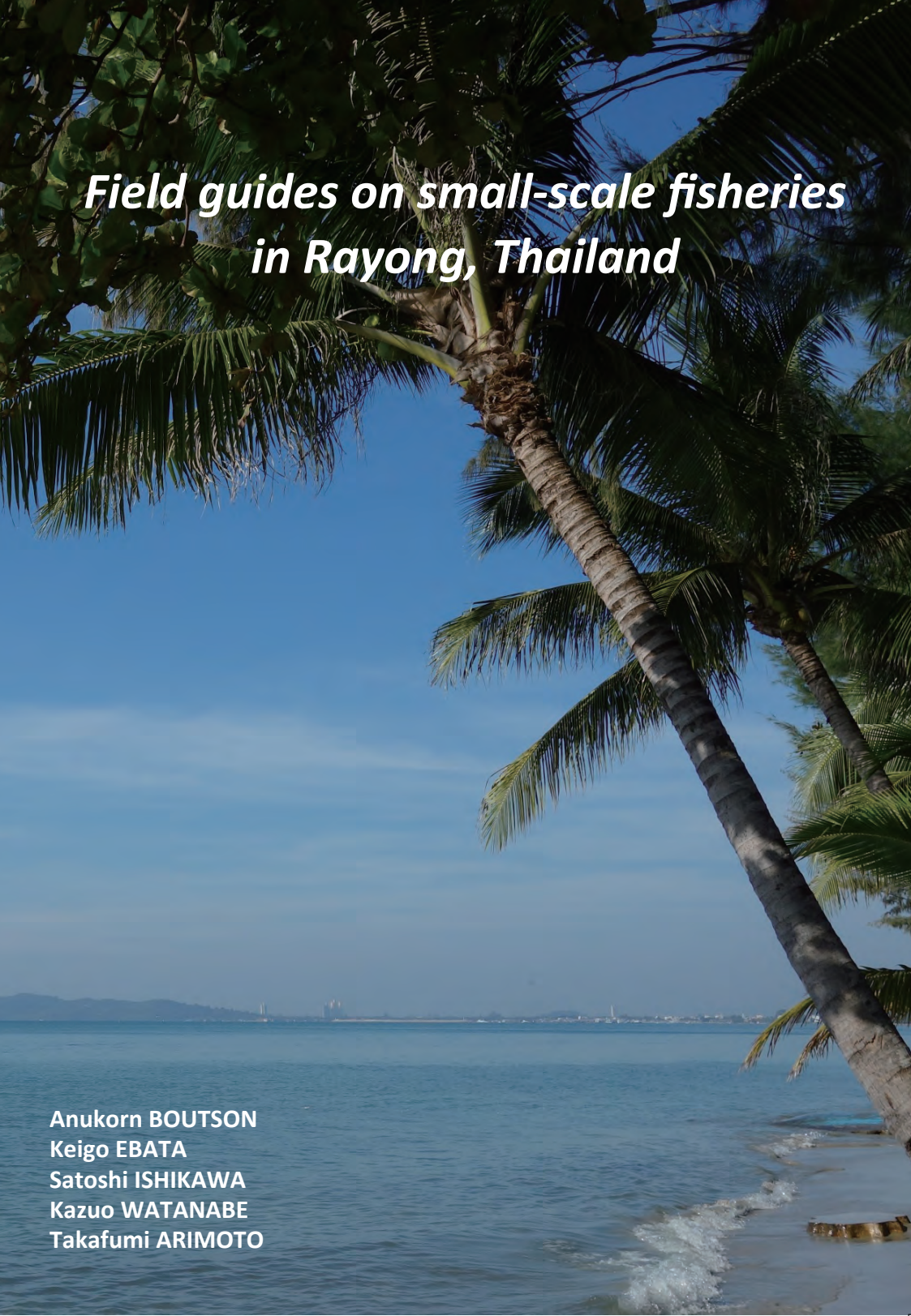
Field guides on small-scale fisheries in Rayong, Thailand



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Preface

Small-scale fisheries play an important role in nutrition, food security, sustainable livelihoods, and poverty alleviation (FAO 2014). Management of small-scale fisheries in developing countries is a challenging endeavor (Sarah *et al*., 2016). However, the significant contribution of small-scale fisheries are not understood well enough, especially in developing countries around the world, and are distorted by a lack of data (D. J. Mills *et al*., 2011).

The original concept of this field guides is to understand fundamentally how small-scale fisheries currently are, and to compile information on actual condition in small-scale fisheries in the coastal area of Rayong Province, Thailand. For each small-scale fisheries such as crab gill-net, fish trap, floated squid trap, troll line and hook-and-line, we compiled not only the fishing gear construction, fishing methods, and the target species, but also the non-target species and seasonal variations of catch and operation sites.

The research has been conducted under the project of “Coastal Area-capability Enhancement in Southeast Asia” which was financially supported by Research Institute for Humanity and Nature. The project creates new idea “Area-capability” which is essential to sustainable development, and refers three aspects as follow: (1) A local community uses resource unique to the region; (2) Resource users understand the importance and take care of the environment that supports the resources used, and (3) A balance is struck between using and caring for resources and the supporting environment, which is evaluated by outside entities (Ishikawa and Watanabe, 2015).

Field surveys on small-scale fisheries have been conducted since December 2012. Thirteen small-scale fishers in total were targeted, and log-books were distributed to all the target fishers to record details of their fishing operations every day. Portable GPS was connected to each fishing

boat of target fishers to record the positions at 3-min intervals in order to determine the operation sites where fishers deployed and retrieved the fishing gear. Not only log-book record and GPS track but also on-board surveys were conducted to observe fishing operations directly. We visited all target fishers at least once every two or three months to interview about the fishing operations. Data on weather and sea conditions in Rayong were obtained from Thai Meteorological Department and the seasonal variations on small scale fisheries were analyzed.

Professors and researchers from Kasetsart University, Kagoshima University, Tokyo University of Marine Science and Technology, and Research Institute for Humanity and Nature have carried out the field surveys with assistance of the Training Department of the Southeast Asian Fisheries Development Center and Eastern Marine Fisheries Research and Development Center, Department of Fisheries, Thailand.

This field guides will be first step to evaluate significant contribution of small-scale fisheries and be useful for those who are interested in small-scale fisheries in Rayong, Thailand. We hope that this field guides will provide a clue to establish a way to develop regions in consideration of regional cultures and environmental feathers and to activate human resources training. We wish that this field guides should be useful in making guideline of management plans for not only Rayong coastal fisheries but also small-scale fisheries in tropical region, Southeast Asia in the near future.

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1. Introduction

1.1 Small-scale fisheries in Rayong

Thailand is one of the top fish-producing countries worldwide owing to its geographical advantage, with a continental coastline of 2,624 km and fishing ground of 316,000 km^2 in the Gulf of Thailand and in the Andaman Sea, where more than 2,500 fishing villages are located. The marine capture fisheries are classified into small-scale and commercial fisheries. According to a census of marine fisheries conducted in 2000, the total number of fishing boats is 58,119 of which 80% are small-scale. The small-scale fisheries use fishing boats of less than 5 gross tonnage that are either non-powered or have outboard or inboard engines. Most small-scale fishers conduct operations near the shore using traditional fishing gear, and the fish products are an important source of income and food for fishers and neighbouring communities (FAO 2006).

Rayong Province is located on the east coast of the Gulf of Thailand with an approximately 100-km-long coastline (Fig. 1-1). Here, the main industry is capture fishery and fish sauce "*nam pla* (น้ำปลา)" is the main product. Several small-scale fishing methods can be seen in this region, including crab gill-net, fish trap, floated squid trap, troll line and hook-and-line.

1.2 Climate in Thailand

Thai climate is divided into three seasons—the southwest monsoon season, the northeast monsoon season, and pre-monsoon season (Aon Cooperation, 2011). The southwest monsoon season is a rainy season and typically occurs from mid-May to mid-October. A stream of very warm and moist air from the Indian Ocean leads to strong wind and heavy rain. The northeast monsoon season is a winter season that typically occurs from mid-October to mid-February and is supported by cool and dry air owing to a high-pressure ridge positioned over China's mainland. The pre-monsoon

season is a summer season and occurs from mid-February to mid-May. The weather in Thailand becomes warmer during this period, and is hottest in April.

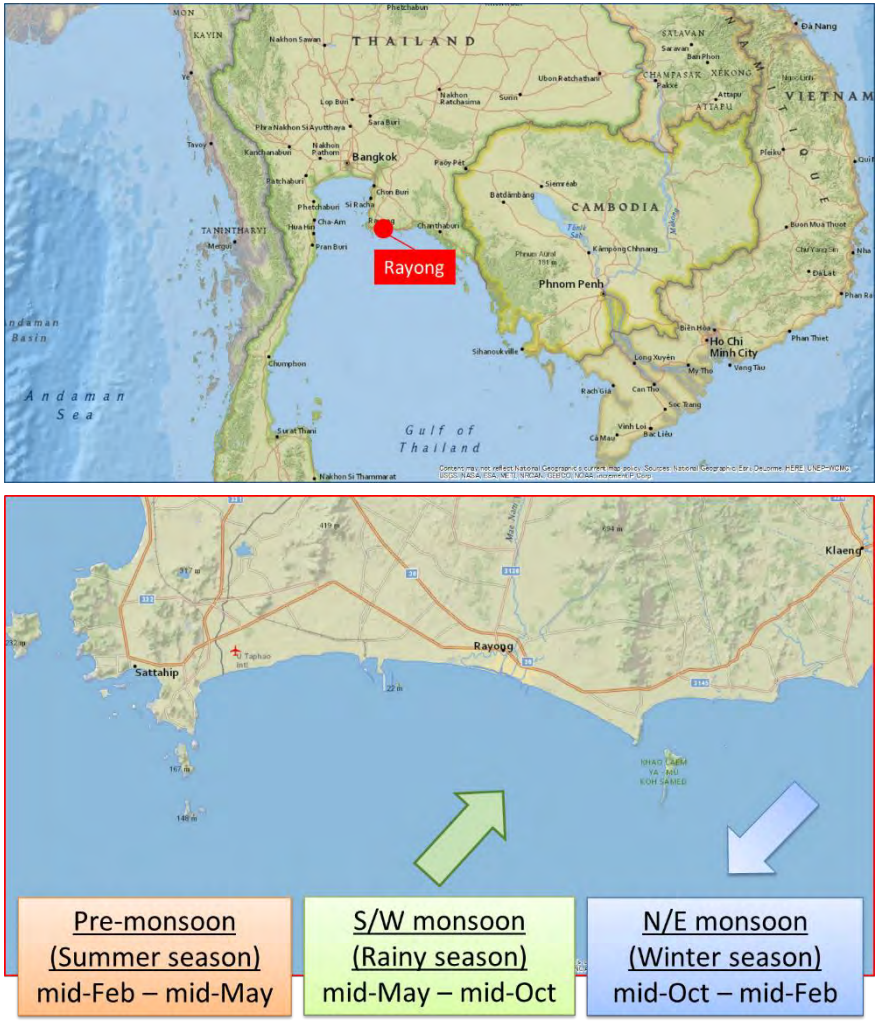


Fig. 1-1 Map of Thailand and Rayong coast.

(Map sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.)

We obtained data on wind speed recorded every three hours by the Thai Meteorological Department in Rayong (Fig. 1-2) and used it to calculate monthly average wind speed (Fig. 1-3). The average wind speed in Rayong was about 1-3 knots in the northeast monsoon season and pre-monsoon season, but increased especially in the first half of southwest monsoon season. Fishers conduct operations by using small boats in the Gulf of Thailand in large-scale shallow waters. Therefore, weather and sea conditions can affect fishing operations, including whether or not fishers will go to sea at all on a particular day.

Fig. 1-2 Thai Meteorological Department in Rayong.

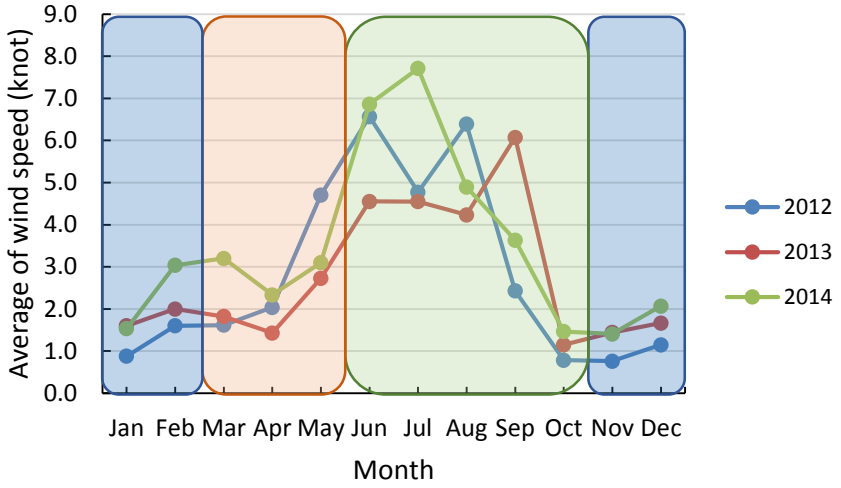


Fig. 1-3 Average wind speed observed by Thai Meteorological Department in Rayong in 2012, 2013 and 2014.

1.3 Fishing boats used in small-scale fisheries

Fishing boats used in small-scale fisheries in Rayong are made of wood (Fig. 1-4). The length of the fishing boats is 6.5-8.0 m, and the width is 1.6-2.6 m. Almost every fishing boat is powered by a diesel engine of 14–19 HP. The life of a fishing boat is normally about 25 years and it requires maintenance on an annual basis (Fig. 1-5). The deck, which is made of plywood, is replaced by a new one every 3–5 years. The bottom of the fishing boat is coated with antifouling paint or covered with FRP sheeting to prevent marine organisms from adhering to it. Some fishers do not use antifouling paint on the bottom of their fishing boats, because they do not anchor the fishing boats in the sea. The fishing boats are landed on the sandy beach after returning to the pier.

Fig. 1-4 Fishing boats used in small-scale fisheries in Rayong.

Fig. 1-5 Maintenance of fishing boat.

2. Crab gill-net

Thai name: Auan-poo (อวนปู), Auan-jom-poo (อวนจมปู)
Auan-jom-poo-maa (อวนจมปูม้า), Auan-poo-maa (อวนปูม้า)
Rayong local name: Auan-poo (อวนปู), Auan-poo-maa (อวนปูม้า)

The crab gill-net is very common fishing gear used to capture the blue swimming crab (*Portunus pelagicus*) along the coast of Rayong Province and all around the coast in Thailand (Fig. 2-1). Crab gill-net fishery is operated in shallow or inshore waters, which some refer to as a "bottom crab gill-net". Because the crab gill-nets are placed on the seabed with sandy mud or sand during the fishing operations. It is used for both small-scale and commercial fishery almost all year round. There is the largest number of fishers who possess and operate this gill-net in Rayong. However, some fishers may use crab gill-net together with other types of fishing gear, such as shrimp trammel-net, beach seine, troll line, and hook-and-line.

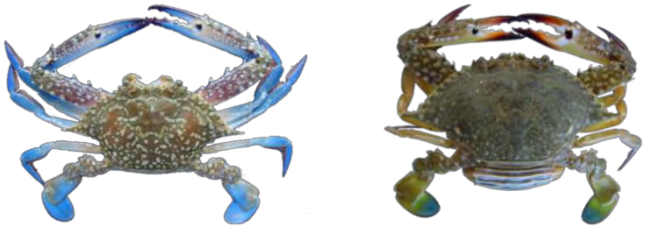


Fig. 2-1 Male (left) and female (right) of blue swimming crab (*Portunus pelagicus*), the main target species of crab gill-net fishery.

2.1 Gear design and construction method

The crab gill-net is stationary fishing gear on seabed fixed with stone weights at the start and the end point of the net deploying. The stone weights and bamboo poles that attached with buoy and flag are connected to the net (Fig. 2-2).

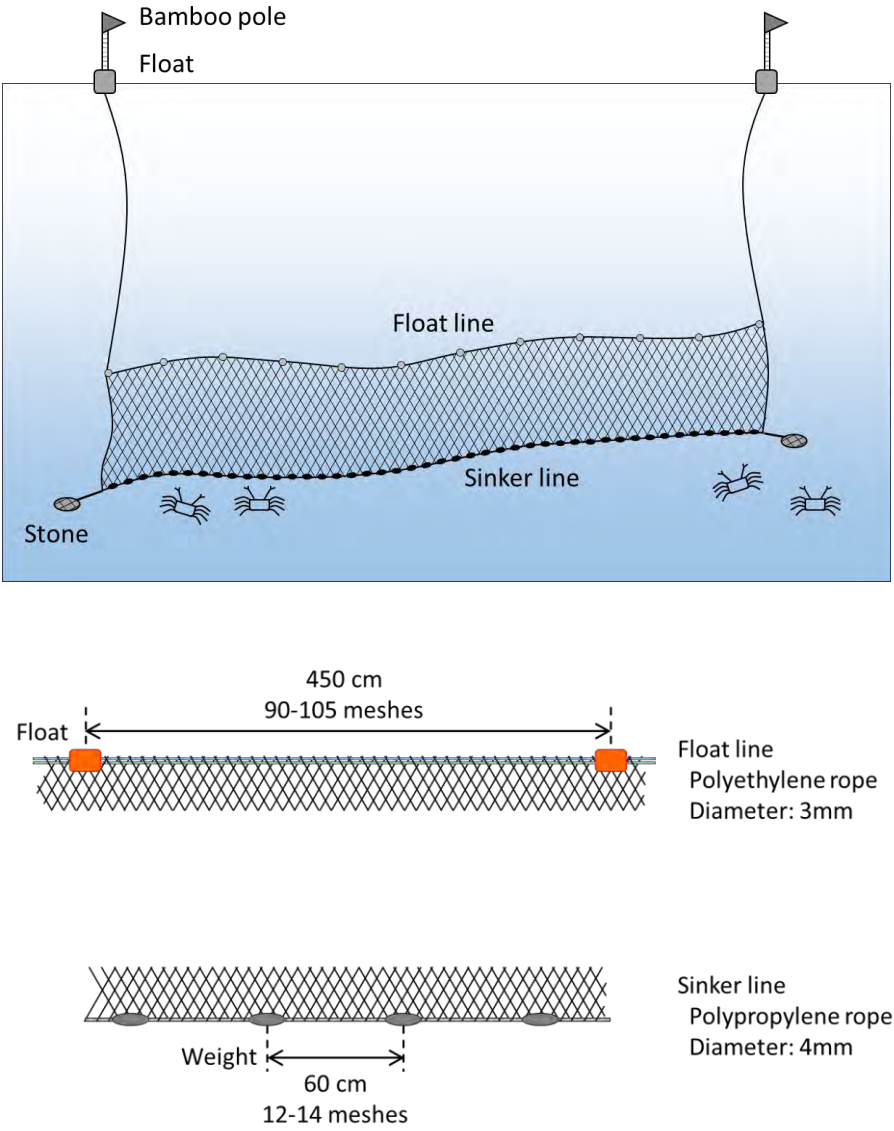


Fig. 2-2 Design of crab gill-net.

Material of plane net:	Nylon monofilament with white or clear color
Mesh size:	90, 100, or 105 mm
Twine diameter:	0.30 mm
Total length:	450-600 m/set (One set consists of five panels)
Mesh in net-depth:	12 meshes
Total weight:	5-8 kg/set

Fishers, with their family, construct crab gill-nets using plane nets, float lines, and sinker lines. Float and sinker lines are made by fishers beforehand. One set of crab gill-net consists of five panels. A float line consists of two polyethylene ropes of 3 mm in diameter each and floats at an interval of 450 cm (Fig. 2-2). A sinker line consists of a polypropylene rope of 4 mm in diameter and rugby-shaped lead weights of 10 g each at 60 cm intervals (Fig. 2-2, 2-3).

A float line and a sinker line are tied tightly between wooden posts (Fig. 2-4 (a)). The distance between both end sides of the posts is approximately 90-120 m, and then the length of a panel is 90-120 m. Fishers thread the plane net with a float line and sinker line (Fig. 2-4 (b, c, d)). The crab gill-net

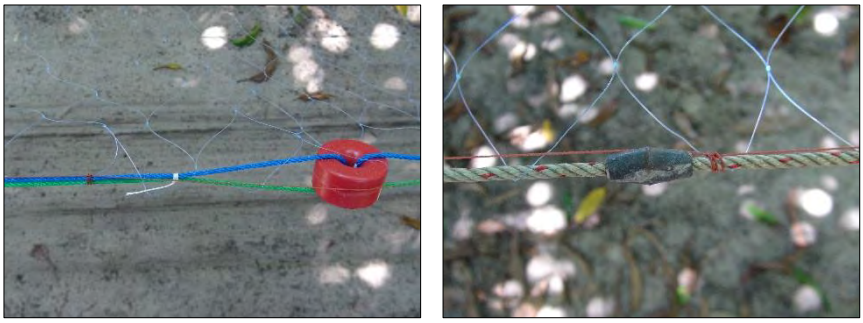
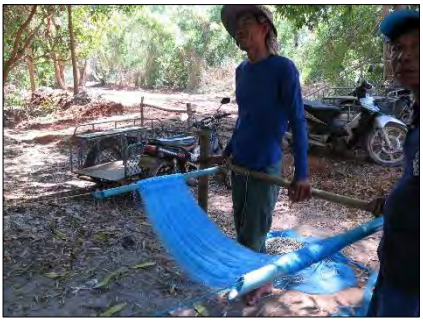


Fig. 2-3 Float line (left) and sinker line (right).

(a)



(b)

(c)

(d)

(e)

(f)

Fig. 2-4 Procedure for constructing a crab gill-net.

is assembled, the body net being joined with float and sinker lines with thread (Fig. 2-4 (e, f)).

The material cost of a crab gill-net is about 3,000 Baht/set in total. Fishers buy the plane nets, ropes, floats, and weights from fishing gear shops near their homes as these shops do not sell a set of ready-made crab gill-net and provide only the material. The life of the rope of the gill-net is about 2 years, and that of the plane net is approximately 3-5 months.

2.2 Operation method and catch species

Operation sites are mainly all around the coast, 3-5 km off the shore at depths of 5-20 m at the sandy or sandy-mud seabed. Fishers conduct crab gill-net operations close to the shore. The operation sites of the crab gill-nets are determined based on fishers' memories and bearing without GPS or navigation system. However, some fishers go further, using GPS to locate the same fishing grounds as those of trawlers or other commercial fisheries. They may obtain a bigger catch size, but there is risk of losing nets, particularly owing to the trawlers.

Fishers usually leave the pier for the fishing ground at dawn and return before noon. After they arrive at the operation site, fishers usually deploy the net parallel with the shoreline initially by dropping the bamboo pole into the sea, followed by the weight, and then releasing the arranged net while the boat is running at 2-4 knots. One or two fishers on board deploy the crab gill-nets, which takes about 3-5 minutes for one set. About 4-8 sets of crab gill-net per trip are deployed. The normal soak time of a crab gill-net is 1-3 days. Fishers observe the catch amount and decide the soak time. If they obtain a good catch, they deploy again and retrieve the net every day. However, if the catch is poor, they leave the net at sea for 2-3 days before retrieving it. The soak time can be extended to 4-7 days in case of strong wind and high wave.

The crab gill-net is normally retrieved during the daytime after the new nets are deployed. Fishers usually turn off the engine of the fishing boat and retrieve the net at the front deck by grasping the pole and pulling it on board and then hauling up the rope that is connected to the body net and the weight, thus gradually retrieving the net on the boat (Fig. 2-5). They complete this manually as fishing boat is usually not equipped with hauler machines.

Fig. 2-5 A fisher hauling up the crab gill-net manually. Some fishers use fishing boats made of FRP.

If there is a single fisher on board, he holds the head and the sinker line together and then hauls it on the deck. However, if there are two fishers on board, one holds the float line, while the other holds the sinker line, hauling

it on board at the same time.

The catch from the crab gill-net usually stays alive and fresh. If the operation is time-consuming or operation sites are far away from the pier, fishers attempt to maintain the freshness of the catch, particularly blue swimming crabs—the main target species—and other costly species by either dipping the nets below the sea surface or putting them in the fish hold which provides sea water circulation, while they continue to haul up the net: The catch entangled in the body net is divided while the net is being retrieved. Fishers separate the part of the body net containing the catch from that without catch. The catch-free net is gathered together by separating the float lines and sinker lines. The part of the body net containing the catch may be dipped into the sea to keep the catch alive and fresh during their retrieval, and then gathered to the top of the net before returning to the pier (Fig. 2-6).

Fig. 2-6 A part of net containing the catch is separated and dipped into a tank containing seawater or below the sea surface to keep the catch alive and fresh.

A few fishers release the catch from the body nets at sea immediately after retrieval (Fig. 2-7), but most fishers bring back all the nets and release the catch from the nets after returning the pier.

Fig. 2-7 Some fishers release the catch on the fishing boat before returning to the pier.

The crabs are removed from the body net and their claws are held together by rubber bands to keep them from moving. The crabs are placed in a tank with seawater and aeration equipment to keep them alive (Fig. 2-8). After release all catch from the body net, the nets are re-arranged for the next deployment and are repaired or changed if required (Fig. 2-9).

(a) Bringing back the nets to the pier.

(b) The crabs entangled in the net.


(c) Fishers remove the crabs from the net with their family members.


(d) The claws of crab are held by rubber bands.


(e) The crabs kept in the tank with seawater and aeration equipment are transported to the fish market via truck.

Fig. 2-8 Work procedure after returning to the pier.

Fig. 2-9 Fishers fold the crab gill-net after releasing the catch from the body net.

The landing price of blue swimming crab, at which the fishers sell the crabs to middlemen at the pier, depends on the body size of the crab and not its sex. Sex of the crab can be distinguished by a body colour and brooding of eggs (Fig. 2-10).

Fig. 2-10 Male (upper) and female (lower) of blue swimming crab.

Fishers usually categorize the crab catch size into small (S), medium (M) and large (L). The prices of S, M, and L crabs are 80-100, 150-180, and 200-250 Baht/kg and the numbers per 1 kg are 10-15, 6-10, 4-5 respectively. The price may vary with the season and the catch amount. A large catch amount may result in a decrease in the price. The highest price is usually in March-April, summer season, when a lots of tourists visit Rayong coast, particularly during the weekend and long holidays.

2.3 By-catch species

Not only blue swimming crab but also many other by-catch species were caught with the crab gill-net. Some of these are economic species which fishers can sell, whereas others are of little or no marketable value, which are discarded, leading to food loss or by-catch and discard issues.

Economic species

(Photo, Thai name, common name, scientific name, and landing price)

Pla-soi-nok-kao (ปลาสร้อยนกเขา)
Painted sweetlip
Diagramma pictum
50-170 Baht/kg

Cha-larm-gob (ปลาฉลามกบ)
Bamboo shark
Chiloscyllium punctatum
50-100 Baht/kg

Pla-sai-dang-mong (ปลาทรายแดงโม่ง)
Ornate threadfin bream
Nemipterus hexodon
40-80 Bath/kg

Pla-sa-lid-hin (ปลาสลิดหิน)
Streaked spinefoot
Siganus javas
20-80 Bath/kg

Gang-gra-daan (กั้งกระดาน)
Flathead lobster
Thenus orientalis
300-350 Bath/kg

Poo-sam-dao (ปูสามดาว)
Three spot swimming crab
Portunus sp.
80-250 Bath/kg

Left: Hoi-khong (หอยโข่ง), Indian volute *Melo melo*, 50 Baht/kg
Right: Hoi-no-ree (หอยโนรี), Noble volute, *Cymbiola nobilis*, 10 Baht/individual

Non or low marketable species

Poo-kam-yaw-kaw (ปูก้ามยาวขาว)
White long-armed crab
Parthenope longimanus

Poo-kam-yaw-dam (ปูก้ามยาวดำ)
Black long-armed crab
Rhinolambrus longispinis

Poo-pea-tum (ปูเป้ตุ่ม)
Porter crab
Dorippe quadridens

Poo-fong-num (ปูฟองน้ำ)
Sponge Crab
Dromidiopsis sp.

Poo-ru-see-khob-muong (ปูฤาษีขอบม่วง)
Box Crab
Calappa clypeata

Poo-ru-see-khob-leuw (ปูฤาษีขอบเลื่อย)
Brick-red box crab
Calappa philargius

Poo-bai-ma-ra (ปูใบ้มะระ)
Round crab
Demania scaberrima

Poo-bai-num-lug (ปูใบ้น้ำลึก)
Square-shelled crab
Galene bispinosa

Poo-mang-moom (ปูแมงมุม)
Spider crab
Doclea tetraptera

Poo-tang-tua (ปูแต่งตัว)
Decorator Crab
Camposcia retusa

Poo-mang-moom-kan-la-pang-ha
(ปูแมงมุมกัลปังหา)
Majid crab
Hyastenus dlacanthus

Poo-kan-ta-yao
(ปูก้านตายาว)
Long-eyed swimming crab
Podophthalamus vigil

Hoi-nham (หอยหนาม)
Stout-spine murex
Murex trapa

Hoi-kwan (หอยขวาน)
Hammer oyster
Malleus albus

Hoi-nang-rom (หอยนางรม)
Spiny oysters
Spondylus sp.

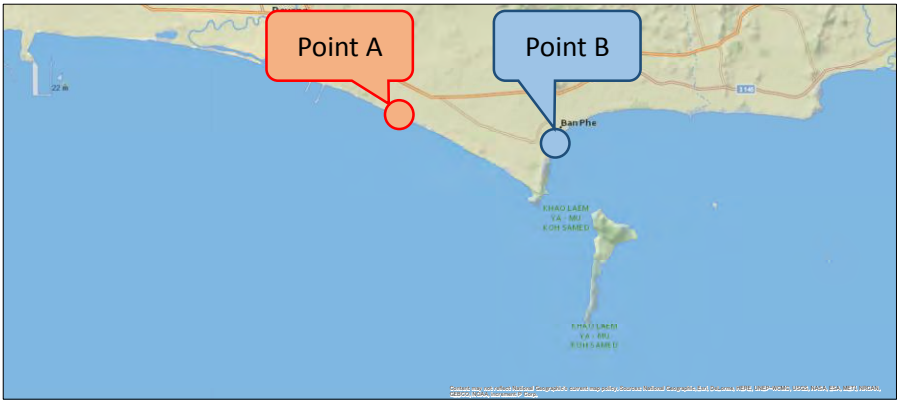
Hoi-je-dee (หอยเจดีย์)
Tower shell
Turritellal sp.

2.4 Seasonal variation of catch and operation site

The crab gill-net is widely used off the Rayong coast and around Samed Island. The operation sites are mainly on the western side of Samed Island during the northeast monsoon season and pre-monsoon season. However, the fishing operation sites changed during the southwest monsoon season. Fishers deployed the gill-nets on the east side of the Samed Island, an area that is not affected by the southwest wind (Fig. 2-11, 2-12).

Fishers conduct fishing operations almost every month on west side of Samed Island in the northeast monsoon season and pre-monsoon season.

The number of operation days, catch weight and catch price decrease in southwest monsoon season due to rough sea conditions (Fig. 2-13, 2-14, 2-15). Fishers do not conduct crab gill-net operations in April and May despite the optimal sea and weather conditions. Instead, they operate hook-and-line and troll line fishery, which target bigfin reef squid, because the catch for the blue swimming crab is not as good as that for bigfin reef squid. Other fishers do not conduct fishing operations and instead use the time to maintain their boats.



Point A (26 Aug 2013)

Point B (29 Aug 2013)

Fig. 2-11 Sea condition in the west (Point A) and east (Point B) of Rayong coast during the southwest monsoon season.

Fig. 2-12 Operation sites of crab gill-net in 2013. (Green: Southwest monsoon, Blue: Northeast monsoon, Orange: Pre-monsoon)

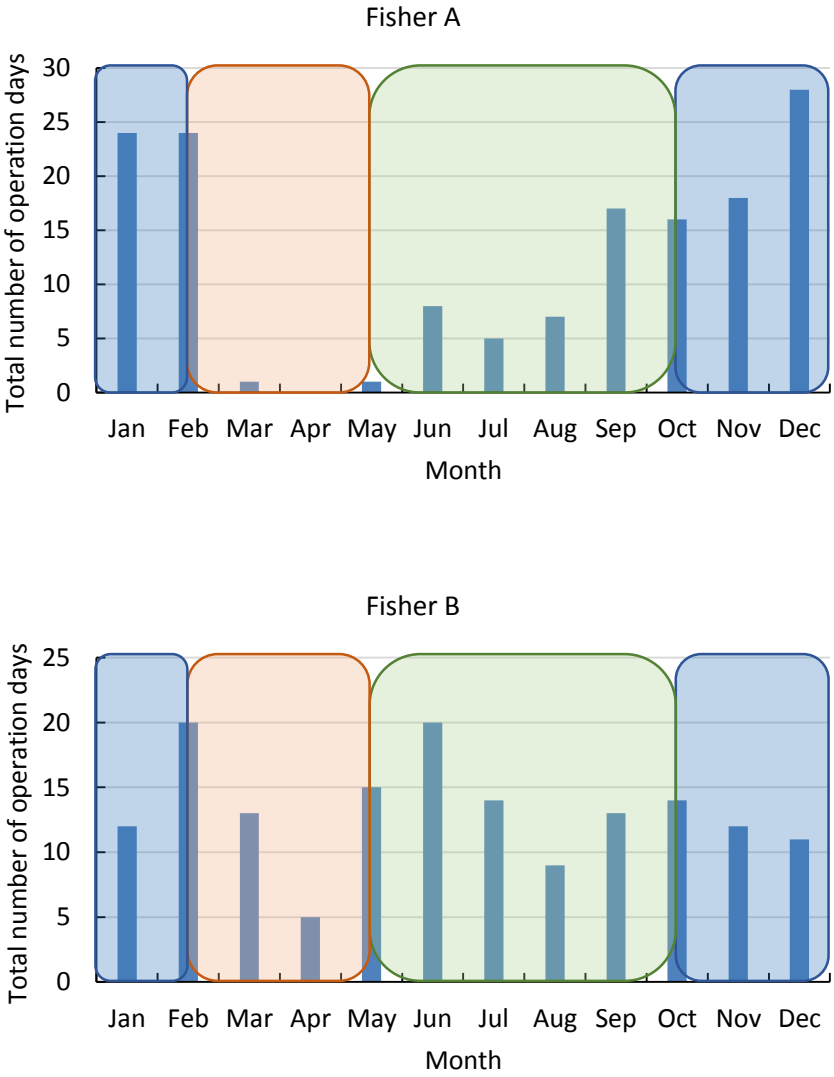


Fig. 2-13 Total number of days which fishers conducted operations of crab gill-net in 2013.

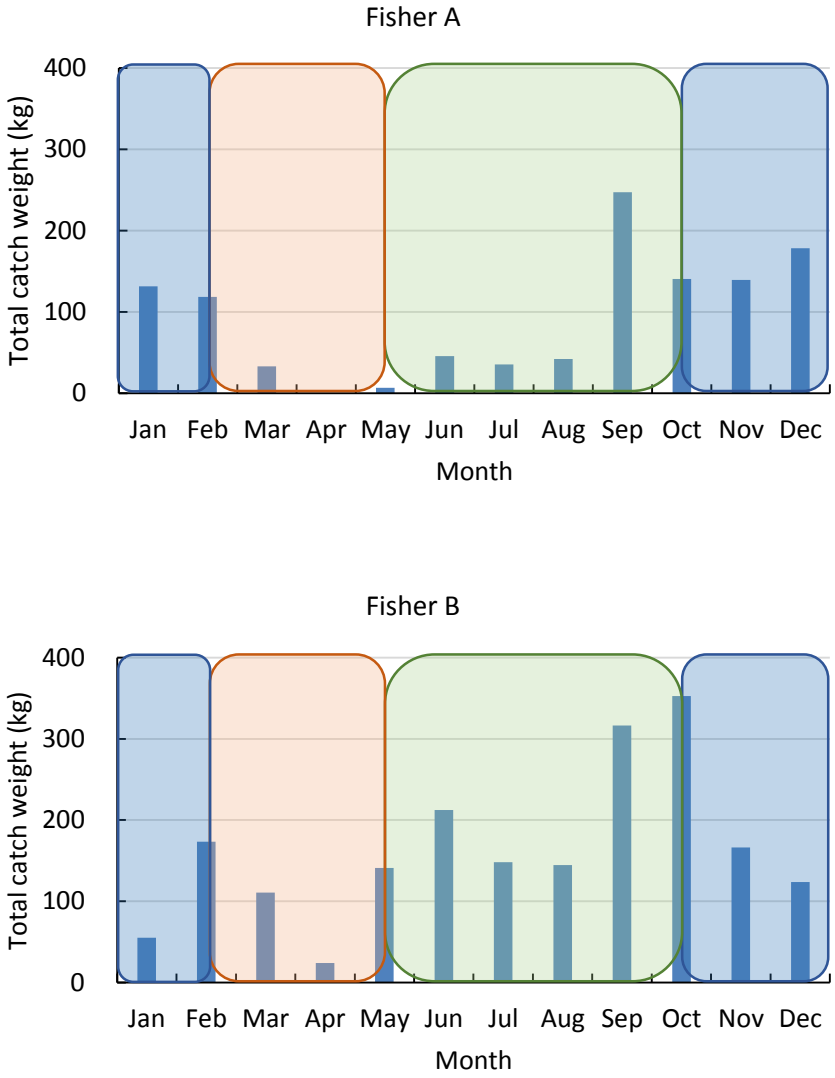


Fig. 2-14 Total catch weight by crab gill-net in 2013.

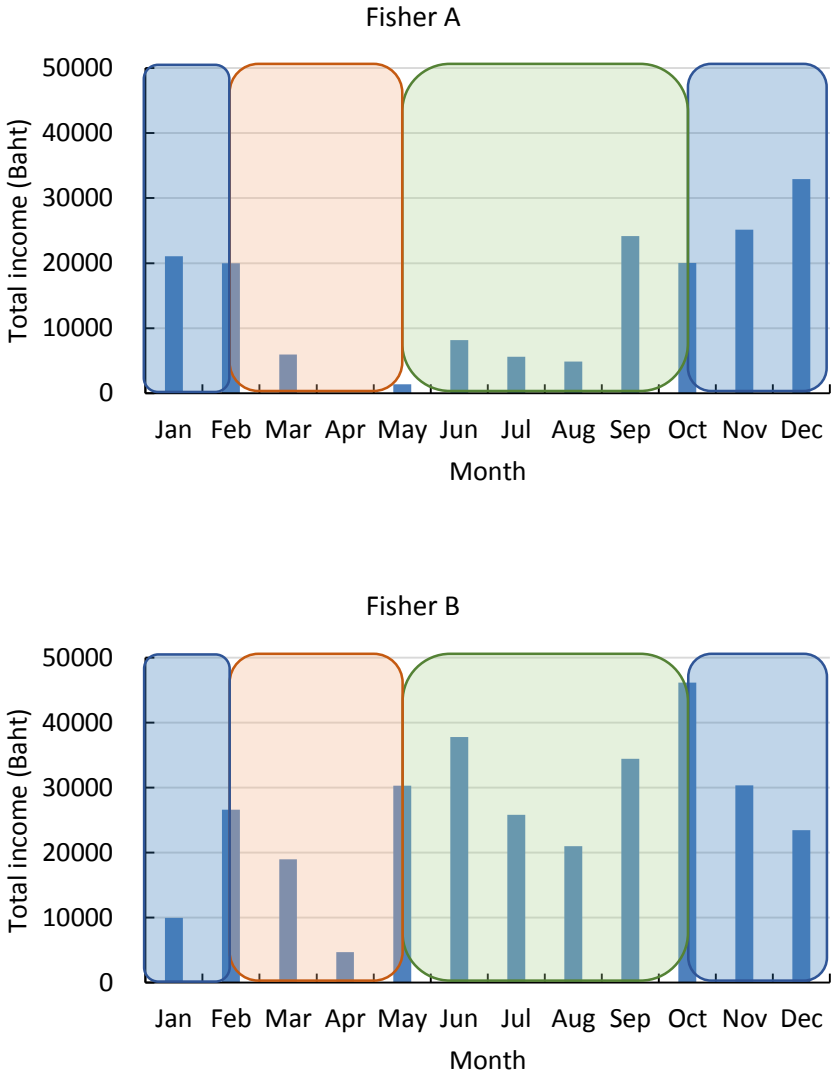


Fig. 2-15 Total income by crab gill-net in 2013.

3. Fish trap

Thai name: Lorb-pla (ลอบปลา), Lorb-pla-gao (ลอบปลาเก๋า)

Rayong local name: Lorb-pla (ลอบปลา)

Fish traps are used in fishing grounds around coral reefs or artificial reefs to target grouper, snapper, rabbit fish, etc. Marine animals are enticed to enter the trap either because of the bait or the trap appears to provide some form of shelter. Fishers in Rayong operate fish traps without baits; the fish enter the trap voluntary. Fish traps are set individually on the seabed with a haul-in line and a float. The float is not on the sea surface, because the position at which a fisher sets the fish trap is secret in order to avoid trap loss or be retrieved by other fishers.

3.1 Construction of fish trap

Fish traps of various sizes and shapes are used in Rayong. Each fisher has his own preference for the trap structure; however, the general process of making a fish trap is similar. Most fish traps are box-shaped (Fig. 3-1); however, dome-shaped traps are also used (Fig. 3-2). According to fishers, although dome-shaped traps are more efficient than the box-shaped ones, dome-shaped traps are more difficult to construct.

Box-shaped fish trap is 206 cm in length, 95 cm in width, and 50 cm in height, with two concrete blocks of about 10 kg attached to both sides of the bottom panel. The total weight of a completed fish trap is approximately 30-40 kg. There is an entrance on the side of fish trap and the length of funnel is 132 cm. Fishers said that the length of funnel is very important for catching target species and optimum length of funnel is two thirds length of fish trap. Timber from the nearby mountain and forest is used for making the frame of the traps (Fig. 3-3). Top, bottom, and back panels are covered with polyethylene netting with a mesh size of 2.5 inches (6.4 cm), and twine

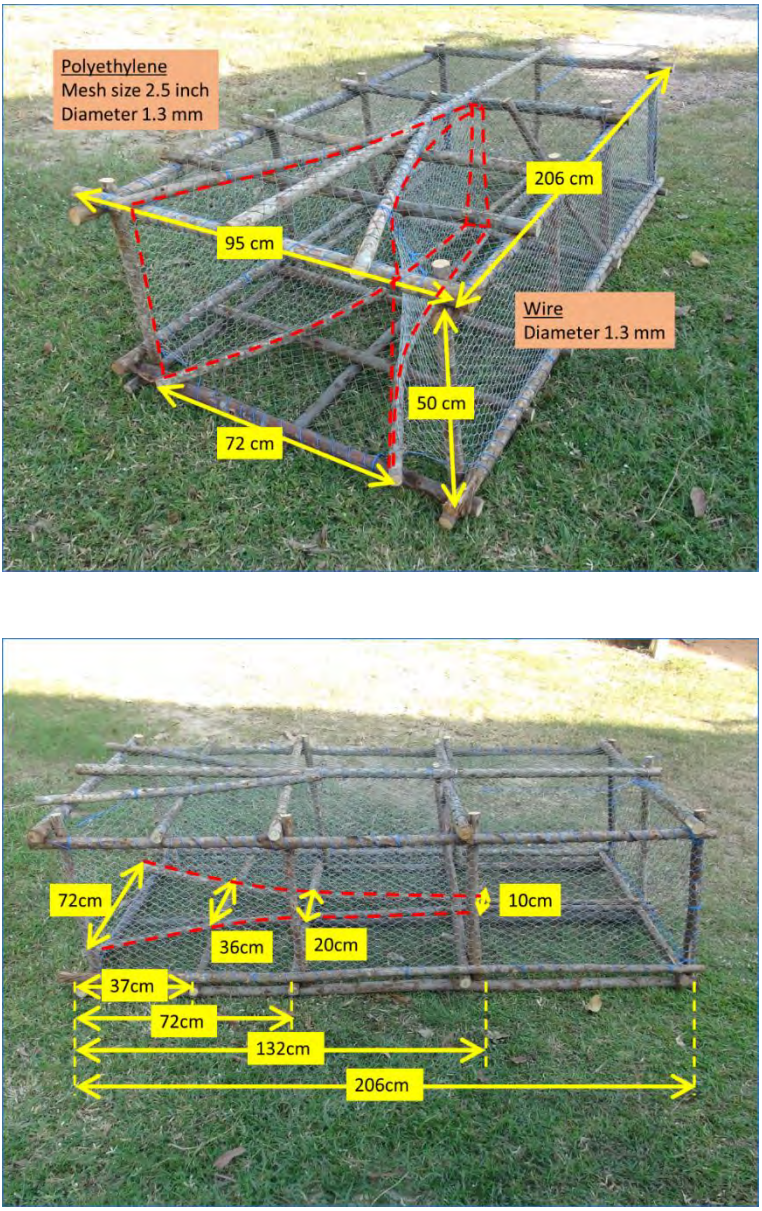


Fig. 3-1 Structure of fish trap. The trap shown above photo has just been completed by the fisher, and it doesn't have any weights yet. Weights are attached to the bottom of both sides before being deployed in the sea.

diameter of 1.3 mm. Side and entrance panels are covered with wire netting, which is hexagonal shaped, with a height and length of 2.5 × 3.2 cm and wire diameter of 1.3 mm to prevent vibration due to sea currents (Fig. 3-4). According to fishers, if the side panels and funnel are covered with polyethylene netting, the net will vibrate due to water flow, which will scare the fish, preventing them from entering the trap.

Fishers buy polyethylene and wire netting from the fishing net shop. The material cost per fish trap is approximately 1,500-2,000 Baht. Fishers normally possess 10-20 traps and use 3-10 traps for each operation.

Fig. 3-2 A dome-shaped fish trap.

Fig. 3-3 Materials used for the frame (left) and construction of the frame of box-shaped trap (right).

Fig. 3-4 Polyethylene netting (left) and wire netting (Right).

The durability of a fish trap is approximately 3-6 months and depends on not only the quality of timber but also the soak time in the sea (Table 3-1). If fishers haul the fish trap up every day or once every two days, the durability of the trap is extended to more than 6 months. If the soak time is 3-4 days or up to 1 week, the durability is reduced by about 6 months and 4 months, respectively.

Table 3-1 Relation between soak time and durability.

Soak time	Duration of fish trap
1-2 days	More than 6 months
3-4 days	About 6 months
1 week	About 4 months

3.2 Operation method and catch species

Fishers usually leave the pier for the fishing grounds around dawn and return to the pier in the afternoon. Fish traps are deployed in the fishing grounds, on either a coral reef or an artificial reef, with 1-2 fishers onboard.

Fish traps are deployed during the daytime, and each position is decided using a portable GPS or bearings. Few fishers have not only GPS but also eco sounder (Fig. 3-5).

(a)

(b)

Fig. 3-5 Portable GPS (a) and GPS navigator ((b) left) and Echo sounder ((b) right).

Fishers set fish traps on the seabed with the direction of the entrance parallel to the tidal current. The position and distance from the coral reef is determined by the habitat range of the target species.

The fish traps are retrieved during the daytime by 1-2 fishers. After reaching the position where the fish trap was placed, the rope which connects to the hook and the buoy is used to retrieve the trap. The rope is dropped into the sea so as to reach the sea bottom (Fig. 3-6 (a, b, c)), and then dragged by moving the boat toward the trap (Fig. 3-6 (d)). The float which is attached to a rope and tied to the top of the front edge of the trap, is approximately 2 m above the trap. After the float is connected to the rope (Fig. 3-6 (e)), it is pulled up to the sea surface by the hauler or manually, and lifted on board (Fig. 3-6 (f), Fig. 3-7, 3-8)).

After retrieve the fish trap on the boat, the trap window is opened and the fish are removed using a scoop ring net. The trap is cleaned, checked for

any damage, repaired if necessary, and the window is closed before re-deployment into the sea. The reset location of the fish trap may be changed if the catch is poor.

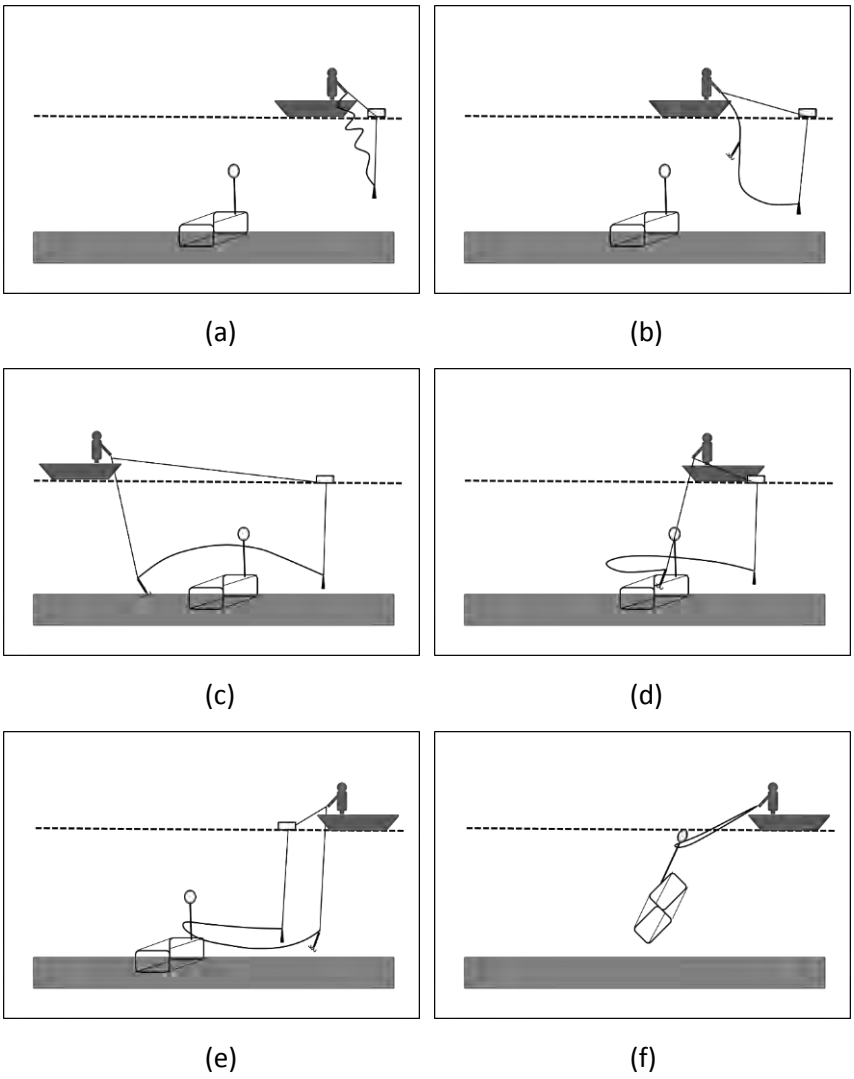


Fig. 3-6 Method of retrieving fish trap (drawn by Mr. Kunut Suthipongkeat).

Fig. 3-7 Fisher hauls the fish trap up by hands and take the catch with a scoop ring net.

Fig. 3-8 Line hauler driven by the engine.

When the trap is hauled up on the deck of the fishing boat, almost all of the fishes caught with the trap is alive. The fishes are kept in a cool box with ice (Fig. 3-9). However, the higher priced fishes such as grouper are kept alive in a fish hold with seawater (Fig. 3-10). If the stomach swells, gas inside the stomach is remove with a syringe before putting the fishes into the fish hold (Fig. 3-11). There are 4-5 small holes on the bottom of fish hold, and are normally sealed with corks or rubber stoppers. The fisher opens the holes when there is a need to circulate the seawater in the fish hold. Seawater circulates in the fish hold while the fishing boat is moving.

After returning to the pier, fishers land the catch, sort and weigh each species to sell to the middleman (Fig. 3-12, 3-13).

Fig. 3-9 The cool box to keep the catch with ice.

Fig. 3-10 The fish hold to keep live fish with seawater.

Fig. 3-11 Removal the gas inside the stomach of the high priced fish with a syringe before putting the fishes into the fish hold.

Fig. 3-12 Returning to the pier to land the catch.

Fig. 3-13 Landing the catch, sorting and weighing each species to sell to the middleman.

Catch species (Photo, Thai name and Rayong local name, common name, scientific name, and landing price)

Thai name: Pla-sa-lid-ta-lay (ปลาสลิดทะเล)
Rayong local name: Pla-sai-lid-hin (ปลาสลิดหิน)
Common name: Rabbitfish, Streaked spinefoot
Scientific name: *Siganus javus* (Linnaeus, 1766)
Price: 15-80 Baht/kg

Thai name: Pla-sa-lid-ta-lay (ปลาสลิดทะเล)
Rayong local name: Pla-sai-lid-hin (ปลาสลิดหิน)
Common name: Rabbitfish, White spotted spinefoot
Scientific name: *Siganus canaliculatus* (Park, 1797)
Price: 15-80 Baht/kg

Thai name: Pla-soi-nok-kow-ta-ley (ปลาสร้อยนกเขาทะเล)
Local name: Pla-kee-nok (ปลาขี้นก)
Common name: Painted sweetlip
Scientific name: *Diagramma pictum* (Thunberg, 1792)
Price: 30-170 Baht/kg

Thai name: Pla-ga-pong-kang-pan (ปลากะพงข้างปาน)
Common name: Russell's snapper
Scientific name: *Lutjanus russelli* (Bleeker, 1849)
Price: 25-130 Baht/kg

Thai name: Pla-ga-pong-luang-ka-min (ปลากะพงเหลืองขมิ้น)
Rayong local name: Pla-sai-bua (ปลาสายบัว)
Common name: Brown stripe red snapper
Scientific name: *Lutjanus vitta* (Quoy & Gaimard, 1824)
Price: 30-150 Baht/kg

Thai name: Pla-ga-pong-luang-ka-min (ปลากะพงเหลืองขมิ้น)
Rayong local name:Pla-luang-ka-min (ปลาเหลืองขมิ้น)
Common name: Bigeye snapper
Scientific name: *Lutjanus lutjanus* (Bloch, 1790)
Price: 25-30 Baht/kg

Thai name: Pla-gao-toog-gea (ปลาเก๋าตุ๊กแก)
Rayong local name: Pla-gao-duang (ปลาเก๋าดวง)
Common name: Grouper, Long fin grouper
Scientific name: *Epinephelus quoyanus* (Valenciennes, 1830)
Price: 250-500 Baht/kg

Thai name: Pla-ga-rung-dok-dang (ปลากะรังดอกแดง)
Rayong local name: Pla-gao (ปลาเก๋า)
Common name: Orange-spotted grouper
Scientific name: *Epinephelus coioides* (Hamilton, 1822)
Price: 250-500 Baht/kg

Thai name: Pla-ga-rung-rai-fa (ปลากะรังลายฟ้า)
Rayong local name: Pla-sa-rong-keag (ปลาโสร่งแขก)
Common name: Bluelined grouper
Scientific name: *Cephalopholis formosa* (Shaw, 1812)
Price: 150-300 Baht/kg

Thai name: Pla-ka-rung-jud-fa (ปลากะรังจุดฟ้า)
Rayong local name: Pla-gao-gud-sa-lad (ปลาเก๋ากุดสลาด)
Common name: Leopard grouper
Scientific name: *Plectropomus leopardus* (Lacepède, 1802)
Price: 350-1,100 Baht/kg

Thai name: Pla-ga-pong-kang-pan (ปลากะพงข้างปาน)
Rayong local name: Pla-ung-geay (ปลาอังเกย)
Common name: Lutjanus johnii
Scientific name: *Lutjanus fulviflamma* (Bloch, 1792)
Price: 150 Baht/kg

Thai name: Pla-hang-luang (ปลาหางเหลือง)
Common name: Yellowtail, Redbelly yellowtail fusilier
Scientific name: *Caesio cuning* (Bloch, 1791)
Price: 60-120 Baht/kg

Thai name: pla-jui-jin-ngeuk-yaw (ปลาจุ๋ยจิ้นเหงือกยาว)
Rayong local name: pla-jui-jin (ปลาจุ๋ยจิ้น)
Common name: African pompano
Scientific name: *Ulua mentalis* (Cuvier, 1833)
Price: 100-120 Baht/kg

Thai name: Pla-ga-pong-sa-mae (ปลากะพงแสม)
Rayong local name: Pla-gra-tai-kood (ปลากระต่ายขูด) / Pla-krued-krad (ปลาครืดคราด) / Pla-od-ad (ปลาออดแอด)
Common name: Javelin grunter
Scientific name: *Pomadasys kaakan* (Cuvier, 1830)
Price: 40-70 Baht/kg

Thai name: Pla-sai-kaw-tab-nam-tan (ปลาทรายขาวแถบน้ำตาล)
Rayong local name: Pla-sai-kraw (ปลาทรายขาว)
Common name: Monogrammed monocle bream
Scientific name: *Scolopsis monograma* (Cuvier, 1830)
Price: 40-80 Baht/kg

Thai name & Local name: Pla-sai-kaw-hu-deang (ปลาทรายขาวหูแดง)
Rayong local name: Pla-sai-kraw (ปลาทรายขาว)
Common name: Lattice monocle bream
Scientific name: *Scolopsis taenioptera* (Cuvier, 1830)
Price: 40-80 Baht/kg

3.3 Seasonal variation of catch and operation site

The number of operation days per month increases during the southwest monsoon and decrease in the northeast monsoon season (Fig. 3-14). Thus, total catch weight and total income for each month increase in the southwest monsoon (Fig. 3-15, 3-16). Catch composition is seasonally changed (Fig. 3-17), Rabbitfish, painted sweetlips, and Russell's snapper are the common economic catch species caught by fish traps during all seasons. But, groupers are caught in mainly northeast monsoon seasons. The other minor economic catch species are yellow tail, brown striped snapper, javelin grunter, etc.

The southwest monsoon and northeast monsoon usually cause rough sea and have negligible impact on the operation sites. However, the operation sites where fishers deployed the fish traps did not change (Fig. 3-18). The position of each fish trap remains the same year round, consistently located in near the coral reefs or artificial reefs.

The catch price depends on the catch species, size and season. Larger-

sized fish are more expensive than the smaller ones. Fishers normally sell their catch to a middleman who buys the fish at the pier or beach. The catch price may increase during weekends or during the summer season that is tourist season.

Groupers are the highest price species and caught occasionally. Some species such as the leopard grouper are sold at more than 1,000 Baht/kg. The price of common species such as rabbitfish, painted sweetlips is low, approximately 15-150 Baht/kg although they comprise the highest catch composition throughout the year.

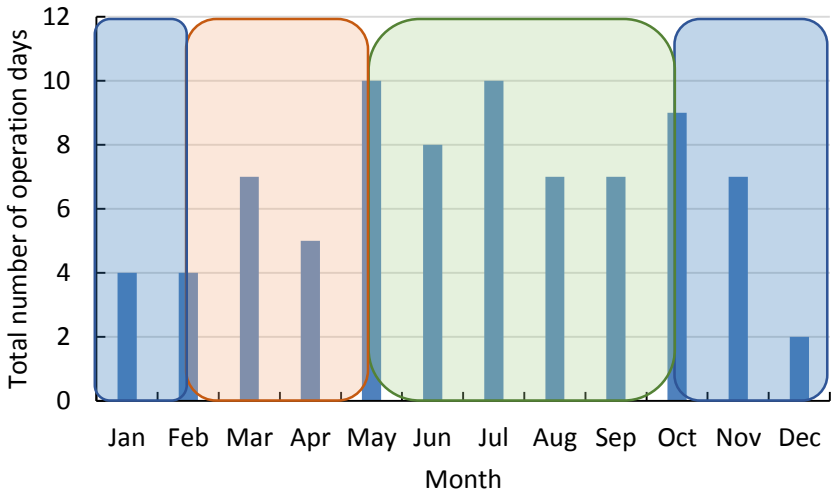


Fig. 3-14 Total number of days which fishers conducted operations of fish trap in 2013.

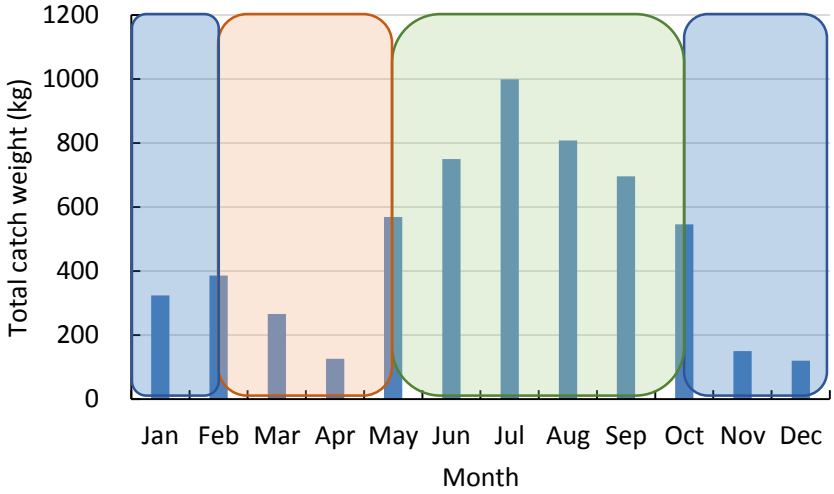


Fig. 3-15 Total catch weight by fish trap in 2013.

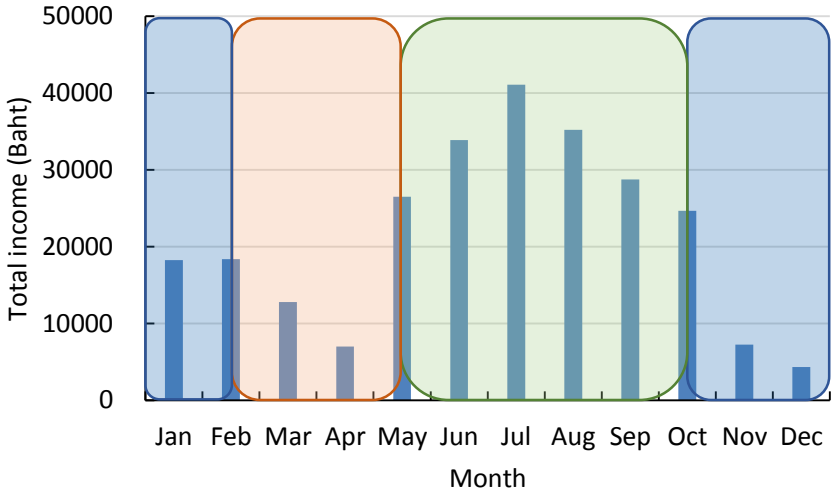
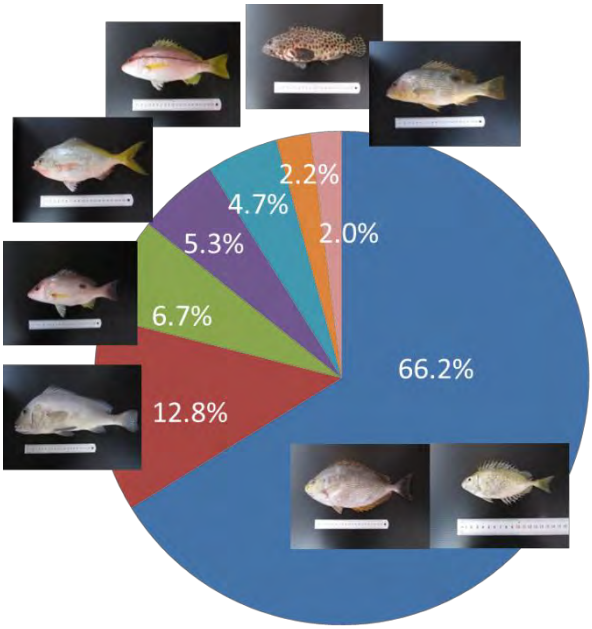
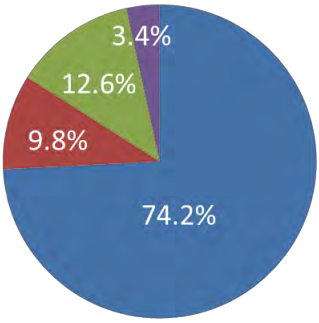


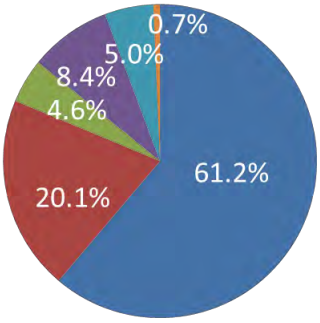
Fig. 3-16 Total income by fish trap in 2013.



Northeast monsoon season (February 2013)



Pre-monsoon season
(April 2013)



Southwest monsoon season
(July 2013)

Fig.3-17 Catch composition by weight in 2013.

Fig. 3-18 Operation sites of fish trap in 2013. (Green: Southwest monsoon, Blue: Northeast monsoon, Orange: Pre-monsoon)

4. Floated squid trap

Thai name: Lorb-muak (ลอบหมึก), Lorb-muak-horm (ลอบหมึกหอม)

Rayong local name: Lorb-muak (ลอบหมึก), Lorb-muak-horm (ลอบหมึกหอม)

The floated squid trap, introduced by Thai fishers in 1977, is effective for catching bigfin reef squid *Sepioteuthis lessoniana* and cuttlefish *Sepia aculeata*. It was invented in Chanthaburi Province located in the eastern part of Thailand along the Cambodian border, by fishers who modified existing fish traps to catch squid only. The new trap design spread, and the floated squid trap became widely used in Thai waters, particularly along the eastern and southern coasts (Chotiyaputta and Yamrungreung, 1998).

Fig. 4-1 Male (left) and female (right) of big fin reef squid.

Fig. 4-2 Pharoah cuttlefish *Sepia pharaonis* (left) and Needle cuttlefish *Sepia aculeata* (right).

4.1 Construction of floated squid trap

Trap fishing gear is normally placed on the seabed. The floated squid trap is unique, because it is the only trap that floats in the sea approximately 2-3 m above the seabed (Fig. 4-3). The floated squid trap is a cylindrical dome with an entrance (Fig. 4-4). It consists of a wood frame of 15-17 mm in diameter covered with black polyethylene netting of 70 mm in mesh size and 0.6 mm in diameter. The floated squid trap is screened with palm leafs called "*Bai Peng* (ใบเป้ง)" to create a dark environment which attract target species. The weight of the squid trap is approximately 2 kg in total. The bamboo pole of 3 m in length is attached at the base with a set of stone weights of approximately 10 kg in weight (Fig. 4-5). To differentiate the traps of different owners, a flag of a particular color is tied to the bamboo pole.

Fishers generally construct their own traps by themselves with the assistance from family members (Fig. 4-6). They obtain wood from the forests to construct the trap. The netting and other materials are purchased from local shops that sell fishing gear. The cost of materials is approximately 300-350 Baht per set, which includes the rope, buoy, bamboo pole and stone weight. The durability of the floated squid trap is approximately 1 month.

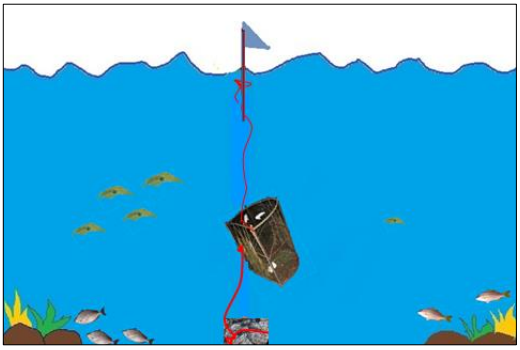
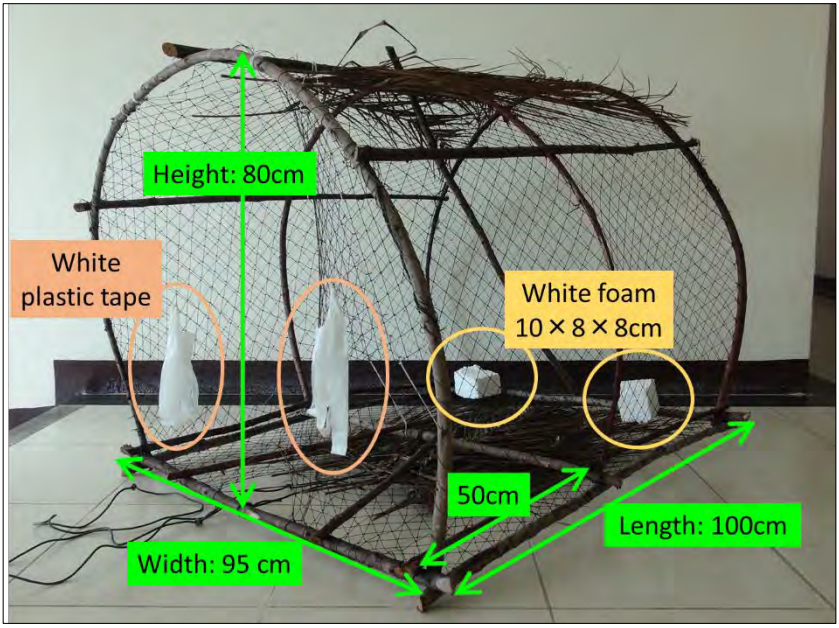


Fig. 4-3 Squid trap deployment in the fishing ground. Trap is floating above the seabed; the entrance is angled upwards with a slight slant. (drawn by Ms. Anpinut Witan-urawat)



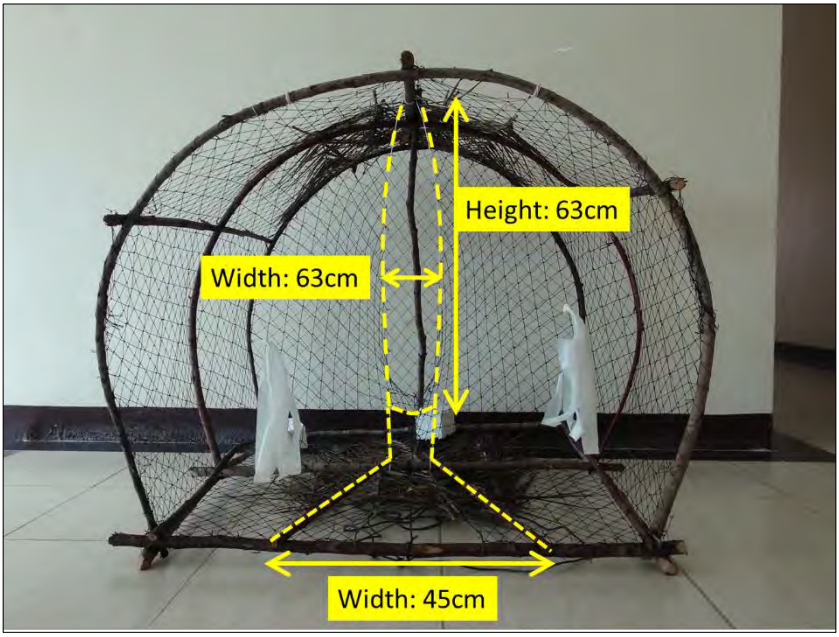


Fig. 4-4 Design of the floated squid trap.

Fig. 4-5 Fresh palm leafs used to cover the top and bottom of the trap (upper), and stones used as a weight (lower).

Fig. 4-6 Fisher's wife constructs the floated squid trap.

4.2 Operation method and catch species

The floated squid traps are set individually, each with a haul-in line slightly longer than the depth at which the traps are set. During setting, the entrance at the front of the trap is faced upwards, and each trap is set to float approximately 2-3 m above the seabed. The squid traps float due to their wooden frame and the fragments of polystyrene foam that are placed inside. This construction allows the traps to float above the seabed, even under the influence of currents. The specific height is set according to the depth of the water at the setting location. Setting traps to float at an appropriate height is important for catching only the target species. Setting the trap too far above the seabed results in a poor squid catch; however, setting it too close to the seabed also leads to a poor catch, and additionally allows the entry of non-target species such as fishes.

Fishers attach a cluster of fresh eggs inside the trap and white plastic tapes at the trap entrance. The eggs are attached using polyethylene thread, then placed inside, beneath the leaves, near the middle part of the top panel. Fresh eggs, white plastic tape and leaves that cover the trap are important factors in ensuring that the target species enter the trap.

Each fishing operation typically uses 50-80 floated squid traps. Floated squid traps are usually deployed during the daytime (Fig. 4-7). The fishing grounds of floated squid trap fishery are also used by commercial pair trawl operations; these are the main causes of loss of squid traps (Fig. 4-8). Other fishing methods used in the area include squid trolling and squid falling nets (Fig. 4-9). Traps are deployed in a straight line for both ease of operation and easier recovery of lost traps. The distance between each trap is approximately 500 m, and the distance between each row of traps is approximately two nautical miles. The distance between rows is approximately twice that of the distance for two fishing boats of pair trawler. This is to allow pair trawler to pass through between rows of the floated squid traps. Before deployment of floated squid traps, fishers always

observe the tracks followed by trawlers. By avoiding these tracks, they minimize losses; however, traps are still lost almost daily, and are also moved from their initial position.

When setting traps, fishers identify an optimal fishing location and then drop the trap, followed by the stone weight and the flag pole. The pole is erected after the weight reaches the seabed. Due to the limited area on the deck of small fishing boat, they usually carry only 16-20 traps, with a maximum of 24 traps per trip (Fig. 4-10). When determining the number of traps to carry on the boat each day, the sea conditions, catch amount, and number of traps lost are important factors. Fishers try to maintain 80 available traps in the fishing ground by replacing lost traps. Approximately 2-3 traps are lost per day due to accidents or other fishing activities, particularly pair trawler operations.

Squid traps are normally retrieved during the daytime (Fig. 4-11). Fishers leave the pier or beach in the early morning, approach the fishing ground, and observe the deployed trap lines. After arriving at the trap position, fishers hold the bamboo pole and haul it up on the boat, and then haul up the rope that is connected to the trap. The trap is hauled up till it reaches the sea surface, it is then manually pulled to the boat gunwale. Fishers take the catch from the trap with a scoop ring net. And then the trap is cleaned, and re-deployed into the sea. If the netting and frame are broken, repairs are done before deployment. Trap positions are changed if the previous catch is poor. Bigfin reef squid, cuttlefish, and other economic fish caught with the floated squid trap are normally alive. After retrieving catch from the floated squid trap, fishers keep the squid on the deck for a short while to weaken the activity of squid (Fig. 4-12). If the squid is put into the fish hold immediately after retrieval from the trap, they eject ink, which pollutes the seawater in the fish hold. Ice is not used to preserve the squids, because ice causes the squids to swell, and also deteriorates their quality and color of meat.

Fishers normally haul up the floated squid traps every day; therefore, soak time is 1 day. However, when the catch is poor, the soak time may be extended to 2-4 days. If the squid catch is quite poor, fishers extend soak time for about 2 weeks. If the catch is still quite poor after 2 weeks, fishers leave the traps at sea and do not retrieve them anymore, which probably causes ghost fishing.

During the retrieval process, fishers always observe the position of eggs which bigfin reef squid laid. If there are too many eggs laid by bigfin reef squid near the bunch of eggs fisher attached or on another position, fishers remove the eggs and keep some fresh eggs for the next deployment (Fig. 4-13). Using new bunch of fresh eggs is important for attract target species. If many eggs are attached to the stone weight, it indicates that the trap was set too far from the seafloor. Fishers then adjust the position by shortening the rope connecting the stone weight to the trap. On the other hand, if there are a large numbers of fish in the trap, it indicates that the trap was positioned too close to the seabed, and length of the rope is adjusted to position of the trap higher from the seabed.

(a) Preparing the traps

(b) Placing the squid eggs inside

(c) Ready to drop the trap

(d) Dropping the trap and weight

(e) Throwing the bamboo pole

(f) The bamboo pole with the flag

Fig. 4-7 Procedure for deploying the floated squid trap.


Fig. 4-8 Pair trawler which consist of two fishing boats operate in the same fishing grounds as the floated squid trap.


Fig. 4-9 Fishing boat of squid trolling (left) and squid falling net (right).


Fig. 4-10 Floated squid traps arranged to be carried on the deck of fishing boat; fishers can carry maximum 24 traps per one trip.

(a) Holding the bamboo pole

(b) Holding the trap

(c) Pulling up the trap

(d) Taking the catch

(e) Replacing eggs with fresh one

Fig. 4-11 Procedure for retrieving the floated squid trap.


(a) Taking the catch from the trap


(b) Keeping the squid on the deck for a short while to weaken its activity


(c) Keeping the squid in the fish hold with seawater

Fig. 4-12 Procedure for keeping the catch.

Fig. 4-13 The bunch of fresh eggs of bigfin reef squid are prepared to replace old eggs.

4.3 Seasonal variation of catch and operation site

Main target species of the floated squid trap were bigfin reef squid and cuttlefish, which were fully mature. A few kinds of fish or animal may enter the squid trap. Our on-board surveys showed that only 2-4 individuals were caught per a trip including 60-80 squid traps, with all of them being economically important fish species. Thus, squid traps have high species selectivity. Thus, the trap had good selectivity for species and size.

The number of operation days per month was not affected by the southwest and northeast monsoon (Fig. 4-14), although the number of the traps deployed decreased in the seasons. Moreover, catch weight and income also decreased during the southwest and northeast monsoon seasons (Fig. 4-15, 4-16). The traps were placed near a coastal area about 10 km off the coast during the southwest monsoon, but is maximum about 50 km off coast in the other season, especially pre-monsoon season (Fig. 4-17).

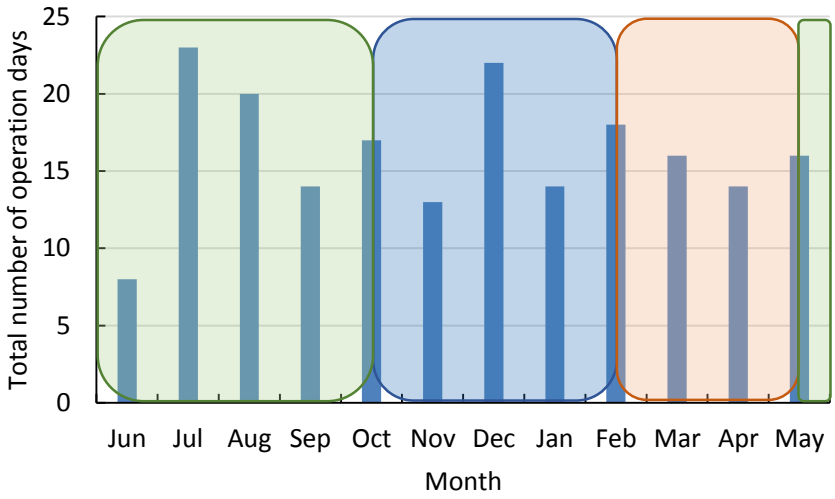


Fig. 4-14 Total number of days which fishers conducted operations of floated squid trap in 2013 and 2014.

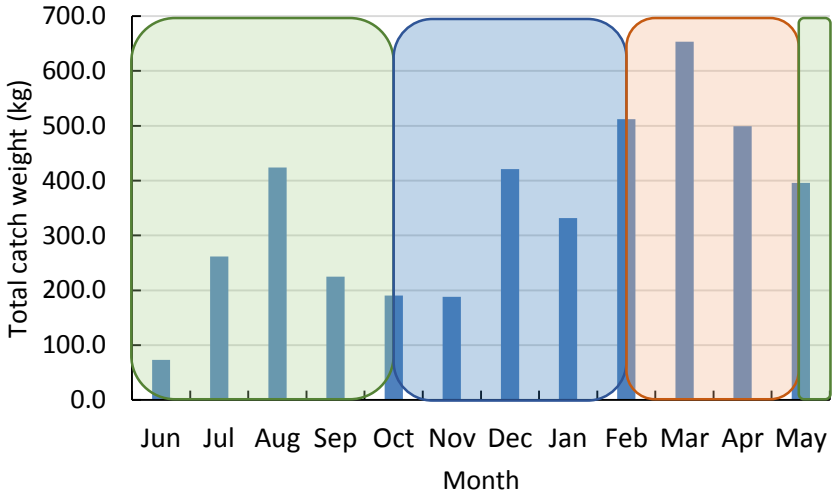


Fig. 4-15 Total catch weight by floated squid trap in 2013 and 2014.

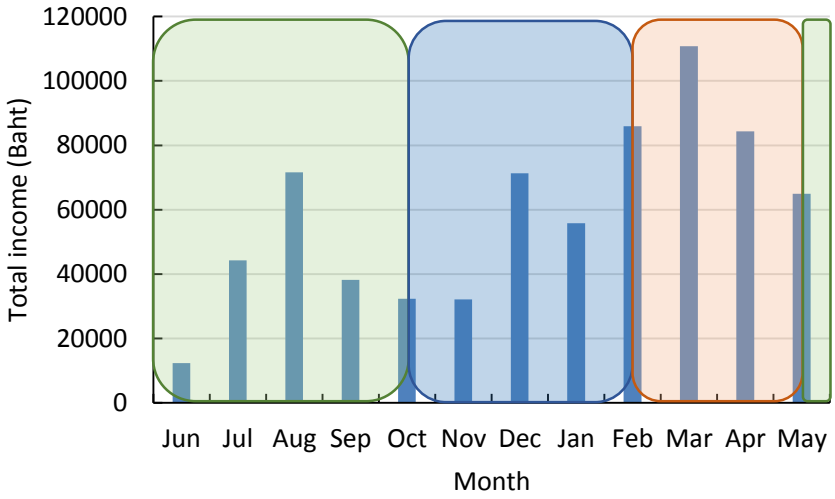


Fig. 4-16 Total income by floated squid trap in 2013 and 2014.

Non-target species (Thai name, common name and scientific name)

Pla-sai-bua (ปลาสายบัว)

Brown stripe red snapper

Lutjanus vitta

Pla-si-kun (ปลาสีกุน หรือ ปลาสีขน)

Blackfin scad

Alepes melanoptera

Pla-hu-chang-khrib-Yaw

(ปลาหูช้างครีบยาว)

Longfin batfish

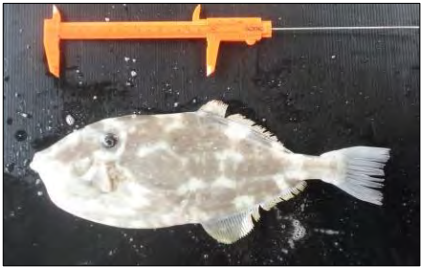
Platax teira

Pla-wua-hang-pad

(ปลาวัวหางพัด)

Fan bellied leatherjacket fish

Monacanthus chinensis



Pla-wua-hang-tud (ปลาวัวหางตัด)

Unicorn leatherjacket filefish

Aluterus Monoceros

Pla-ga-pong-kang-pan (ปลากะพงข้างปาน)

Russell's snapper

Lutjanus russelli

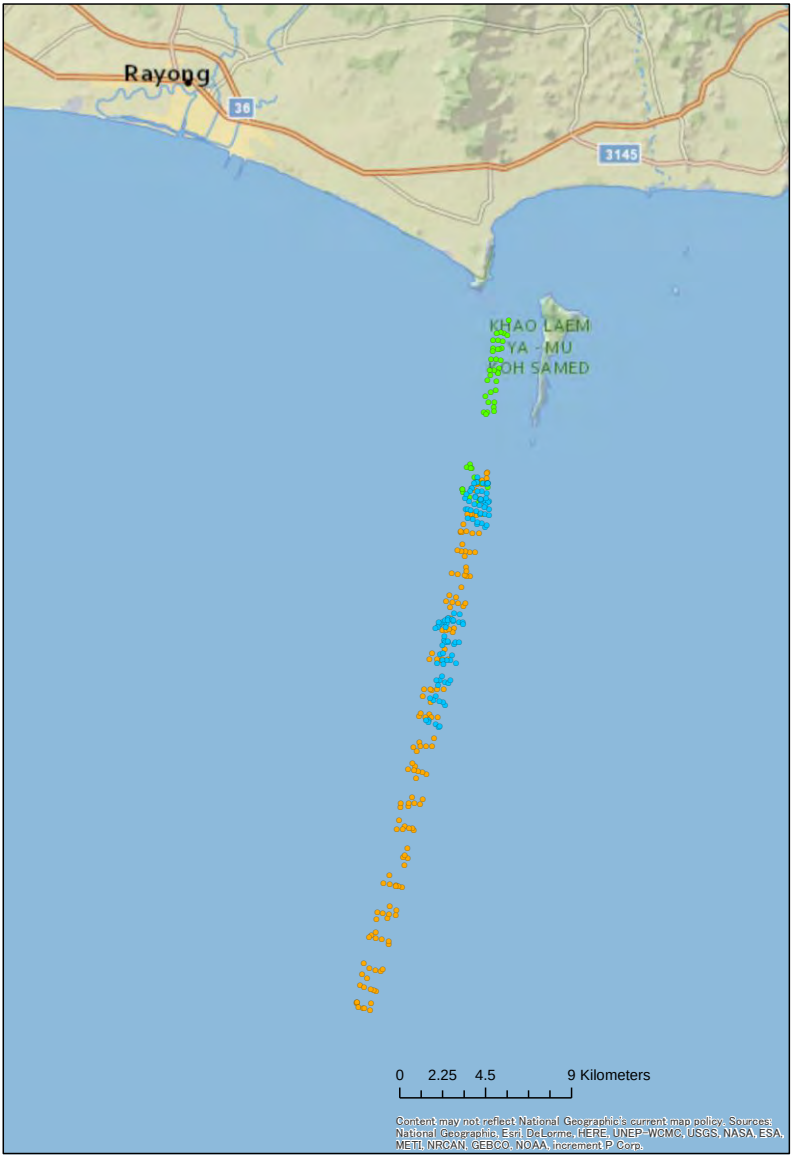


Fig. 4-17 Operation sites of floated squid trap in 2013 and 2014. (Green: Southwest monsoon, Blue: Northeast monsoon, Orange: Pre-monsoon)

5. Troll line and Hook-and-line

Thai name: Troll line = Bed-larg (เบ็ดลาก), hook-and-line = Bed-sai (เบ็ดสาย)
Rayong local name: Bed-larg (เบ็ดลาก), Bed-sai (เบ็ดสาย)

Most small-scale fishers conduct troll line and hook-and-line fishing either as a primary or secondary occupation. Since the line fishing gear is not large or complex, fishers who operate crab gill-nets or fish traps usually carry the fishing gear of troll line and hook-and-line when they go to the sea.

The operation of crab gill-net are normally conducted from dawn till noon. Some fishers of crab gill-net go to sea again after finish to land the catch with crab gill-net, to conduct the operation of troll line and hook-and-line. The fishers of fish trap fishery conduct the operation of troll line and hook-and-line on going to operation site or returning to the pier.

It is the best season for catch bigfin reef squid with troll line from March to May. The catch of crab gill-net fishery decreases from March to May. Hence some fishers of crab gill-net switch from crab gill-net to troll line for catching bigfin reef squid. The fish trap has little catch in northeast monsoon season. Therefore, some fishers of fish trap conduct the operation of troll line and hook-and-line during northeast monsoon season.

5.1 Gear construction and operation method

There are various kinds of line fishing such as troll line and hook-and-line. The line fishing gear consist of lines, sinkers, hooks, and baits or lures. Live and frozen fishes are used as a bait. The design and construction of troll line and hook-and-line gears are similar. Both troll line and hook-and-line is very simple. Fishers drop the line fishing gear into the sea, holding one end of the line, and moving the bait or lure to attract the target species. The length of the line is determined by the depth of water at which the target species swim. However, the method of operation of these gears is different (Fig. 5-1).

In troll line fishing, the fisher holds the line, to which artificial baits or lures are attached, or fishers connect the line to bamboo pole (Fig. 5-2). The operation is conducted on a moving fishing boat at the speed of about 3 knots. One or more lines with some baits or lures are towed behind moving fishing boat (Fig. 5-3, 5-4). On the other hand, hook-and-line is operated around coral reefs and artificial reefs while engine is halted and fishing boat is drifting or anchored. Fishers hold the line which has some hooks with baits (Fig. 5-5). Line and frozen small fishes are used for the bait (Fig. 5-6).

For small-scale fisheries such as crab gill-net, fish trap, and floated squid trap, fishers generally leave for the fishing ground and return to the pier in less than 12 hours. However, the operation time of troll line and hook-and-line sometimes extends to more than 2 days. Fishers conduct overnight fishing operations, or may also conduct operations during the daytime and stop by the island, for example Samed Island, and return to the pier two days later.

5.2 Seasonal variation of catch and operation site

The number of days of fishing operations decreases between the south west monsoon season (Fig. 5-7), thereby the catch weight and income also decrease during the season (Fig. 5-8, 5-9). The main target species of troll line and hook-and-line fishing are bigfin reef squid, Spanish mackerel and barracuda (Fig.5-10). The catch composition shows seasonal changes. Bigfin reef squid forms the major catch at the end of the northeast monsoon season, pre-monsoon season, and at the beginning of southwest monsoon season. However, Spanish mackerel comprises the major catch during the northeast monsoon seasons. The fishing operation sites don't change all year around and don't appear to be affected by the southwest and northeast monsoon (Fig. 5-10).

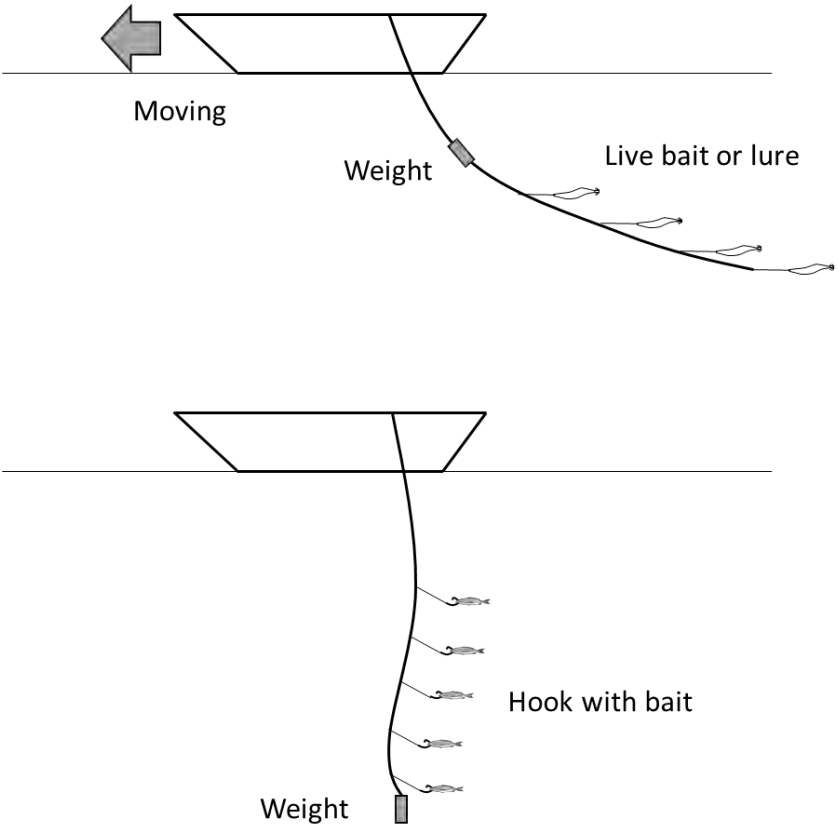


Fig. 5-1 The operation method for troll line (upper) and hook-and-line (lower). The fishing boat is moving during the operation of troll line fishing, but the fishing boat is drifting or anchored during the operation of hook-and-line fishing.

Fig. 5-2 The operation of troll line with bamboo poles.

Fig. 5-3 Various colors of lure used for troll line (Upper: for Spanish mackerel, Lower: for bigfin reef squid). Fishers choose the color of lure by weather condition and transparency of the seawater.

Fig. 5-4 Fisher hold the troll line (left) and catch bigfin reef squid.

Fig. 5-5 Fisher holds and moves the hook-and-line (left). Hook used for hook-and-line (right).

Fig. 5-6 Small fishes used for bait of hook-and-line.

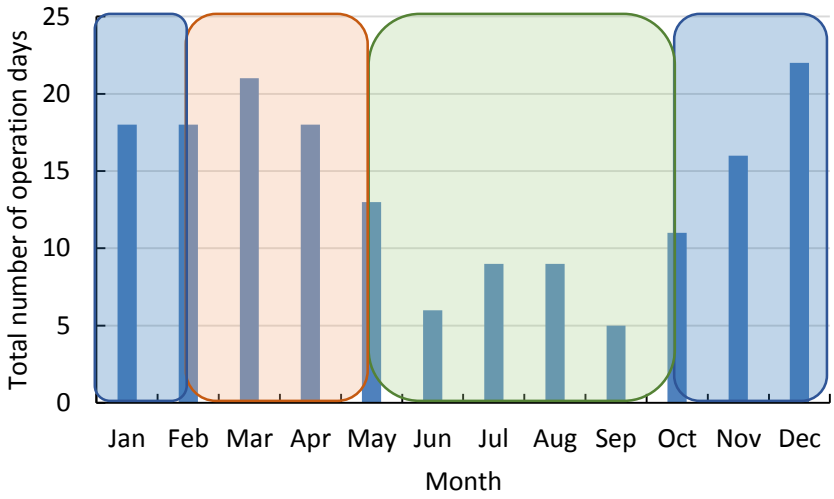


Fig. 5-7 Total number of days which fishers conduct operation of troll line and hook-and-line as primary occupation in 2013.

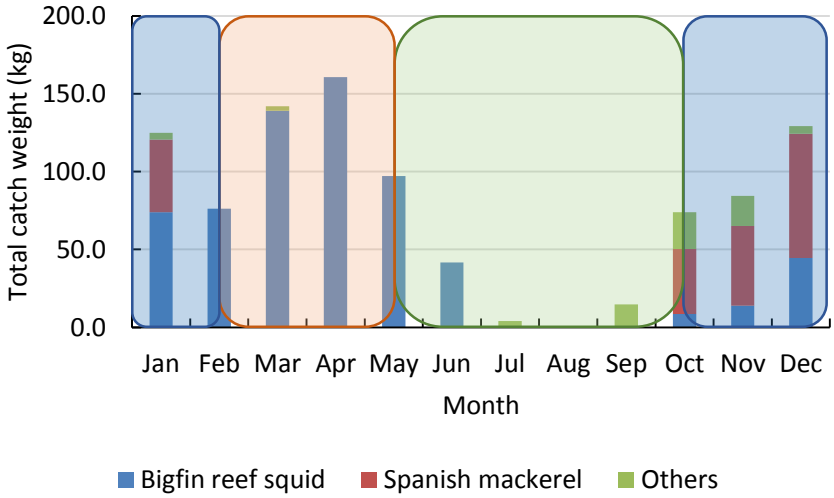


Fig. 5-8 Total catch weight by troll line and hook-and-line in 2013.

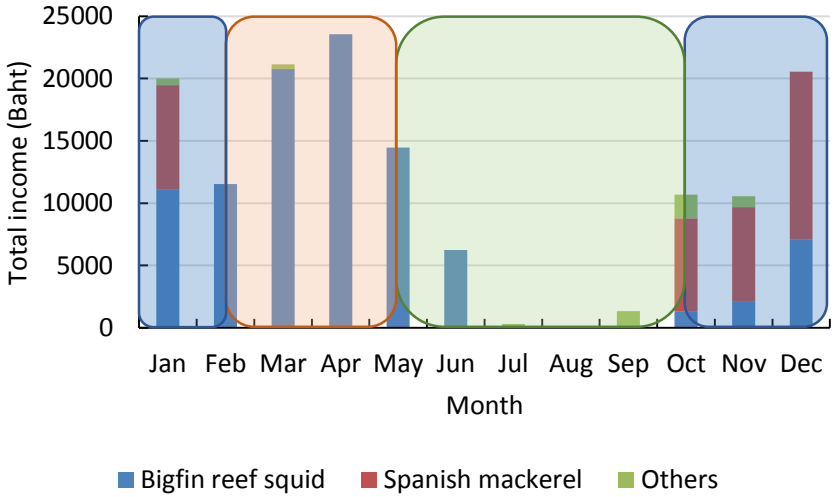


Fig. 5-9 Total catch income by troll line and hook-and-line in 2013.

Target species (Thai name, common name, scientific name and landing price)

Pla-in-see (ปลาอินทรี)
Spanish mackerel
Scomberomorus commersoni
180-120 Baht/kg

Pla-saak (ปลาสาก)
Baracuda, Seapike
Sphyraena sp.
90-100 Baht/kg

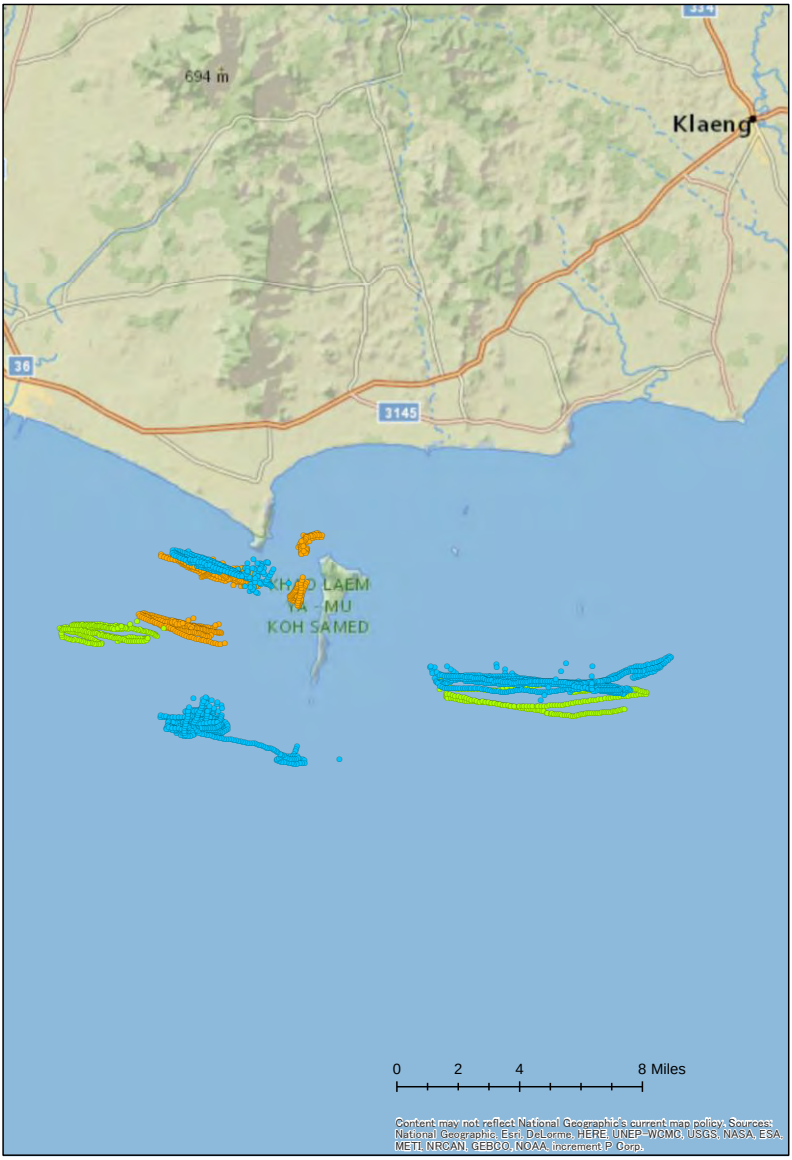


Fig. 5-10 Operation sites of troll line and hook-and-line in 2013. (Green: Southwest monsoon, Blue: Northeast monsoon, Orange: Pre-monsoon)

6. Safety at sea

During field surveys, we got fishing boats onboard with the fishers, to observe the operation of small-scale fisheries in Rayong. We also interviewed the fishers about safety and accidents that occur at sea.

Most fishers whom we interviewed have no experience of serious accidents. However, one or two fishers in Rayong were killed or got injured seriously by lightning particularly during the southwest monsoon season every year. Besides, the following accidents had occurred:

A fisher operating a crab gill-net fishery had been caught in heavy rain and strong wind that continued for an hour during the southwest monsoon season. He waited for the rain to stop, keeping his boat running on the original course. He thinks that effective measures to prevent accidents is important. He always keeps in it mind to carry a cell phone and conduct fishing operation in an area closer to the shore where the cell phone is available.

One fisher operating fish trap fishery had been wounded when his leg became entangled with rope while deploying a fish trap and the trap slid on the fishing boat as the boat rolled in dangerous sea conditions. Another fisher was caught in heavy rain, strong wind, and high waves at sea from 9 o'clock PM until dawn. He took measures to prevent the fishing boat from capsizing. On a different occasion, the fisher has aided another fishing boat that was stopping at sea due to engine trouble.

A fishing boat sank in an area with high current speeds; when the fish trap was hauled up, the boat rolled over.

Most fishers in Rayong do not carry lifejackets when they go to sea, but carry empty plastic fuel tanks to use as floats in the case of accidents. Fishers mostly go to sea alone or with only one additional fisher by small fishing boats. Therefore, fishers sometimes put off going fishing ground when the weather forecast predicts heavy rain and strong wind. Some fishers returned to shore immediately when weather and sea condition are

changed and it is unsuitable for safe operation.

Therefore, based on the results of the field survey, generally the fishing activity of small-scale fisheries in Rayong cannot be considered to be safe enough, because there are many issues regarding safety at sea that need to be resolved.

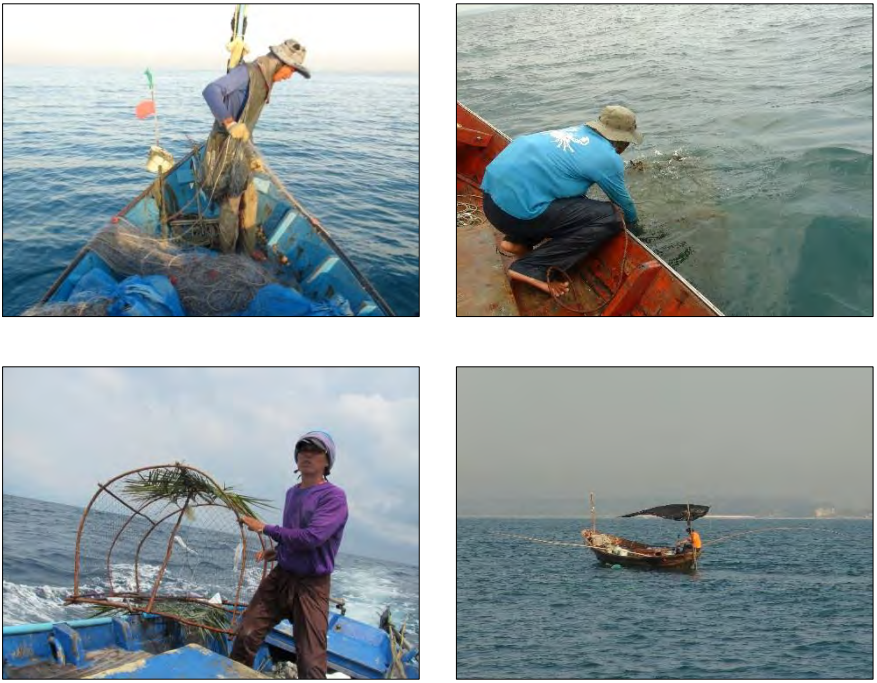


Fig. 6-1 Safety at sea is a crucial issue for small-scale fisheries in Rayong.

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