



**Establishment and Operation of a Regional System of
Fisheries *Refugia* in the South China Sea and Gulf of Thailand**

**FISHERIES *REFUGIA* PROFILE
FOR THAILAND: TRAT**

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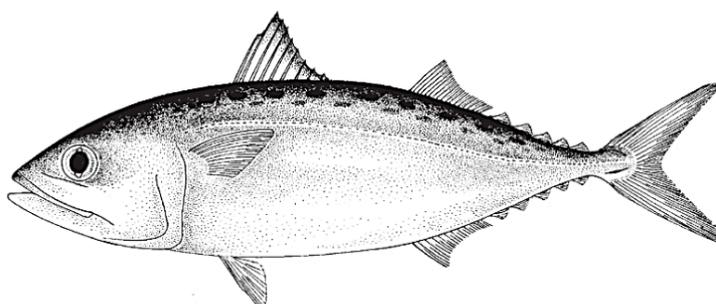
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Carpenter and Niem (2001)

**SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
TRAINING DEPARTMENT**



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1. INTRODUCTION

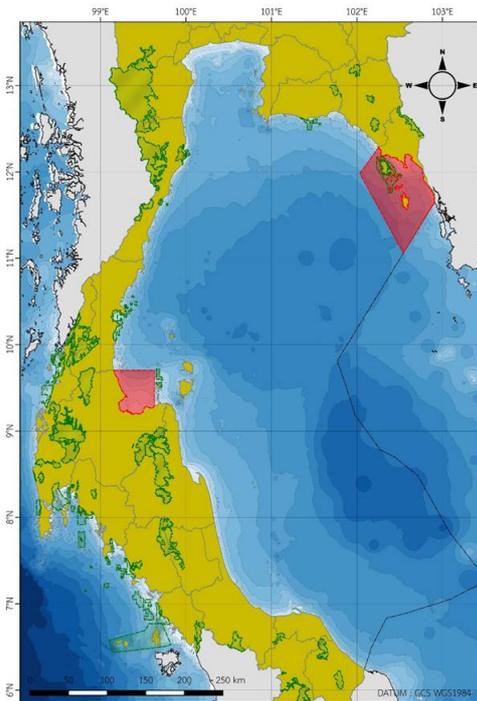


Figure 1-1 Priority fisheries *refugia* sites in Thailand

Thailand is one of the six countries participating in the project entitled “Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand”. Among 15 priority fisheries *refugia* sites for project implementation in the region, two sites have been defined in Thailand, located in the coastal areas of Trat Province in the East and Surat Thani Province in the South (Fig. 1-1).

Considering Trat Province, it has been regarded as one of the richest coastal ecosystem in Thailand due to its high abundances of mangroves, coral reefs, and seagrass beds, as well as a number of small and big islands. Coastal communities in the province mostly depend on coastal and fisheries resources; and fisheries have played the important role in Gross Provincial Product (GPP) of the province. It was found that 13% of GPP in Trat province came from fisheries sector (Trat Provincial office, 2017).

However, fisheries resources in Trat Province have been degenerated, evidenced from the data in fisheries statistics of Thailand that fishing catches in Trat Province gradually decreased in the past 10 years, from 91,185 tons in 2005 to 45,212 tons in 2015 while fishing efforts were reported increased (Department of Fisheries, 2017a). Considering that coastal habitats play a critical role in sustaining fish stocks, food supply, and incomes, fisheries *refugia* approach has been being applied in the specific areas during critical stages of the life cycle of priority species in Trat Province.

The implementation of fisheries *refugia* project in Thailand was initiated by signing of the Letter of Agreement between SEAFDEC and Department of Fisheries as the national lead agency in March 2017. National Fisheries Refugia Committee, National Scientific and Technical Committee, and Site-Based Fisheries Refugia Management Boards were then established to be the framework of project management. Preliminary surveys were firstly done, followed by stakeholder initiation meetings in the two sites. The project was further operated by decision-making, guidance, cross-sectorial coordination, technical provision, and community-led action by means of committee/board meetings along with stakeholder consultation workshops and technical consultation meetings.

For Trat site, short mackerel was defined as the priority species according to its significance as one of the most economical important marine species in Thailand, called “fish of the nation”. Moreover, it has been regarded as the prominent trans-boundary species between Thailand and Cambodia which need the proper co-management. Tentative fisheries *refugia* boundaries for short mackerel were also provided to proceed to community forums and so on.

This technical report is aimed to provide baseline information of the fisheries *refugia* site in Trat Province, including its geographic location, site information, and priority species information. The contents were obtained from land and sea surveys, community interviews, literature reviews, and other evidential documentations. This report is expected to be holistically area-based information on fisheries resources and their related surroundings which would be

usable not only for the fisheries *refugia* project implementation and evaluation, but also for the other community-based coastal research and development programs in the area.

2. SITE NAME

Trat, Thailand

3. GEOGRAPHIC LOCATION

There are 2 options of tentative boundaries for fisheries *refugia* at Trat site as follows:

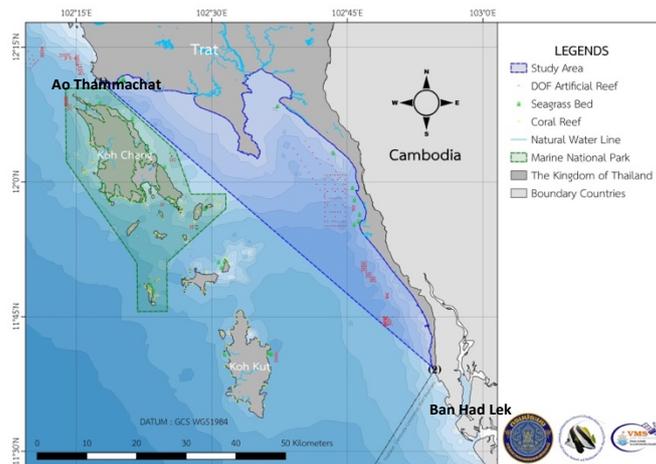


Figure 3-1 Priority fisheries *refugia* site: Trat, Thailand (Option 1)

Option 1: an area of 1,135.46 km² with its boundary straight lining along the coast of Trat Province, from Ao Thammachat to Ban Had Lek (Fig. 3-1).

Geographic location:

(1) 12°11'13.61"N 102°17'42.60"E

(2) 11°39'8.42"N 102°54'41.31"E

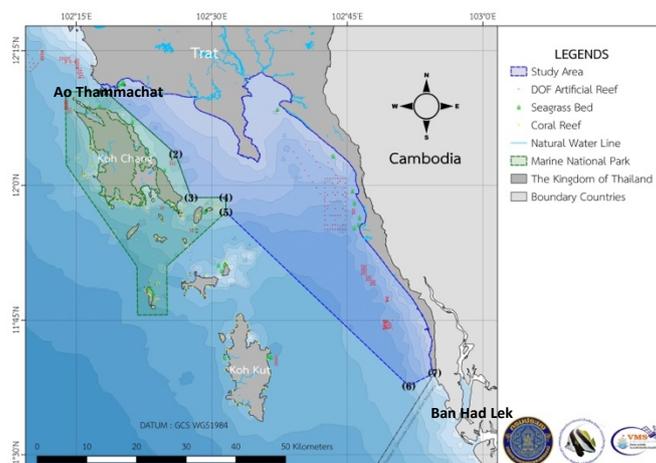


Figure 3-2 Priority fisheries *refugia* site: Trat, Thailand (Option 2)

Option 2: an area of 1,402.19 km² bordered with the same boundary line of Koh Chang Marine National Park and straight to the edge of coastal seas line in Ban Had Lek (Fig. 3-2)

Geographic location:

(1) 12°10'28.48"N 102°18'14.36"E

(2) 12°3'30.21"N 102°26'0.94"E

(3) 11°58'38.80"N 102°27'42.63"E

(4) 11°58'40.12"N 102°31'33.67"E

(5) 11°57'2.63"N 102°31'33.97"E

(6) 11°37'40.52"N 102°51'48.59"E

(7) 11°39'8.42"N 102°54'41.31"E

4. SITE INFORMATION

4.1. GEOGRAPHY

Trat site is located at the coastal zone of Trat Province in the Gulf of Thailand, border on Cambodia. The province is the easternmost of the country, covering 2,819 km² of land-area and 7,257 km² of sea-area with 165.5 km coastline; it is regarded as the second wettest places having over 4,500 mm of precipitation per year. Climate of Trat is generally under the influence of 2 major monsoons: Southwest Monsoon, May-October; and Northeast Monsoon, October-February. There are 2 main rivers, Trat and Weru Rivers, and several canals running into Trat Seas, resulted in high nutrient which makes the area significantly productive. Two prominent shelter areas in Trat site are shown by Ao Trat (Trat Bay) and Chong Chang (Chang Strait). Seafloor is

rather smooth with low slope. Mud flat is the majority of its coastal topography, led to the high abundance of mangroves and seagrass beds in the coastal area. Fisheries *refugia* site is tentatively proposed to be the area lying along the entire mainland-coast of the province, having 0-19 m of water depth, 28°C-33°C of water temperature, and 8-32 psu of salinity with good water quality. (Kanchanapun and Intasein, 2013; Amatayakul and Chomtha, 2016; Department of Marine and Coastal Resources, 2018, 2020)



Figure 4.1-1 Topographic map of Trat fisheries *refugia* site
Source: GISTDA (2018)

4.2. HISTORY, POPULATION, SOCIO-ECONOMY

4.2.1. HISTORY

Trat Province is the major upcountry in the eastern Thailand having fishing activities for more than 300 years. Fisheries in Trat can be traced back to the year 1876 when bamboo stake trap was introduced into the province. Similar to the fisheries status in all areas of the country, fishing in Trat was preliminary operated near-shore by simple handmade gears in small paddling boats. Engine for fishing was then introduced, led to the occurrence of commercial fisheries and increase of fishing gears & fishing boats. Expansion of fishing efforts had caused deterioration to fishery resources and coastal ecosystems in the area, while the national fisheries law, Fisheries Act B.E. 2490 (1947), was still in use. After high effort to reform the national fisheries measure, the Royal Ordinance on Fisheries B.E. 2558 (2015) and Royal Ordinance on Fisheries (No.2) B.E. 2560 (2017) have been enacted, aiming to reorganize fisheries in Thailand in compliance with international measures and regulations on combating Illegal, Unreported and Unregulated (IUU) Fishing.

From focus-group interviews in the coastal communities, history of Trat regarding fisheries can be grouped into 3 chronological periods: 1) predevelopment period, before 1960, 2) fishing technology development period, 1960-2014, and 3) degeneration period, 2015-2019. Significant fisheries status in each period is shown in Figure 4.2.1-1 (Sustainable Development foundation, 2020).

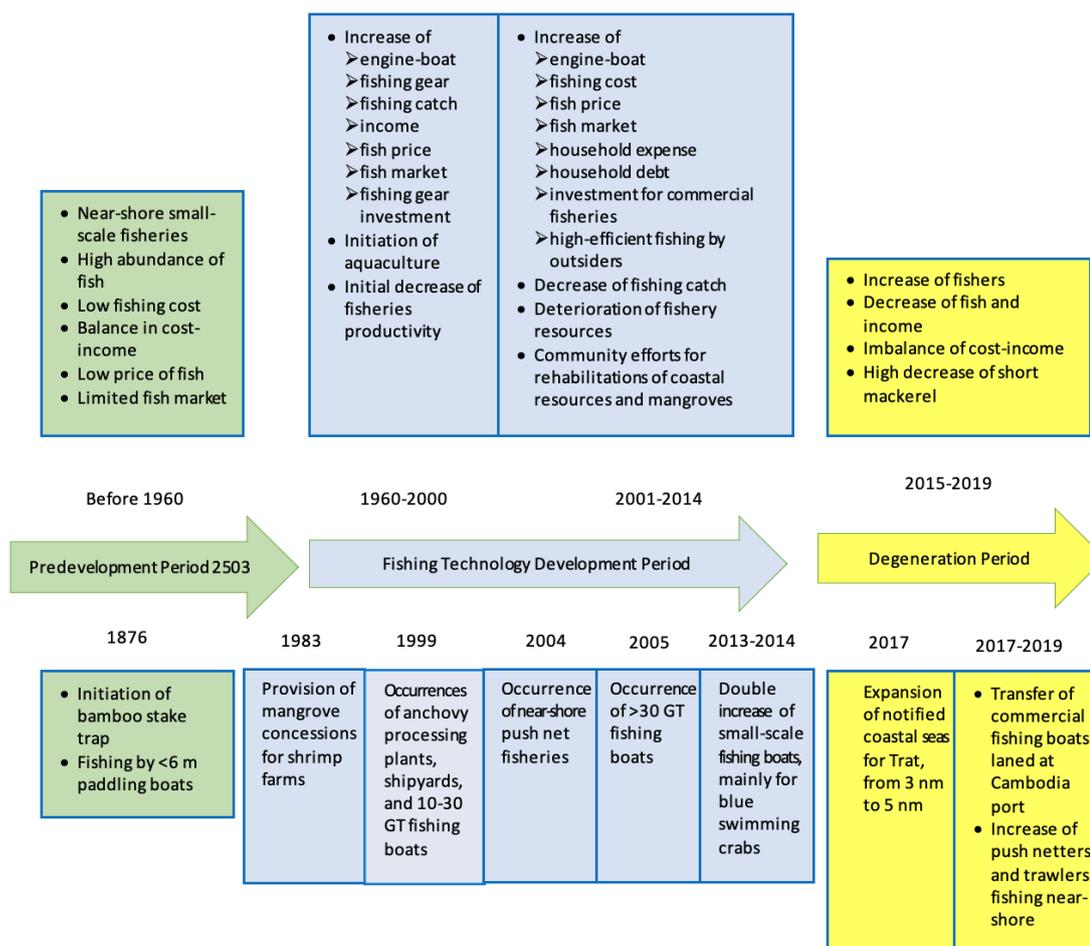


Figure 4.2.1-1 Chronological sequence of fisheries in Trat fisheries *refugia* site

Source: Sustainable Development Foundation (2020)

4.2.2. POPULATION

Total population in Trat Province as of 31th December 2019 was 229,958, comprising 113,973 males and 115,985 females, ranked at 74th of the country with the density of 81.6 persons/km² and 102,355 households (Department of Provincial Administration, 2020a). Out of all, there were 4,165 marine fishing households with a population of 81,276, living in 107 villages of 24 sub-districts in 6 districts of the province (Sustainable Development Foundation, 2017; Trat Provincial Office, 2017; Trat Provincial Social Development and Human Security Office, 2018).

4.2.3. SOCIO-ECONOMY

4.2.3.1. GENERAL SOCIO-ECONOMY

The majority of Trat citizens, 92.82%, are Buddhists, while 2.37% are Muslims, and 0.63% are Christians. As of 2017, there were 40,106 people studied via 3 educational systems: formal education, non-formal education, and informal education, from pre-elementary school to diploma levels in 145 of schools and other academic places in Trat Province. Most of Trat citizen, 99.97%, could access to the national health security. There were totally 1,234 communities, 242 civil society organizations/NGOs, 34 agricultural cooperatives, 329 agricultural groups, and 50 learning centers in the province. The majority of Trat people were in the working

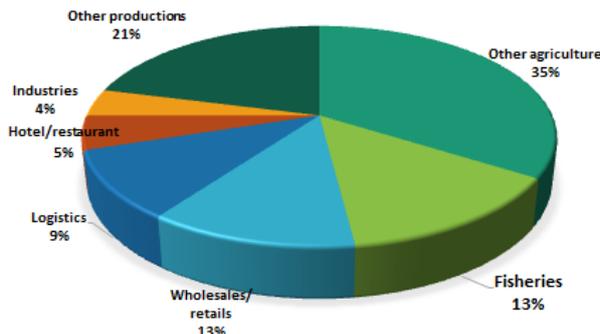


Figure 4.2.3-1 Economic structure of Trat Province in 2015

Source: Trat Provincial office (2017)

ages (25-59 years old), 99.63% of which were employed. Average household income was 235,281 baht/year, while average personal income was 82,883 baht/year. Regarding employment, 48.86% were in agricultural sector contributed 47.91% of agricultural value among a total of 39,597 million baht of Trat Gross Provincial Product (GPP) in 2015; and 13% (5,145 million baht) were from fisheries (Fig. 4.2.3-1). (Trat Provincial office, 2017; Trat Provincial Social Development and Human Security Office, 2018)

4.2.3.2. SOCIO-ECONOMY IN FISHERIES

There were 4-8 members in a fisheries household in Trat, mostly gathering into a village along coastal and river-mouth areas with no document of right; many of them were found encroach on the river. Out of all the fisheries households, 87% operated fishing for their principal incomes, while the rest earned their livings mainly by agriculture, aquaculture, and being employee. (Sustainable Development Foundation, 2017)

The majority of fishers, 69% males and 57% females, educated from primary schools; the second most, 14% males and 22% females, was non-educated (Fig. 4.2.3-2). Non-educated fishers found the most in the older generation, 51-60 years old (Fig. 4.2.3-3). Fishers engaged in the activities of resources conservation were mainly males, while females usually participated in the workshops for supplemental earnings. (Sustainable Development Foundation, 2017)

Incomes and expenses in the fisheries households varied directly with the sizes of fishing vessels. Expenses for both small-scale and commercial fishing households were found mainly on food, followed by education, infrastructure, social activities, and health care, respectively. Almost of the fishers were in debt, taking on a loan mainly from “National Village and Urban Community Fund” and “Group Savings to the Villagers”. (Sustainable Development Foundation, 2017)

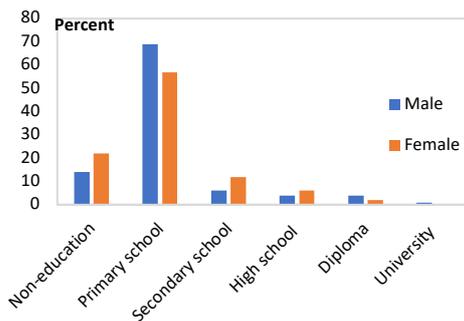


Figure 4.2.3-2 Education levels of fishers in Trat

Source: Sustainable Development Foundation (2017)

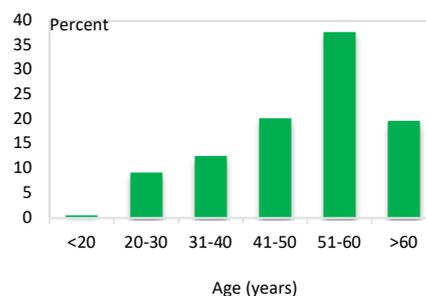


Figure 4.2.3-3 Non-educated fishers by ages in Trat

Source: Sustainable Development Foundation (2017)

According to fisher interviews conducted by Sustainable Development Foundation in 2019, it revealed that socio-economics of the fishers depended mostly on fisheries resources. From fishers' point of view, fisheries resources in Trat had significantly decreased since 2015 which considerably affected the economics security of both small-scale and commercial fisheries. (Sustainable Development Foundation, 2020)

Considering the contribution to economics in the province, Fisheries in Trat has brought about a number of continuous fisheries industries: 12 icehouses, 3 seafood cold storage factories, 4 fish sauce factories, 2 fish meal factories, 2 canned crab factories, 6 shipyards, 7 repair shipyards, and many of small-scale fish processing places (Trat Provincial office, 2017).

4.3. IMPORTANT COASTAL HABITATS IN TRAT SITE

4.3.1. CORAL REEFS

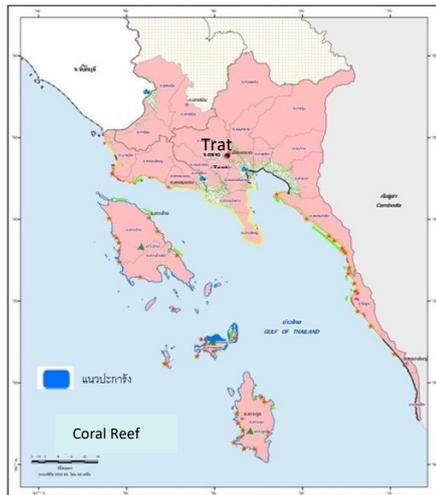


Figure 4.3.1-1 Coral Reefs in Trat fisheries refugia site

Source: Department of Marine and Coastal Resources (2018)

There were 28.41 km² of coral reefs located in Trat Waters (Fig. 4.3.1-1). The reefs were found in clear water at 4 moh koh (islands) and 13 stone piles, mainly composed of hump corals, star corals, staghorn corals, table corals, brain corals, and larger star corals. It was found from surveys in 2015 that the majority of coral reefs in Trat were in damaged condition. Their pressures were raised by both nature and human. Natural pressures were climate change, coral diseases, and storms; while the main damages were caused by lots of human activities, such as illegal fishing, coastal community developing, industrial developing, anchoring, tourist activities, and marine debris disposal. (Department of Marine and Coastal Resources, 2018)

4.3.2. MANGROVES

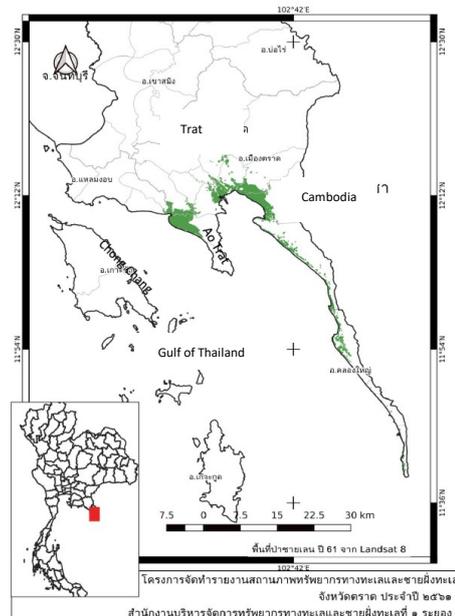


Figure 4.3.2-1 Mangroves in Trat fisheries refugia site

Source: Department of Marine and Coastal Resources (2018)

Total area of mangroves in Trat was 95.53 km², the third most abundance in the Gulf of Thailand; it scattered along Trat Coast, densely in Ao Trat and southern mainland-coast of Chong Chang in Muang District (Fig. 4.3.2-1). A number of 16 species in 16 genera of 8 families of the mangrove trees were recorded, mainly in Rhizophoraceae family. Average density of the trees in the mangroves in Trat Site was reported at 215 trees/1,600 m² (1 Thai rai) contributed the carbon storage value of 0.509 million tons/1,600 m² in the area. It was found that 8 families of economic marine species inhabited in the mangrove areas of Trat Province. Pressures on the mangroves in Trat were identified into 6 categories: 1) increases of aquaculture, 2) increases of homestay business, 3) illegal occupations of mangrove areas, 4) expansions of communities, 5) invasions for agriculture, and 6) deforesting. (Department of Marine and Coastal Resources, 2018)

4.3.3. SEAGRASSES



Figure 4.3.3-1 Seagrasses in Trat fisheries *refugia* site
Source: Department of Marine and Coastal Resources (2018)

Seagrasses in Trat were found lying along nearshore sandy beds, in both mainland and islands, and somehow between shores and coral reefs, in the total area of 10.16 km² (Fig. 4.3.3-1). There were 9 species of seagrasses in Trat, dominated by fiber-strand grass (*Halodule pinifolia*), toothed seagrass (*Cymodocea serrulata*), veinless spoon-grass (*Halophila decipiens*), and tropical eelgrass (*Enhalus acoroides*); their conditions were considered as moderate–good. Pressures on seagrass beds in trat were identified, namely, coastal community developing, discharges from communities and industries, monsoons and climate change, fishing, and port constructions. (Department of Marine and Coastal Resources, 2018)

4.3.4. ARTIFICIAL REEFS

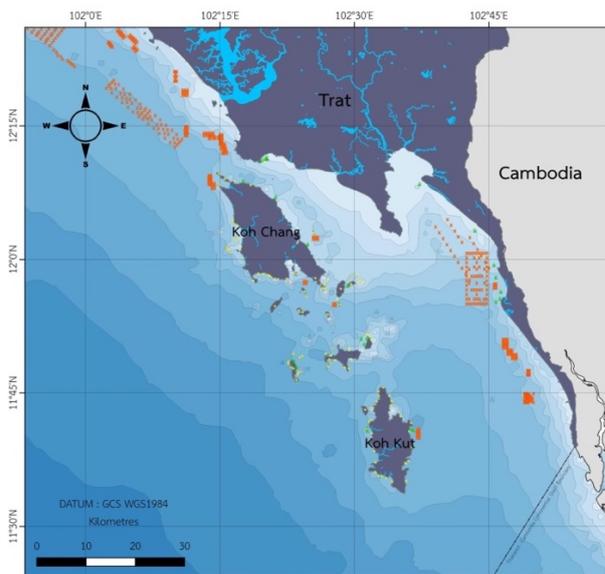


Figure 4.3.4-1 Artificial Reefs in Trat fisheries *refugia* site
Source: Loychuen (2020)

Artificial reefs developed by the Department of Fisheries are usually constructed in the structure of 1.5x1.5x1.5 m³ hollow concrete blocks, installed in the coastal zones by assembling the blocks into small and large units of the reefs; it's aimed to promote fish habitats and enhance productivity by providing new ecosystems in the areas. Artificial reefs have been gradually installed in Trat Waters since 1989. There were 3 large units (615-15,440 blocks/unit) and 44 small units (361-843 blocks/unit) of artificial reefs in Trat Coast, located in the water of 5-30 m depth and 2-8 km offshore, covering the total area of 125 km² (Fig. 4.3.4-1). (Department of Fisheries, 2009, 2010, 2011, 2018a)



4.4. NUMBERS AND TYPES OF FISHING VESSELS OPERATING IN THE REFUGIA AREA

Fishing vessels in Thailand are principally categorized into 2 major groups: commercial, >10 GT, and small-scale, <10 GT, fishing vessels. As per the fishing vessel and fisher registration data up to 2019, there were 798 commercial fishing vessels and 1,909 small-scale fishing vessels operating in Trat *refugia* area (Eastern Gulf Fisheries Research and Development Center (Rayong), 2015; Department of Fisheries, 2020). Anchovy falling nets were the maximum among commercial fishing vessels, whereas those of small-scale vessels were shrimp gill nets. Detailed numbers for each group of the vessels are shown in Table 4.4-1 and 4.4-2.

Table 4.4-1 Numbers of commercial fishing vessels by each fishing gear in Trat fisheries *refugia* site

Fishing vessels	Numbers
Vessels with low-efficient fishing gears	246
Short-necked clam dredges	16
Other clam dredges	4
Longlines (>100 m)	15
Fish traps	2
Crab traps	72
Squid traps	2
Octopus traps	9
Squid falling nets	88
Gill nets	38
Vessels with high-efficient fishing gears	552
Light luring vessels	102
Anchovy falling nets	208
Anchovy purse seines	17
Purse seines	31
Beam trawls	55
Pair trawls	4
Otter board trawls	135
Total commercial fishing vessels	798

Source: Department of Fisheries (2020)

Table 4.4-2 Numbers of small-scale fishing vessels by each fishing gear in Trat fisheries *refugia* site

Fishing vessels	Numbers
Shrimp gill nets	667
Crab gill nets	390
Short mackerel gill nets	68
Mullet gill nets	27
Other gill nets	94
Fish traps	12
Crab traps	263
Squid traps	48
Handlines	64
Longlines	38
Short-necked clam dredges	13
Squid falling nets	32
Others	193
Total small-scale fishing vessels	1,909

Source: Eastern Gulf Fisheries Research and Development Center (Rayong) (2015), Department of Fisheries (2020)

4.5. THE SPECIES AND SIZE SELECTIVITY OF THE PRINCIPAL FISHING GEARS USED

There were 11 types of fishing gears considered as the principal gears, both commercial and small-scale ones, used in Trat fisheries *refugia* area according to their significances in the catches. The commercial fishing gears were purse seine, light luring purse seine, purse seine with fish aggregating device, beam trawl, otter board trawl, pair trawl, and light luring anchovy falling net. The small-scale ones were crab gill net, crap trap, shrimp gill net, and short mackerel gill net. As per landing surveys at Trat fishing ports by the Eastern Gulf Fisheries Research and Development Center during 2016-2018, fishing areas, catch rates, species compositions and size selectivity for each principal fishing gear were resulted, shown in Figure 4.5-1 and 4.5-2, and concluded as follows:

4.5.1. Commercial Fishing Gears

- Purse seines
 - Purse seines: fishing was operated in the offshore seas between mainland and Koh Kut, and the outer side of Koh Kut. Catch rates were 2,540-3,776 kg/day, composed mainly of sardine (*Sardinella gibbosa*), Indian mackerel (*Rastrelliger kanagurta*), short mackerel (*Rastrelliger brachysoma*), and round scad (*Decapterus maruadsi*). Average sizes of those dominant species were over their sizes at first maturity except that of Indian mackerel.
 - Light luring purse seines: fishing was found densely at the offshore seas, out of Koh Chang and Koh Kut. Catch rates were 2,382-3,833 kg/day, composed mainly of sardine (*Sardinella gibbosa*), Indian mackerel (*Rastrelliger kanagurta*), yellowtail scad (*Atule mate*), short mackerel (*Rastrelliger brachysoma*), and little tunas (*Euthynnus affinis*). High numbers of immature Indian mackerel and little tuna were recorded.
 - Purse seines with fish aggregating devices: fishing areas were quite far in the southern part of Trat Seas. Catch rates were 3,017-3,384 kg/day, composed mainly of sardine (*Sardinella gibbosa*), Indian mackerel (*Rastrelliger kanagurta*), round scad (*Decapterus maruadsi*), yellowtail scad (*Atule mate*), short mackerel (*Rastrelliger brachysoma*), and little tunas. On average, round scad was caught at over its first mature size, while the rest had average sizes close to their sizes at first maturity.
- Trawls
 - Beam trawls: fishing was densely operated in the offshore seas between mainland and Koh Kut, and the outer side of Koh Chang. Catch rates were 11.22-13.46 kg/day, composed mainly of economic shrimps: jinga shrimp (*Metapenaeus affinis*) and banana shrimp (*Penaeus merguensis*). The shrimps were caught at the average sizes close to their sizes at first maturity.
 - Otter board trawls: fishing was found mainly at the offshore seas near Koh Chang. Catch rates were 24-54 kg/day, comprised 44-49% of economic fish and 51-53% of trash fish. Average sizes of economic fish were under their sizes at first maturity.
 - Pair trawls: fishing areas were found at the offshore seas, west and south of Koh Chang. Catch rates were 92-170 kg/day, comprised 60-66% of economic fish, 34-40% of economic fish, and 0.67-8.07% of short mackerel (*Rastrelliger brachysoma*). Among the economic fish, sardine was found, on average, a bit over its first mature size.
- Light luring anchovy falling nets: fishing was operated densely at offshore areas close to the coastal seas of Trat. Catch rates were 671-979 kg/day, composed mainly of anchovy, and some amount of short mackerel (*Rastrelliger brachysoma*). Average sizes were about the same as their first mature sizes.

4.5.2. SMALL-SCALE FISHING GEARS

- Crab gill nets: almost fishing was done in the coastal seas, more densely at Ao Trat and Chong Chang. Catch rates were 0.12-0.20 kg/100 m net, composed mainly of blue swimming crab (*Portunus pelagicus*), average size of which was close to its size at first maturity.

- Crab traps: fishing was operated in both coastal and offshore seas, between mainland and Koh Kut, densely in Chong Chang. Catch rates were 0.18-0.33 kg/10 traps, composed mainly of blue swimming crab (*Portunus pelagicus*). The crabs were caught at bigger sizes than those from gill net resulted in the high proportion of the sizes over first maturity.
- Shrimp gill nets: fishing was done along the coastal seas and Chong Chang. Catch rates were 0.18-0.33 kg/100 m net, composed mainly of banana shrimp (*Penaeus merguensis*), jinga shrimp (*Metapenaeus affinis*), and scallop (*Amusium pleuronectes*). Size of the dominant species, banana shrimp, was found close to its first mature size.
- Short mackerel gill nets: fishing was done along the coastal seas and Chong Chang. Catch rates were 2.34-5.503 kg/100 m net, composed mainly of gizzard shad (*Anodontostoma chacunda*), short mackerel (*Rastrelliger brachysoma*), and Spanish mackerel (*Scomberomorus* spp.). Average size of short mackerel was nearly the same as its size at first maturity.

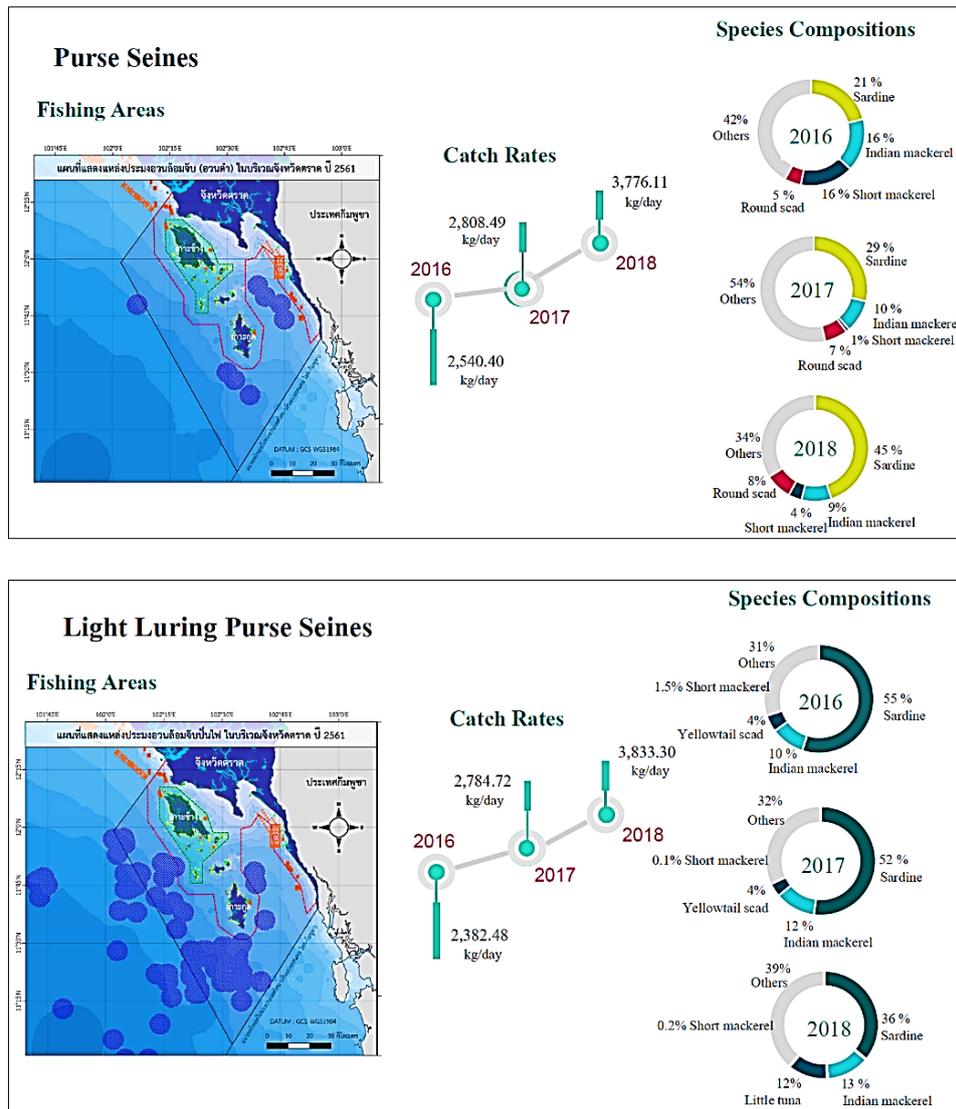


Figure 4.5-1 Fishing areas, catch rates, and species compositions of the principal fishing gears used in Trat fisheries *refugia* site
Source: Loychuen (2020)

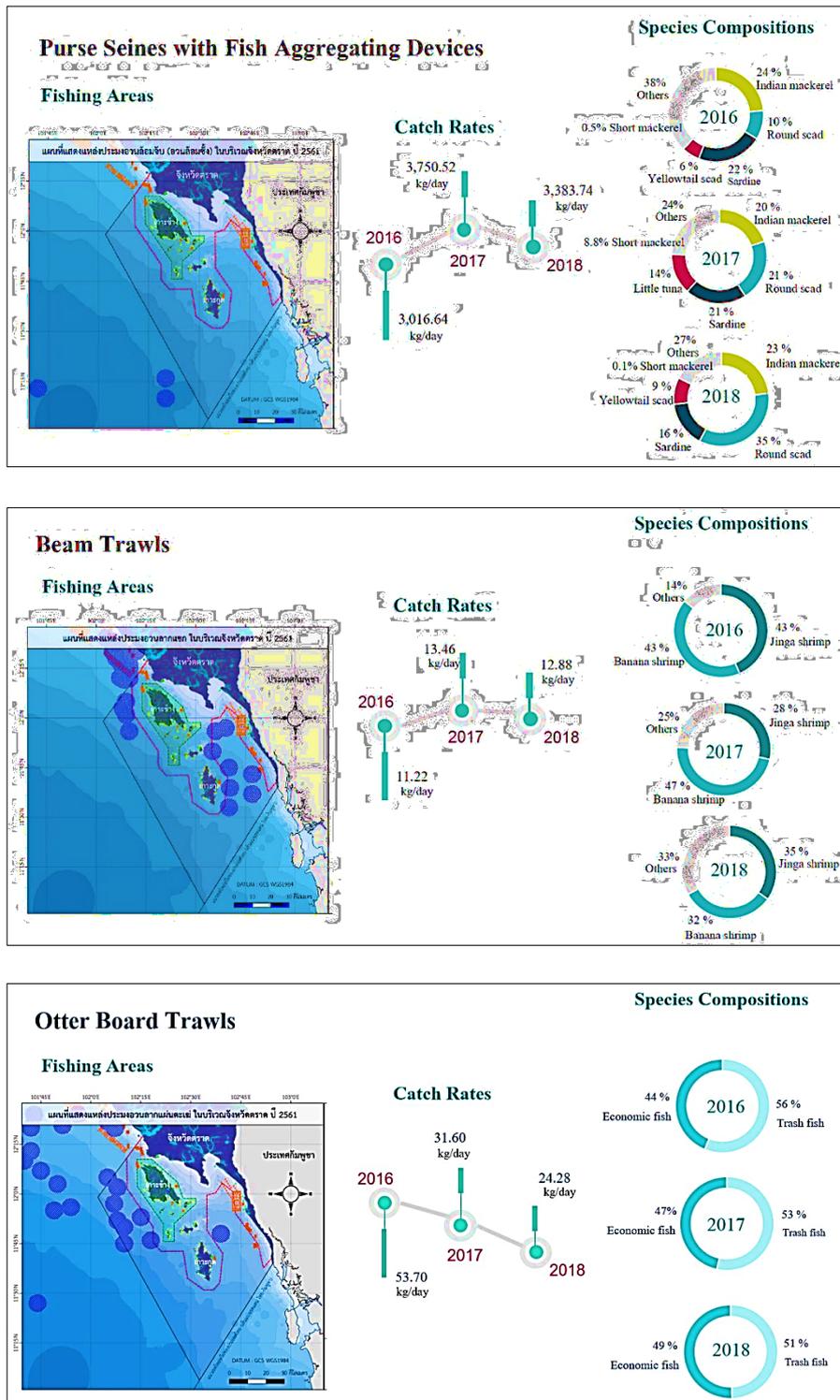


Figure 4.5-1 Fishing areas, catch rates, and species compositions of the principal fishing gears used in Trat fisheries refugia site (cont.)

Source: Loychuen (2020)

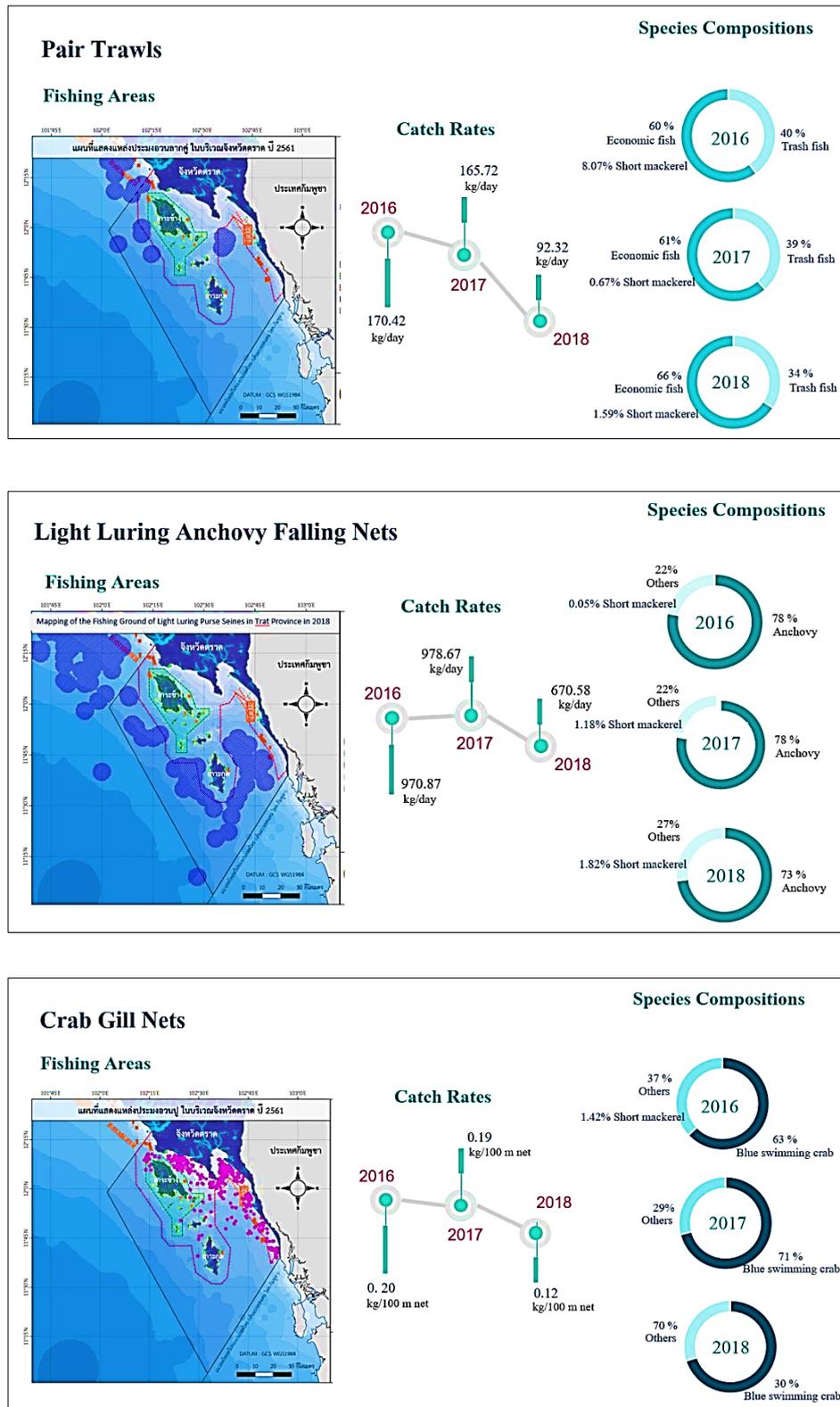


Figure 4.5-1 Fishing areas, catch rates, and species compositions of the principal fishing gears used in Trat fisheries *refugia* site (cont.)

Source: Loychuen (2020)

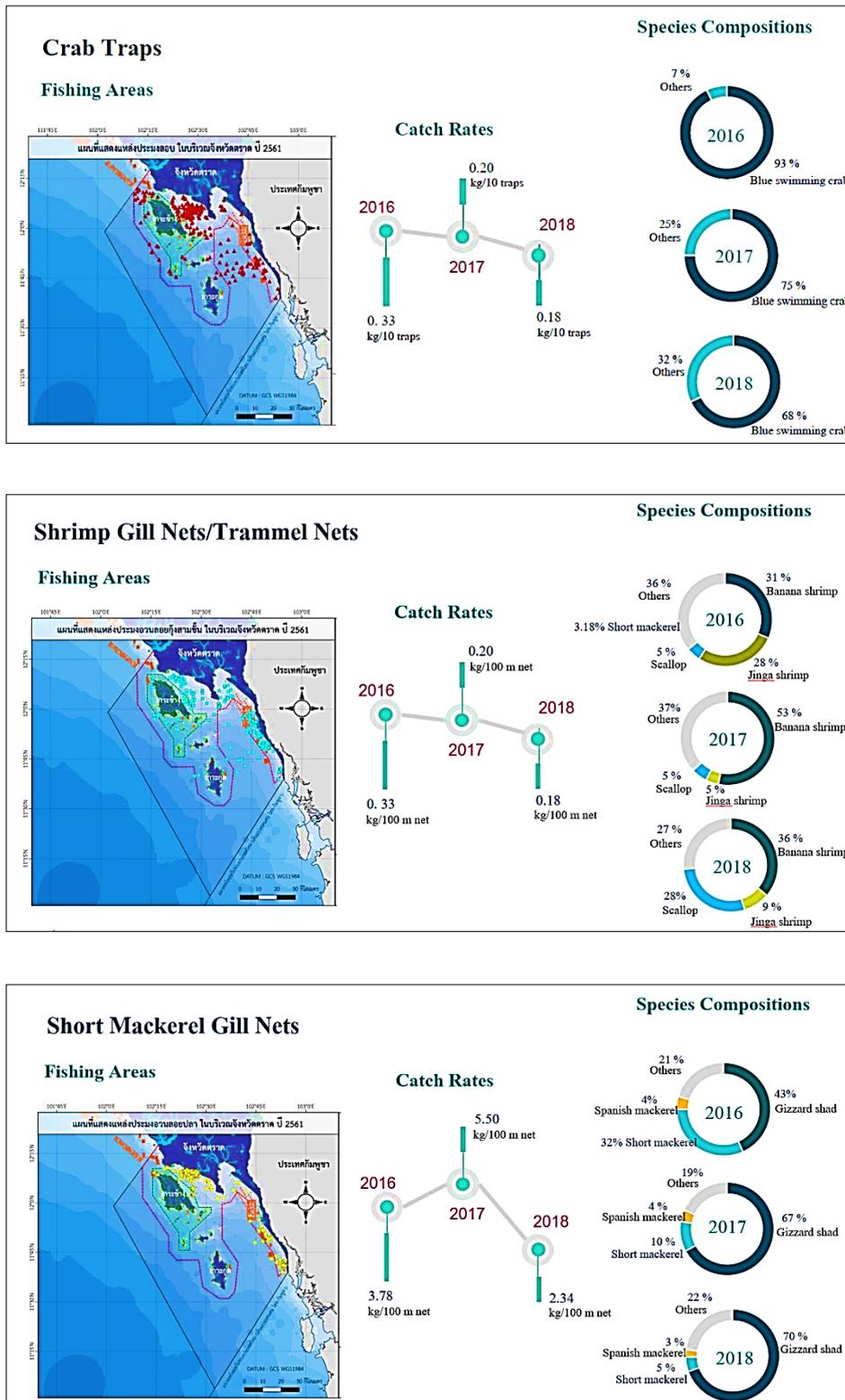


Figure 4.5-1 Fishing areas, catch rates, and species compositions of the principal fishing gears used in Trat fisheries *refugia* site (cont.)

Source: Loychuen (2020)

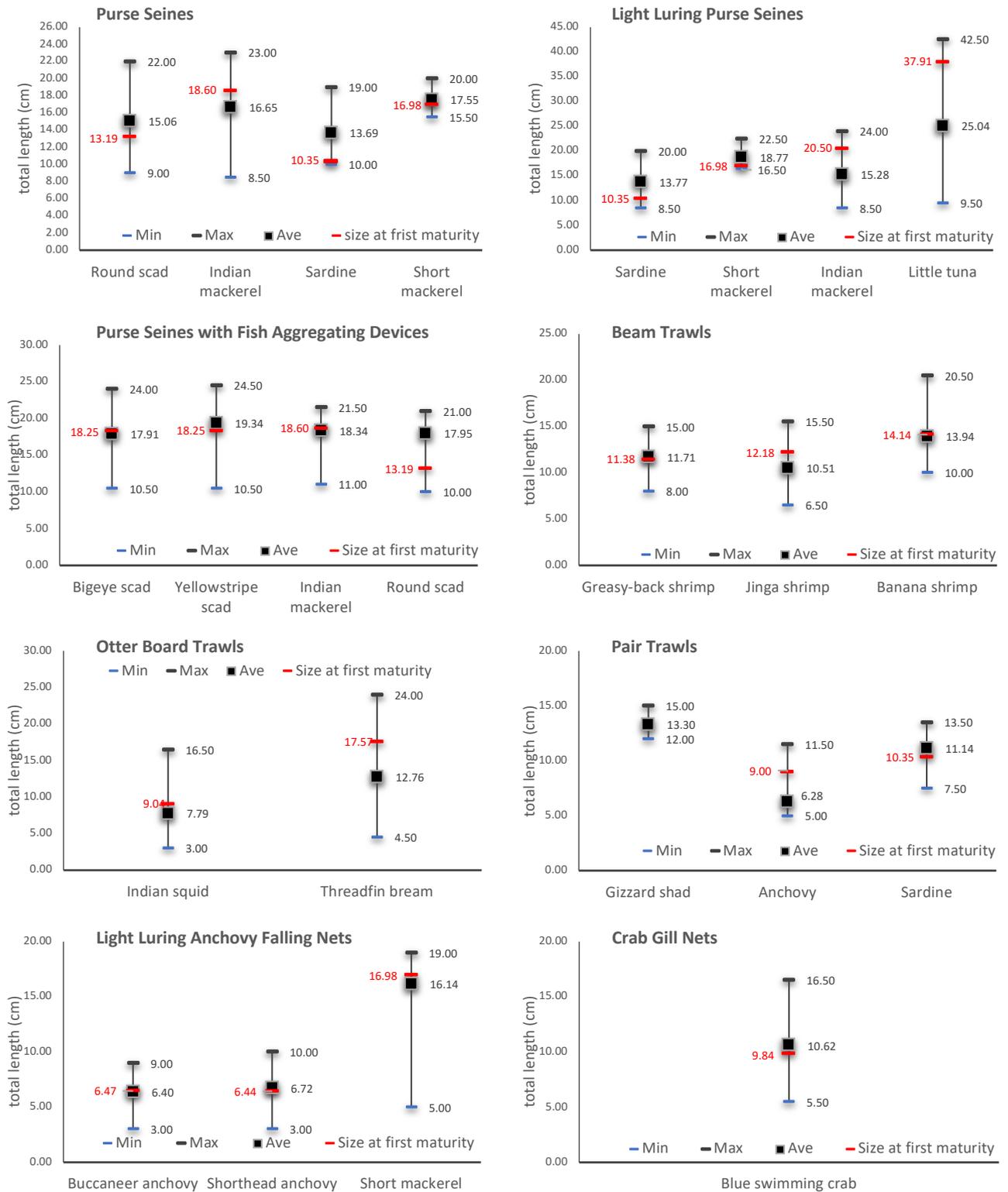


Figure 4.5-2 Size selectivity of the principal fishing gears used in Trat fisheries *refugia* site
Source: Eastern Gulf Fisheries Research and Development Center (Rayong)

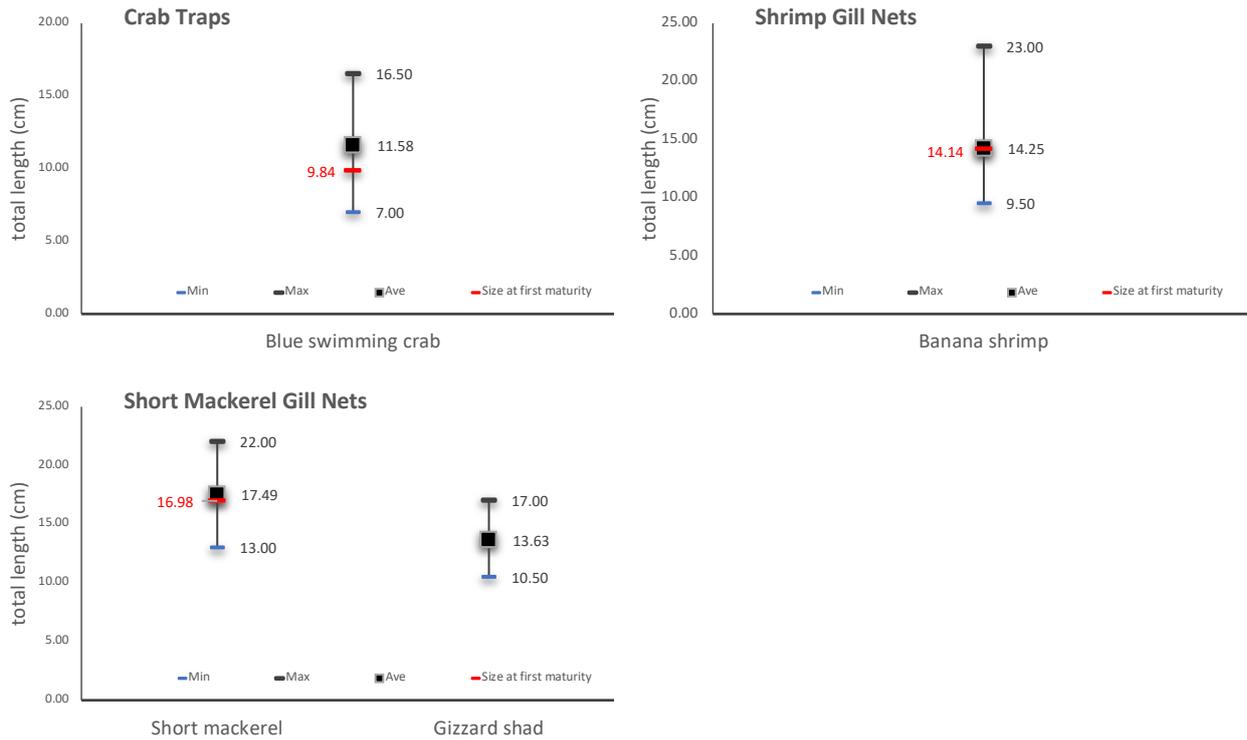


Figure 4.5-2 Size selectivity of the principal fishing gears used in Trat fisheries *refugia* site (cont.)
Source: Eastern Gulf Fisheries Research and Development Center (Rayong)

4.6. THE ROLE OF FISHERIES REFUGIA IN THE PRODUCTION AND ECONOMIC VALUE OF PRIORITY SPECIES

Referring to the statistics of marine fish at landing places in Thailand from the year 2010 to 2018, short mackerel landed at the fishing ports in Trat Province contributed to the area the amount of 209-2,004 tons, valued at 7.76-46.18 million baht. Among those past 9 years, the highest amount landed was recorded in the year 2012, then the production decreased to the lowest in 2017, with a small lift in 2018. The value was also highest in 2012 at 46.18 million baht, and declined to 7.76 million baht in 2017, then raised up a bit in 2018 (Fig. 4.6-1) (Department of Fisheries, 2012, 2013, 2014, 2015, 2016, 2017a,b, 2018b). Considering these declines, fisheries *refugia* is aimed at the area-based approach to ensure the survival of short mackerel in its spawning stage in order to maintain the sustainable utilization which would be resulted in the increase of production and economic value of this species in the area.



Figure 4.6-1 Total weights and values of short mackerel landed in Trat fisheries *refugia* site

4.7. NUMBER OF FISHERIES COMMUNITIES IN THE AREA



Figure 4.7-1 Fisheries communities in Trat fisheries *refugia* site
Source: Sustainable Development Foundation (2020)

There are 6 districts out of seven in Trat province having coastal areas close to both the shelter zones–Ao Trat and Chong Chang– and the open sea of the Gulf of Thailand. A number of 107 fisheries communities (villages in Thailand) scatter along 24 sub-districts of those 6 districts, densely around Ao Trat in Muang District (Fig. 4.7-1) (Trat Provincial Office, 2017; Department of Provincial Administration, 2020b; Sustainable Development Foundation, 2020). Number of fisheries communities in each district are as follows:

- Muang District: 48 villages in 11 sub-districts
- Khlong Yai District: 18 villages in 3 sub-districts
- Laem Gnop District: 15 villages in 4 sub-districts
- Khao Saming District: 9 villages in 2 sub-districts
- Koh Chang District: 9 villages in 2 sub-districts
- Koh Kut District: 8 villages in 2 sub-districts

4.8. EXISTING FISHERIES MANAGEMENT MEASURES IN THE AREA OF THE SITE

Marine fisheries management measures in Trat fisheries *refugia* site are based on the national fisheries laws, Royal Ordinance on Fisheries B.E. 2558 (2015), and Royal Ordinance on Fisheries (No.2) B.E. 2560 (2017). Notifications regarding fisheries conservation and management measures in Trat Province were issued by the Minister of Agriculture and cooperatives, and the Chairperson of Trat Provincial Fisheries Committee, under the related sections in the Royal Ordinances. In accordance with marine fisheries management measures, six principal regulation/notifications are in force in Trat fisheries *refugia* site, listed as follows:

- 1) Ministerial Regulation on Prescribing Areas for Coastal Seas, B.E. 2560 (2017):

Areas of the coastal seas in Trat Province are defined at the distances of 5 nautical miles from the baseline of mainland, and 3 nautical miles from the baseline of islands, shown in Figure 4.8-1.

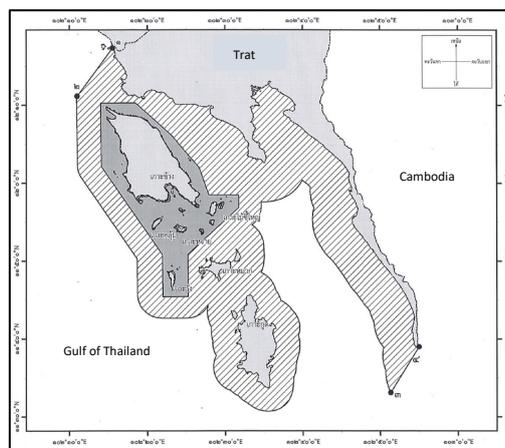


Figure 4.8-1 Coastal seas area in Trat Province
Source: Ministerial Regulation Prescribing Areas for Coastal Seas, B.E. 2560 (2017)

2) Notification of Ministry of Agriculture and Cooperatives Re: Prescribing of Fishing Gears, Fishing Methods, and Fishing Areas Prohibited from Fishing in Coastal Seas, B.E. 2560 (2017):

The prohibited fishing gears are:

- All types of trawl nets fitted to motor vessels,
- Purse seines with purse lines,
- Fish gill nets, 2,500 meters in length or over, in a fishing vessel,
- Crab gill nets, 3,000 meters in length or over, in a fishing vessel,
- Shrimp gill nets, 2,500 meters in length or over, in a fishing vessel,
- Squid gill nets, 2,500 meters in length or over, in a fishing vessel,
- Crab traps, below 2.5 inch in mesh-size or over 300 traps, in a fishing vessel,
- Squid traps, over 100 traps, in a fishing vessel,
- Octopus traps, over 2,000 traps, in a fishing vessel,
- Squid falling nets or lift nets operated with electric generators,
- Anchovy falling nets or lift nets operated with electric generators, and
- All types of fishing gears operated with electric generators by using underwater fish-luring lights.

3) Notification of Ministry of Agriculture and Cooperatives Re: Prescribing of Fishing Gears, Fishing Methods, and Fishing Areas Prohibited from Fishing in Coastal Seas (No. 2), B.E. 2562 (2019):

This notification prescribes the jellyfish trawl nets as an exception to all types of trawl nets prohibited from fishing in coastal seas prescribed in the previous Notification. The exception lasts for 2 years, from November 2019 to December 2021, for the purpose of technical study. Specifications for the exceptional jellyfish trawl nets are described in the Notification.

4) Notification of Trat Provincial Fisheries Committee Re: Prescribing Areas for Aquatic Species Sanctuaries, B.E. 2561 (2018):

The following areas are prescribed as aquatic species sanctuaries:

- Fishing ground in the coastal seas off Ban Laem Thein, Ao Yai Sub-district, Muang District, Trat Province, covering the area of 81,989 m² (Fig. 4.8-2(1)),
- Fishing ground in Nong (swamp) Wat Sai Thong, Nong Sano Sub-district, Muang District, Trat Province, covering the area of 3,606 m² (Fig. 4.8-2(2)),
- Fishing ground in Koh Kra, Koh Mak Sub-district, Koh Kut District, Trat Province, covering the area of 3,349 m² (Fig. 4.8-2(3)).

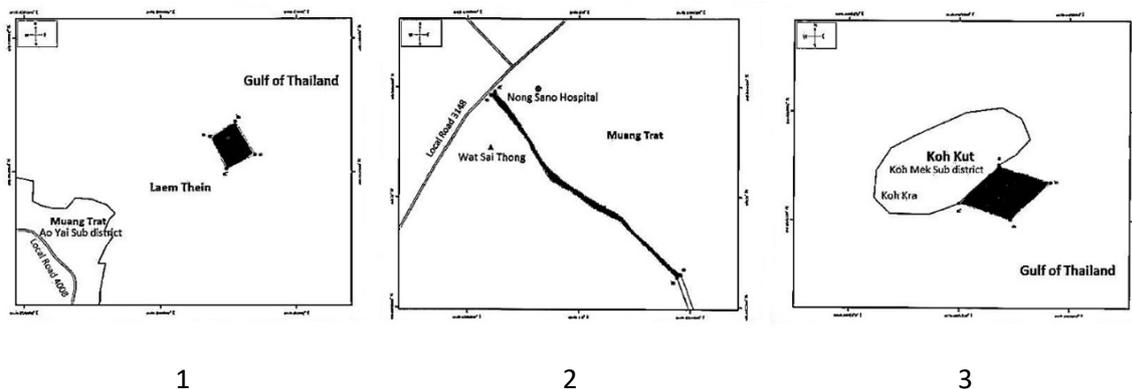


Figure 4.8-2 Aquatic species sanctuaries in Trat Province

Source: Notification of Trat Provincial Fisheries Committee Re: Prescribing Areas for Aquatic Species Sanctuaries, B.E. 2561 (2018)

5) Notification of Trat Provincial Fisheries Committee Re: Prescribing of Fishing Gears, Fishing Methods, and Fishing Areas Prohibited from Fishing in Fishing Grounds, B.E. 2561 (2018):

A number of 15 fishing grounds in Trat Province are prohibited from fishing by any types of fishing gears, with an exception of some specified small-scale fishing gears prescribed in each of them. The total prohibited areas are 12.96 km² (8,101 Thai rai). Area maps of those 15 fishing grounds are illustrated in Figure 4.8-3.

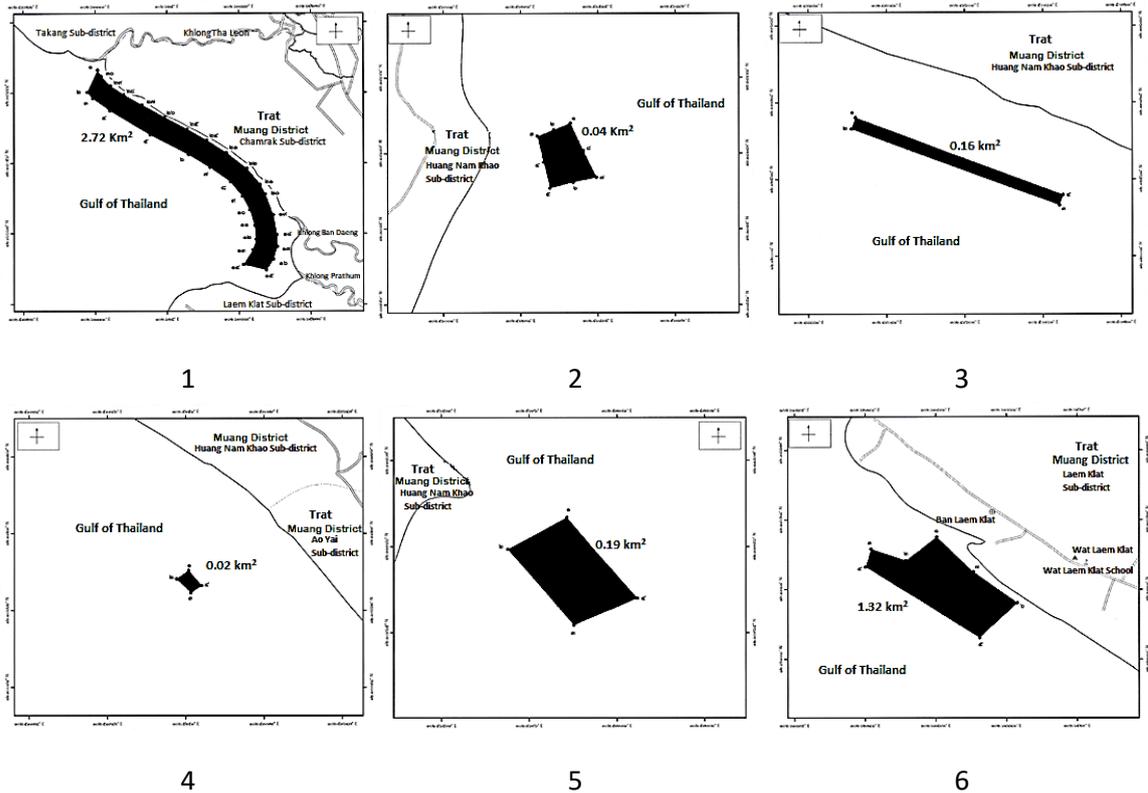
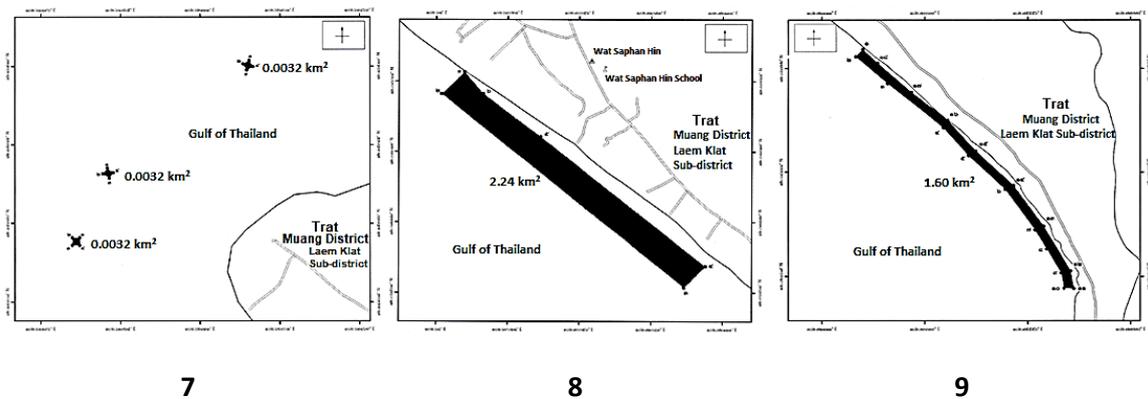


Figure 4.8-2 Aquatic species sanctuaries in Trat Province

Source: Notification of Trat Provincial Fisheries Committee Re: Prescribing Areas for Aquatic Species Sanctuaries, B.E. 2561 (2018)



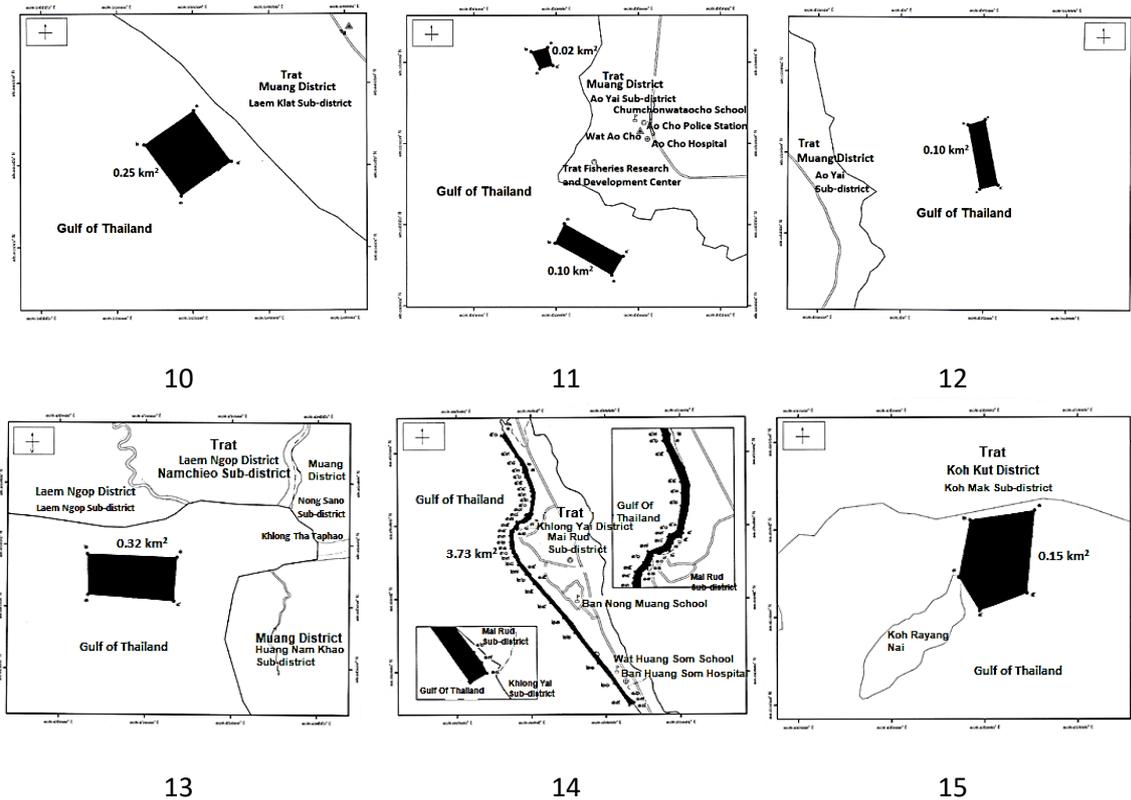


Figure 4.8-3 Prohibited fishing grounds in Trat Province (cont.)

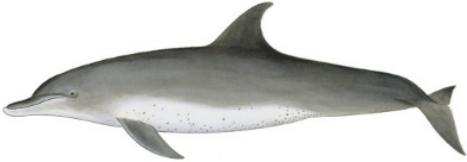
Source: Notification of Trat Provincial Fisheries Committee Re: Prescribing of Fishing Gears, Fishing Methods, and Fishing Areas Prohibited from Fishing in the Fishing Grounds, B.E. 2561 (2018)

- 6) Notification of Ministry of Agriculture and Cooperatives Re: Prescribing of Fishing Gears, Descriptions, and Fishing Areas of Clam Dredges Prohibited from Fishing in Fishing Ground, B.E. 2560 (2017):
- No person shall use clam dredges fitted to motor vessels fishing in the fishing grounds in inland waters and coastal seas,
 - No person shall use clam dredges fitted to motor vessels having the following gear descriptions and vessel sizes fishing in the fishing grounds in offshore seas:
 - Clam dredges with a width over 3.5 meters,
 - Clam dredges with a sieve-size below 1.2 centimeters,
 - Fishing vessels with a length over 18 meters, and
 - The number of over 3 dredges in a fishing vessel.

4.9. USAGE OF REFUGIA BY THREATENED AND ENDANGERED MARINE SPECIES

There were 6 species of threatened and endangered marine species existing in Trat fisheries *refugia* site, namely, Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), finless porpoise (*Neophocaena phocaenoides*), Irrawaddy dolphin (*Orcaella brevirostris*), hawksbill turtle (*Eretmochelys imbricata*), green turtle (*Chelonia mydas*), and dugong (*Dugong dugon*), among which Irrawaddy dolphin was dominant (Department of Marine and Coastal Resources, 2018). The numbers of those species found in Trat Site are shown in Table 4.9-1.

Table 4.9-1 Numbers of threatened and endangered marine species in Trat fisheries *refugia* site

Species		Numbers
	Indo-Pacific bottlenose dolphin (<i>Tursiops aduncus</i>)	20
	Finless porpoise (<i>Neophocaena phocaenoides</i>)	40
	Irrawaddy dolphin (<i>Orcaella brevirostris</i>)	200
	Hawksbill turtle (<i>Eretmochelys imbricata</i>)	Not reported, but 3-5 stranded turtles per year were found
	Green turtle (<i>Chelonia mydas</i>)	Not reported, but 3-5 stranded turtles per year were found
	Dugong (<i>Dugong dugon</i>)	5

Source: Department of Marine and Coastal Resources (2018)

According to the surveys on existence of dolphins in Trat Waters during the year 2008-2017, dolphins were found all along the coastal area from Ao Trat to Cambodia border as shown in Figure 4.9-1 (Marine and Coastal Resources Research and Development Center, the Eastern Gulf of Thailand, 2017). With regard to the records of stranded endangered marine species along Trat

Coast during the year 2004-2015, Irrawaddy dolphins were found the most stranded aground at the number of 5-25 ind/year, followed by 5-15 ind/year of finless porpoises, 2-4 ind/year of green turtles, and 1-2 ind/year of hawksbill turtles. The areas in which those stranded species found are shown in Figure 4.9-2. Pressures on threatened and endangered marine species in Trat Site included net & trap fishing, marine debris, community expansions, and illusions of endangered species consumption. (Department of Marine and Coastal Resources, 2018)

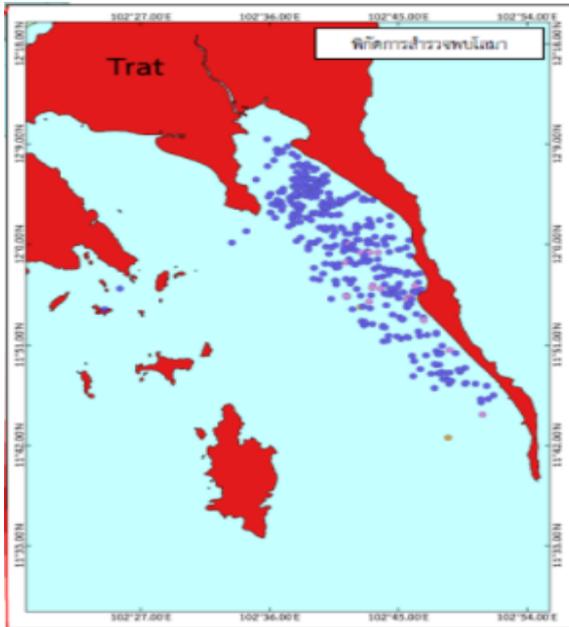


Figure 4.9-1 Existing areas of dolphins in Trat fisheries *refugia* site
Source: Marine and Coastal Resources Research and Development Center, the Eastern Gulf of Thailand (2017)

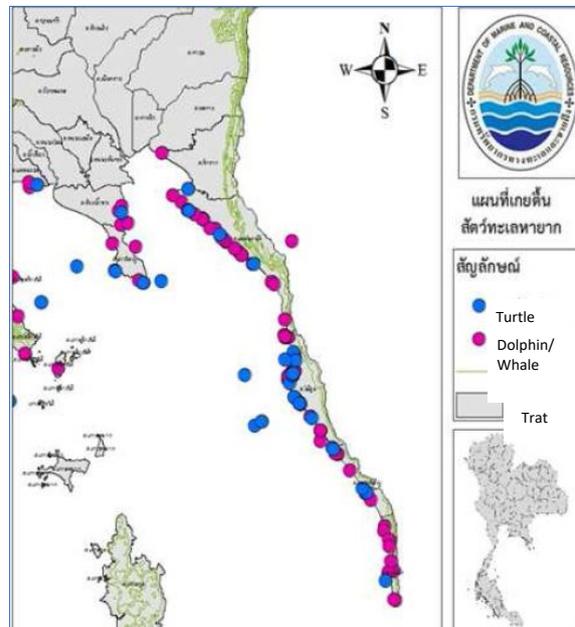
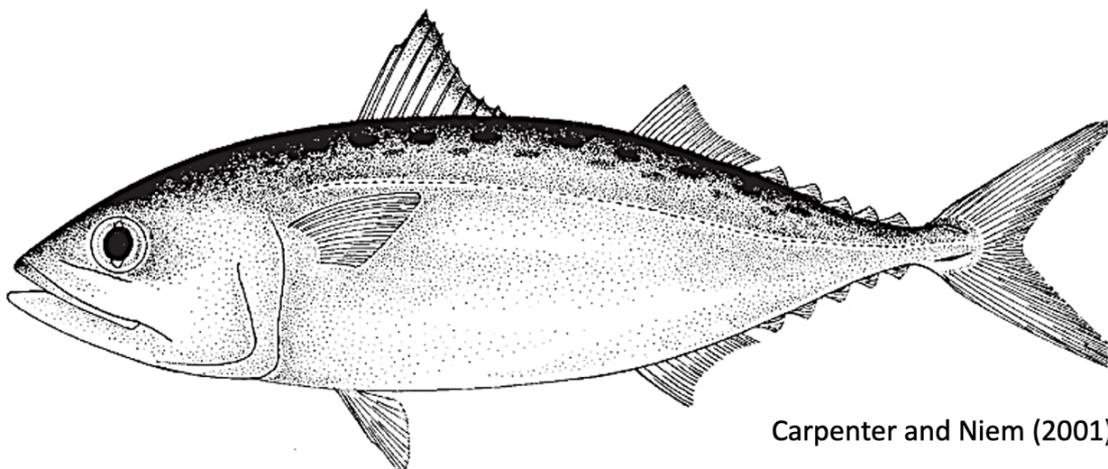


Figure 4.9-2 Distribution of stranded endangered marine species in Trat fisheries *refugia* site
Source: Department of Marine and Coastal Resources (2018)

5. PRIORITY SPECIES INFORMATION

5.1. NAME (COMMON/LOCAL/SCIENTIFIC NAME)



Carpenter and Niem (2001)

COMMON NAME: short mackerel, Indo-Pacific mackerel, short-bodied mackerel, chub mackerel

LOCAL THAI NAME: Pla Thu

SCIENTIFIC NAME: *Rastrelliger brachysoma* (Bleeker, 1851)

SCIENTIFIC SYNONYMS: *Rastrelliger neglectus* (van Kampen, 1967), *Scomber brachysoma* (Bleeker, 1851), *Scomber neglectus* (van Kampen, 1907) (Carpenter and Niem, 2001; FAO, 2020)

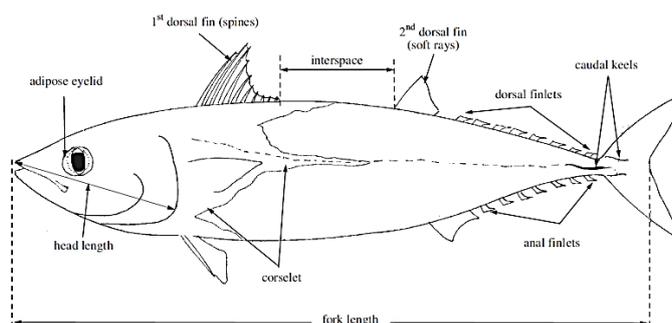
5.2. MORPHOLOGY

Short mackerel has fusiform and compressed body, covered by small ctenoid scale with adipose eyelid on the eyes. Body colour is bluish green in the top part and slightly silvery below. Its diagnostic characters are as follows:

- Body very deep, its depth at posterior margin of opercle 3.7 to 4.3 times in fork length; head equal to or less than body depth.
- Maxilla covered by lacrimal bone but extending nearly to end of lacrimal.
- Gill rakers very long, visible when mouth is opened, 30 to 48 on lower limb of first gill arch; numerous bristles on longest gill raker, about 150 on one side in specimens of 12.7 cm, 210 in specimens of 16 cm, and 240 at 19 cm fork length.



Photo by Williams, J.T. (FishBase, 2017)



Carpenter and Niem (2001)

- Intestine very long, 3.2 to 3.6 times fork length.
 - 8-10 dorsal spines, 12 dorsal soft rays, 11-12 anal soft rays, and absence of anal spines.
 - Spinous dorsal fin yellowish with a black edge, pectoral and pelvic fins dusky, other fins yellowish.
- (Carpenter and Niem, 2001; Goutham and Mohanraju, 2015; FishBase, 2017)

5.3. DISTRIBUTION

Short mackerel is an epipelagic, neritic species widely distributed in the Indo-Pacific region, from the Andaman Sea of the Central Indo-West Pacific east to Thailand, Malaysia, Singapore, Cambodia, Vietnam, Indonesia, Papua New Guinea, Philippines, Solomon Islands and Fiji (Fig. 5.3-1). It can tolerate slightly reduced salinities in estuarine habitats and occurs in areas of where the depth is not over 30 m and surface temperatures range between 20° and 30°C. (Carpenter and Niem, 2001; Meksumpun *et al.*, 2013)

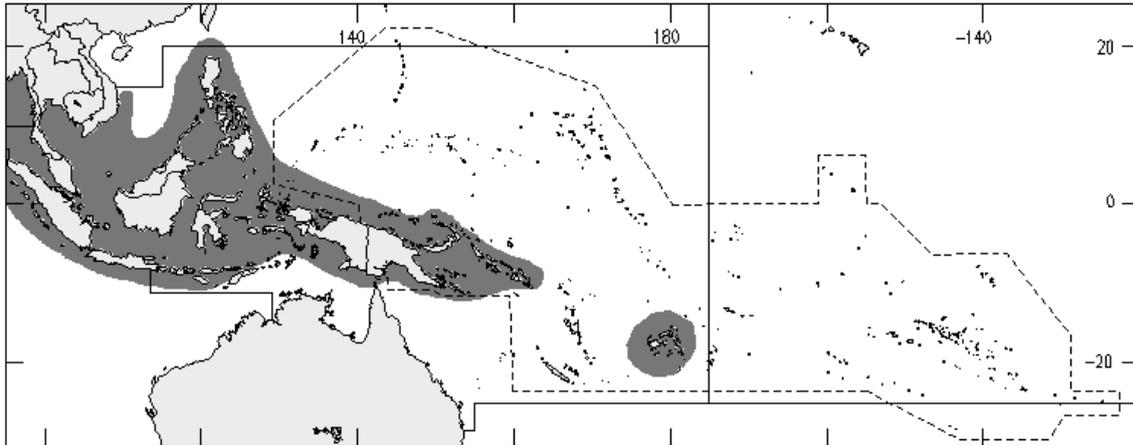


Figure 5.3-1 Distribution of short mackerel

Source: Carpenter and Niem (2001)

5.4. LIFE CYCLE AND MATING BEHAVIOR

According to the biological studies of short mackerel in the Gulf of Thailand, the fish is firstly mature at the age of 9-10 months; female highly spawns at its length of 18.7-20.0 cm, while male is firstly mature at the length of 16.45 cm. Short mackerel forms school by sizes and spawns within the school, where massive females and males release eggs and sperm into the water for external fertilization. Short mackerel is a multiple spawner with asynchronous development of the oocytes; it spawns not in its feeding ground in surface area but in mid-water of 18-25 m-depth, usually at nightfall. Female fish has fecundity of approximately 200,000-500,000 ready for each batch-releasing of about 20,000-30,000 eggs which extends for 3-4 consecutive days. Released egg is semi-buoyant, spherical, and transparent, with a diameter of 0.7-0.9 mm. Eggs and larvae of short mackerel are usually found in the areas of 1-40 NM from coastline with water temperature of 27°C-31°C and salinity of 31-32 ppt. The fish spawns all year with high peaks in February-May and July-October in the central area of the western Gulf of Thailand. (Boonprakob, 1965; Suyama *et al.*, 2000; Krajangdara *et al.*, 2007; Rittitum *et al.*, 2012; Meksumpun *et al.*, 2013)

With regard to life cycle, fertilized egg takes 16.5 hours on average to hatch out for yolk-sac larva, and 3 days to develop into pre-larva. It reaches post-larval stage at day 15 and be a juvenile fish at day 28. The fish feeds chiefly on microplankton with a high phytoplankton component and some portions of fish/shrimp larvae, having growth rate of 0.61-0.69 mm/d. It takes 3 months to grow up to young fish with early developed gonad, and 2 more months to be adult. Short mackerel is mature at the age of 9-10 months preparing for migration in a large school at an average speed of 1.01 NM/h to a suitable location to spawn. Diagram of its life cycle is illustrated in Figure 5.4-1. (Boonprakob, 1965, 1974; Somchaiwong and Chullasorn, 1967; Rittitum *et al.*, 2012; Meksumpun *et al.*, 2013; Srichanngam *et al.*, 2014)

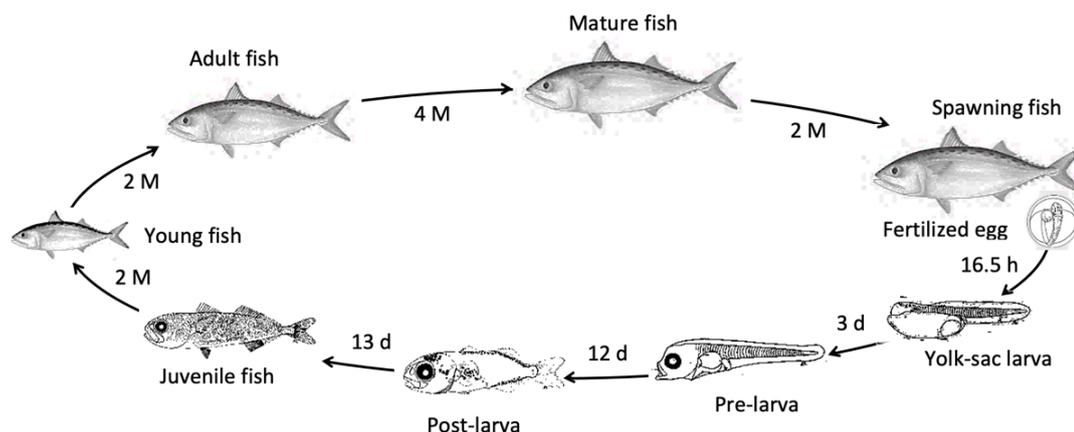


Figure 5.4-1 Life cycle of short mackerel in the Gulf of Thailand
(larval and juvenile short mackerel drawn by Termvidchakorn, A., cited from Rittitum *et al.*, 2012)

5.5. LENGTH AT FIRST MATURITY/SIZE/WEIGHT/AGE

Length at first maturity in the context of fisheries biology normally defined as L_m or L_{50} , i.e., length at which 50% of the fish are mature. Length at first maturity of short mackerel varies by areas and times, due to the changes of environmental conditions and fishing pressures. It was shown by research findings that short mackerel in the Gulf of Thailand reach maturing stage earlier than before; and its first mature sizes in each part of the Gulf are different. Age and growth of short mackerel in the Gulf of Thailand were also attained by the employment of otolith microstructure technique. The followings are recent findings of size and age of short mackerel in the Gulf of Thailand, some of which are specified in Trat fisheries *refugia* site:

Gulf of Thailand:

- Length at first maturity: male 16.45 cm
female 17.95 cm
- Length at fisheries recruitment: 6.82–19.73 cm
- Age at fisheries recruitment: 107–398 days (approximately 3.5 months – 1.09 years)
- Maximum length ever found: 25 cm
- Length-weight relationship: male $W = 0.0142 TL^{2.9402}$
female $W = 0.0074 TL^{3.1670}$
- Length-age relationship: male $t = 68.146e^{0.00769*TL}$ (days)
female $t = 65.603e^{0.00876*TL}$ (days)
- Growth equation: $L_{(t)} = 22.229(1 - e^{-2.432(t - (-0.00426))})$
- Sex ratio; male:female 1:1.19

(Krajangdara *et al.*, 2007; Srichanngam *et al.*, 2014)

Trat fisheries *refugia* site:

- Length at first maturity: male 16.25 cm
female 15.93 cm
 - Length at first capture: male 14.41 cm
Female 15.21 cm
 - Length at fisheries recruitment: 4.75–23.40 cm
 - Sex ratio; male: female 1:1.28
- (Khrueniam and Chareonsombat, 2012; Khrueniam *et al.*, 2013; Worasing *et al.*, 2014)

5.6. MATURATION AND SIZE FREQUENCY

5.6.1. MATURATION

Mature short mackerel, both males and females, were found every month in a year in Trat fisheries *refugia* site (Fig. 5.6.1-1). It can be deduced from the annual maturations of females together with males that short mackerel in Trat spawns all year with peaks in February-April and June-July. (Khrueniam *et al.*, 2013)

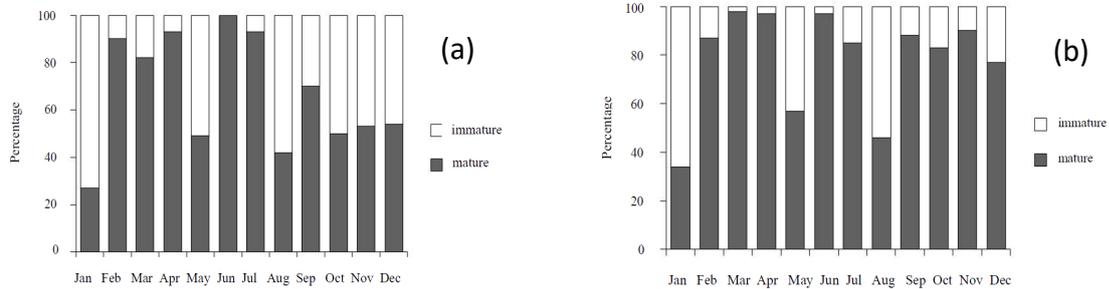


Figure 5.6.1-1 Annual maturations of male (a) and female (b) short mackerel in Trat fisheries *refugia* site

Source: Khrueniam *et al.* (2013)

5.6.2. SIZE FREQUENCY

Considering overall size frequency in the Gulf of Thailand, landing data of short mackerel from its main fishing gears, i.e., bamboo stake traps, purse seines, and trawls during the year 1968-2005 were pooled. It was found that short mackerel recruited into fisheries in the Gulf of Thailand at the length of approximately 7-24 cm. Length frequency distribution of short mackerel is shown in Figure 5.6.2-1, illustrated with its length at juvenile-early maturity (L_r), length at first maturity (L_m), optimum length for fishing (L_{opt}), and asymptotic length (L_{max}/L_{∞}). (Saikliang, 2013)

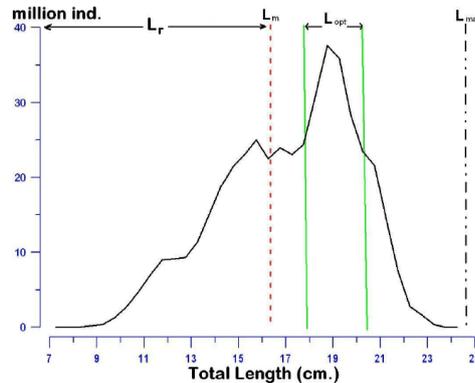


Figure 5.6.2-1 Length frequency distribution of short mackerel in the Gulf of Thailand (from purse seines, trawls, and bamboo stake traps)

Source: Saikliang (2013)

With regard to Trat fisheries *refugia* site, catch data of short mackerel was collected in 2009 from its principal fishing gears: purse seines, trawls, gill nets, and bamboo stake traps, fishing in Trat Seas. Total lengths were found at the range of 13.30-20.30 (16.31±1.07) cm in males and 13.50-23.40 (16.89±1.11) cm in females. The most frequent length was 16.75 cm both in males and females, while their average lengths showed that females were significantly bigger than males. Length frequency distribution is shown in Figure 5.6.2-2. (Khrueniam *et al.*, 2013)

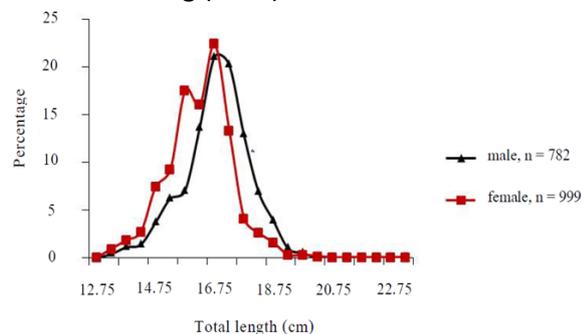


Figure 5.6.2-2 Length frequency distribution of short mackerel in Trat fisheries *refugia* site (from purse seines, trawls, gill nets, and bamboo stake traps)

Source: Khrueniam *et al.* (2013)

The other pattern of the length frequency of short mackerel in Trat fisheries *refugia* site was derived from catch data of commercial fishing gears: purse seines, light luring purse seines, anchovy purse seines, anchovy falling nets, and otter board trawls landed at the fishing ports in Trat Province in 2014. These lengths were found smaller than those in the previous record due to a number of small fish caught by light luring fishing gears. From these catch data, short mackerel had their lengths ranged at 4.75-22.25 (15.46±0.03) cm with the highest frequency at 16.5 cm. Out of all number of the fish, 92.06% was found smaller than its first mature size. Length frequency distribution is shown in Figure 5.6.2-3. (Noranartragoon, 2016)

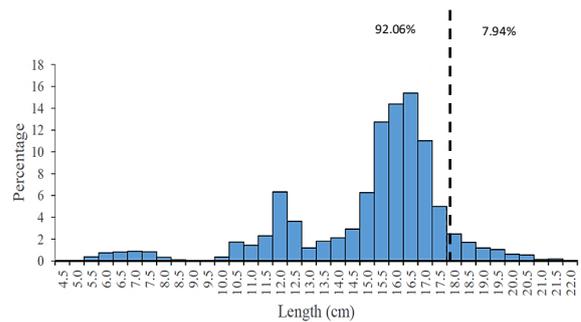


Figure 5.6.2-3 Length frequency distribution of short mackerel in Trat fisheries *refugia* site (from purse seines, light luring purse seines, anchovy purse seines, anchovy falling nets, and otter board trawls)

Source: Noranartragoon (2016)

5.7. MIGRATION PATTERN

According to the recent study for baseline populations of short mackerel in the Gulf of Thailand based on genetic approach, it is suggested that there are possibly 4 different populations in the Gulf of Thailand, namely those from 1) Trat, 2) Samut Songkhram, 3) Prachuap Khiri Khan, and 4) Surat Thani (Fig. 5.7-1) (SEAFDEC, 2017).

Principal migration patterns are those in the western coast and the eastern coast of the Gulf of Thailand, of which migration in the west has been long-time significantly studied and wildly acknowledged.

With regard to the well-known migration of short mackerel in Thailand, the fish spawns around the islands in Surat Thani during February– May then moves upwards along the coast to the nutrient-rich area at Samut Songkhram in the inner Gulf of Thailand until maturing, and subsequently offshore back through Prachuap Khiri Khan and Chumphon to Surat Thani for spawning.

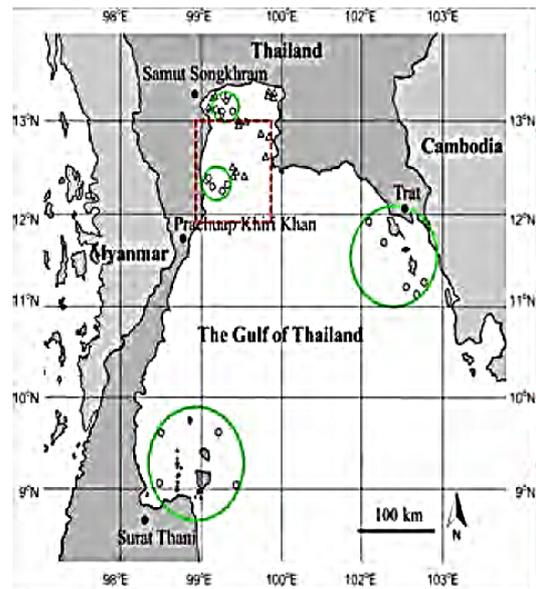


Figure 5.7-1 Baseline populations of short mackerel in the Gulf of Thailand

Source: SEAFDEC (2017)

Concerning the population of short mackerel in Trat, as a hypothesis, the mackerel migrates between Cambodia and Thailand by travelling from Sihanoukville in Cambodia to Trat in Thailand, then going west through Chong Chang to the coastal area of Chanthaburi, some of which forwarding far to Rayong and Chonburi & Samut Songkhram in the inner Gulf of Thailand, then eastward migrating back (Meksumpun *et al.*, 2013).

Both of the main migration patterns in the Gulf of Thailand, derived from prolonged researches in the west and hypothesis in the east, are consistent with the gene flow patterns based on genetic studies showing that the migrations are mainly between the stocks of “Trat and Samut Songkhram” and “Surat Thani and Samut Songkhram” (Fig 5.7-2). From the genetic data, little movements are also observed for the stocks between “Trat and Prachuap Khiri Khan”, “Trat and Surat Thani”, and “Surat Thani and Prachuap Khiri Khan”. In addition, there is the possibility that the same stock of short mackerel is utilized by some countries in the Gulf of Thailand. (SEAFDEC, 2017)

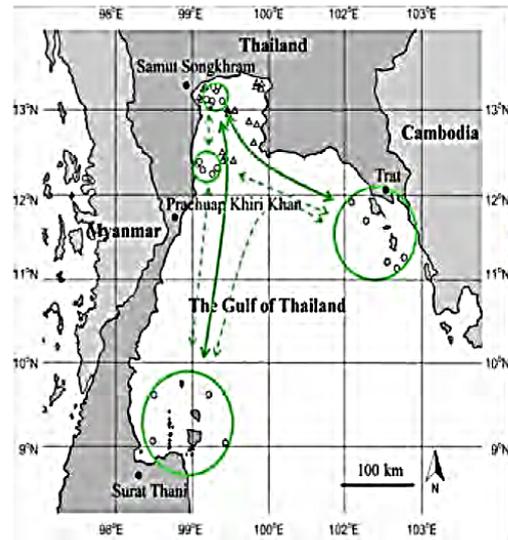
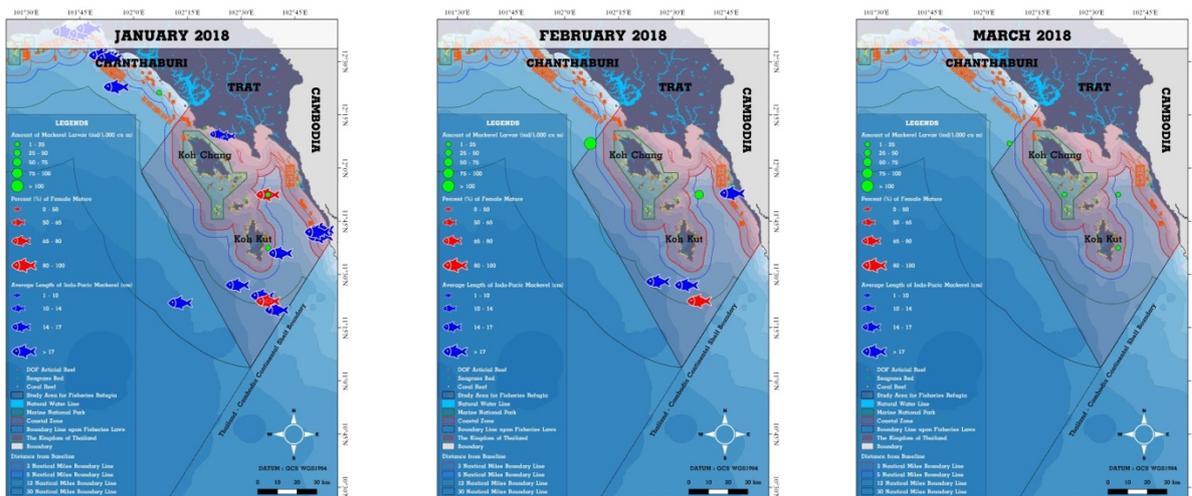


Figure 5.7-2 Migrations of short mackerel in the Gulf of Thailand based on gene flow patterns
Source: SEAFDEC (2017)

5.8. IMPORTANCE OF THE SITE TO LIFE CYCLE OF THE SPECIES

It is evidenced from sampling surveys during the year 2017-2018 that proposed Trat fisheries *refugia* site serves as the spawning and nursery grounds for short mackerel migrating into the area in a certain time. As refer to the annual distribution of larval, juvenile-adult, mature, and fully mature short mackerel in the site, high number of fully mature fish came into the area at the period of January- February, and the larvae were found abundant during February-May (Fig. 5.8-1).



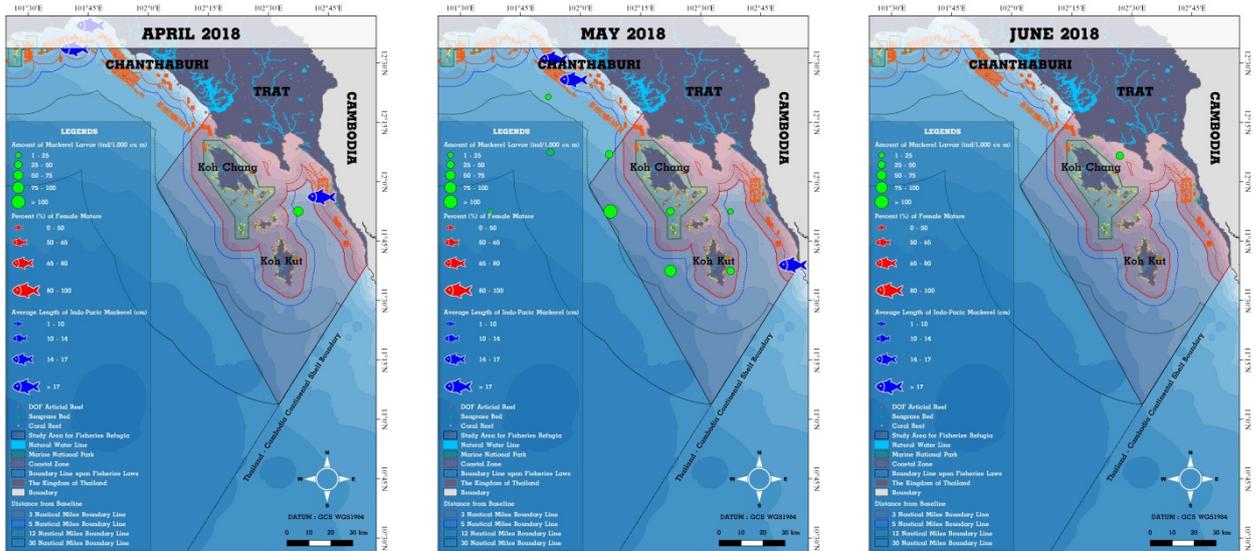


Figure 5.8-1 Annual distribution of short mackerel (larval, juvenile-adult, and mature fish) in Trat fisheries refugia site

Source: Eastern Gulf Fisheries Research and Development Center (Rayong)

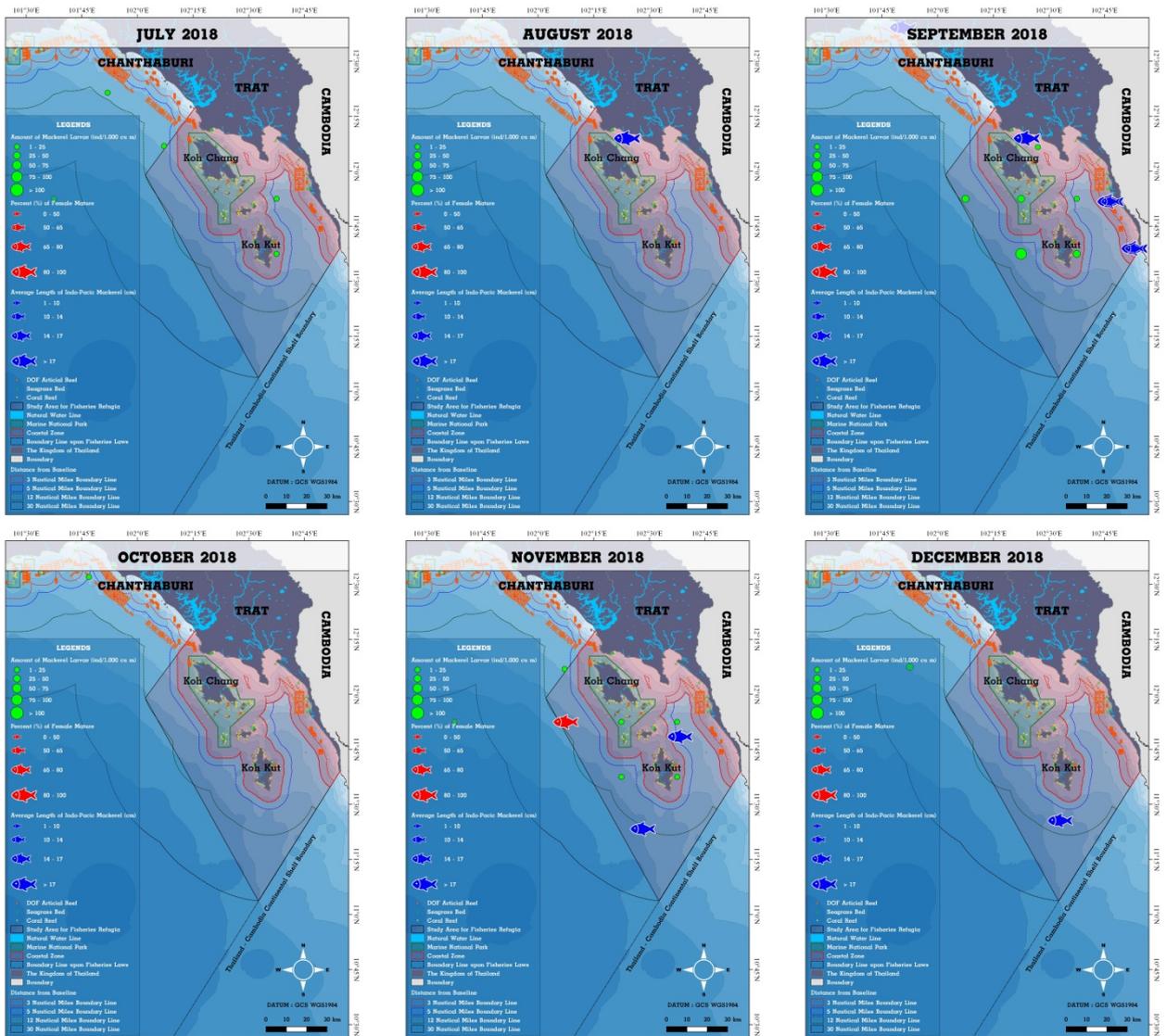


Figure 5.8-1 Annual distribution of short mackerel (larval, juvenile-adult, and mature fish) in Trat fisheries *refugia* site (cont.)

Source: Eastern Gulf Fisheries Research and Development Center (Rayong)

5.9. STOCK INFORMATION

With reference to the assessment of fisheries status of short mackerel in the Gulf of Thailand using 1968-2009 sampling data and fisheries statistics from the main fishing gears, it revealed that short mackerel resources in the Gulf of Thailand had been exploited over its maximum sustainable yield, MSY, since the year 1999 (Saikliang, 2013). From such the assessment, MSY for short mackerel in the Gulf of Thailand was estimated at 112,416 tons, and its optimum fishing effort was 200,892 days (Fig. 5.9-1).

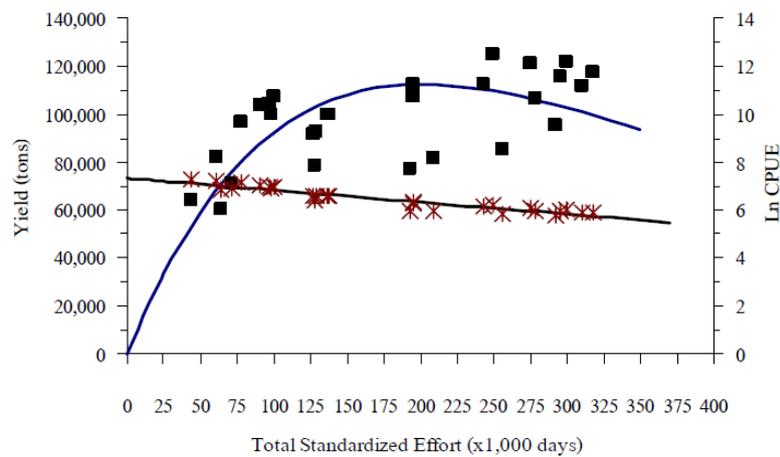


Figure 5.9-1 Relationship between total standard fishing effort, total catch, and CPUE (kg/day) of short mackerel fisheries in the Gulf of Thailand by Fox's model showing maximum sustainable yield and optimum fishing effort

Source: Saikliang (2013)

Stock information of the major groups of fisheries resources have been recently estimated by Department of Fisheries for the purpose of being the biological reference points for sustainable utilization of fisheries resources in Thai Waters. Concerning short mackerel, the recent stock information are shown in Table 5.9-1 and 5.9-2.

Table 5.9-1 MSY and fishing effort of short mackerel in the Gulf of Thailand in 2018

MSY (tons)	Fishing effort at MSY (days)	Catch (tons)	Fishing effort (days)	Status	Remark
123,514.79	58,806.01	12,309.64	208,078.64	71.74% over MSY	By Fox surplus production model

Source: Noranarttragoon *et al.* (2019)

Table 5.9-2 CPUEs of short mackerel from purse seine fisheries in the Gulf of Thailand and Trat Seas in 2018 and 2019

	Gulf of Thailand (kg/d)	Trat Seas (kg/d)
2018	58.96 *	55.69 ***
2019	138.89 **	8.28 ***

Source: * Department of Fisheries (2019);

** Data from Fisheries Resource Assessment Group, Marine Fisheries Research and Development Division, Department of Fisheries;

*** Data from Eastern Gulf Fisheries Research and Development Center (Rayong)

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