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Catch composition and estimated economic impacts of ghost-fishing squid traps near Suan Son Beach, Rayong province, Thailand

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ABSTRACT: The catch composition and economic impacts of ghost fishing in the fishing grounds near Suan Son Beach, Rayong province, Thailand, were examined based on interviews of squid fishers and experiments using ghost-fishing squid traps. In the province, 27 fisher families are engaged in squid trap fishing, and each family operates 100–300 squid traps. The catch per unit effort (CPUE) of the traps is 30–40 kg/100 traps/trip. The average price of a squid trap is 135 Thai baht (US$ 4.50), and traps have a lifespan of 1–2 months. Squid traps can ghost fish when they are lost in bad weather conditions, due to gear conflict, or when the trap materials deteriorate. The catches of experimental ghost-fishing traps were examined during two periods in 2017: May–July and August–October. The traps caught cephalopods and other species, both commercial and non-commercial. The commercial species included bigfin reef squid (*Sepioteuthis lessoniana*), other squids, cuttlefishes, groupers, snappers, and blue swimming crabs. The total number of aquatic animals, total weight, and total economic value of the catches during May–July and August–October 2017 were 51 and 38 specimens; 12 000 g and 7250 g; and 6318.0 baht/27 traps and 5302.5 baht/28 traps, respectively.

KEYWORDS: abandoned, ghost fishing, Rayong province, squid trap

INTRODUCTION

Squid traps are a commonly used in artisanal fisheries in Thailand. The traps are made of wood and covered with net and palm leaves. Squid eggs are hung inside to lure and capture squids. The traps are used in coastal areas and attached to surface buoys that suspend the traps 2–3 m above the seafloor [1]. Each trap costs about 200–300 Thai baht (US$ 7–10). The number of traps used by fishers ranges from 20–200/family; this number depends on the size of fishing boat used and the needs of the fisher. Fishers set the traps and retrieve them 1–2 days later [2].

A major problem that squid-trap fishers face is the loss of traps. Traps are lost for many reasons, such as theft, bad weather conditions (strong waves, strong current during the monsoon season), gear conflicts (when many fishers operate in the same area), accidental cutting of buoys by vessels or other human error, and operating gear in deep water [3–5]. When the traps are lost, many continue to fish and trap animals, which is known as ghost fishing.

Abandoned, lost and discarded fishing gear can have impact on marine environments, marine ecosystems, benthic habitats, wildlife and the fishing industry [6, 7]. Ghost fishing occurs when this gear continues to capture fish or other living organisms [8, 9]. Ghost fishing nets are often considered perpetual killing machines because they cannot stop fishing [10]. Fish and crustaceans are frequently caught by ghost fishing gear, especially in lost traps. Around the world, ghost fishing has impacted on aquatic animal resources, killing thousands of fish that might otherwise be caught and sold by fishers. About US$ 250 million in marketable lobster is believed to be lost each year because of ghost fishing. Studies have been conducted in European waters concerning the effects of ghost fishing by gill nets, trammel nets, and traps [11]. Fishing gear that operates in deep waters and is not damaged by waves or storms can continue to ghost fish for long periods [12]. In Puget Sound and Hood Canal in Washington, USA, more than 50% of shrimp pots are lost each year due to strong currents [13]. Fish aggregating devices (FADs) have also been shown to

ghost fish; 17 drifting FADs and 3 abandoned European FADs were documented to catch 13 species of aquatic organisms comprising 103 marine animals that included 30 marine turtles, 27 leather jackets, 13 rainbow runners, 10 sharks, 7 porpoises, 7 triple-tails, 3 sea chubs, 2 wahoo, skipjack, barracuda, and remora [14].

In Thailand, information on ghost fishing is limited. This study was carried out to better understand ghost fishing by squid traps through the examination of the species and quantity of aquatic organisms caught, their economic value, and the investment losses incurred by squid fishers near Suan Son Beach, Rayong province, Gulf of Thailand.

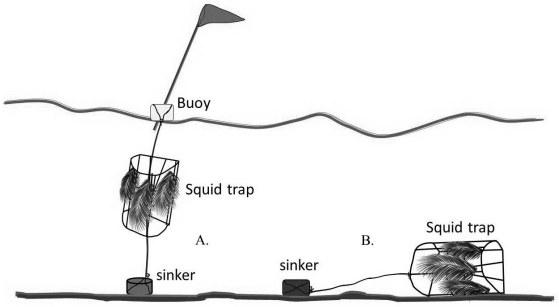

Fig. 2 Squid traps: (A) trap attached to buoy (normal fishing condition) and (B) trap disconnected to buoy (ghost-fishing trap).

MATERIALS AND METHODS

A squid trap, made of eucalyptus wood and covered with net and coconut leaves, measures $60 \times 100 \times 50$ cm. Thirty-one squid traps were set in the fishing grounds near Suan Son Beach, in 6 lines, 5 traps/line, where the distance between the line was 400 m, and between the trap was 200 m. The control trap, which was set between lines 1 and 2 (Fig. 1), included a control group and a ghost-fishing group. In the control group, the gear was attached to a surface buoy, so the trap was suspended in the water column as it is normally fished (Fig. 2). In the ghost-fishing group, the line attached to the surface buoy was cut so that each trap rested on the seafloor. Observation were conducted during two periods: May–July 2017 and August–October 2017, representing the pre-monsoon and late-monsoon seasons, respectively.

The catch composition and amounts of target and non-target species in the traps were observed using fish visual census techniques by SCUBA divers, and the commercial species were taken to the laboratory for identification and measurement (size and weight) once a week until the traps were lost from the observation area.

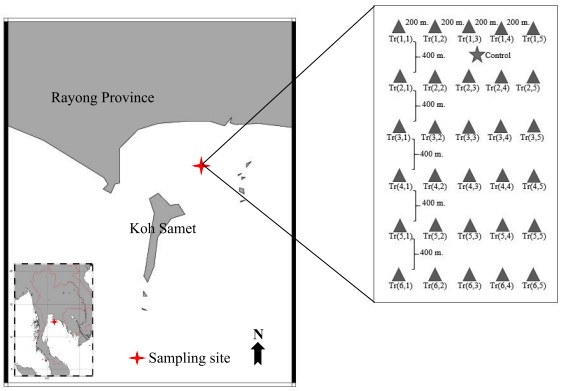

Fig. 1 Map of the study area near Suan Son Beach, Rayong province.

The economic value of the collected species was estimated using the following equation: $\Sigma_{i=1}^{n} Q_i \times P_i$, where Q_i is the number of aquatic animal species i, P_i is the price (from local market) of aquatic animal species i, and n is the number of species of aquatic animals.

Interview of at least 80% of fishers operating squid trap around Rayong province was conducted to obtain required information. For example: number of squid traps operated per fishers, number of squid traps lost in each month, cause of trap lost, and fishing ground, etc.

All experiments and procedures used in this study were approved by the Institute of Animals for Scientific Purpose Development (IAD) at Kasetsart University (Approval No. U1-01982-2558; ACKU 60-FIS-004).

RESULTS

Ghost-trap experiment

The control traps in the water column collected three commercial cephalopods; 90% of catches number were composed of bigfin reef squid and 10% were cuttlefishes (pharaoh cuttlefish and needle cuttlefish). When the nets were clean and coconut leaves used to cover the traps were fresh, these were the only species collected.

The ghost-fishing traps on the seafloor collected six commercial species (bigfin reef squid, cuttlefishes, other squids, grouper, snapper, and blue swimming crab) and 12 non-commercial species (fugu fish, cardinalfish, batfish, damselfish, com-

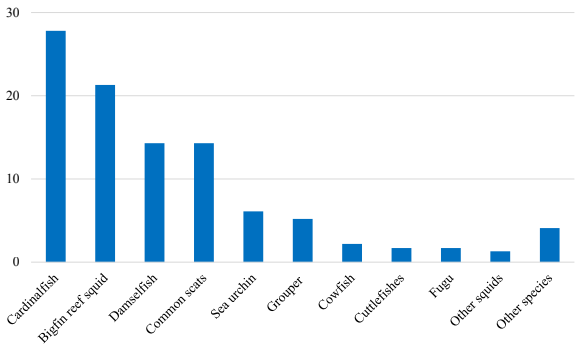

Fig. 3 Percentage of aquatic species found inside the ghost-fishing squid traps.

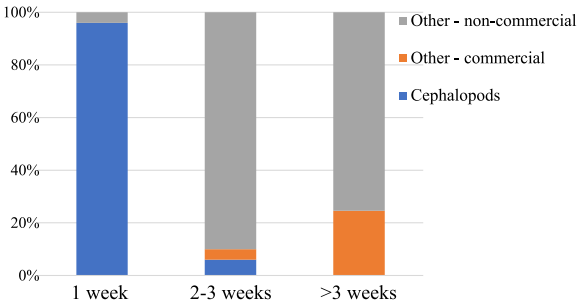

Fig. 4 Change over time of percentage of aquatic animals caught by ghost-fish traps during May–June.

mon scat, butterflyfish, toadfish, cowfish, sea urchin, sea cucumber, jellyfish and small crabs) (Fig. 3). The catch composition changed depending on how long the traps remained on the seafloor and their condition. During the first week, with the nets still clean and coconut leaves still fresh, the traps caught mostly bigfin reef squid, but over time, the nets became covered with mud and other materials, the coconut leaves began to decompose, and the catch composition changed (Fig. 4 and 5).

The ghost-fishing traps caught more aquatic animals during May–July than during August–October (Table 1). This is because the first period occurred during the pre-monsoon season, when the waves and currents were not strong, while in the second period, the waves and currents were very strong. Blue swimming crabs were caught only during the second period.

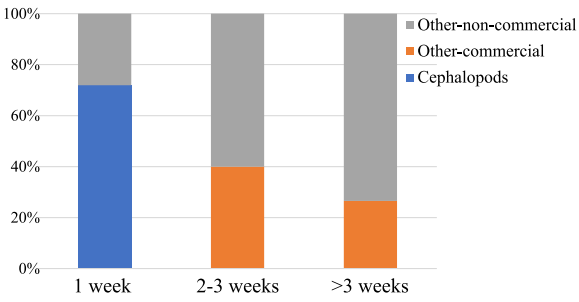

Fig. 5 Change over time of percentage of aquatic animals caught by ghost-fish traps during August–October.

Table 1 Species, number, weight and economic value of catches in the ghost-fishing traps during the two observation periods. The economic value is the estimated revenue lost from commercial species killed by the traps.

	Number (n)	Weight (g)	Economic value†
May–July 2017			
Bigfin reef squid	30	9000	2250.00
Grouper	9	1800	360.00
Seabass	12	1200	63.00
Total	51	12 000	2673.00
August–October 2017			
Bigfin reef squid	19	4750	1187.50
Cuttlefishes	2	500	100.00
Other squids	3	300	30.00
Grouper	3	600	120.00
Blue swimming crab	11	1100	85.00
Total	38	7250	1522.50

† Economic value (Thai baht) estimated based on prices at local markets.

Interviews

At Suan Son Beach, 27 families are engaged in squid fishing, in terms of experience in fishing, the fishers indicated that they had been fishing for 3–35 years, and each family uses 100–300 traps. The average price of each trap is 135 Baht/trap. The fishers usually catch squids (mainly bigfin reef squid (*Sepioteuthis lessoniana*)) and cuttlefishes (pharaoh cuttlefish (*Sepia pharaonis*) and needle cuttlefish (*Sepia aculeata*)). The catch rate depends on the fishing area and season. In this study, the catch rates of the squid traps were 30–40 kg/100 traps/trip. Water quality in the area was within the standard range (Table 2) [15].

The squid fishers reported that they experience damages and loss of traps. Damage can be caused

Table 2 Water quality at Suan Son Beach, Rayong province†

Observation period	Temp. (°C)	DO (mg/l)	Salinity (PSU)	Transp. (m)	Depth (m)
May–Jul	32.0–32.6	5.2–6.9	30–31	1.5–2.5	4.8–5.9
Aug–Oct	29.7–29.9	4.8–6.2	30–31	1.6–2.0	4.8–6.2

† DO = dissolved oxygen; PSU = practical salinity unit; Transp. = water transparency.

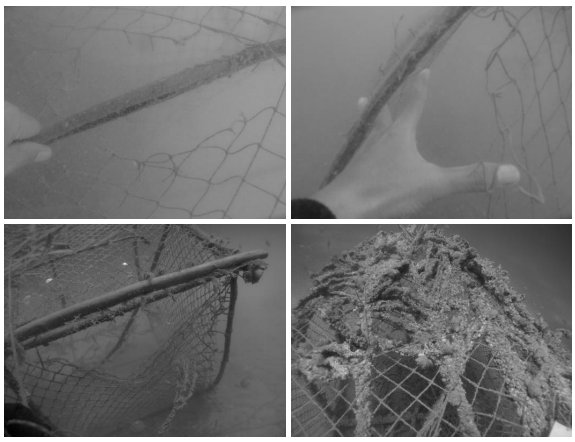

Fig. 6 Damaged and muddy nets in ghost-fishing traps.

by a collapse of the trap or when the net is damaged. Traps are made of young eucalyptus wood, and when traps are left in the water for many days, the eucalyptus wood becomes soft and collapses easily. Net damages can occur when fishers recover the traps, and the nets that covers the traps come in contact with the boat. The nets also degrade over time (Fig. 6). The life span of squid traps used near the Suan Son Beach is 30–60 days.

Loss of traps is the main problem in squid trap fishing and could be because of two factors. The first is gear conflict. Fishers operating near Suan Son Beach use many types of fishing gears, such as gill net, trammel net, crab gill net, crab trap, and squid trap, with such fishing gears operating in the same fishing ground, some of which move with the currents, such as gill net and trammel net. When these moving gears entangle with stationary squid traps, fishers will try to save the fishing gear by cutting the squid trap and leaving it in the water. The second factor is poor weather conditions. Strong waves and water currents during the monsoon season can break the rope that connects the trap to a buoy, which will cause the trap to settle on the seafloor and begin ghost fishing. The fishers who operated squid trap around Suan Son Beach reported that they lost about 10–25 traps/100 traps/fisher/month.

During the experiment from May–July, 15 traps were lost and 12 traps were damaged. The losses and damages started during the second week after the traps were set. In August–October, 18 traps were lost and 10 traps were damaged. Losses began only 3 days after they were set. More traps were lost in the second period because of strong waves and water current in the monsoon season.

Table 3 Estimated economic losses caused by ghost-fishing squid traps due to lost gear and lost revenue from commercial species killed by the traps. All values shown in Thai baht.

Observation period	No. of traps damaged	No. of traps lost	Gear cost†	Catch value	Total loss	Loss/ trap
May–Jul	12	15	3645	2673.00	6318.00	234.00
Aug–Oct	10	18	3780	1522.50	5302.50	189.38

† Average price of squid trap is 135 Baht/trap.

The economic losses caused by ghost fishing gear were estimated based on the cost to repair and replace gear, as well as the lost revenue from target organisms killed by ghost fishing (Table 3).

DISCUSSION

Observation of the squid trap fisheries near Suan Son Beach was made by interviewing fishers and analyzing the data collected by experimental ghost-fishing squid traps. Lost squid traps that ghost fish can lure aquatic animals into the traps. However, new, clean traps caught more aquatic animals than older, muddier traps. The catch rate of octopus traps decreased after 24 h of deployment [8].

The catch composition in the traps could be divided into commercial and non-commercial species. The commercial species comprised 6 groups: bigfin reef squid, cuttlefishes, other squids, grouper, sea bass, and blue swimming crab. The non-commercial species comprised 13 groups: fugu fish, cardinalfish, batfish, damselfish, butterfly fish, goatfish, toadfish, cowfish, sea urchin, sea fan, sponge, jellyfish, and small crabs. In ghost-fishing octopus traps, predators such as conger eels are often found in the traps, where they can live for more than one month [8]. In our study, many species of predators were found in the traps, including fugu fish, cowfish, grouper, and toadfish.

Abandoned, lost and discarded fishing gear is of increasing concern and receiving increasing international attention in the past decade [16]. Most of the lost fishing gears are gillnets and pots, and there have not been any surveys or estimates of how many gillnets or pots are lost annually [17]. Traps can be lost due to two factors. The main factor is interaction with other gears (gear conflict), and the other factor is poor weather conditions. The loss of lobster pots in the Kosterhavet National Park, Sweden, was reportedly caused by the steep slope in a deep area with heavy traffic and fishing intensity area [18].

In this study, during May–July, 46% of traps were lost and 40% were damaged. In August–October, 56.7% were lost and 33.3% were damaged. The estimated cost and lost revenue from ghost-fishing squid traps were 6318 baht and 2673 baht (during May–July), respectively, and 5302.50 baht and 1522.50 baht (during August–October 2017), respectively. In Oman, fishers reported to lose 18 traps/fisher each year or 15 390 total traps in a study area, the benefit lost from fish traps was estimated to be US$ 2.63 million, which is 2.1% of the total landing value of the Omani fishery in 2006 [19]. The escape from the Antillean fish traps used in the Caribbean averaged 11.6% per day [20]. Fish traps in Oman were observed, and it was found that 10% escape rate occurred in the large, single opening wire traps, and 95% mortality rate for ghost-fishing traps [21]. Abandoned, lost or otherwise discarded fishing gear continue to increase every year, and approximately 10% of marine debris is composed of fishing gear [5]. There may have been some trap-related incidents causing high mortality to aquatic animals caused by predators. For example, octopuses need several minutes to escape from a trap through the net and are therefore susceptible to attack by moray eels or conger eels in the trap [8]. Management options to address problems associated with ghost fishing comprise both curative and preventative methods to reduce net loss [4].

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