind and waves began to calm, the researchers surveyed and collected samples by scuba diving with surveying the vicinity in the experimental area. It was found some crab trap and gill nets from the experimental that drifted about 500-1000 meters away and sank onto the sand as well as some were blown away which was assumed to be lost by sediments on the sea floor. Moreover, from scuba diving to explore nearby vulnerable areas such as seagrass and coral reefs, the fishing gear from the experimental was not found in that area.

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