Compilation of the Thailand work under the Project

December 2016

Strategies for trawl fisheries bycatch management project

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Strategies for trawl fisheries bycatch management (REBYC-II CTI; GCP/RAS/269/GFF)

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Acronyms used

AFN	Anchovy falling net
APS	Anchovy purse seine
CDD	Community Development Department
CMDEC	Chumphon Marine Fisheries Research and Development Center
CPUE	Catch per unit of effort
DoF	Department of Fisheries
EMDEC	Eastern Marine Fisheries Research and Development Center (in Rayong)
EJF	Environment Justice Foundation
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GoT	Gulf of Thailand
GPP	gross provincial product
ILO	International Labour Organization
LOA	Length over all
MEY	Maximum economic yield
MFRDB	Marine Fisheries Research and Development Bureau
MFRDD	Marine Fisheries Research and Development Division
MSC	Marine Stewardship Council
MSY	Maximum sustainable yield
NSO	National Statistics Office
NTO	National Technical Officer
OBT	Otter board trawler
OBT1	Small-sized otter board trawler, length less than 14 m
OBT2	Medium-sized otter board trawler, length 14-18 m
PT	Pair trawl

REBYC-II CTI (GCP/RAS/269/GFF)	The Project "Strategies for Trawl Fisheries By-catch Management"
SEAFDEC	Southeast Asian Fisheries Development Center
TPS	Thai purse seine
VMS	Vessel Monitoring System
nm	nautical mile
t	tonne

Summary

This report synthesizes the main outcome of nine technical papers produced in Thailand under the regional REBYC-II CTI project in 2012-2015. The topics of these reports included investigations on the status of marine fisheries resources, quantity and composition of trawl bycatches, fish larvae distributions, regulation of trawl fisheries, experiments on trawl codend selectivity, and socio-economic studies. The work in Thailand was conducted in pilot sites in Trat and Prachuap Khiri Khan-Chumphon Provinces.

In the past three decades, various studies of the demersal and invertebrate resources in the Gulf of Thailand (GoT) indicated over-exploitation of fisheries resources. Catch composition has changed from big sized and high value species to smaller and less value species. In 2013 the total marine capture from all types of gear in Thai waters was 1,614,536 tonnes. The catch from trawlers in 2013 accounted to 513,325 tonnes which was 24.29 % of total catch from GoT. The MSY calculation indicates that the present overall fishing effort is greater than the optimum level by 32.8%, and it should therefore be managed. The experiments using the 4 cm trawl codend mesh size showed that it helped saving many juvenile fishes from getting caught. Though there was some short-term economic loss to fishers using the nets, the long term benefits of the saved resources was realized. Three year project was done to find the effective information i.e. status of fisheries resources, socio-economic of fishers, fish larvae distribution, enlarging trawl cod-end mesh size and Thai Laws in Relation to Trawl Fisheries. The research projects were done in collaboration of stakeholders to achieve the acceptance of the result. The outcome of the research was used to support decision making by both governors and primary stakeholders. The project also helped disseminate the details of various national fisheries management measures especially those under the latest Royal Ordinance on Fisheries B.E.2558 (2015).

The main conclusion of the project activities in Thailand was that appropriate and research-based seasonal and area closures for trawl fishing and codend mesh size enlargement of trawl gear are effective measures to reduce trash fish in trawl catches. One of the lessons learned in the project is that to encourage the key stakeholders to understand and consider the scientific evidence, they should be provided with adequate information of the status of fisheries resources and socio-economic impacts of the planned management measures. This can be effectively done through stakeholder consultation meetings. Such meetings will build trust and acceptance, and will thereby strengthen the fisheries management planning.

One of the key outcomes of the project is that the potential biological and socio-economic effects of management measures should be investigated and considered carefully in close collaboration with key stakeholders. Local knowledge should be included to improve the acceptance and to strengthen the planning. That will increase the confidence in decision making processes. Management measures should be periodically reviewed to ensure that they continue to meet the expected goals and objectives. Clearly defined monitoring and evaluation procedures, as well as a set of indicators, are required to benchmark the sustainability of fisheries management.

Capacity development for fisheries officers and other key stakeholders on fishery governance and social interactions was one of the key factors for the successful preparation of fisheries management plans.

The project recommends that the Department of Fisheries (DoF) disseminates the lessons learned to other areas in Thailand that have similar type of critical problem on trawl bycatch and trash fish. Furthermore, the project acknowledges that widely published information about the status of fisheries resources and fisheries as well as fisheries management plan increases the awareness and acceptance by stakeholders.

1. Introduction

The Project, Strategies for trawl fisheries bycatch[1] management (REBYC-II CTI; FAO project code GCP/RAS/269/GFF) is contributing to the more sustainable use of fisheries resources and healthier marine ecosystems in the Coral Triangle and Southeast Asia waters by reducing bycatch, discards and fishing impact by trawl fisheries.

The Project is funded by the Global Environment Facility (GEF) and executed by FAO with collaboration of Project Regional Facilitation Unit at the Southeast Asian Fisheries Development Centre (SEAFDEC/RFU) in Bangkok, Thailand, and governments in the participating countries Indonesia, Papua New Guinea, Philippines, Thailand and Viet Nam in partnership with the private sector and relevant national, regional and international organizations. The project has four components:

1. Policy, legal and institutional frameworks component. This component works towards the establishment of national or area specific trawl fisheries bycatch management plans and building institutional capacity for their implementation. The need for adequate legislation and regulations to support the implementation of improved management measures is being addressed. At the regional level, a bycatch policy/strategy to be developed that is consistent with the FAO Code of Conduct for Responsible Fisheries and the ecosystem approach to fisheries.
2. Resource management and fishing operations component. This component is to lead to the adoption of more selective fishing gear and practices, provide a basis for implementing zoning of fishing areas and developing spatial-temporal closure management measures, and generate better data on number of vessels and recommendations for fishing effort and capacity management. The management measures will be supported by the identification of incentive packages that promote more responsible fishing. The results from this component are to inform the regional bycatch policy/strategy and the national and/or area specific trawl fisheries bycatch management plans.
3. Information management and communication component. This component includes bycatch data collection (e.g. at landing sites and onboard vessels, and mapping of fishing ground characteristics), establishment of socio-economic monitoring procedures, and means for communicating bycatch data and information (website and information, education and communication-IEC-material). Standardized methods for bycatch data collection are to be promoted across project countries.
4. Awareness and knowledge component. This component addresses the awareness of and knowledge on trawl fisheries bycatch management issues and how they relate to sustainability, and what measures that are available to make fishing more responsible. Private sector/fishers, policy makers, fisheries managers, officials, extension officers and NGOs are being offered training and workshops to enhance their knowledge on best management practices and responsible fisheries.

Eastern Marine Fisheries Research and Development Center in Rayong (EMDEC) and Chumphon Marine Fisheries Research and Development Center in Chumphon (CMDEC) of DoF conducted research activities in Trat and Prachuap Khiri Khan - Chumphon Provinces.

1. **Trat Province: Survey and research for the purpose of demarcation of conservation zone for juvenile fish and breeding stocks in the area of Trat Province.**
2. **Prachuap Khiri Khan - Chumphon Provinces: Experiment on enlarging trawl codend mesh size in the areas of Prachuap Khiri Khan and Chumphon Provinces.**

[1] The term "bycatch" is a generic term referring to catch that is incidental to the target species, noting that in many fisheries using non-selective gears, such as fish trawls, the term is sometimes used interchangeably for the unwanted portion of the catch that is discarded or sometimes to refer to the less desirable fish that are landed, i.e. low value/trash fish

The project outputs came consist of 9 technical papers in 5 topics i.e. law and regulation of trawl fisheries and concerned issues, status of marine fisheries, experiment on codend mesh size for trawlers, fish larvae and distribution, and socio-economic study. The following reports were produced under the project.

Status of marine fisheries

- Review of the Marine Fisheries in Trat Province, Thailand, by Pavarot Noranarttragoon, Marine Fisheries Research and Development Division, Department of Fisheries, Bangkok, Thailand.
- Review of the Marine Fisheries in Prachuap Khiri Khan and Chumphon Province, by Pavarot Noranarttragoon, Marine Fisheries Research and Development Division, Department of Fisheries, Bangkok, Thailand.
- Present Situation of Marine Fisheries in Trat Province, Thailand, by Pavarot Noranarttragoon, Marine Fisheries Research and Development Division, Department of Fisheries, Bangkok, Thailand.
- Present Situation of Marine Fisheries in Prachuap Khiri Khan and Chumphon Provinces, Thailand, by Pavarot Noranarttragoon, Marine Fisheries Research and Development Division, Department of Fisheries, Bangkok, Thailand.

Socio-economic studies

- Socio-Economic Status of Fishers in Trat Province, Thailand, by Sirisuda Jumnongsong, Department of Fishery Management, Faculty of Fisheries, Kasetsart University, Thailand.
- Socio-Economic Status of Trawl Fishers in Prachuap Kiri Khan Provinces, Thailand, by Sirisuda Jumnongsong, Department of Fishery Management, Faculty of Fisheries, Kasetsart University, Thailand.

Experiment on codend mesh size for trawlers

- Trawling experiment using an enlarged mesh size in codend, by Ratanawalee Phoonsawat, Udomsin Auksonphaob, Thitipon Cheuamankong and Sampan Panjarat, Department of Fisheries.

Fish larvae and distribution

- Biodiversity, abundance and distribution of fish larvae in Ao Trat by Apichart Termvichakorn.

Law and regulation of trawl fisheries and concerned issue

- Review of Thai Laws in Relation to Trawl Fisheries, Bycatch Management Project “Strategies for Trawl Fisheries Bycatch Management” by Chintana Nettasna.

This compilation paper has been prepared as a part of the Project “Strategies for Trawl Fisheries Bycatch Management” (REBYC-II CTI; GCP/RAS/269/GFF) and it aims to compile and summarize all of those 9 technical papers listed above and add information for better understanding for the convenience for readers especially the policy makers. We also hope this report will be useful for researchers, students and other interested persons. The copies of completed document will be accessible worldwide through the project website.

2. Overview of trawl fisheries in the Gulf of Thailand

Development of trawl fisheries

Trawl fisheries in Thailand was developed since 1960s under the technical assistance from the Government of Germany. The project aimed to introduce Thai fishers to the use of otter board trawl by training and conducting trawl surveys in the Gulf of Thailand (GoT). The introduction of trawl fishery was very successful due to user acceptance and the high efficiency otter board trawling could achieve

in production. As a result, the total marine fisheries production rapidly increased from 233,275 t in 1960 to 1,548,157 t in 1972. It made Thailand to rank among one of top ten of high marine productivity countries and thus created downstream and uapstream industries of the country.

After the introduction of the trawl fisheries, the state of demersal fishery resources has been monitored and evaluated through routine standardized research vessel trawling surveys. These surveys have been conducted by the Marine Fisheries Division, Department of Fisheries, since 1961 up to present (Figure 1). The catch per unit of effort (kg per trawling hour or CPUE) of the trawling surveys showed a continuously decreasing trend from 1961 to 2014. In 1961, an average CPUE of the total catch of the research vessel was 297.8 kg/h and declined to 61.5 kg/h in 1975. From 1975 to 1983 the catches fluctuated, partly due to oil crisis, and the CPUE was approximately 50-60 kg/h and slightly increased in 1984 to 62.1 kg/h. A sharp decline occurred from 1984 to 1989 with an average CPUE of 22.7 kg/h but it increased to 37.1 kg/h in 1992. From 1994 to 2014 the CPUE trend was rather steady with the average CPUE approximately 15-25 kg/h. In 2014 the average catch rate was 23.9 kg/h.

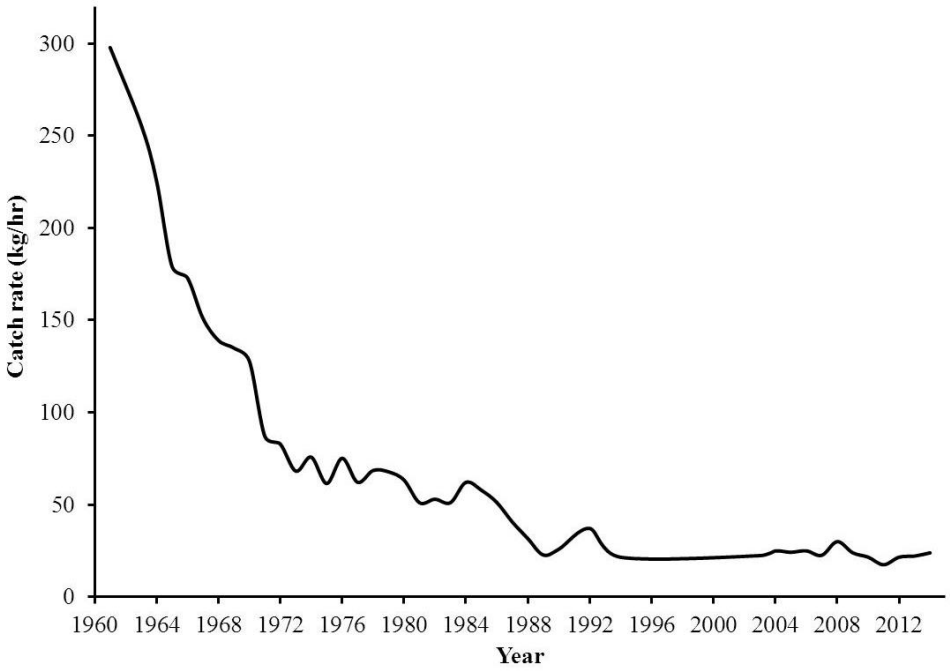


Figure 1: CPUEs obtained from trawl surveys in the Gulf of Thailand from 1961 to 2014 Source: MFRDD, 1961-2014.

In the past three decades, various studies of the demersal and invertebrate resources in the Gulf of Thailand indicated over-exploitation of fisheries resources. Catch composition has changed from big sized and high value species to smaller and less value species. The catch composition from trawler comprises of smaller (juveniles) economic species in substantial quantity. One of the severe problems with trawl fishery in the Gulf of Thailand (GoT) is that this gear is non-selective and harvests not only marketable size but also smaller (young) specimen of the economic species, including crab, squid, and finfish, and of low value species. This is known as “bycatch” although in Thailand there is no specific definition for bycatch; in practice, fishers are more familiar with the word “trash fish”.

Trash fish is a combination of true trash fish and small juveniles of economic fish. There is also no discard from marine capture in Thailand, all landing products can be utilized into various processes (Supongpan and Boonchuwong, 2010). Such practice of exploitation of trash fish may create a severe problem on growth over-fishing.

Ministry of Agriculture and Co-operatives has issued several laws and regulations (see: review of Thai Laws in Relation to Trawl Fisheries) to improve management of the fisheries, and address excess

fishing capacity and illegal fishing activities which still persist. In 2009, DoF formulated and implemented the Marine Fishery Management Master Plan that has been commissioned for a period of 10 years beginning in 2009. Its three goals are:

1. Security and sustainability of Thailand's marine fisheries: its annual landing of 1.7 - 2.0 million tonnes comprising at least 80% of economically important species from fishing grounds within the EEZ, and 1.0-1.6 million tonnes from distant water fishing;
2. Fishermen's organization at the provincial level actively participating in the marine fisheries management: at least one organization per province and its networking with other organizations in the proximity;
3. Active participation of fishing communities: at least 10% of all fishing communities participate.

The first goal of the Master Plan is to solve the problems on over-exploitation, over fishing capacity, composition of small and low valued species in trawl fishery. In order to address the problems from trawl fisheries and bycatch, two activities are conducted for this goal, extension of prohibited fishing ground for trawlers and push netters from 3 km to 3 nm from shoreline and enlargement of codend mesh size of trawlers.

On 28 April 2015, the Command Center for Combating Illegal Fishing (CCCIF) was established by the National Council for Peace and Order (NCPO) to counter illegal, unreported, and unregulated (IUU) fishing. The CCCIF envisages tackling IUU fishing, including the formulation and implementation of the National Plan of Action to Prevent, Deter and Eliminate IUU Fishing (NPOA-IUU). CCCIF has issued several regulations to solve IUU fishing and over fishing capacity issue in Thailand e.g. prohibit fishing without license, limit number of fishing days, port in - port out system etc. (see: review of Thai Laws in Relation to Trawl Fisheries).

In order to comply with the international arrangement, the fisheries law B.E. 2558 (2015) was revised to be Royal Ordinance on Fisheries B.E. 2558 (2015) on 13 November 2015. This recognizes the significant improvement of managing the fisheries of Thailand in sustainable manner that requires the development and implementation of a fisheries management plan. The Marine Fisheries Management Plan (FMP) 2015-2019 outlines the nature of the management challenges facing Thailand and details what actions and management measures are required to transform. It is essential to change open-access fishery by regulating open access fishery based on balancing the fishing effort with the productivity of the resources (Maximum Sustainable Yield, MSY). The Marine Fisheries Management Plan (FMP) of Thailand is closely linked to the 2015 National Plan of Action to prevent, deter and eliminate Illegal, Unreported and Unregulated (IUU) fishing (NPOA-IUU) and the 2015 National Control Plan (NCP). The FMP recognizes that there are many threats to the sustainable management of marine fisheries in Thailand, but based on a risk assessment it has identified the high priority issues as overfishing and overcapacity, especially by the commercial fleet, and the IUU fishing. The FMP aims to reduce the fishing capacity and fishing effort over the next 3 years. The specific capacity reductions targets include for demersal fish; 40% in the Gulf of Thailand and 10% in the Andaman Sea by 2018 and for pelagic fish; 30% in the Gulf of Thailand and 20% in the Andaman Sea by 2018. The main measures to achieve include: the removal of currently illegal fishing vessels; and reducing the total allowable fishing days.

2.1. Location

Thailand is located in the Southeast Asian Peninsula with area of 513,155 km^2. The coastline of Thailand is separated by the Malay Peninsula into two parts, one is the Gulf of Thailand and the other connects to the Andaman Sea. Thailand's sea territory (Maritime Zone) under the UN Convention on the Law of the Sea, 1982, is approximately 350,000 km^2 with the total coastline of approximately 2,625 km (Figure 2). The Gulf of Thailand extends northwest from the southern part of the South China Sea

(SCS). It covers an area of approximately 320,000 km^2, 1,840 km of coastal line, and average depth is 45 meter, with many large rivers which bring out the rich nutrients into the sea.

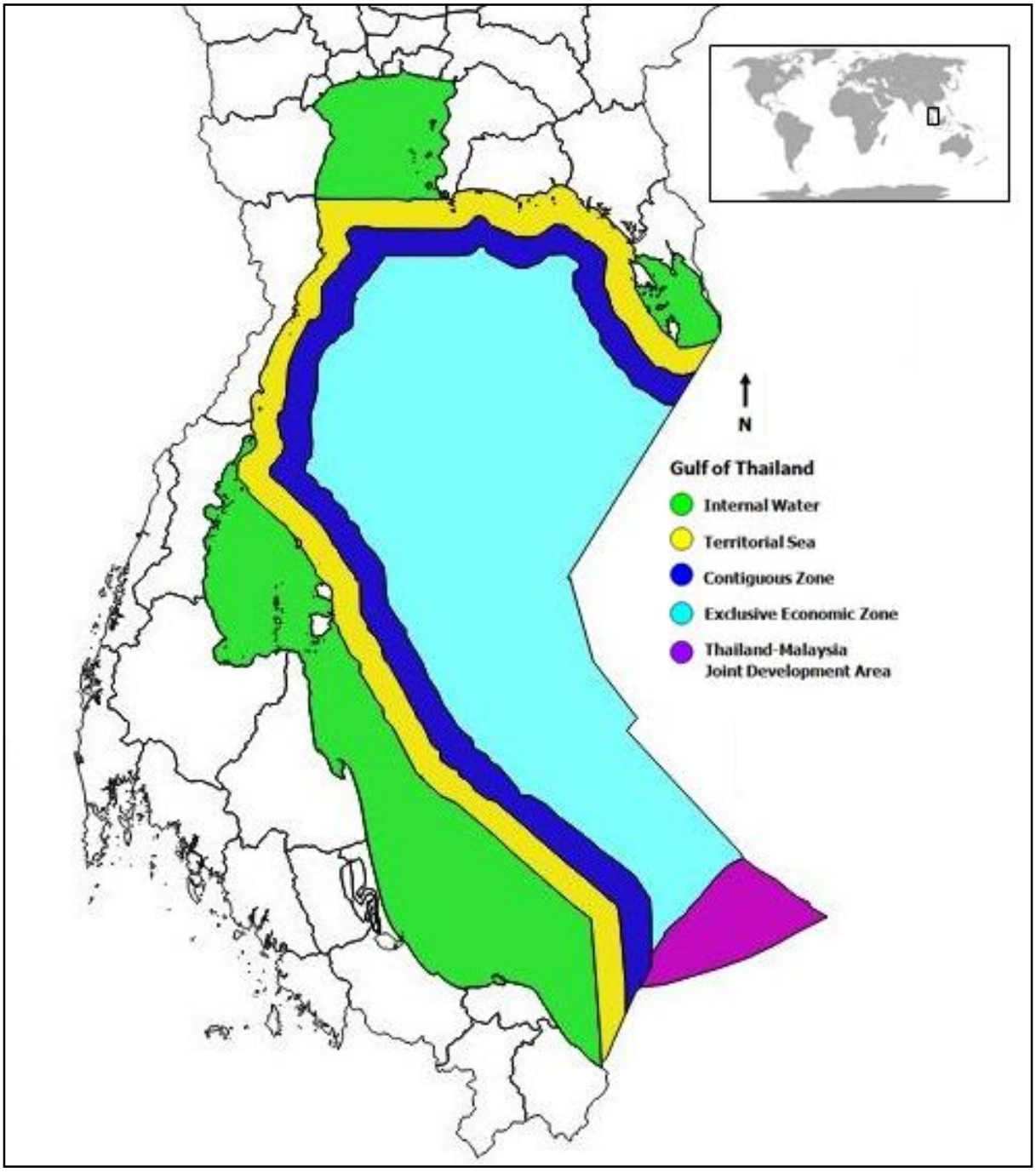


Figure 2: Thailand territorial sea in the Gulf of Thailand.

2.2. Fisheries in the Gulf of Thailand

The Gulf of Thailand is the main fishing ground for more than a century; the fishers operate with various types of fishing vessels and fishing gears. The main fishing gears employed by the fishers are trawl, purse seines, gill nets, traps, etc. Among those fishing gears, trawl is considered as an effective fishing gear for exploiting demersal species.

2.3. Fisheries production of the Gulf of Thailand

2.3.1. Catch and composition of marine capture

In 2013 the total marine capture from all types of gear in Thai waters was 1,614,536 tonnes. The GoT accounted to 70.08% of total marine capture. The catch comprised of pelagic fish group (38.92%), demersal fish group 223,290 t (13.83%), other food fish (9.57%), trash fish (22.07%), crab (2.00%), shrimp (2.94%), squid and cuttlefish (8.69%), molluscs 20,091 t (1.78%), jellyfish 2,378 t (0.21%) and other invertebrates 45 t (0.00%) (Figure 3).

In terms of value, marine capture from all types of gear in Thai waters was 92,858.73 million Baht. The GoT accounted to 89.5% of total value of marine capture. The value of catch comprised of pelagic fish group of 42,981 million Baht (51.71%), demersal fish group of 15,186.65 million Baht (18.27%), other food fish of 6,274.03 million Baht (7.55%), trash fish of 1,909.9 million Baht (2.30%), crab of 3,015.71 million Baht (3.63%), shrimp of 3,646.98 million Baht (4.39%), squid and cuttlefish of 9,631.45 million Baht (11.59%), molluscs of 459.85 million Baht (0.55%), jellyfish of 7.21 million Baht (0.01%) and others invertebrates of 1.83 million Baht (0.00%) (Figure 3).

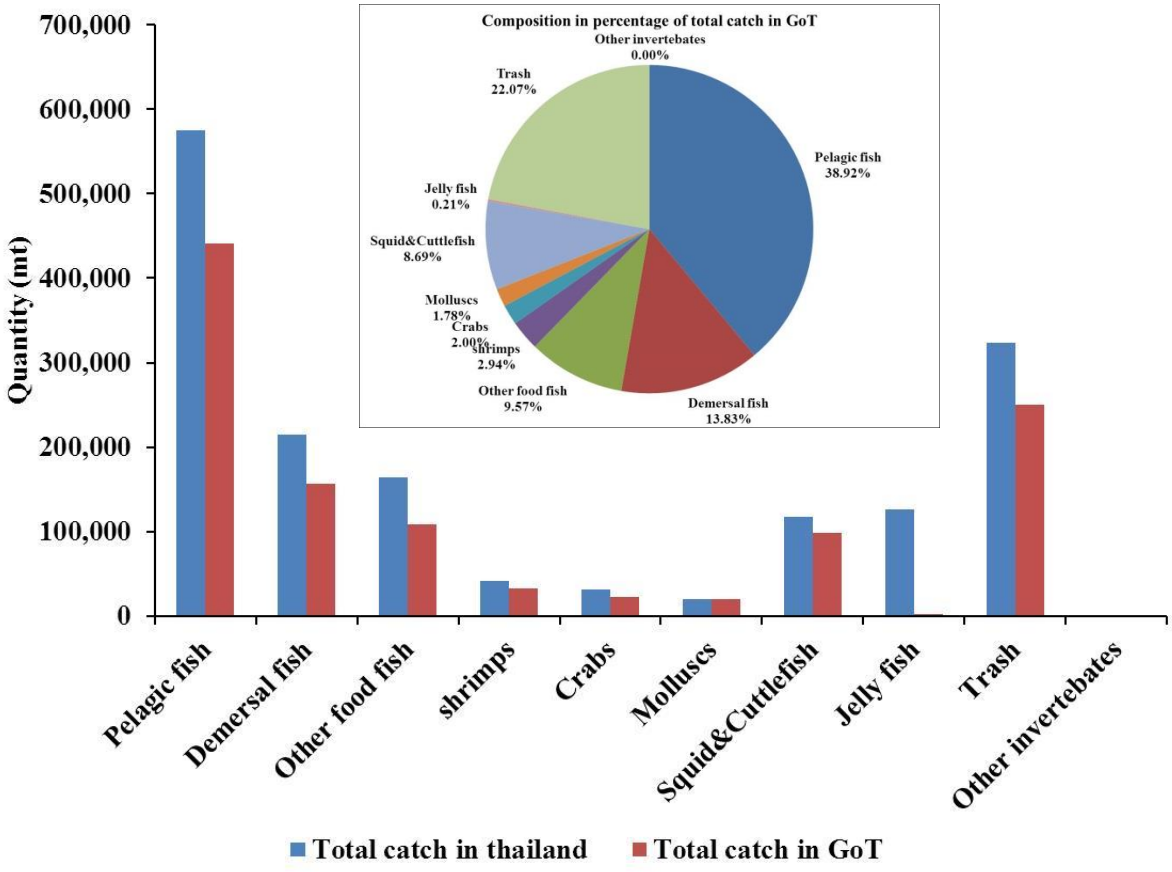


Figure 3: Production and percentage by group of marine species in the Gulf of Thailand, 2013. Source: Fisheries statistic of Thailand, Department of Fisheries, 2013.

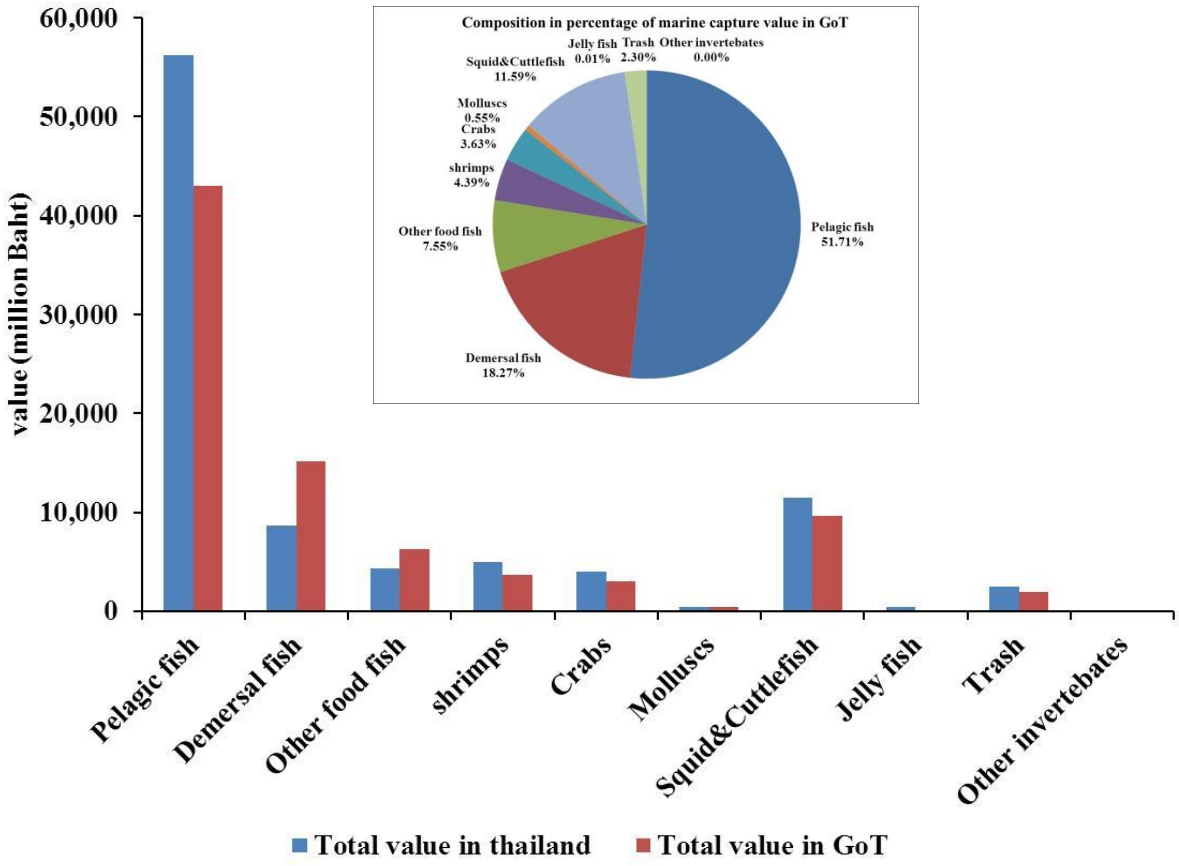


Figure 4: Value and value composition by group of marine capture from all types of gear in the Gulf of Thailand in 2013 (1US$ = 35 Baht). Source: Fisheries statistic of Thailand, Department of Fisheries, 2013

2.3.2. The catch and composition of marine capture by trawler

The catch from trawler in 2013 accounted to 513,325 tonnes which was 24.29 % of total catch from GoT. Total catch from trawler comprised of pelagic fish 51,646 t (10.06%); demersal fish 107,302 t (20.90 %); other food fish 66,159 t (12.89%); trash fish 210,649 t (41.04%); shrimp and crab 17,977 t (3.50%); cephalopod 54,167 t (10.55%) and others 5,425 t (1.06%) (Tables 1 and 2).

Table 1: Catch and value of marine capture by trawler in the Gulf of Thailand, 2013.

Group	OBT		PT		BT		Total	
	(t)	(million Baht)	(t)	(million Baht)	(t)	(million Baht)	(t)	(million Baht)
Total	320,191	11,884.18	190,039	5,643.67	3,095	106.36	513,325	17,634.21
Pelagic fish	26,285	1,089.74	25,361	1,279.64		0.00	51,646	2,369.37
Demersal fish	73,179	3,037.43	32,566	1,460.45	1,557	62.85	107,302	4,560.72
Other food fish	49,994	1,302.35	16,161	420.99	4	0.10	66,159	1,723.44
Trash fish	111,129	851.25	98,362	753.46	1,158	8.87	210,649	1,613.58
Shrimp and crab	17,200	1,596.40	540	71.99	237	20.99	17,977	1,689.39
Cephalopod	38,405	3,615.92	15,623	1,506.46	139	13.55	54,167	5,135.92
Others	3,999	391.10	1,426	150.69		0.00	5,425	541.78

Source: modified from DoF, 2015

Table 2: Catch and value composition of marine capture by trawler in the Gulf of Thailand, 2013. OBT = Otter board trawler, PT = Pair trawler BT = Beam trawler

Group	OBT		PT		BT		Total	
	(Catch %)	(Value %)	(Catch %)	(Value %)	(Catch %)	(Value %)	(Catch %)	(Value %)
Pelagic fish	8.21	9.17	13.35	22.67		8.21	10.06	13.44
Demersal fish	22.86	25.56	17.14	25.88	50.31	22.86	20.90	25.86
Other food fish	15.61	10.96	8.50	7.46	0.13	15.61	12.89	9.77
Trash fish	34.71	7.16	51.76	13.35	37.41	34.71	41.04	9.15
Shrimp and crab	5.37	13.43	0.28	1.28	7.66	5.37	3.50	9.58
Cephalopod	11.99	30.43	8.22	26.69	4.49	11.99	10.55	29.13
Others	1.25	3.29	0.75	2.67		1.25	1.06	3.07

Source: modified from DoF, 2015

2.3.3. The value of marine capture by trawler

Total value of marine capture from all types of gear in GoT accounted to 42,981 million Baht in 2013. The value of marine capture from trawler accounted to 17,634 million Baht which was 41.03 % of total value in GoT. Total value from trawler comprised of pelagic fish 2,369 million Baht (13.44%); demersal fish 4,560 million Baht (25.86 %); other food fish 1,723 million Baht (9.77%); trash fish 1,613 million

Baht (9.15%); shrimp and crab 1,689 million Baht (9.58%); cephalopod 5,135 million Baht (29.13%) and others 5,135 million Baht (3.07%) .

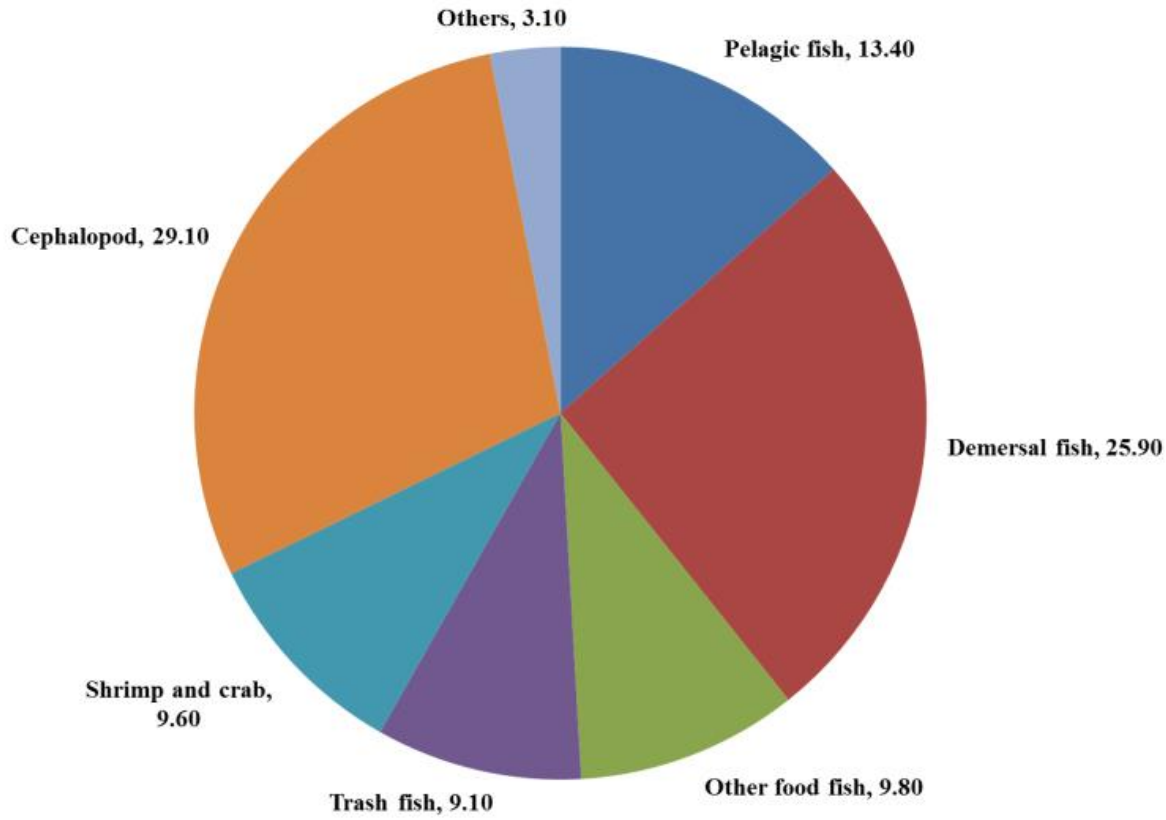


Figure 5: Composition of marine capture in percentage value in GoT.

2.4. Production trend

The production trend from 1999 to 2013 can be seen in Figure 6. The total production in GoT had a peak in 2000 with 2,023,172 t. After 2000, the total production showed gradual decrease from 1,784,590 t in 2005 to 993,148 t in 2008. In 2009-2013, the total production showed gradual increase to 1,131,486 t in 2013. Pelagic fish group and demersal fish group showed production trend similar to total production trend. Other group showed gradual decrease every year. The total production value in GoT had a peak in 2005 with 44,411 million Baht. After the year 2005 it showed rapid decrease to 27,484 million Baht in 2008 and after that, it showed an increase to 42,982 million Baht in 2013. For trash, the production trend, in terms of quantity, it was always in third rank among different groups and it was lowest in term of value. (Figure 7).

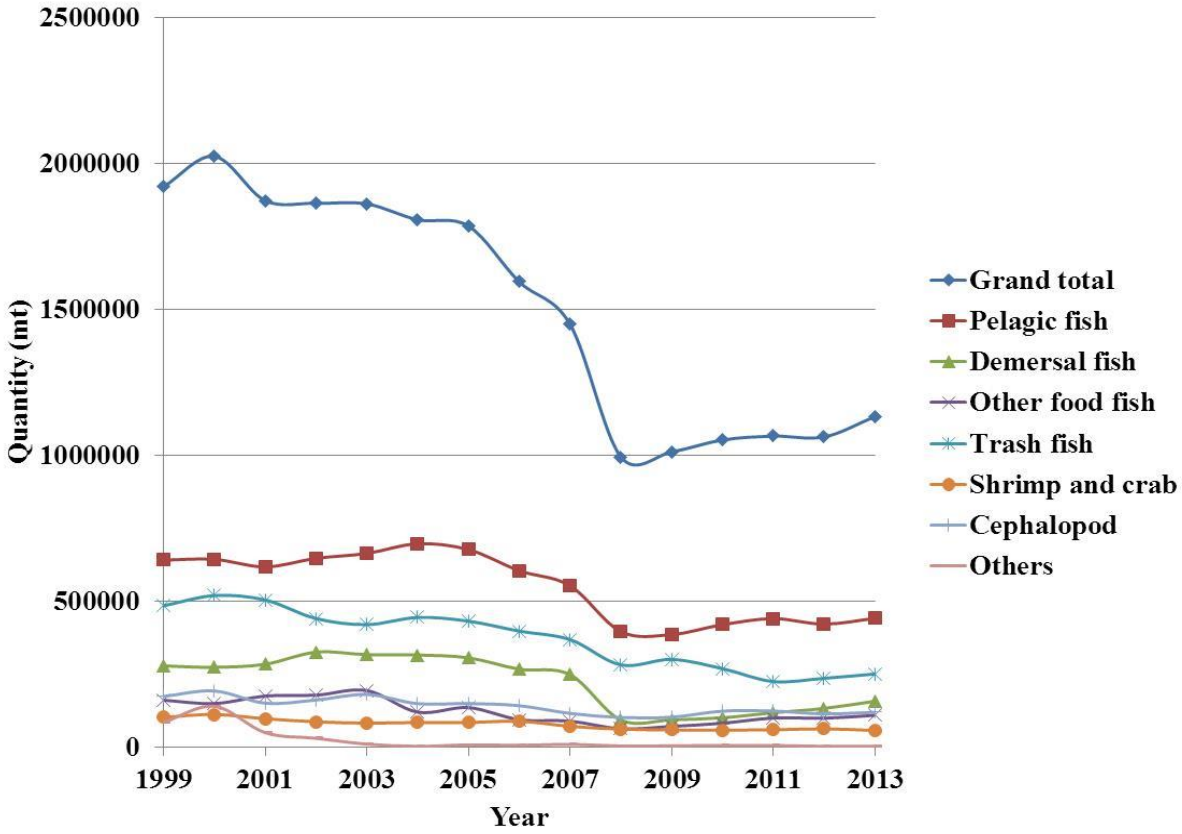


Figure 6: Production of marine capture in the Gulf of Thailand caught by all types of gear, 1999 to 2013.

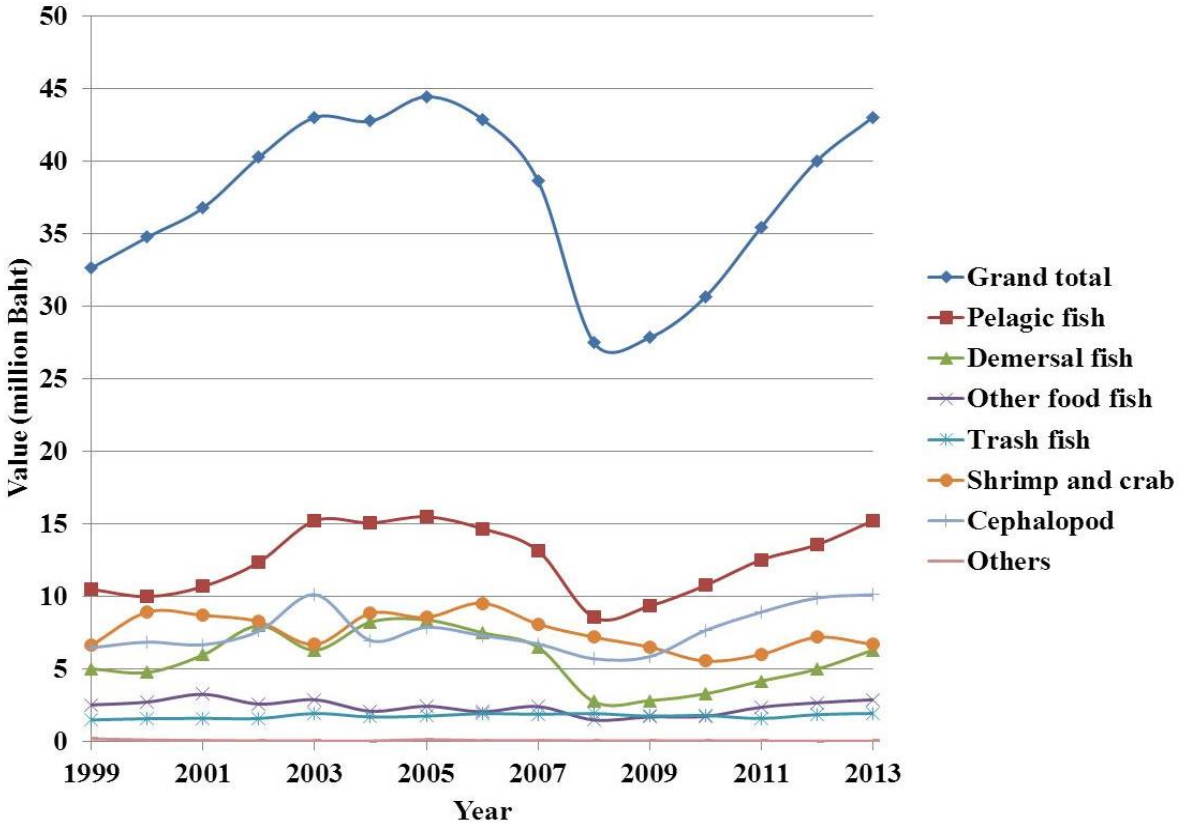


Figure 7; Value of marine capture in the Gulf of Thailand caught by all types of gear, 1999-2013.

3. Trawl fisheries in the Gulf of Thailand

3.1. Types and number of vessels and fishing license of trawler

3.1.1. Types of trawler

There are 3 types of trawler in Thailand, i.e. otter board trawler, pair trawler and beam trawler.

Otter board trawler (OBT) has a pair of wooden otter boards and some of them has 2 small timber or steel plate installing aside of the vessel for net opening (Figure 8a). The main target species are fish and shrimps. The vessel overall lengths (LOA) are 6-43 m, the majority is 10-18 m LOA. Horse power for this vessel ranges from 10 hp to 1,700 hp. The number of crew per vessel varies from 2-20 persons depending on size of vessel. Otter board trawler of the overall length more than 25 m mainly operates fishing in neighbouring countries waters with bilateral agreements and joint venture.

Pair trawlers (PT) have two vessels for net opening (Figure 8b). The main target species are fish and squids. The vessel sizes are 14-25 m LOA. The majority size is 18-25 m LOA. The horse power ranges from 250 hp to 550 hp. The number of crew per vessel varies from 18-22 persons. Pair trawlers are in normal operation for fishing in Thai waters.

Beam trawler (BT) has a pair of metal beams installed on either side of vessel and in front of net for net opening (Figure 8c and 8d). Target species is shrimp. The vessel sizes are 6-20 m LOA. The horse power ranges from 5 hp to 250 hp. Due to target catch is shrimp, they normally operate fishing in coastal areas.

Figure 8: Trawlers in the Gulf of Thailand: a) Otter board trawler, b) Pair trawlers, c) and d) Beam trawler.

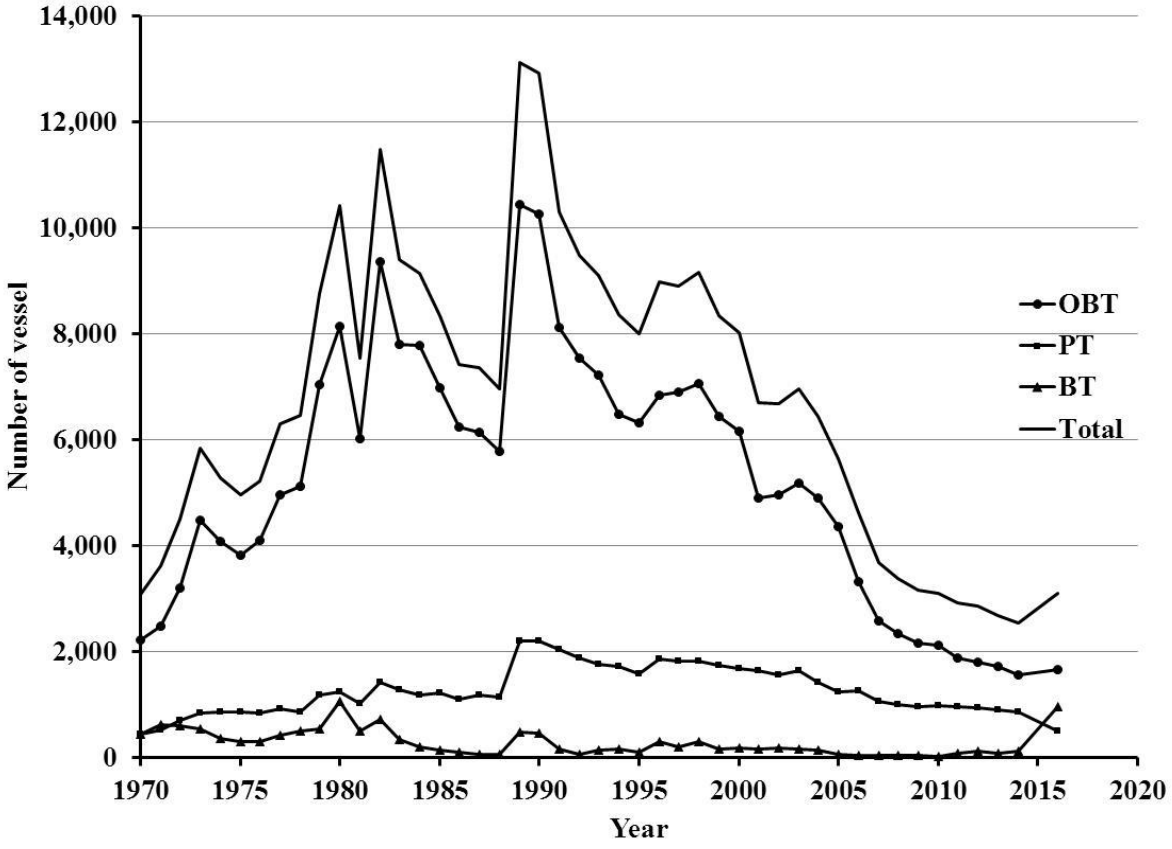
3.1.2. Number of vessels and fishing license

Referring to registered fishing license statistics of the DoF, the number of registered fishing vessels in GoT from 1970-2016 is shown in Appendix 1. The number of trawlers in 1970 was 3,082 and increased to 10,421 in 1980. In 1978, the cabinet had agreed to reduce the number of trawlers and push nets.

As indicated, 2 years later the DoF had implemented the tenure system (or freezing number of fishing gear) since 1st March 1980. Owners of trawler (otter board trawl and pair trawl) have to renew their licenses every fishing year (1st April to 31st March of the following year). If there is no license renewal, the license is terminated automatically. The license is non-transferable except to their descendants. Only one type of gear on a motorized vessel can be registered (pair trawl can have two vessels with one trawling gear). However, the tenure system was temporarily suspended until 23 March 1983. Number of trawlers during 1980 to 1983 increased with a fluctuated number until it reached the highest number in 1982 with 11,475. After 1982 the number of fishing vessels further decreased until 1988 ending in a number of 6,948. In 1989 and 1996, the tenure system was temporarily suspended to revise the license system. For that reason, the number of trawlers increased to 13,111 in 1989 and slowly decreased to 8,885 in 1997 and then increased to 9,161 in 1998. After 1998 the number of fishing vessels further decreased continuously until 2014 it becoming 2,537.

In 2015, the Royal Ordinance on Fisheries B.E. 2558 was enacted on 13th November 2015. One of the objectives of this Royal Ordinance was the use of best available scientific evidence to achieve long-term economic, social and environmental sustainability, in line with the ecosystem based approach and precautionary approach, to ensure that fisheries resources are maintained or restored to a level that can produce the maximum sustainable yield. As indicated, DoF established quota system by using MSY in 2015 as a reference point to manage the number of fishing license. As a result, in 2016 the number of trawlers in the Gulf of Thailand increased to 3,092. Although, total number of trawlers did increase but the number of PT, the highest fishing efficiency, had decreased.

Due to the political intervention, the number of registered trawlers increased in 1980, 1982, 1989 and 1996. In addition, the number of trawlers increased again in 2016 because of the new policy on fishing license registration system based on quota management concept. (Figure 9)

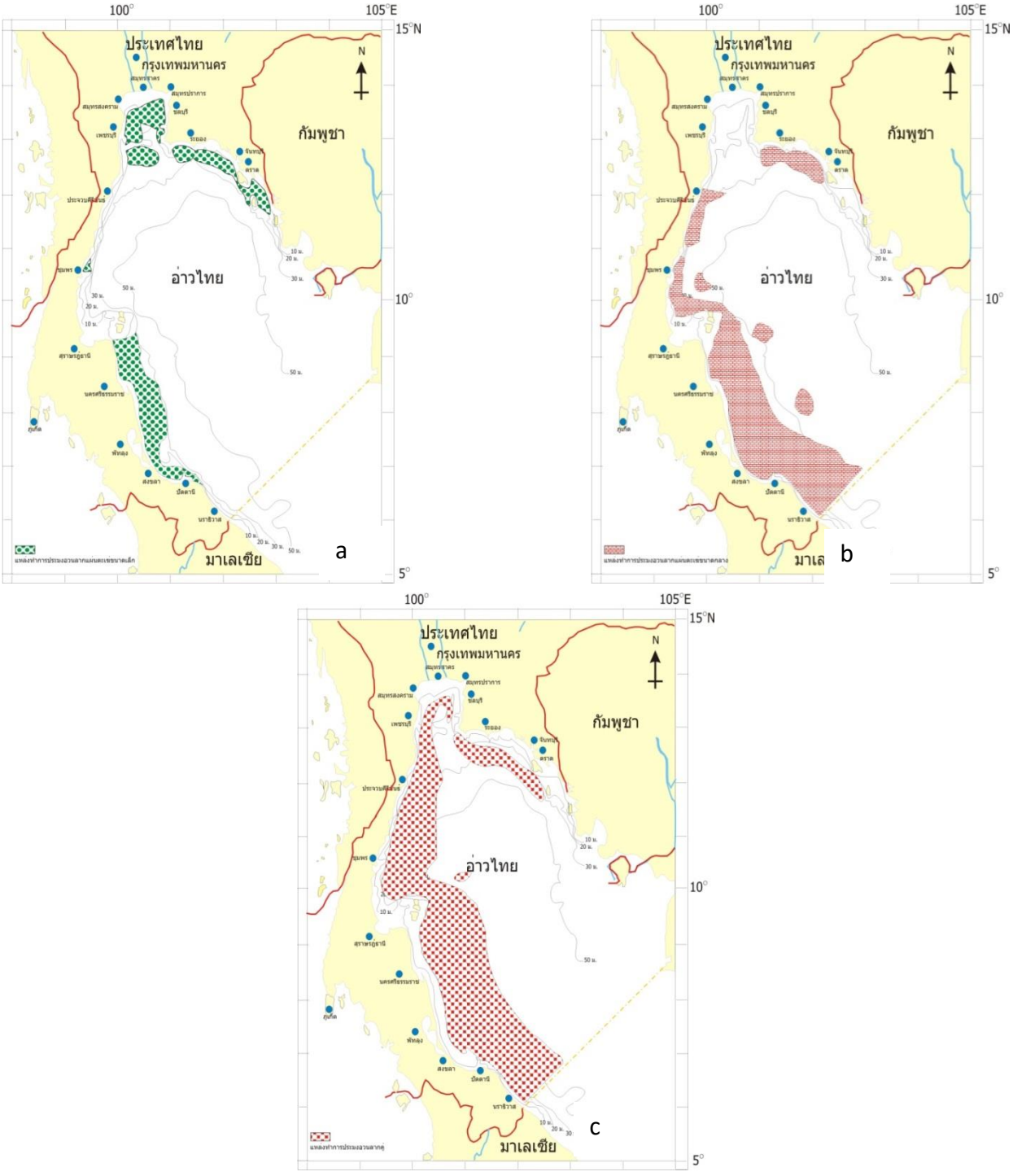


Source: Fisheries statistic of Thailand, DoF, 1970-2015.

Figure 9: Number of registered trawler in the Gulf of Thailand, 1970-2016.

3.2. Fishing Ground

Kongprom *et al*. (2008) studied the fishing grounds of trawler in GoT. The study revealed that OBT1 (small-sized otter board trawl <14 m LOA) operated within 20 m water depth at near shore and OBT2 (medium-sized otter board trawl 14-18 m LOA) operated within 30 m water depth at coastal zone. Pair trawlers (PT) operated in deeper water up to 50 m depth (Figure 10).



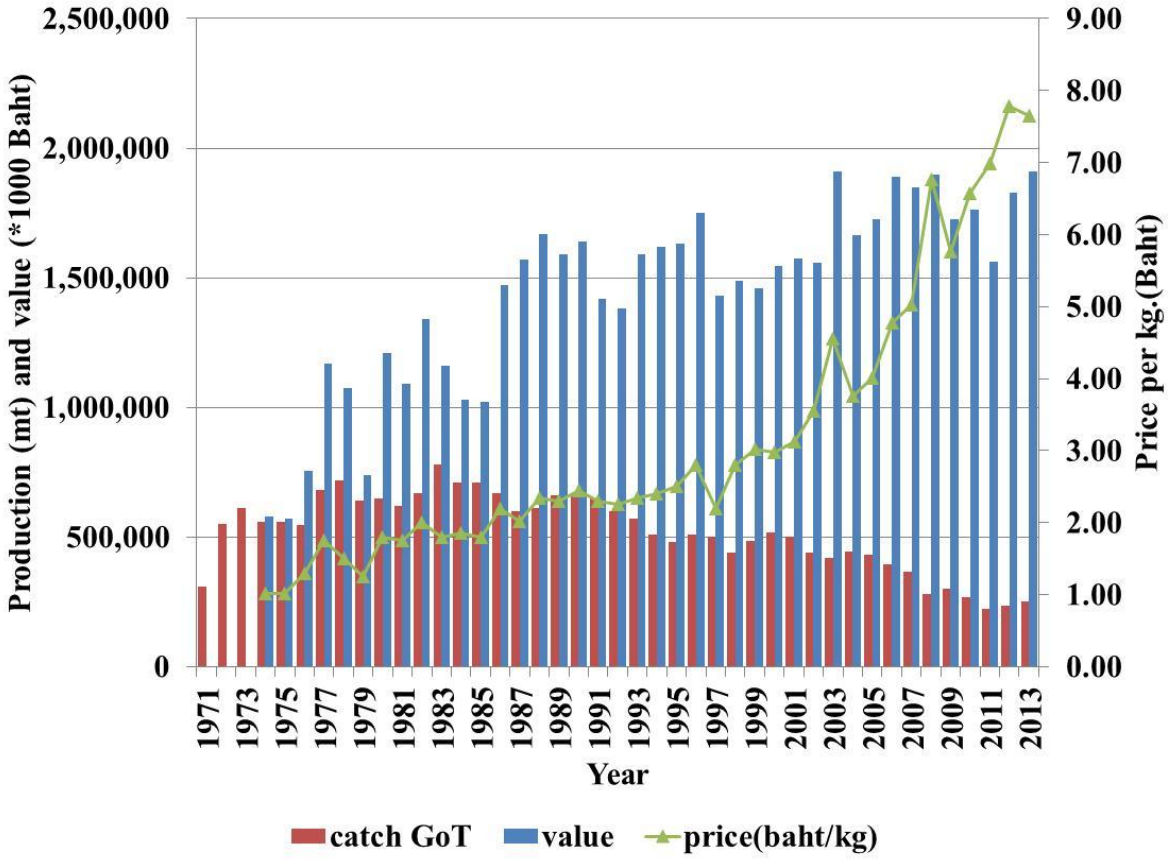
Source: Kongprom et al. (2008).

Figure 10: Fishing ground of trawler in the Gulf of Thailand. (a) small size OBT (<14 m of LOA), (b) medium size OBT (14-18 m of LOA) and (c) PT.

3.3. Production of low value / trash fish captured

Figure 11 shows production, value and price per kg of trash fish in Thailand from 1971 to 2013. The trash fish production reached a peak in 1983. After that, it showed gradual decrease due to over fishing for both economic juvenile and true trash fish stocks. The value of trash fish fluctuated but was increasing due to rise in the price per kg. All of trash fish production in Thailand is processed for consumption and fishmeal and some part used directly for fish culture feeding and animal feeding. The quantity of raw material used for fish meal production comprised of trash fish, other food fish (low value) and fish left from processing plants. Table 3 also shows the total fish meal production and number of fish meal plants from the years 1987 to 2013. In 2013 the fish meal plants have decreased to 74 plants.

Trash fish production from trawlers in GoT during 1971 to 2013 showed highest peak at 774,874 t in 1990 then declined to 198,136 t in 2013 (Figure 12). The decrease of trash fish production might be at least partly a result of the improvement of conservation and management schemes enforced, such as gear restrictions, and area and seasonal closures.



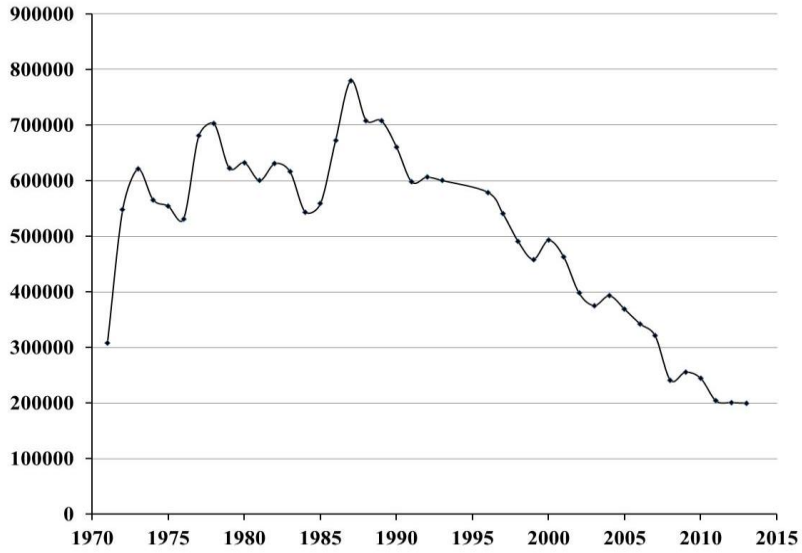
Source: Fisheries statistic of Thailand, DoF, 1971-2013

Figure 11: Landing and value of trash fish in the Gulf of Thailand, 1971-2013.

Table 3: Trash fish used in fish meal production, whole country 1987-2013.

Year	No. of plants	Marine fish disposed in fish meal production (tonnes)				Total fish meal production
		Total	Trash fish	Remained from fish processing	Other fish	
1987	95	894,516	838,184		56,332	212,980
1988	96	943,780	888,774		55,006	236,892
1989	98	1,071,025	1,012,708		58,317	268,524
1990	104	1,087,025	1,022,106		64,919	285,042
1991	98	1,115,298	1,029,852		85,446	279,949
1992	106	1,389,521	1,295,104		94,417	348,624
1993	115	1,374,683	1,304,249		70,434	344,599
1994	118	1,555,221	1,473,138		82,083	389,885
1995	122	1,796,673	1,749,608		47,065	449,788
1996	118	1,697,918	1,652,688		45,230	425,075
1997	111	1,515,757	799,814	670,187	45,756	378,940
1998	97	1,323,887	758,465	511,581	53,841	342,438
1999	98	1,202,283	755,832	388,987	57,464	309,248
2000	96	1,147,091	725,489	358,927	62,675	299,073
2001	93	1,437,731	722,109	659,259	56,363	378,352
2002	93	1,507,644	679,640	768,096	59,908	391,582
2003	100	1,529,028	695,999	769,361	63,668	392,312
2004	95	1,555,950	771,723	671,641	112,586	423,866
2005	99	1,554,541	754,416	731,699	68,426	414,505
2006	96	1,405,302	672,679	670,515	62,108	372,029
2007	96	1,312,266	583,076	670,537	58,653	354,663
2008	90	1,249,850	442,648	737,716	69,486	328,117
2009	88	1,314,915	468,807	742,351	103,757	337,158
2010	87	1,294,065	418,990	730,165	144,910	332,664
2011	86	1,287,709	355,813	783,824	148,072	327,666
2012	76	1,200,327	321,732	623,675	254,920	312,585
2013	74	1,083,325	323,632	525,753	233,940	282,115

Remark: the quantity of trash fish between1987-1996 included the fish remained from fish processing industry. Source: Fisheries statistic of Thailand, DoF, 1987-2013



Source: Fisheries statistics of Thailand, DoF, 1971-2013

Figure 12: Trash fish production caught by trawlers in the Gulf of Thailand, 1971-2013.

3.4. Composition of "trash fish" in the Gulf of Thailand

Khemakorn *et al*. (2005) reviewed fish species in trash fish component which consisted of juvenile economic fish and true trash fish as shown in Table 4. The economic juvenile fish that appear in the Table with high percentage are demersal fish (Mullidae, Synodontidae, Nemipteridae, Priacanthidae, Sphyraenidae); pelagic fish (Engraulidae, Carangidae, Scombridae) and invertebrate group (Crab trash, Penaeidae, Sepiidae and Loliginidae). These species should be reduced from the trash fish capture.

Table 4: Species groups composition of trash fish from marine fisheries capture in the Gulf of Thailand. Source: Khemakorn et al. (2005).

Family	% in trash fish	Family	% in trash fish
Leiognathidae	25.1	Scombridae	1.2
Misc. trash	7.4	Stomatopoda	1.1
Engraulidae	7.2	Callionymidae	0.9
Mullidae	5.7	Scorpaenidae	0.8
Synodontidae	5.0	Gobiidae	0.7
Apogonidae	4.5	Soleidae	0.3
Crab trash	4.4	Blenniidae	0.2
Bothidae	3.9	Sphyraenidae	0.2
Carangidae	3.6	Dasyatidae	0.2
Balistidae	3.2	Misc. other	0.2
Tetraodontidae	3.1	Lutjanidae	0.1
Nemipteridae	2.7	Fistulariidae	0.9
Priacanthidae	2.6	Clupeidae	0.9
Penaeidae	1.7	Muraenesocidae	0.7
Platycephalidae	1.6	Siganidae	0.3

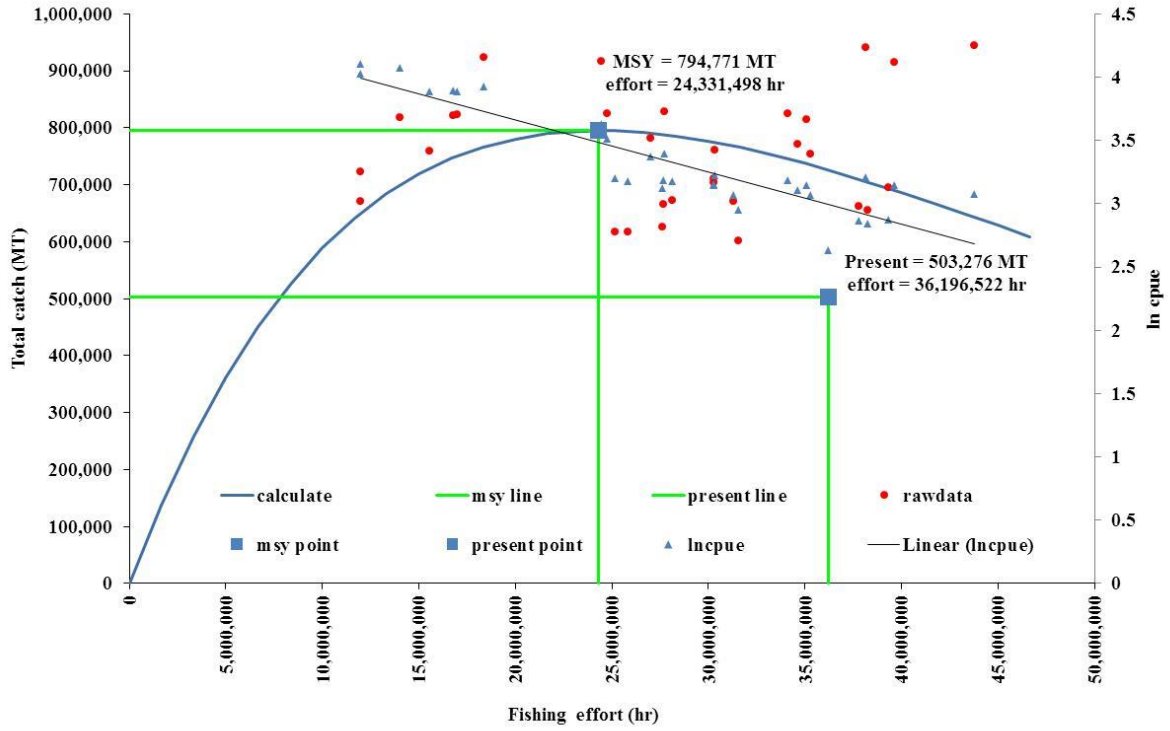
Miscellaneous demersal	1.4	Misc. pelagic	0.3
Sepiidae	1.3	Octopodidae	0.2
Loliginidae	1.3	mollusc	0.2
Sciaenidae	1.3	Synanceiidae	0.2
Cynoglossidae	1.2	Psettodidae	0.1
Trichiuridae	1.1		

4. Demersal marine resource status

The Maximum Sustainable Yield (MSY) is considered to be the biological reference point at which stocks can be harvested without negative effect on resources and in equilibrium with the production of nature in Thai waters. MSY of demersal marine resources of GoT was estimated by using the surplus production model (Fox, 1970). This model requires statistical data and information on catch, CPUE and effort data of all fishing operations, including small-scale fishing gears and large-scale fishing gears. The demersal production statistical data in GoT from DoF from 1971 to 2013 were used for estimation of MSY. In addition, total production of demersal fish in 2014 was added into the estimation. It was estimated based on the fishing vessel survey carried out in June and July 2015.

The total number of fishing vessels used for MSY assessment of demersal resources in GoT was 28,279 vessels, consisting of 4,425 large-scale fishing vessels and 23,754 small-scale fishing vessels. The standard CPUE obtained from research vessel monitoring trawl surveys by DoF has been used to estimate the total standardized effort for MSY estimation. The result shows that the MSY of demersal marine resource is 794,771 t with the optimum fishing effort of 24.33 million hours (Figure 13). The 2014 catch of demersal resource was 503,276 t with fishing effort of 36.20 million hours.

The calculation indicates that the present overall fishing effort is greater than the optimum level by 32.8%, and this issue should therefore be addressed appropriately managed.



Source: Stock assessment working group, MFRDD, DoF, 2015.

Figure 13: The Maximum Sustainable Yield (MSY) assessment of demersal marine resource.

5. The management problems

Trawling often leads to overfishing; this is partly because the gear is not selective but in general the main cause is excessive fishing effort. Overfishing by trawler is a direct threat to local fishing communities and to tourism from sport fishing. The juveniles of valuable species caught by other fishermen are often referred to “trash fish”. DoF has implemented a lot of activities to manage and reduce the impact of trawl fisheries in GoT. Nettasna (in press) studied on management problems related to trawl fisheries in law and regulation point of view. The study had shown that there are 4 gaps and weakness that needed to solved by decision makers as follows:

5.1. Problems of inconsistent policy and the practice of government.

DoF stated that trawler is aimed at capturing demersal fisheries as the main catch and has to be dragged along the sea floor. DoF has noted that such a fishing gear may destroy the aquatic resources and habitat of animals. In addition, Thailand has the tools to manage and control measures on trawlers to solve the problem. But often there is a violation and this is influenced by political intervention by setting up new guidelines and measures.

5.2. Problem of decentralized fisheries management and the participation of the community.

The Fisheries Act B.E. 2490 (1947) did not allow community participation in resource management at all. All the fishermen in the area have the potential to co-manage their own fishery resources and offer greater protection. But groups or community organizations that seek to maintain marine resources had not been supported, and no legal mechanisms adopted. They also allegedly overstepped the duties of citizenship and in some cases it is an offense itself. However, The Royal Ordinance B.E. 2558

(2015) provided legal mechanisms to support fishers under fisheries organization to participate in Provincial Fisheries Committee. The committee shall have the power to issue notifications regarding fishing gears according to their forms, fishing methods, fishing areas, the size of fishing vessels used in fishing operation and other conditions that are prohibited from fishing operations in fishing grounds. In addition, DoF should be strengthened to allow stakeholders to participate in this legal mechanism to get best result.

5.3. Problems of law enforcement, arrests, and legal loopholes.

This is a practical problem with the officials and the annual budget supply is not enough to perform effectively. The number of officials in the field and patrol vessels to inspect and enforce the regulations is too few. There is also a need for more officials in the field, better infrastructure and facilities for enforcement, and delegation of sufficient authority for enforcement of the regulations to the provincial authority, such as an appointed committee for this purpose, rather than only to the provincial fisheries officials.

5.4. Problem of controlling the number of trawl vessels and vessel registration and subrogation of fishing gear registration.

Thailand aims to reduce and cancel fishing trawl and push nets by issuing a long-term measure since B.E. 2523 (1980). In B.E. 2523, the Department of Fisheries announced that it will not issue permits for new trawl fishing vessels as part of its target to reduce the number of trawl vessels in the long run. However, with the movement of the operator and the trawl fisheries at that time, the Department of Fisheries had to allow illegal trawl fishing without registration to be able to register according to law, or called “Amnesty for illegal trawl vessels.” In the past, amnesty for illegal trawl fishing vessels has taken place five times, including in B.E. 2523 (1980), 2524 (1981), 2525 (1982), 2532 (1989) and 2539 (1996).

In addition, the control of fishing vessels is complicated because the DoF lacks comprehensive authority to manage fishing in the waters of Thailand. For example, the Marine Department licenses shipbuilding, and new and used fishing vessels. The Ministry of Industry regulates the manufacturing of nets of various types. Lastly, the Department of Commerce controls rare animal species export. These matters should be fully supervised by the primary agency concerned with fishing, which is the Department of Fisheries.

6. Result of research works and activity in project sites

Two project sites were established to develop fisheries resource management plans under bycatch reduction concept as following.

- Trat Province: Survey and research for the purpose of demarcation of conservation zone for juvenile fish and breeding stocks in the area of Trat Province.
- Prachuap Khiri Khan-Chumphon Provinces: Experiment on enlarging trawl cod-end mesh size in the areas of Prachuap Khiri Khan and Chumphon Provinces.

6.1. Trat Province

6.1.1. Overview of the project site

Under REBYC-II CTI, Department of Fisheries conducted the project in the area of Trat Province. The project aimed at demarcation of conservation zone to reduce bycatch from trawl fisheries and to expand the management/conservation zone to cover critical areas of juvenile and breeding stock of marine resources in the project site. This activity was performed by the Eastern Marine Fisheries Research and Development Center (EMDEC) in Rayong Province. The project was implemented under

participatory fisheries management concept as specified in Royal Ordinance on Fisheries B.E. 2558 (2015) to formulate proposed action plan as follows:

1. Review existing data, collect new data, and analyze the information such as fishery resource status, socio-economic and fish larvae distribution, including local knowledge, to formulate proposed action plan.
2. Provide information for fisheries management plan in Consultation meeting.
3. Public hearing with fishers and other stakeholders.
4. Propose agreed management plan to the Provincial Fisheries Committee.
5. Propose approved management plan to the DoF.
6. DoF further submit the plan to the Minister of Agriculture and Co-operatives to issue the Ministerial Notification.
7. Announcement in the Royal Gazette, to become effective.
8. Awareness campaign for the new fisheries management measures, through seminars meeting and media.

Trat Province is located in the eastern part of GoT bordered by Kingdom of Cambodia and Chanthaburi Province. The land area is 2,819 km^2, sea area is 7,257 km^2 with 165.5 km of coastline. There are seven districts with five seaside districts and 52 islands governed by Trat Province (Figure 14). The southern Trat is close to Gulf of Thailand and Cambodian waters.

There are several rivers running into the sea at Trat such as Trat River and Welu River. Those rivers bring lots of nutrients to the sea and Trat water becomes one of the high productivity areas in the Gulf of Thailand. Furthermore, mangrove forests can be found along the coast of Trat with area approximately 99 km^2. In addition, coral reefs exist throughout the group of islands covering an area of 28 km^2. Sea grass beds also exist in coastal area of Trat along coastline of Khlong Yai district covering about 7 km^2. They benefit the aquatic animals for taking refuge and are used as breeding and nursing grounds of number of aquatic species. (DMCR: Central Database System and Data Standard for Marine and Coastal Resources Website, 2015)

The gross provincial product (GPP) of Trat province in 2009 was 18,550 million Baht including 9,022 million Baht from agricultural sector. Fisheries sub-sector contributed about one half of agricultural sector GPP (4,250 million Baht). Capture fisheries made up one third of fisheries sub-sector GPP while fish culture sums up to the remaining. The GPP from capture fisheries had grown up swiftly from 2003-2007 from 1,176 to 1,517 million Baht. After 2007, however, its GPP share lessened slightly. The last report in 2009 showed that it was 1,431 million Baht (www.trat.go.th).

Although GPP gained from non-agricultural sector reached 51% of Trat total GPP in 2009, industrial sub-sector made up only 4% of the province GPP. This indicates that Trat is not an industrial province. As a result, marine fishing ground can be maintained in good quality as it is not affected by chemical pollutants from the factories.

Source: http://th.wikipedia.org/wiki/Trat_Province

Figure 14: Trat Province with the districts (Amphoe) numbered: 1) Mueang Trat, 2) Khlong Yai, 3) Khao Saming, 4) Bo Rai, 5) Laem Ngop, 6) Ko Kut, and 7) Ko Chang.

Intercensal Survey of Marine Fishery on number of fishers and fishery establishments in Thailand was held on 2000 by NSO. In Trat Province, the number of marine capture fishery establishments was added up to 2,959 establishments making up 8.13% of the establishments along the Gulf of Thailand whereas the number of fishers during peak season was counted to 6,389 fishers calculated to 5.30% of the fishers along the Gulf of Thailand (Table 5).

The study on baseline socio-economic by Jumnongsong (in press) showed that the number of fishing vessels in Trat Province in 2000 was 2,729 (4.7% of total number of fishing vessels in Thailand) (Table 6). The DoF recorded the numbers of fishing vessels in Trat in 2011 via the 2011 Fishing Vessel Survey Website by MFRDB (2016), and these data are presented in Figure 15. The total number of fishing vessels in Trat in 2011 was 3,204 which can be grouped into 11 types of fishing vessels. Gillnetter was the most common type of fishing vessel in Trat (1,473 vessels corresponding to 46% of total number of fishing vessels in Trat), followed by fishing trap (583 vessels or 18%), and longline & handline group (276 vessels or 9%). There were 200 trawlers (6%) and 112 push net vessels (4%) in Trat. The number of fishing vessels increased by about 17% between 2000 and 2011, from 2,729 (DoF, 2013) to 3,204 (MFRDB, 2016).

Table 5: Numbers of fishery households in Trat Province.

	District	Sub-district	Small scale		Medium-Large scale	
			Numbers	% (n=2202)	Numbers	% (n=131)
1	Mueang Trat	Nhong Samet	42	1.91	0	-
		Nhong Sano	7	0.32	0	-
		Nhong Khansong	130	5.90	0	-
		Houng Nam Khao	140	6.36	0	-
		Ao Yai	310	14.08	0	-
		Wang Kra Jae	99	4.50	120	91.60
		Ta Kang	28	1.27	0	-
		Cham Rak	8	0.36	0	-
		Laem Klad	147	6.68	0	-
	Total		911	41.37	120	91.60
2	Klong Yai	Klong Yai	284	12.90	0	-
		Mai Root	303	13.76	0	-
	Total		587	26.66	0	-
3	Khao Saming	Saen Toong	59	2.68	0	-
		Tha Some	139	6.31	0	-
	Total		198	8.99	0	-
4	Laem Ngop	Laem Ngop	38	1.73	1	0.76
		Bang Pid	142	6.45	3	2.29
		Klong Yai	70	3.18	7	5.34
	Total		250	11.35	11	8.40
5	Ko Kut	Ko Mak	28	1.27	0	-
		Ko Kut	60	2.72	0	-
	Total		88	4.00	0	-
6	Ko Chang	Ko Chang	59	2.68	0	-
		Ko Chang Tai	109	4.95	0	-
	Total		168	7.63	0	-
Total	6 Districts	20 Sub-districts	2202	100.00	131	100.00

Source: CDD, 2013 and DoF, 2013

Table 6: Excerpts of the 2000 Intercensal Survey of Marine Fishery by NSO: Number of fishery households, fishing vessels and fishermen during peak season in Trat, Coastal Zone 1, and Thailand

		Trat	Coastal Zone 1	Total
No. of fishery households		2,959	6,351	57,801
No. of fishing vessels	Total	2,729	6,200	58,119
	Non-powered vessel	12	60	2,639
	Outboard powered vessel	1,377	3,296	42,217
	Inboard powered vessel	1,340	2,844	13,263
No. of fishers during peak season	Total	6,389	14,267	168,140
	Family member	3,842	8,402	80,857
	Employee	2,547	5,865	87,283

Source: DoF, 2013

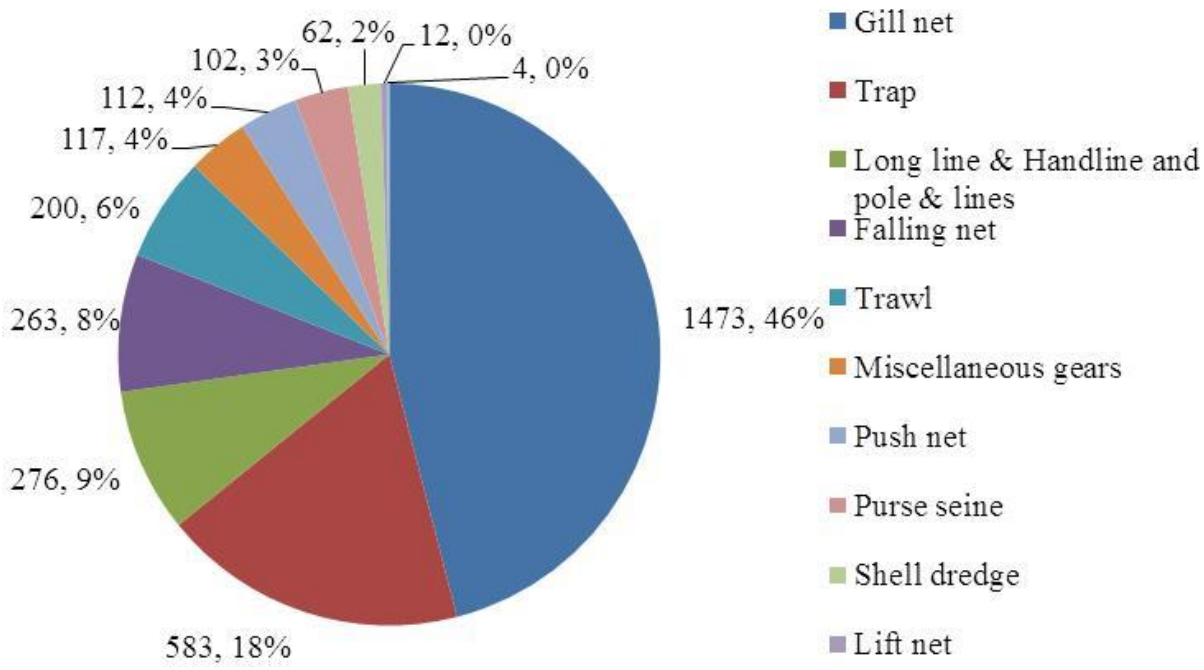


Figure 15: Types of fishing vessels in Trat Province in 2011. Source: MFRDB website (2016). http://www.platalay.com/boatsurvey2554/prvsearch.php

6.1.2. Landing places in Trat Province

There are three main landing sites in Trat Province in Mueang Trat, Klong Yai, and Laem Ngop districts. Total marine fish recorded by landing sites in quantity (t) and value (1,000 Baht) between 2006 and 2011 are presented in Figure 16 and Figure 17. The total quantity and value of marine fish were taken from a variety of fishing gears landed at main landing sites. In the period between 2006 and 2011, the quantity and value of marine fish recorded at landing place in Klong Yai was higher than the other two sites (31,460-36,180 t compared to 10,263-25,894 t, and 345-582 million Baht compared to 155-327 million Baht).

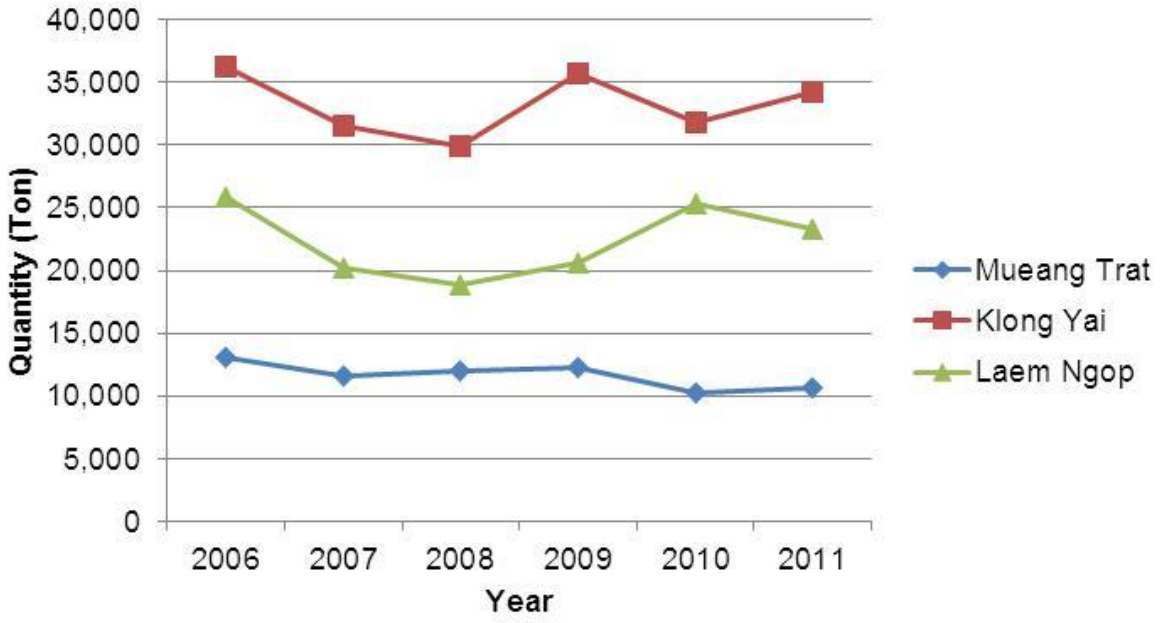


Figure 16: Total landing in quantity (tonnes) of marine fish by landing place in Trat Province (2006-2011). Source: DoF, 2013.

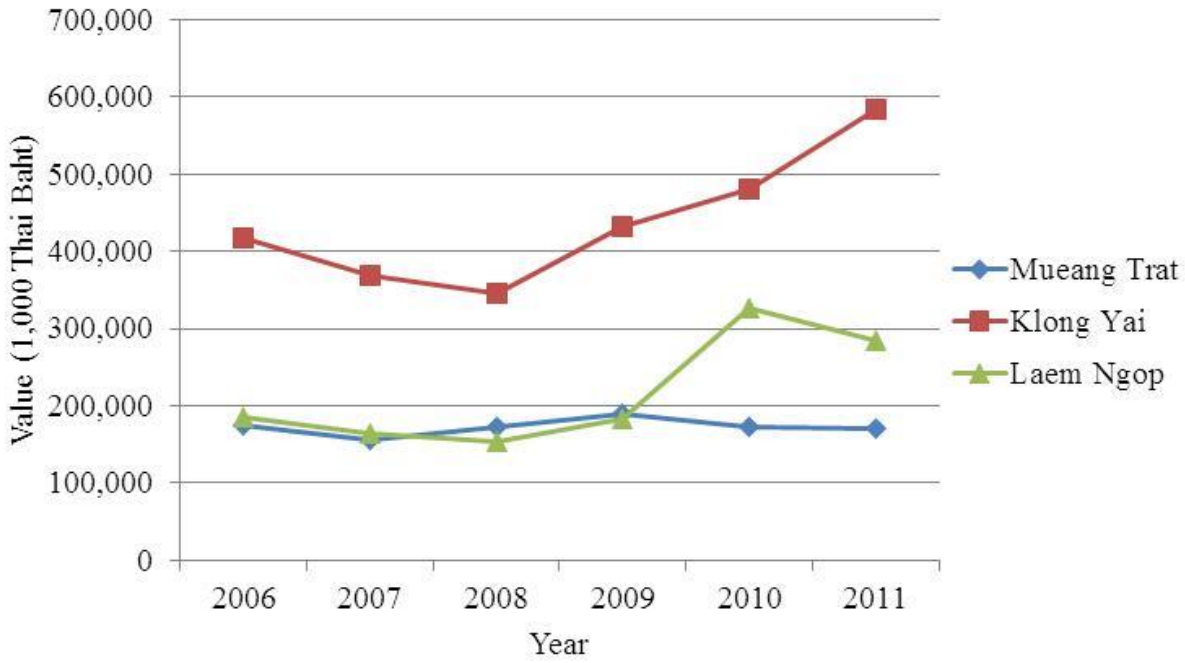


Figure 17: Total landing in value (1,000 Baht) of marine fish by landing place in Trat Province (2006-2011). Source: DoF, 2013.

6.1.3. Fisheries resources

The surveys of the study on "Fisheries Resources in Trat Province, Thailand" had been carried out during January to December 2014 (Noranarttragoon, 2016a). Catch Data and fishery information from commercial fishing vessels, i.e., Thai purse seine (TPS), light luring purse seine (LPS), anchovy purse seine (APS), anchovy falling net (AFN) and otter board trawl (OBT) were collected at fishing ports in

three districts in Trat province, i.e., Mueang District, Laem Ngop District and Khlong Yai District. The data from fishing vessels operated in Trat province were selected to analyze while the data from fishing vessels landed at fishing ports in Trat province but excluded their fishing grounds outside Trat province.

It was found that the CPUE of TPS, LPS, APS and AFN were 3,825, 5,859, 2,949 and 685 kg/day, respectively. Short mackerel and goldstripe sardinella were the highest composition of TPS and LPS while anchovies were the main composition of APS and AFN. In addition the CPUE of OBT was 23 kg/h of which 64% was food fish and 36% was trash fish. For the total food fish, Threadfin breams were the major composition (7.95%). In trash fish group, juvenile of economic fish accounted for 40% whereas the remaining 60% was true trash fish. Among the true trash fish, Ponyfishes were the highest composition (47%) of which 10% was splendid ponyfish which are regarded as food fish in present.

Noranarttragoon (2014) reported that the CPUE of TPS in the area of catch statistical data: Trat, Chantaburi and Rayong Province, was 4,169 kg/day. Indian mackerel, short mackerel and yellowtail scad were the main composition of TPS that made up more than half of catch composition. And the CPUE of OBT1 and OBT2 were 12.45 and 11.39 kg/h, respectively. The ratio of economic fish and trash fish was 69:31 and 71:29, respectively. However, a large amount of true trash fish remained in the composition, 71% of OBT1 and OBT2's composition.

The results of CPUE illustrated the CPUE in Trat waters were extremely higher than the average CPUE in the Gulf of Thailand (Table 7). Although, the comparison of AFN's CPUE was vague due to different pattern of data analysis, CPUE of small AFN in Trat was much higher than in the Gulf of Thailand but of large AFN was less than average. These indicated that Trat waters is one of the high productive areas in the Gulf of Thailand.

Table 7: Comparison on CPUE of different fishing gear in this study (Trat Province) and previous study (Gulf of Thailand).

Gear	CPUE		Reference
	This study (Trat Province)	Previous study (Gulf of Thailand)	
TPS	3,824.912 kg/day	2,353.926 kg/day (2007)	Thongsila *et al*., 2012
LPS	5,858.824 kg/day	2,298,274 kg/day (2007)	Thongsila *et al*., 2012
APS	2,949.048 kg/day	2,521.70 kg/day (2008)	Sinanun *et al*., 2012
AFN	684.752 [1] kg/day	499.46 kg/day [2] (2008)	Sinanun *et al*., 2012
		1,327.41 kg/day [3] (2008)	Sinanun *et al*., 2012
OBT	23.726 kg/hour	23.642 kg/hour (2003-2005)	Kongprom *et al*., 2007

Remark: [1] CPUE of all sizes AFN

[2] CPUE of small-sized AFN (vessel overall length less than 14 m)

[3] CPUE of large-sized AFN (vessel overall length more than 14 m)

Years in parenthesis are data collection year.

Thirteen species were selected to present the current status of fisheries resources by comparing between mean length and size at first maturity (Table 8). The mean length of three pelagic species, namely Indian scad, shorthead anchovy and goldstripe sardinella, were larger than their size at first maturity while other ten economic species, including four pelagic species, two demersal species, two squid and cuttlefish species and two shrimp species, were smaller than their size at first maturity.

As a consequence of the large amount of small-sized fish caught, this results to decreasing proportion of older fish in the catch together with high CPUE of high efficient commercial fishing gear, therefore

effective management measures are urgently needed in order to prevent recruitment overfishing which may otherwise lead to decline of fisheries resources. Even though there are some fisheries management measures currently implemented in Trat waters, they do not cover all commercial fishing gears. Therefore, the prohibition of high efficient fishing gears in some season and area is a potential measure, particularly in the coastal area of Trat Province, to safeguard fisheries resources and use resources in a sustainable manner.

Table 8: Mean length of some economically important species caught in Trat Province in 2014 and female size at first maturity compiled from available technical papers.

Common name	Scientific name	Range (cm)	Mean (cm)	Female size at first maturity (cm)	Sources
Yellowtail scad	*Atule mate*	7.75 – 27.75	14.74 ± 0.06	21.25	Premkit *et al*., 2004
Indian scad	*Decapterus russelli*	4.25 – 22.75	13.45 ± 0.08	13.19	Husadee *et al*., 2015
Shorthead anchovy	*Encrasicholina heteroloba*	2.50 – 9.00	6.52 ± 0.001	6.44	Yakoh *et al*., 2014
Torpedo scad	*Megalaspis cordyla*	8.75 – 32.75	15.39 ± 0.10	21.55	Songkaew *et al*., 2009
Short mackerel	*Rastrelliger brachysoma*	4.75 – 22.25	15.46 ± 0.03	17.95	Krajangdara *et al*., 2007
Goldstripe sardinella	*Sardinella gibbosa*	2.25 – 20.75	12.27 ± 0.01	10.35	Nasuchon *et al*., 2010
Yellowstripe scad	*Selaroides leptolepis*	2.25 – 16.25	8.65 ± 0.04	11.73	Yakoh and Chalee, 2008
Purple-spotted bigeye	*Priacanthus tayenus*	1.75 – 18.75	6.99 ± 0.12	14.19	Krajangdara and Yakoh, 2005
Lattice monocle bream	*Scolopsis taeniopterus*	6.75 – 22.75	11.11 ± 0.28	17.57	Krajangdara and Hettanon, 2000
Indian squid	*Photololigo duvaucelii*	2.75 – 24.25	7.46 ± 0.15	9.04	Suppanirun *et al*., 2011
Needle cuttlefish	*Sepia aculeata*	3.25 – 13.75	8.69 ± 0.41	9.44	Charoensombat *et al*., 2013
Jinga shrimp	*Metapenaeus affinis*	5.25 – 14.75	10.32 ± 0.05	12.18	Sritakon *et al*., 2012
Banana prawn	*Penaeus merguiensis*	8.75 – 20.25	12.63 ± 0.09	13.38	Yakoh *et al*., 2013

6.1.4. Fish larvae and distribution

The study on "Biodiversity, abundance and distribution of fish larvae in Ao Trat" was carried out during the period March 2014 to January 2015 in Ao Trat and Chang Strait, Trat Province (Apichart, 2015). The specimens were collected from 9 stations in 6 periods of study time.

- 1st in March 2014 was a representative of summer.
- 2nd in May 2014 was a representative of rainy season.
- 3rd in July 2014 was a representative of rainy season.
- 4th in September 2014 was a representative of rainy season.
- 5th in November 2014 was a representative of winter.
- 6th in January 2015 was a representative of winter.

The result of fish larvae species identification showed that 7 orders 31 families 35 genera (1 sample could not be identified because of damage). The most frequent species is Carangidae, found 5 genera and the other 1 or 2 species in family (Table 9).

Table 9: Species composition of fish larvae at Ao Trat and Chang Strait between March 2014 and January 2015.

Order		Family			Genus/Species	
1	Clupeiformes	1	Anchovies	Engraulidae	1	*Stolephorus* spp.
		2	Sardine	Clupeidae	2	*Sardinella* spp.
2	Gadiformes	3	Codlet	Bregmacerotidae	3	*Bregmaceros* spp.
3	Atheriniformes	4	Silversides	Atherinidae	4	*Atherina* spp.
4	Scorpaeniformes	5	Scorpion fish	Scorpaenidae	5	*Scorpaenoides* spp.
		6	Velvetfish	Synanceiidae	6	*Minous* spp.
		7	Flatheads	Platycephalidae	7	*Platycephalus* spp.
5	Perciformes	8	Lates perches	Latidae	8	*Lates* spp.
		9	Cardinalfish	Apogonidae	9	*Apogon* spp.
					10	*Cheilodipterus* spp.
		10	Triple tail	Lobotidae	11	*Lobotes* spp. *Lobotes surinamensis*
		11	Threadfin breams	Nemipteridae	12	*Nemipterus* spp.
		12	Croaker	Sciaenidae	13	*Sciaena* spp.
		13	Sickle fish	Drepaneidae	14	*Drepane* spp.
		14	Anemone fishes	Pomacentridae	15	*Amphiprion* spp.
		15	Tigerperch	Terapontidae	16	*Terapon* spp.
		16	Bigeyes	Priacanthidae	17	*Priacanthus* spp.
		17	Blenny	Blenniidae	18	*Omobranchus* spp.
		18	Rabbitfish	Siganidae	19	*Siganus* spp.
		19	Grouper	Serranidae	20	*Serranus* spp.
		20	Sillago	Sillaginidae	21	*Sillago* spp.
		21	Trevally	Carangidae	22	*Caranx* spp.
					23	*Gnathanodon speciosus*
					24	*Scomberoides* spp.
					25	*Selar spp.*
					26	*Trachinotus* spp.
		22	Ponyfish	Leiognathidae	27	*Leiognathus* spp.
		23	Mojarra	Gerreidae	28	*Gerres* spp.
		24	Goatfish	Mullidae	29	*Upeneus* spp.
		25	Dragonet	Callionymidae	30	*Callionymus* spp.
		26	Goby	Gobiidae		
		27	Barracuda	Sphyraenidae	31	*Sphyraena* spp.

6	Pleuronectiformes	28	Lefteye flounders	Bothidae	32	*Bothus* spp.
		29	Tonguefish	Cynoglossidae	33	*Cynoglossus* spp.
7	Tetraodontiformes	30	Filefish	Monacanthidae	34	*Aluterus* spp.
		31	Puffer	Tetraodontidae	35	*Tetraodon* spp.

The amount of fish larvae was 1,377 individuals or 8,133 individuals per 1,000 cubic meters which showed the dominance of Gobiidae, Carangidae and Clupeidae that were 37, 21 and 20 individuals/1,000 cubic meters. The result showed that the density of fish larvae depend on the monsoon season or breeding and spawning season, the northeast monsoon season in March is the most abundant fish larvae season.

In order to analyze and compare the ecology index of fish larvae in sampling period, Species richness, Evenness index, Diversity index, Cluster analysis and Ordination multi-dimension scaling (MDS) were used.

Species richness index indicated that by the period, the maximum value was in March 2014 and 6th station was the maximum value by the station.

Evenness index characterized that by the period, the maximum value was in July 2014 and by the station, 4th station was the maximum value.

Diversity index characterized that by the period, the maximum value was in July 2014 and 6th and 9th stations were the maximum value by the station.

Comparing the similarity and level of composition and amount of fish larvae species in sampling station by Cluster analysis and MDS indicated that by the period and sampling station, fish larvae population do not show statistically significant difference (p-value <0.05).

The fish larvae distribution pattern showed that commercial fish larvae were in highest abundance at zone 1 and zone 2 in March 2014. True trash fish was in highest abundance at zone 1 and zone 2 in March 2014 and at zone 2 in September 2014. (Figure 18 and Figure 19).

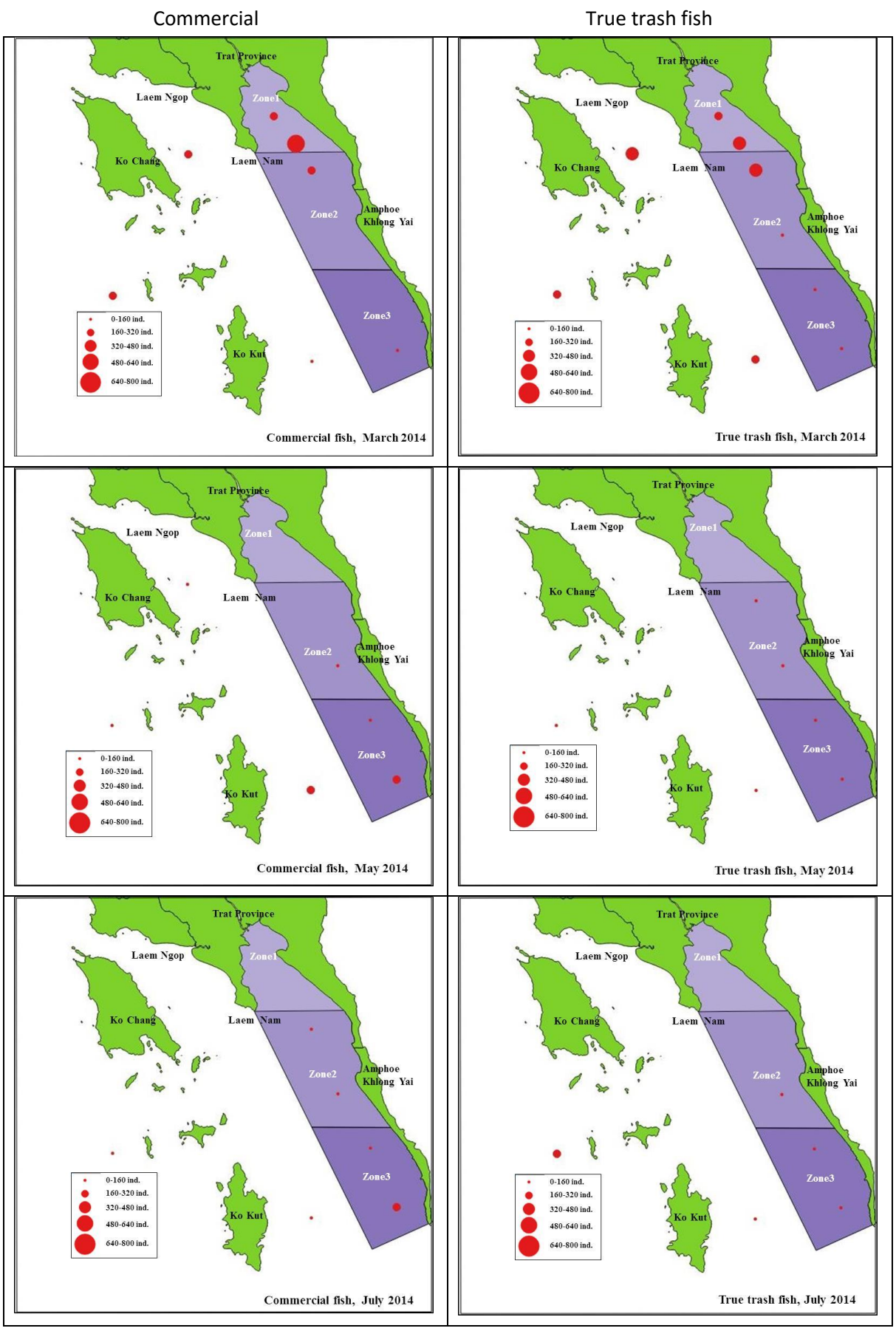


Figure 18: Distribution pattern of total commercial and trash fish larvae in Trat Province March, May and July 2014.

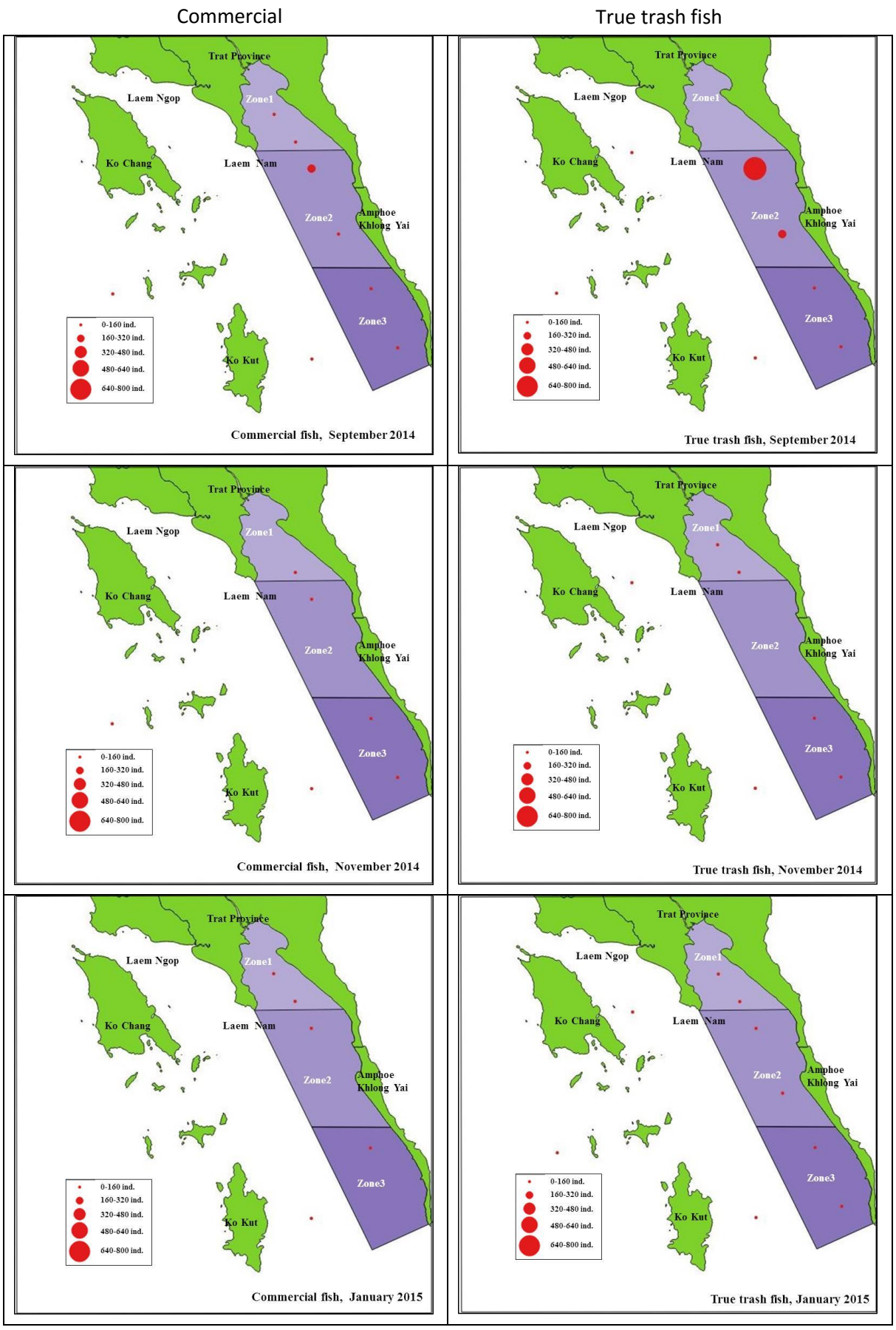


Figure 19: Distribution pattern of total commercial and trash fish larvae in Trat Province September, November 2014 and January 2015.

6.1.5. The socio-economic conditions of fisheries

The study was carried out to investigate the "Socio-Economic Status of Fishers in Trat Province, Thailand". The specific objective of this study was to clarify existing socio-economic conditions of small-scale and commercial fishers in Trat Province, Thailand.

Existing socio-economic data on small-scale and commercial fishers in Trat Province was collected and collated from the DoF, at central and local offices, statistical records and from other relevant agencies. Socio-economic data included the number of fishers and fishing vessels, landing sites, fish prices, and related socio-economic data.

The survey on socio-economic study of small-scale, medium-scale and commercial-scale fisheries in Trat Province was carried out in 6 districts: Mueang Trat, Klong Yai Khao Saming, Laem Ngop, Ko Kut and Ko Chang by questionnaire and interviewing. The interview schedule included four sections: 1) general background information on the respondents; 2) fishing activities, catch, income, and cost of fishing in the previous year; 3) respondent's perceptions of fisheries resources conditions, threats, laws and regulations and participation in decision making, and their perspective on fishing in the future; and 4) measures and options for fisheries management in Trat. The interviews were conducted by officers of EMDEC during September to November 2014. Data from questionnaire was analysed and the results used as supplementary information to support the implementation of REBYC-II CTI Project.

The results from this study were concluded as shown in the following.

- The number of fishery households decreased between 2000 and 2013 (from 2,959 in 2000 (DoF, 2013) to 2,333 in 2013 (CDD, 2013) while the number of fishing vessels increased between 2000 and 2011 (from 2,729 in 2000 (DoF, 2013) to 3,204 in 2011 (MFRDB, 2016). The data from these reviews are contradictory. Fishery resources are still under pressure from an increasing number of fishing vessels despite a reduction in the number of fishery households.
- The respondents represent the fishers in 21 sub-districts of the 6 coastal districts in Trat. Most of them were from Mueang Trat District (44%) and Klong Yai District (23.6%). The results show that 86% of respondents were vessel owners who do fishing by themselves, which increased the reliability of the data used for analysis in this study. The respondents are likely to have good knowledge of fishing activities in their province given their responsibilities.
- In general, most of respondents were men, Buddhist, and had completed primary school. The average age of respondents was 47. The government should use this demographic information of fishermen in Trat as a criterion for designing projects for additional employment for fishing communities in Trat. The study considered differences in fishing activities, income, and cost, and other major differences between small-scale fishery households and medium to large-scale fishing households. Main fishing gears used, main fishing zones, and incomes (before deducting cost) were different for the two groups of respondents. The main fishing gears used by small-scale households were shrimp trammel nets, crab gillnets, and crab traps while for medium to large-scale households, push nets, trawls, and purse seines were more common. The Fishing grounds of small-scale households were close to the shore (zone 4, 1, 3, and 5, respectively) while medium-large-scale households had their fishing grounds further from the shore (zones 7 and 6, respectively). Incomes before deducting the cost of fishing were higher for medium to large-scale households than for small-scale fishers, by a factor of 7 times (1,000 and 7,000 Baht per day). To demarcate fishery conservation zone, there is a need to consider these fishing grounds. While banning fishing gears, in particular the main fishing gears, the possible impact of such bans on the two groups should be considered carefully. Loss of income during closed season would result in negative impacts to the livelihoods of fisheries households.

- The levels of fishing activities of small-scale and medium to large-scale households were similar, around 19 days per month and 11 months per year. Most of the respondents (68%) had a single occupation, which was fishing. When the government introduces measures that might impact on fishing activities, they should prepare alternative livelihoods, compensation or any mitigation measures that can reduce the impacts of proposed measures on local communities.
- Nearly 60% of the respondents were moderately satisfied with the benefits from fishing in the study area. These responses are consistent with the question about the future of their fishing. Most of the respondents (84%) said that they could continue with their current fishing activities. This suggests that fishing in the study area still provides benefits to the local community.
- Fishers perceive the condition of local fisheries resources not to be good with the main threats being illegal fishing and the increase in numbers of fishers and fishing gears. It is important to demarcate conservation zones for juvenile fish and fishery stock, in addition to measures that prevent the impacts of these threats and both should be integrated, implemented and strengthened.
- Fishers should be provided with knowledge and awareness about fisheries laws and regulations. Some of the fishers are not aware or do not know about the fishery laws and regulations (21% of small-scale respondents and 8% of medium to large-scale fishing respondents).
- The issues on law compliance, enforcement and participation in decision-making should be improved in order to maintain management scheme of fisheries in Trat.
- Awareness-raising campaigns should be undertaken to encourage fishers to join fisheries management groups. Membership will provide benefits such as receiving and exchanging fisheries information among the members and between the government agencies. About 62% of small-scale respondents do not participate in any groups at present.
- There were similar responses between the small-scale fishery households and medium to large-scale fishery households for fishery management options no. 1-3 and 8–14 while the options no. 4 – 7 were perceived differently (please see Appendix II). Option no. 1 (no fishing in zone 1-3 permanently) and option no. 3 (no fishing in zone 1 and 2 permanently) were disagreed or strongly disagreed by most respondents of the two groups. The implementation of these two management options is likely to be difficult for DoF. It could be also challenging to implement option no. 4 – 7 (seasonal closure of fishing in the different zones or gear restrictions in certain seasons) because of differences in perceptions of the two groups, which could lead to the conflict between small-scale fishery households and medium to large-scale fishery households. The points that both the small scale, medium and large scale fishers agree in general are promotion of dolphin watching tourism, public campaign for no take zone for fish larvae, reserved spawning and feeding area for sea turtle, reserving existing areas of sea grass for further planting of suitable species, promotion of crab bank, squid egg hatching bank, and increase in mussel culture. The participation of the local community is highly recommended in this case to avoid confrontation and ensure community engagement (see Appendix II).

6.1.6. Results from stakeholder consultation

Four Stakeholder Consultation Meetings were conducted under the project as follows;

1. The Management measures for marine fisheries in Trat Province on 29 October 2013. The objectives were as follows.
   1.1. To introduce reduction of bycatch from trawl fisheries (REBYC-II CTI) project to the stakeholders in study area.
   1.2. To encourage stakeholders on participation in the process for fishery management in defining area, season, and proposal for closing area and closing season in Trat province.
   1.3. To clarify and ensure the stakeholders collaboration in data collection program in fishery biology and socio-economic study.
   1.4. To inform stakeholders on resource assessment data analysis process and its results, and participation in development for closed season.
2. Area and Season Closure Management on 30 November 2015. The objectives were as follows.
   2.1. To discuss on the impacts of implementing the seasonal closures in Ao Trat.
   2.2. To get agreement on seasonal closure in Ao Trat.
   2.3. To get agreement on types of fishing gears that should be prohibited.
3. Results on the fish larvae distribution study in Trat for management on 14th December 2015. The objectives were as follows.
   3.1. To present results from the fish larvae identification and distribution study.
   3.2. To discuss implications of the study on the Seasonal Closures planned for Ao Trat.
   3.3. To define area to be closed and duration and what types of fishing gear to be prohibited.
4. Public Hearing Meeting on management measures in Ao Trat on 25th December 2015. The objectives were as follows.
   4.1. To explain to the stakeholders on present fisheries resource situation in Ao Trat.
   4.2. To seek comments and recommendations from stakeholders on management measures in Ao Trat which will be accepted.
   4.3. To seek a proper fisheries management scheme for sustainable fisheries in Ao Trat.

An average of 124 participants participated in each meeting with representatives from small scale fishers, commercial fishers, fish processors, fish dealers, fishers organizations in Trat, Provincial Administrative Organization (PAO), Sub district Administrative and Organization (SAO) and government officials from DoF, DMCR, NGOs, etc. In the 1st meeting, Representative of EMDEC presented the status of fishery resources in Trat Province and proposed some ideas to manage the fisheries resources through demarcation of conservation zones. From 2014 to 2015, EMDEC and consultants of the project conducted experimental survey on marine resources, fish larvae distribution and survey on socio-economic condition of fishers. The results of the studies are summarized in the previous parts. In late 2015 and early 2016, three consultation meetings were conducted to present the outcome of the studies and propose suitable conservation zones based on scientific evidences.

Figure 20 shows the draft of conservation zone based on scientific evidences. It was presented to stakeholders for comments and recommendations. The area was divided into three zones, i.e., Zone 1 is located in Ao Trat with area of 201 km^2. Zone 2 is located from Laem Nam to southern boundary of Mai Root Sub-district of Khlong Yai district, western boundary is parallel to the coastline with distance around 14 km and the total is 395 km^2. Zone 3 is located from Zone 2 to Cambodia territorial waters, western boundary is parallel to the coastline with distance around 14 km and the total is 374 km^2.

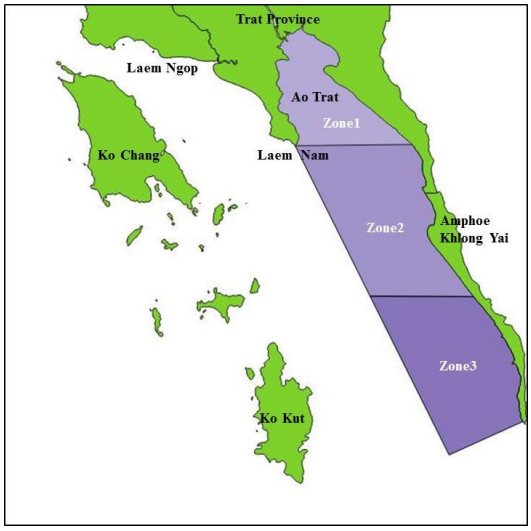


Figure 20: Draft of conservation zones in Trat Province.

During 4 meetings, other information on marine resources were supplemented to the meeting. The size distribution of *Rastrelliger brachysoma* that was caught by PT in Trat Province, indicated that small size with length less than the size at first maturity (male = 16.25 cm and female = 15.93 cm in total length (Khrueniam and Chareonsombat, 2012)) was caught every month. In March and May the average size of *R. brachysoma* is smaller than other months (Figure 21). Information on dolphin distribution, sea grass beds mangrove forest and artificial reef mapping in the proposed areas were addressed for discussion in all meetings (Figure 22).

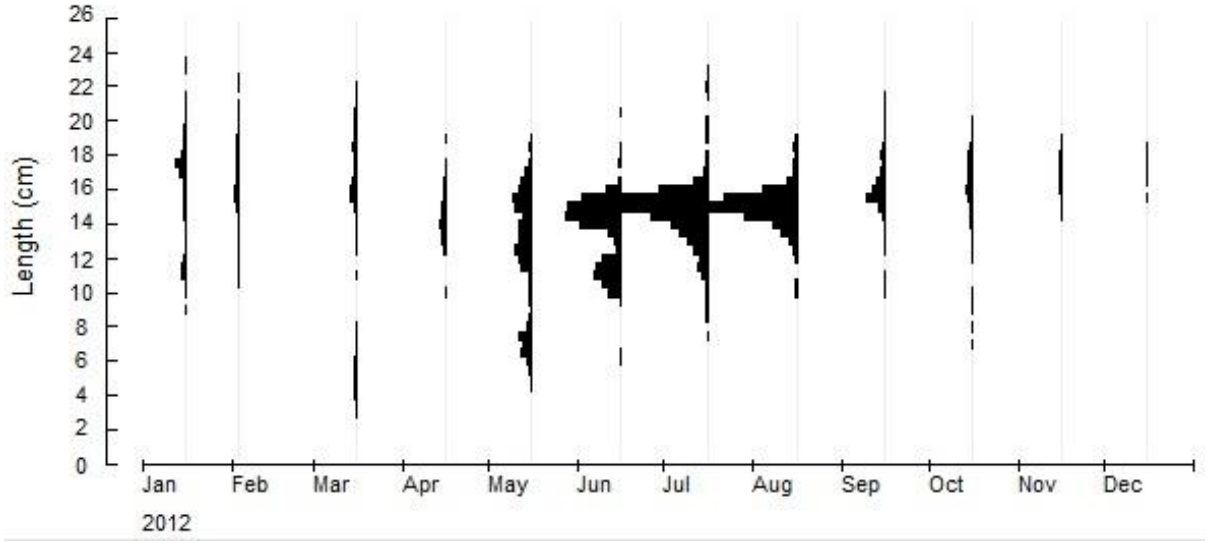


Figure 21: Size distribution of Rastrelliger brachysoma from PT fisheries in Trat Province, 2012.

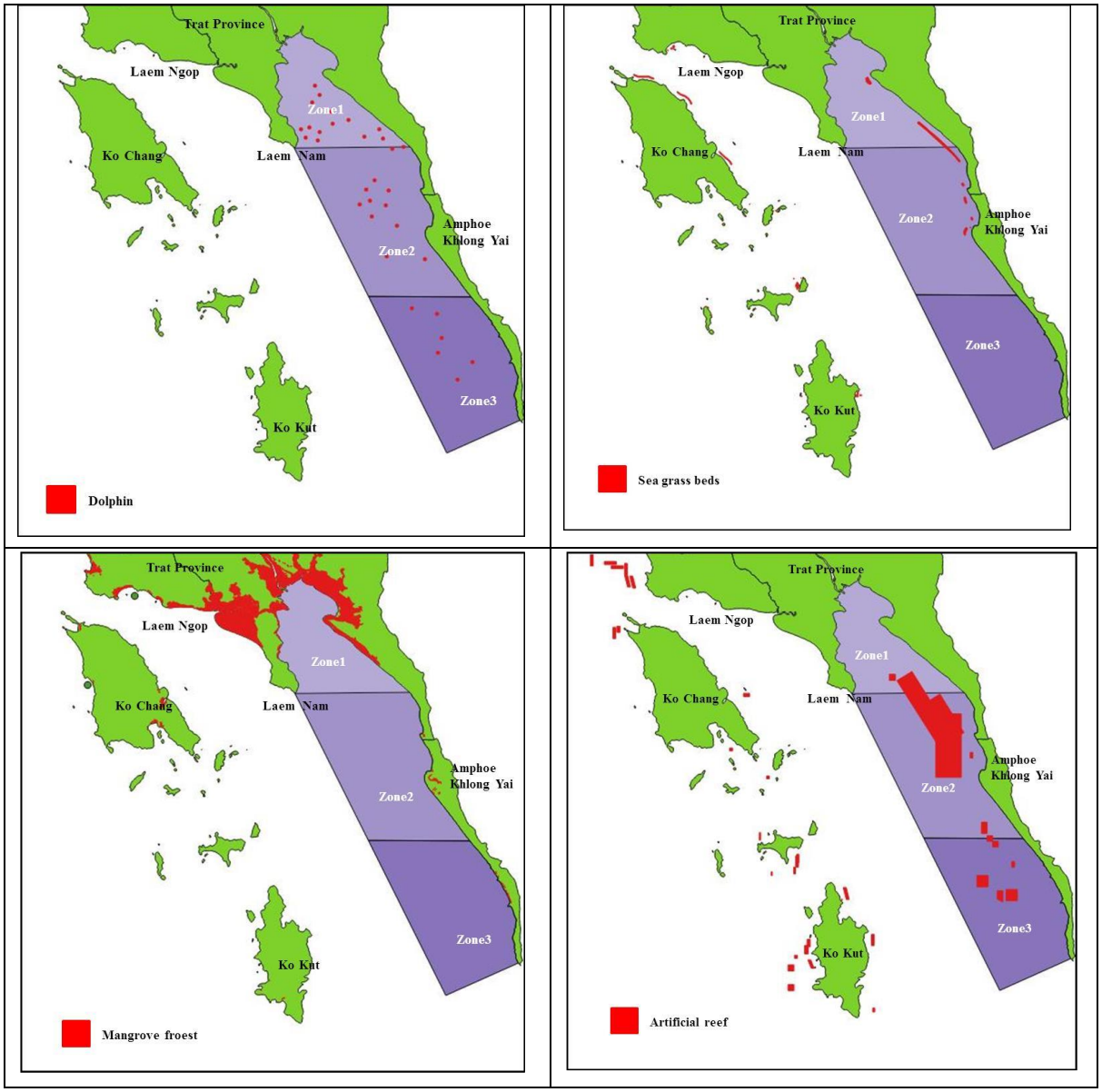


Figure 22: Distribution of a) dolphins, b) sea grass beds, c) mangrove forest and d) artificial reefs, in Trat Province.

In the 4th meeting, EMDEC asked the participants to consider the proposal on demarcation of conservation zones. The consideration was to focus on gear prohibition i.e., 1) trawlers, 2) purse seiner with purse line, 3) encircling gill netter and 4) gill netter with mesh size larger than 4.5 cm operated in zone 1, 2 and 3 from 1st March to 31th May annually. Results of the vote of 90 stakeholders was 72 agreed and 18 did not agreed. They also suggested DoF to have more public hearing meeting and DoF should promote and announce widely beforehand.

6.2. Prachuap Khiri Khan and Chumphon

6.2.1. Overview of the project site

The other study under REBYC-II CTI project was an experiment on enlarging trawl cod-end mesh size in the areas of Prachuap Khiri Khan and Chumphon Provinces. This activity was conducted by Chumphon Marine Fisheries Research and Development Center in Chumphon (CMDEC). The project had used participatory fisheries management concept as specified in Royal Ordinance on Fisheries B.E.2558 (2015) to formulate action plan. The process and steps for implementing fisheries management are similar to Trat Province.

Prachuap Khiri Khan and Chumphon Province is located in the upper part of the Western Gulf of Thailand. Prachuap Khiri Khan Province adjoins Republic of the Union of Myanmar in the west, Phetchaburi Province in the north and Chumphon in the south. There are 23 islands in Prachuap Khiri Khan Province; however, all islands are smaller than one km^2 except Talu Island which is 1.18 km^2. The land area is approximately 6,368 km^2 and the island area is 3.23 km^2. The coast line is about 225 km. All eight districts open to the Gulf of Thailand (Figure 23).

Figure 23: Prachuap Khiri Khan Province with the districts (Amphoe) numbered 1) Mueang Prachuap Khiri Khan, 2) Kui Buri, 3) Thap Sakae, 4) Bang Saphan, 5) Bang Saphan Noi, 6) Pran Buri, 7) Hua Hin and 8) Sam Roi Yot, Source: http://en.wikipedia.org/wiki/Prachuap.

Chumphon Province adjoins Republic of the Union of Myanmar in the northwest, Ranong Province in the west and Surat Thani Province in the south. There are 54 islands in the province. Only two of them are larger than one km^2. The land area is roughly 6,011 km^2 and the island area is 7.27 km^2. The coast line is 222 km. Six of eight districts open to the Gulf of Thailand (Figure 24).

Figure 24: Chumphon Province with the districts (Amphoe) numbered1) Mueang Chumphon, 2) Tha Sae, 3) Pathio, 4) Lang Suan, 5) Lamae, Phato, 7) Sawi and 8) Thung Tako, Source: http://en.wikipedia.org/wiki/Chumphon_Province.

The upper part of the Western Gulf of Thailand is the most productive area in terms of capture fisheries production. The statistical areas in the Gulf of Thailand are divided into five areas (Figure 25). Area 3, the locality of Prachuap Khiri Khan, Chumphon and Surat Thani Provinces, contributed the highest fisheries production in terms of quantity and value. In 2011, the catch of Area 3 was 333,115 t comprising 306,950 t of commercial fisheries and 26,165 t of small scale fisheries. Fisheries production of area 3 accounted for almost one third of the Gulf of Thailand's production of 1,064,772 t (DoF, 2013a-c).

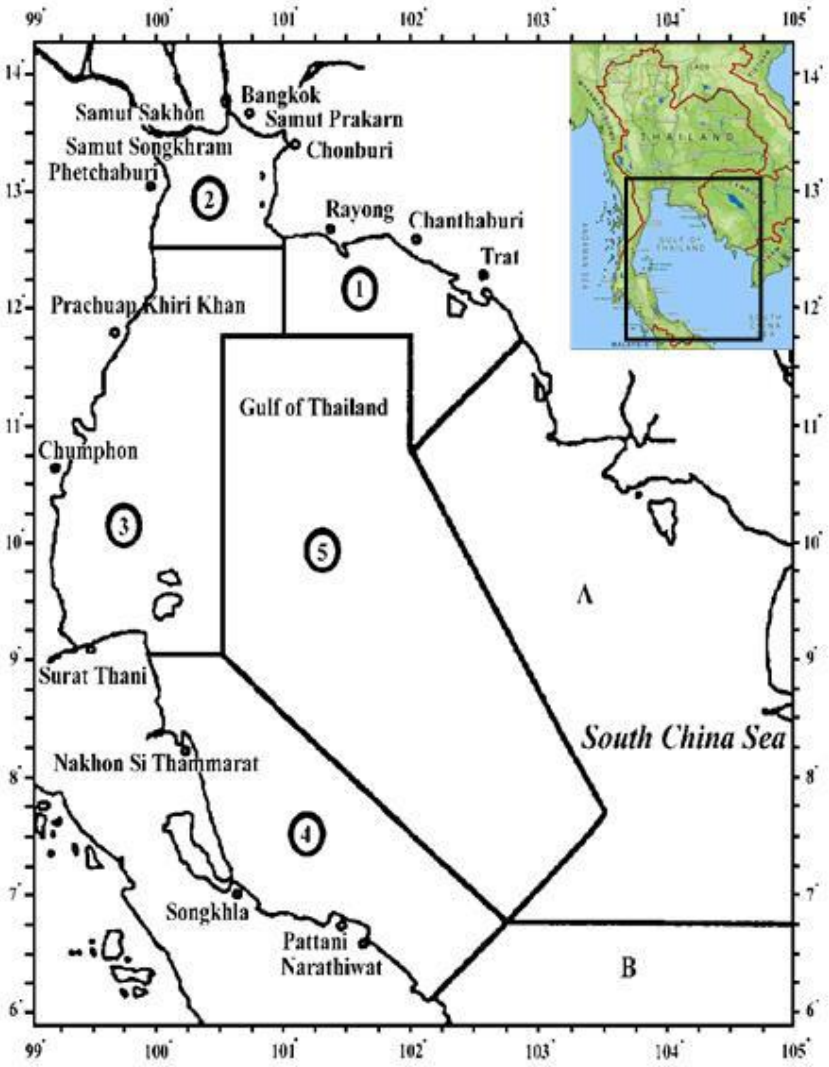


Figure 25: The areas of catch statistical data in the Gulf of Thailand.

6.2.2. Number of trawlers in Prachuap Khiri Khan and Chumphon Provinces

The number of fishing vessels registered as trawlers in Prachuap Khiri Khan and Chumphon during 1990-2011 were reviewed by Noranarttragoon (2015) in the baseline report "Review of the Trawl Fisheries in Prachuap Khiri Khan and Chumphon Province, Thailand", REBYC-II CTI; GCP/RAS/269/GFF. The total number of registered trawl vessels reduced from 120 to 22 vessels in Prachuap Khiri Khan and from 500 to 150 vessels in Chumphon. OBT vessel was the most common type of trawler registered in the two provinces compared to other types of trawler (PT and BT).

During the planning phase for sampling design of this socio-economic study (in 2014), the most recent records of trawler including Otter Board Trawl (OBT) and Pair Trawl (PT) at the Fisheries Provincial Offices in Prachuap Khiri Khan and Chumphon Provinces for the fishing period between 1st April 2013 and 31st March 2014, showed 150 fishing licenses for OBT (96%) and only 6 fishing licenses for PT (4%) (Table 10).

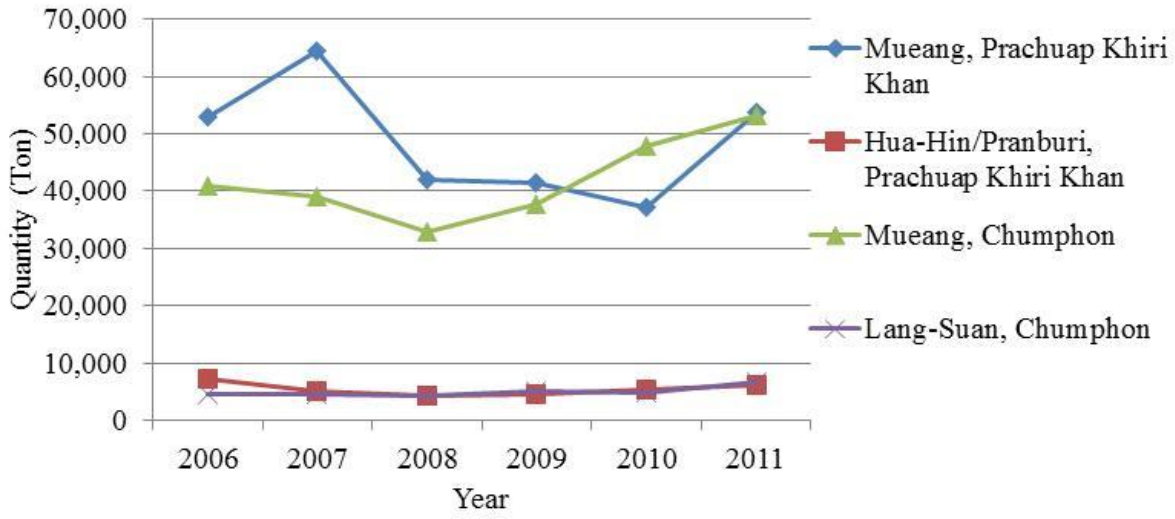
Table 10: Numbers of trawlers in Prachuap Khiri Khan and Chumphon (1 April 2013 - 31 March 2014).

Fisheries Provincial Office	Types of trawl fishing gears licensed at Fisheries Provincial Offices		
	Otter board trawl (OBT)*	Pair trawl (PT)	Total (OBT & PT)
	Number of trawlers	Number of trawlers	Number of trawlers
Prachuap Khiri Khan	16	1 (0.9%)	17 (14.7%)
Chumphon	97 (83.6%)	2 (1.7%)	99 (85.3%)
Total	113 (97.4%)	3 (2.6%)	116 (100.0%)

Remark: * including Otter Board Trawl (OBT), Otter Board with Beam Trawl (OBBT), and Beam Trawl (BT). Source: Prachuap Khiri Khan and Chumphon Fisheries Provincial Offices, DoF, 2014

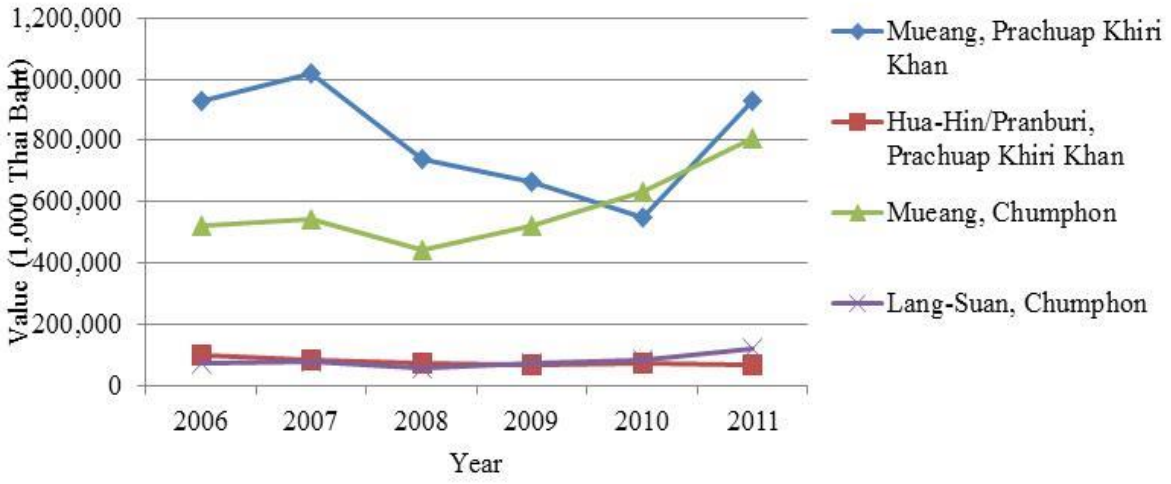
6.2.3. Landing places in Prachuap Khiri Khan and Chumphon Provinces

There are four main landing sites in Prachuap Khiri Khan and Chumphon Provinces. The landing sites are Mueang-Prachuap Khiri Khan, Hua Hin/Pranburi-Prachuap Khiri Khan, Mueang-Chumphon, and Lang Suan-Chumphon. Total marine fish recorded by landing sites in quantity (tonnes) and value (1,000 Baht) in 2006-2011 are presented in Figure 26 andFigure 27. It is noted that this total quantity and value of marine fish were collected from various types of fishing gears including trawl vessels that landed at main landing sites. In the period between 2006 and 2011, the quantity and value of marine fish recorded at landing places in Mueang-Prachuap Khiri Khan and Mueang-Chumphon were higher than the other two sites (approximately 30,000-64,000 t compared to less than 10,000 t and 400-1,000 million Baht compared to less than 200 million Baht)



Source: DoF, 2013.

Figure 26: Total landing of marine fish by landing place in quantity (ton) (2006-2011)



Source: DoF, 2013.

Figure 27: Total landing of marine fish by landing place in value (1,000 Baht) (2006-2011).

6.2.4. Fish prices

The prices of marine fish at landing place for the years 2006 to 2011 are shown in Table 11. The average price of giant tiger prawn, banana shrimp and green tiger prawn at landing place were higher than other marine fish (220-263 Baht per kilogram). Among fish, snapper and king mackerel had higher average prices than other fishes (88-105 Baht per kg). The average price of crab was 73 Baht per kg. Price of trash fish was ranging between 4.77 and 7.17 Baht per kilogram and the average price was 5.66 Baht per kg. Trash fish price has been increasing since 2006.

Table 11: The price of marine fish at landing place, Trat Province 2006-2011 (Baht per kg).

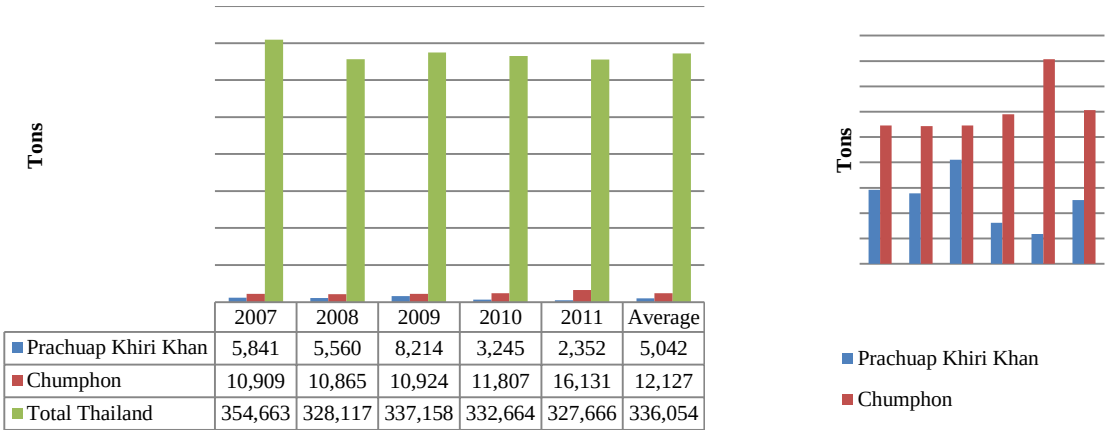
	2006	2007	2008	2009	2010	2011	Average*
Indo Pacific mackerel	30.21	30.51	32.87	32.44	36.29	38.65	33.50
Indian mackerel	26.18	26.07	25.56	27.71	31.20	36.31	28.84
King mackerel	86.53	87.44	87.90	83.62	88.01	92.56	87.68
Longtail tuna & Eastern little tuna	29.00	32.62	32.93	34.75	36.12	38.69	34.02
Round scads	18.51	20.88	19.11	19.39	22.60	31.28	21.96
Hardtail scads	18.72	18.28	18.80	20.15	21.32	22.45	19.95
Trevallies	19.16	19.62	20.35	20.97	22.43	24.32	21.14
Sardines	9.35	9.50	11.02	11.24	12.25	14.58	11.32
Anchovies	6.66	7.23	8.32	9.05	10.76	10.35	8.73
Threadfin breams	23.06	23.21	24.00	25.62	26.99	27.42	25.05
Lizard fish	14.91	14.32	15.31	16.52	17.08	19.68	16.30
Snapper	91.56	88.62	88.75	95.54	100.35	105.53	95.06
Big-eyes	15.17	13.64	14.69	16.67	17.82	20.04	16.34
Other food fish	46.06	43.36	37.48	35.35	32.95	32.14	37.89
Trash fish	4.77	5.00	5.28	5.59	6.13	7.17	5.66
Banana shrimp	244.79	245.47	249.56	245.31	232.11	230.55	241.30
Giant tiger prawn	264.78	258.18	260.13	247.64	273.26	270.24	262.37
Green tiger prawn	240.86	238.26	226.59	220.23	200.30	209.93	222.70
School prawn	122.90	114.52	111.67	115.98	121.36	121.24	117.95
Other shrimp	59.53	63.91	64.56	67.76	63.61	71.12	65.08
Mantis shrimp & lobster	128.37	122.49	117.31	133.67	142.39	143.08	131.22
Crabs	62.36	57.47	70.47	75.17	86.65	88.52	73.44
Squid	68.11	66.93	63.68	60.11	65.51	76.58	66.82
Cuttlefish	65.04	60.48	60.62	57.19	64.51	72.63	63.41
Octopus	39.10	37.10	37.68	38.35	42.17	48.92	40.55
Bigfin reef squid	78.54	79.92	73.50	73.03	66.86	82.31	75.69
Shellfish	37.86	32.29	32.36	23.51	35.28	25.49	31.13

Remark: * Average price was calculated from the prices recorded in 2006-2011.

Source: DoF, 2013

6.2.5. Fish meal

Figure 28 presents the production of fish meal in Prachuap Khiri Khan and Chumphon in comparison to whole Thailand from 2007 to 2011. The proportion of the production of fish meal in the two provinces was very small (1.50-3.61%) compared to the total production in Thailand. The production of fish meal in Prachuap Khiri Khan has been lower than in Chumphon since 2007. The production of fish meal in Chumphon has increased while in Prachuap Khiri Khan it has decreased since 2007. In general, the production of fish meal in Thailand has slightly decreased since 2007.



	2007	2008	2009	2010	2011	Average
Prachuap Khiri Khan	5,841	5,560	8,214	3,245	2,352	5,042
Chumphon	10,909	10,865	10,924	11,807	16,131	12,127
Total Thailand	354,663	328,117	337,158	332,664	327,666	336,054

Figure 28: Production of fish meal by province in 2007-2011. Source: DoF, 2013b.

6.2.6. Fisheries resources

Study on fisheries resources from commercial trawlers operated in the locality of Prachuap Khiri Khan and Chumphon Province was conducted by collecting data from small-sized otter board trawl (<14 m LOA; OBT1), medium-sized otter board trawl (14-18 m LOA; OBT2) and pair trawl (PT) landed at Prachuap Khiri Khan and Chumphon fishing ports during June 2013-May 2014 Noranarttragoon (2016b). The results found that the catch per unit effort (CPUE) of OBT1, OBT2 and PT were 48.21, 27.78 and 150.02 kg/h, respectively. The proportions of food fish and trash fish were 36:64, 58:42 and 46:54, respectively. In food fish group, demersal fish and shrimp and prawn were the main composition of OBT1 and contributed 86% of total food fish; demersal fish and cephalopod were the main composition of OBT2 and contributed 77% of the total. Pelagic fish and demersal fish were the main composition of PT and contributed 83% of the total. In trash fish group, small-sized economically important species showed the significant high percentages of 78% (OBT1), 64% (OBT2) and 74% (PT) of total trash fish whereas the remaining were true trash fish.

Comparison of length of some economically important species was separately analysed between food fish and trash fish which were obviously sorted on board by fishers. For length distribution of each species caught by each gear, the length data from food fish and trash fish were pooled in order to present a complete picture of each fish species status. The pooled length data were compared with the size at first maturity of each species gathered from available technical papers and shown in Tables 12-14. It was found that mean length of most species were smaller than their size at first maturity particularly pelagic and demersal species caught by all gear. The length composition also revealed that most individuals of economically important species caught were smaller than their size at first maturity.

Table 12 : Mean length of some economically important species caught by small-sized otter trawls in Prachuap Khiri Khan and Chumphon Province during June 2013-May 2014 and female size at first maturity complied from available technical papers.

Common name	Scientific name	Food fish		Trash fish		Female size at first maturity (cm)	Source
		Range (cm)	Mean (cm)	Range (cm)	Mean (cm)		
Yellowtail scad	*Atule mate*	–	–	–	–	21.25	Premkit *et al*., 2004
Short mackerel	*Rastrelliger brachysoma*	–	–	–	–	17.95	Krajangdara *et al*., 2007
Indian mackerel	*R. kanagurta*	–	–	–	–	17.12	Krajangdara *et al*., 2007
Goldstripe sardinella	*Sardinella gibbosa*	–	–	–	–	10.35	Nasuchon *et al*., 2010
Bigeye scad	*Selar crumenophthalmus*	–	–	–	–	18.25	Phuttharaksa *et al*., 2008
Yellowstripe scad	*Selaroides leptolepis*	9.75 – 15.75	12.50 ± 0.13	10.75 – 12.75	11.75 ± 0.04	11.73	Yakoh and Chalee, 2008
Ornate threadfin bream	*Nemipterus hexodon*	8.75 – 28.75	16.54 ± 0.84	4.75 – 9.25	7.38 ± 0.12	14.57	Pinputtasin *et al*., 2008
Purple-spotted bigeye	*Priacanthus tayenus*	13.25 – 20.25	15.39 ± 0.17	5.75 – 13.25	8.02 ± 0.18	14.19	Krajangdara and Yakoh, 2005
Slender lizardfish	*Saurida elongata*	13.25 – 30.75	18.23 ± 0.43	8.25 – 15.25	11.75 ± 0.28	31.62	Vibunpant *et al*., 2012
Brushtooth lizardfish	*S. undosquamis*	–	–	–	–	28.26	Vibunpant *et al*., 2011
Lattice monocle bream	*Scolopsis taeniopterus*	10.25 – 26.25	15.72 ± 0.27	6.25 – 12.75	8.83 ± 0.09	17.57	Krajangdara and Hettanon, 2000
Mitre squid	*Photololigo chinensis*	–	–	–	–	17.71	Suppanirun *et al*., 2011
Indian squid	*P. duvaucelii*	5.75 – 21.25	10.09 ± 0.67	–	–	9.04	Suppanirun *et al*., 2011
Needle cuttlefish	*Sepia aculeata*	5.75 – 17.75	9.50 ± 0.44	–	–	9.44	Charoensombat *et al*., 2013
Pharaoh cuttlefish	*S. pharaonis*	6.25 – 25.25	9.78 ± 2.66	–	–	14.30	Chotiyaputta, 1982
Jinga shrimp	*Metapenaeus affinis*	8.25 – 14.25	11.13 ± 0.18	–	–	12.18	Sritakon *et al*., 2012
Greasyback shrimp	*Metapenaeus ensis*	7.25 – 16.75	11.13 ± 0.15	–	–	11.24	Pinputtasin *et al*., 2012
Banana prawn	*Penaeus merguiensis*	12.75 – 22.75	15.85 ± 0.40	–	–	13.38	Yakoh *et al*., 2013

Table 13: Mean length of some economically important species caught by medium-sized otter trawls in Prachuap Khiri Khan and Chumphon Province during June 2013-May 2014 and female size at first maturity complied from available technical papers.

Common name	Scientific name	Food fish		Trash fish		Female size at first maturity (cm)	Source
		Range (cm)	Mean (cm)	Range (cm)	Mean (cm)		
Yellowtail scad	*Atule mate*	10.75 – 23.75	14.54 ± 0.88	8.75 – 11.25	10.25 ± 0.02	21.25	Premkit *et al*., 2004
Short mackerel	*Rastrelliger brachysoma*	14.75 – 19.75	17.08 ± 0.17	5.75 – 8.75	7.15 ± 0.01	17.95	Krajangdara *et al*., 2007
Indian mackerel	*R. kanagurta*	11.75 – 19.75	14.87 ± 0.20	–	–	17.12	Krajangdara *et al*., 2007
Goldstripe sardinella	*Sardinella gibbosa*	–	–	–	–	10.35	Nasuchon *et al*., 2010
Bigeye scad	*Selar crumenophthalmus*	–	–	–	–	18.25	Phuttharaksa *et al*., 2008
Yellowstripe scad	*Selaroides leptolepis*	9.25 – 18.75	12.95 ± 0.16	7.25 – 12.25	7.89 ± 0.02	11.73	Yakoh and Chalee, 2008
Ornate threadfin bream	*Nemipterus hexodon*	7.75 – 28.75	14.06 ± 0.22	5.75 – 9.75	7.44 ± 0.02	14.57	Pinputtasin *et al*., 2008
Purple-spotted bigeye	*Priacanthus tayenus*	8.75 – 22.25	13.89 ± 0.09	6.75 – 13.75	9.30 ± 0.03	14.19	Krajangdara and Yakoh, 2005
Slender lizardfish	*Saurida elongata*	11.75 – 39.75	19.96 ± 0.37	10.25 – 11.25	10.84 ± 0.01	31.62	Vibunpant *et al*., 2012
Brushtooth lizardfish	*S. undosquamis*	13.75 – 28.75	19.08 ± 0.20	–	–	28.26	Vibunpant *et al*., 2011
Lattice monocle bream	*Scolopsis taeniopterus*	8.25 – 28.25	14.94 ± 0.18	5.25 – 12.75	8.98 ± 0.04	17.57	Krajangdara and Hettanon, 2000
Mitre squid	*Photololigo chinensis*	12.25 – 38.25	20.39 ± 1.07	–	–	17.71	Suppanirun *et al*., 2011
Indian squid	*P. duvaucelii*	5.75 – 18.25	10.54 ± 0.11	–	–	9.04	Suppanirun *et al*., 2011
Needle cuttlefish	*Sepia aculeata*	5.75 – 18.25	10.00 ± 0.17	–	–	9.44	Charoensombat *et al*., 2013
Pharaoh cuttlefish	*S. pharaonis*	5.25 – 25.75	12.97 ± 0.84	–	–	14.30	Chotiyaputta, 1982
Jinga shrimp	*Metapenaeus affinis*	–	–	–	–	12.18	Sritakon *et al*., 2012
Greasyback shrimp	*Metapenaeus ensis*	–	–	–	–	11.24	Pinputtasin *et al*., 2012
Banana prawn	*Penaeus merguiensis*	11.75 – 19.75	15.96 ± 0.66	–	–	13.38	Yakoh *et al*., 2013

Table 14: Mean length of some economically important species caught by pair trawl in Prachuap Khiri Khan and Chumphon Province during June 2013-May 2014 and female size at first maturity complied from available technical papers

Common name	Scientific name	Food fish		Trash fish		Female size at first maturity (cm)	Source
		Range (cm)	Mean (cm)	Range (cm)	Mean (cm)		
Yellowtail scad	*Atule mate*	8.75 – 29.25	15.51 ± 0.16	7.75 – 10.75	8.16 ± 0.01	21.25	Premkit *et al*., 2004
Short mackerel	*Rastrelliger brachysoma*	12.25 – 21.75	15.62 ± 0.01	3.75 – 10.75	6.62 ± 0.00	17.95	Krajangdara *et al*., 2007
Indian mackerel	*R. kanagurta*	11.25 – 23.75	18.74 ± 0.06	–	–	17.12	Krajangdara *et al*., 2007
Goldstripe sardinella	*Sardinella gibbosa*	9.75 – 19.25	12.99 ± 0.01	5.75 – 14.25	8.92 ± 0.01	10.35	Nasuchon *et al*., 2010
Bigeye scad	*Selar crumenophthalmus*	8.75 – 25.75	17.54 ± 0.15	4.25 – 12.75	5.59 ± 0.04	18.25	Phuttharaksa *et al*., 2008
Yellowstripe scad	*Selaroides leptolepis*	8.25 – 19.75	12.94 ± 0.02	2.25 – 13.75	6.17 ± 0.01	11.73	Yakoh and Chalee, 2008
Ornate threadfin bream	*Nemipterus hexodon*	8.75 – 28.75	15.69 ± 0.12	4.25 – 10.75	7.70 ± 0.02	14.57	Pinputtasin *et al*., 2008
Purple-spotted bigeye	*Priacanthus tayenus*	7.75 – 26.25	15.44 ± 0.05	3.25 – 16.25	6.22 ± 0.02	14.19	Krajangdara and Yakoh, 2005
Slender lizardfish	*Saurida elongata*	12.75 – 41.25	21.69 ± 0.29	10.25 – 17.25	13.71 ± 0.06	31.62	Vibunpant *et al*., 2012
Brushtooth lizardfish	*S. undosquamis*	11.75 – 30.75	18.00 ± 0.20	4.75 – 16.75	9.13 ± 0.02	28.26	Vibunpant *et al*., 2011
Lattice monocle bream	*Scolopsis taeniopterus*	10.75 – 28.25	15.85 ± 0.39	8.25 – 14.25	8.57 ± 0.11	17.57	Krajangdara and Hettanon, 2000
Mitre squid	*Photololigo chinensis*	15.75 – 42.25	22.76 ± 0.40	–	–	17.71	Suppanirun *et al*., 2011
Indian squid	*P. duvaucelii*	6.75 – 20.25	9.95 ± 0.04	–	–	9.04	Suppanirun *et al*., 2011
Needle cuttlefish	*Sepia aculeata*	6.25 – 16.25	10.84 ± 0.10	–	–	9.44	Charoensombat *et al*., 2013
Pharaoh cuttlefish	*S. pharaonis*	5.75 – 29.75	12.88 ± 0.59	–	–	14.30	Chotiyaputta, 1982
Jinga shrimp	*Metapenaeus affinis*	–	–	–	–	12.18	Sritakon *et al*., 2012
Greasyback shrimp	*Metapenaeus ensis*	–	–	–	–	11.24	Pinputtasin *et al*., 2012
Banana prawn	*Penaeus merguiensis*	–	–	–	–	13.38	Yakoh *et al*., 2013

6.2.7. Trawl codend selectivity experiments

The experiment using trawl net with a 4 cm mesh size codend was conducted in Chumphon Province in collaboration with local fishers, FAO and SEAFDEC (Phoonsawat *et al*., 2015). The report presents result of the sea trials and indicates positive socio-economic impact in case of small economic species being caught are released back to the sea. The loss in benefit by landing and utilizing the small economic species as well as positive benefit if released back to nature was investigated.

To achieve the acceptance of the result of the experiment by the fishing sector, the project invited trawl fishers from Prachuap Khiri Khan, Chumphon and Surat Thani province to participate the experimental process. Through the various workshops, stakeholders jointly discussed and considered the experimental design, technical data collection and data analysis. Thus, the information gained from the workshop and the finding of the experiment could lead to effective fisheries resources management in order to achieve the sustainable uses of the resources as well as the fishery occupation.

Study on catch rate, catch composition and escapement rate between current codend and 4 cm mesh size codend.

Pair trawl

Codend mesh size 1.8 cm

The experiment used the 1.8 cm mesh size codend for trawling for 5 hauls. The trawling duration of each haul was 5 hr and the speed of vessel was 2.5 knots. The experiment carried out 4 hauls in the daytime and 1 haul in the night time. The result showed average catch rate was 1,555 kg/haul that comprised of economic fish of 32 % and of trash fish of 68%. Trash fish comprised of economic fish of 49% and true trash fish of 51% (Table 15 and Figure 29a).

Codend with mesh size 4.0 cm (with a codend cover of mesh size of 1.8 cm)

Experiment was carried out by trawling with the 4 cm mesh size codend net which was covered with codend cover of 1.8 cm mesh size to collect the escapees. Five hauls were made. The trawling duration of each haul was 5 hours and the speed of vessel**.**2.5 knots. The average total catch was 1,258 kg/haul. The average catch in the 4 cm codend was 825 kg/haul which comprised of economic fish 64% and trash fish 36%. The average share of escaped fish in the 4 cm codend net was 34% (Table 15 and Figure 29b).

The percentage ratio of economic fish, trash fish and escaped fish was 42:24:34. For the escapement, it comprised of pelagic fish 49%, true trash fish 35%.

Table 15: Catch rate, percentage and escaped rate of marine fauna caught by PT using 1.8 mesh size codend net and 4.0 cm codend net cover with the 1.8 cm mesh size net.

	Codend mesh size 1.8 cm				Enlarged mesh size to 4.0 cm (cover by 1.8 cm)						
Group	**Codend**				**Codend**				**Cover net**		**Rate of**
	CPUE	**%**	**% in**		**CPUE**	**%**	**% in**		**CPUE**	**%**	**Escape**
	(kg/haul)		**group**		**(kg/haul)**		**group**		**(kg/haul)**		**(%)**
Total catch	1,555.270	100			825.360	100.00					
Total economic fish	501.470	32.24	100		525.160	63.63	100				
Pelagic fish	160.595	10.33	32.02		174.597	21.15	33.24				
Demersal fish	287.035	18.46	57.24		313.817	38.02	59.76				
Cephalopod	47.100	3.03	9.39		34.400	4.17	6.56				
Shrimp	0.290	0.02	0.06		0.600	0.07	0.11				
Crab	0.910	0.06	0.18		0.000	0.00	0.00				
Other	5.540	0.36	1.10		1.745	0.21	0.33				
Total trash	**1,053.800**	**67.76**	**100.00**		**300.200**	**36.37**	**100**		**433.200**	**100.00**	**34.42**
Total small sized economic fish	**511.843**	**32.91**	**48.57**		**198.244**	**24.02**	**66.04**		**281.219**	**64.92**	**22.34**
Pelagic fish	317.887	20.44	30.17		105.600	12.79	35.16		210.676	48.63	16.74
Demersal	125.723	8.08	11.93		73.556	8.91	24.5		63.102	14.57	5.01
Cephalopod	61.208	3.94	5.81		1.628	0.20	0.55		7.268	1.68	0.58
Shrimp	0.314	0.02	0.03		0.000	0.00	9.97		0.114	0.03	0.01
Crab	6.320	0.41	0.60		14.023	1.70	4.67		0.057	0.01	0.005
Other	0.392	0.03	0.04		3.437	0.42	1.16		0.000	0.00	0.00
True trash	**541.957**	**34.85**	**51.43**		**101.956**	**12.35**	**33.96**		**151.981**	**35.08**	**12.08**

Source: Phoonsawat *et al*. (2016)

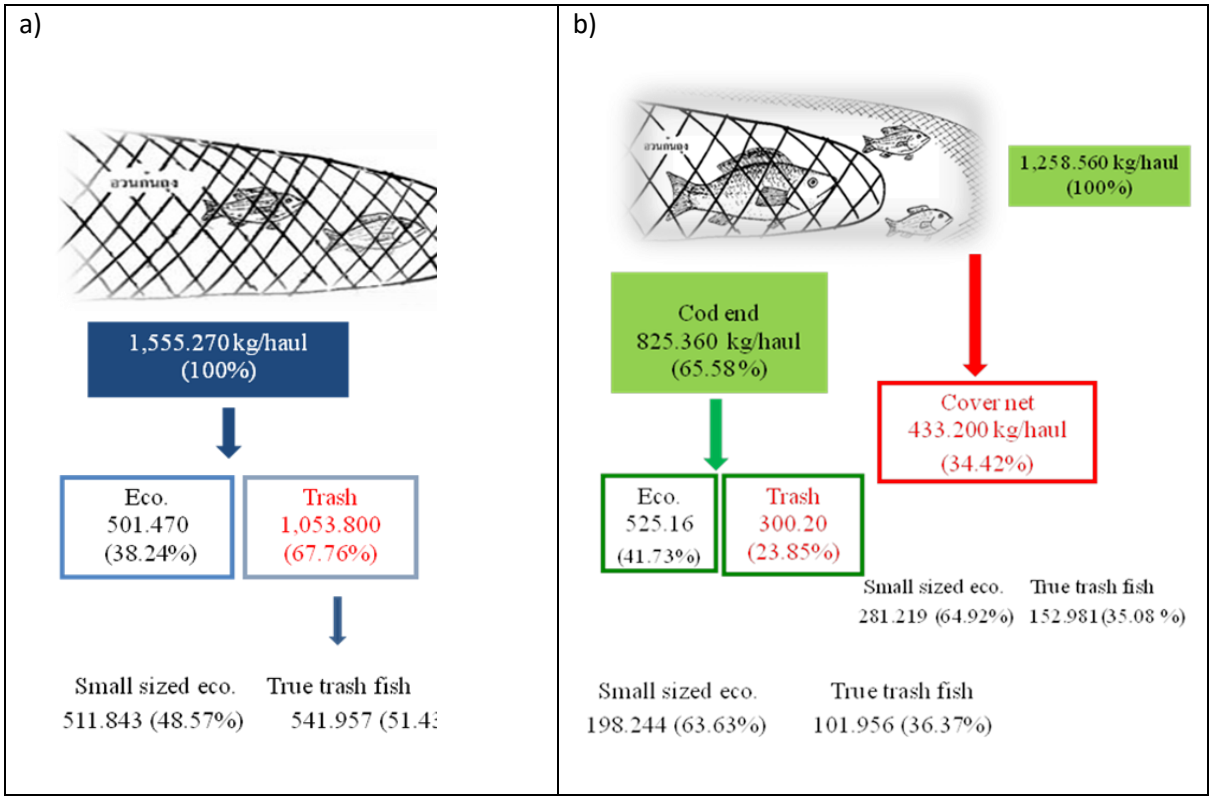


Figure 29: Summary of catch for pair trawler. Experiment time 5 hr/haul a) codend mesh size 1.8 cm and b) codend mesh size 4.0 cm cover with 1.8 cm cover net (enlarge mesh size). Source: Phoonsawat et al. (2016).

Otter board trawl

The experimental trawling with the 1.25 cm codend was done for 11 hauls which operated for 4 hr/haul. Six hauls were made during daytime and five hauls during the night time. The average towing speed was 2.5 knots. The average catch was 159 kg/haul. The catch included the economic fish for 59% and trash fish for 41%. Trash fish comprised of small economic fish 25.34 % and true trash fish 74.66% (Table 16 and Figure 30a).

Experiment on enlarged codend with a mesh size of 4 cm and with a codend cover by current codend mesh size of 1.25 cm revealed that the escape from 4 cm codend was on average 43%. The retained catch of 4 cm codend mesh size was 83 kg/haul that comprised of economic fish 80% and trash fish 20%. Trash fish comprised of economic fish 14% and true trash fish 86%. Escaped fish from 4 cm codend comprised of small sized economic fish of 40 % and of true trash fish of 60%. All catch that escapes from 4 cm codend and were retained in 1.25 cm codend cover and was sold as true trash fish with price 5.1 Baht/kg. (Table 16 and Figure 30b).

Table 16: Catch rate, percentage and rate of escape of marine fauna caught by otter board trawl using codend mesh size of 1.25 cm and enlarged mesh size of 4.0 cm and cover with mesh size of 1.25 cm. Source: Phoonsawat et al. (2015).

Group	Codend mesh size 1.25 cm			Enlarge mesh size to 4.0 cm cover by 1.25 cm					
	Codend			Codend			Cover net		Rate of
	CPUE (kg/haul)	%	% in group	CPUE (kg/haul)	%	% in group	CPUE (kg/haul)	%	Escape (%)
Total catch	**158.554**	**100.00**		**82.618**	**100.00**				
Total economic fish	**93.872**	**59.21**	**100**	**65.890**	**79.75**	**100**			
Pelagic fish	2.746	1.73	2.93	1.232	1.49	1.87			
Demersal fish	45.565	28.74	48.54	30.112	36.45	45.7			
Cephalopod	5.807	3.66	6.19	5.671	6.86	8.6			
Shell	0.285	0.18	0.30	16.580	20.07	25.17			
Shrimp	6.672	4.21	7.11	6.570	7.95	9.97			
Crab	0.530	0.33	0.56	2.342	2.83	3.55			
Other	32.267	20.35	34.37	3.383	4.10	5.14			
Total trash fish	**64.682**	**40.79**	**100.00**	**16.727**	**20.25**	**100**	**62.864**	**100.00**	**43.21**
Total small sized economic fish	**16.391**	**10.34**	**25.34**	**2.288**	**2.77**	**13.68**	**25.451**	**40.49**	**17.49**
Pelagic fish	1.180	0.74	1.82	0.321	0.39	2.01	1.604	2.55	1.10
Demersal fish	13.682	8.63	21.15	1.866	2.26	11.67	17.656	28.09	12.14
True trash fish	**48.291**	**30.46**	**74.66**	**14.440**	**17.48**	**86.32**	**37.412**	**59.51**	**25.72**

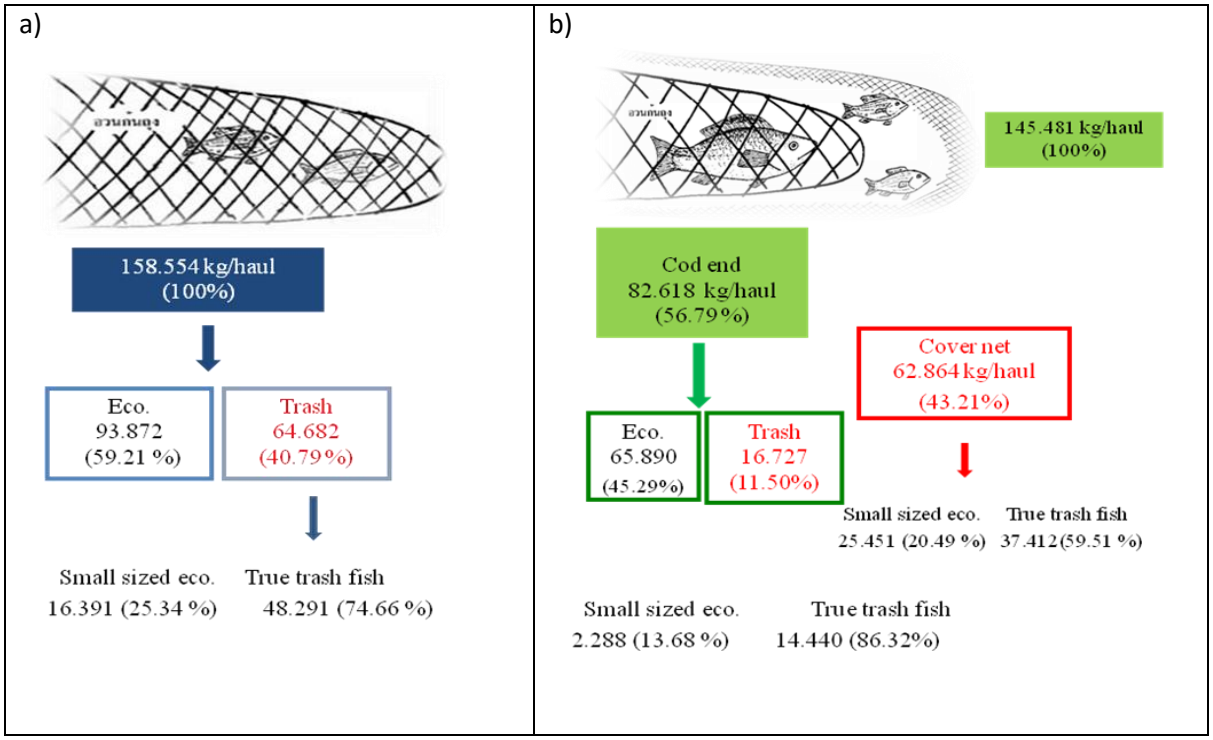


Figure 30: Summary of catch for otter board trawler experiment a) codend mesh size 1.25 cm (current use) and b) codend mesh size 4.0 cm cover with 1.25 cm cover net (enlarge mesh size). Source: Phoonsawat et al. (2015)

Comparison analysis of the revenue between trawling with the current mesh size codend and 4 cm mesh size codend.

Pair trawl

The income of pair trawling with the 1.8 cm mesh size codend net was 20,504 Baht/haul. Income of trawling with the 4 cm mesh size codend net was 21,619 Baht/haul. These increasing incomes was from the increasing of demersal fish, pelagic fish and shrimp which accounted for 5,440, 799 and 98 Baht/haul, respectively. The incomes derived from cephalopod (squid and cuttlefishes), shell, crabs, other and trash fish were decreased (Table 17).

The major income of pair trawls, whether 1.8 or 4.0 cm mesh size, was from demersal and pelagic fish which contributed for 52.21% and 78.39% of the total income from all fish catch, respectively. The increase of the mesh size in codend resulted in the decrease of catch for 730 kg/haul or for 47 %. However, those highest decreasing composition were trash fish which decreased from 1,053.800 to 300.200 kg/haul. Accordingly, the decreasing trash fish was 753.600 kg which accounted by the escaped small sized economic fish for 313.599 kg. Therefore, these escaped small sized economic fish were excluded from the trash fish which usually sold out for fishmeal industry at a low price of 5.10 Baht/kg. Thus, the losing income according to the decreasing of trash fish was only 3,843.36 Baht/haul.

Table 17: Income of pair trawl when using a codend with mesh size of 1.8 cm and enlarged to 4 cm.

Group	Codend mesh size 1.8 cm		Codend mesh size 4 cm		Difference
	Income (Baht/haul)	percent	Income (Baht/haul)	Percent	
Pelagic fish	4,942.21	24.10	5,741.34	26.56	799.13
Demersal fish	5,764.52	28.11	11,205.01	51.83	5,440.49
Cephalopod	4,124.50	20.11	2,934.19	13.57	-1,190.31
Shell	150.00	0.73		0.00	-150.00
Shrimp	91.64	0.45	189.60	0.88	97.96
Crab	16.41	0.08	-	0.00	-16.41
Other	41.28	0.20	17.45	0.08	-23.82
Trash fish	5,374.38	26.21	1,531.02	7.08	-3,843.36
Total	20,504.94	100.00	21,618.61	100.00	1,113.67

Remark: 1 Baht = 0.028 USD
Source: Phoonsawat *et al*. (2015)

Otter board trawl

The income of trawling with the 1.25 cm codend net was 3,810 Baht/haul whereas the income of trawling with the 4.0 cm codend was 3,831 Baht (Table 18). The increase of income was only 22 Baht/haul and that was from the scallop which accounted for 1,629 Baht/haul, from cephalopod for 11 Baht/haul and from crab for 37 Baht/haul. Incomes from others were all decreased.

The enlarging of the codend mesh size resulted in the decreasing of trash fish. The trash fish from 1.25 cm mesh size codend was 65 kg/haul which were sold out at the price of 5.10 Baht/kg. So, fishers derived 329.88 Baht/haul. The trash fish from 4.0 cm codend decreased to 16.727 kg/haul and the income from these catch was 85.31 Baht/haul. Therefore, fisher lost their income from losing trash fish for only 244.57 Baht/haul.

Table 18: Income of Otter board trawl when using codend mesh size of 1.25 cm and 4 cm.

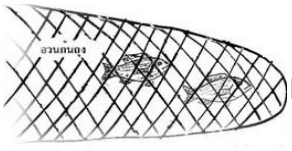
Group	Codend mesh size 1.25 cm		Codend mesh size 4 cm		Difference
	Income (Baht/haul)	Percent	Income (Baht/haul)	Percent	
Pelagic fish	41.19	1.08	12.84	0.34	-28.35
Demersal fish	1,632.47	42.85	670.64	17.50	-961.83
Cephalopod	429.24	11.27	440.18	11.49	10.94
Shell	28.532	0.749	1,658.00	43.28	1,629.47
Shrimp	1,122.19	29.46	877.70	22.91	-244.49
Crab	32.44	0.85	69.21	1.81	36.77
Other	193.60	5.08	17.25	0.45	-176.35
Trash fish	329.88	8.66	85.31	2.23	-244.57
Total	3,809.53	100.00	3,831.13	100.00	21.60

Remark: 1 Baht = 0.028 USD

Source: Phoonsawat *et al*. (2015**)**

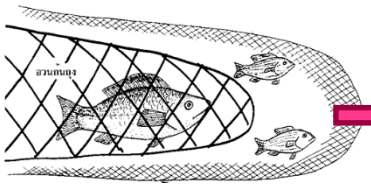
The assessment of financial impacts of changing the codend mesh size to 4.0 cm.

The assessment of the "financial losses" is by examination of the trash caught by the current codend. The expected "financial gains" of replacing the current codend net with the 4 cm codend net is examined by the calculation of the excluding economic fish from the 4 cm codend which are in trash of the current codend net. Thus, these fish are the losses of the current codend, but they are the gains for the 4 cm codend. Following this assumption, the small sized economic fish in trash in cover net is separated. The number of individual fish and weight of each species were estimated by using the length-weight relationship equation, the von Bertalanffy's growth equation, and the Exponential decay model (Sparre and Venema, 1998). So, it resulted in extrapolating the market weight of those small sized economic fish if left for some time to grow, assuming that they all will survive after the escape from the trawl codend (*more information of the potential survival of escapees can be found in Suuronen, 2005, and Broadhurst et al., 2006*). Then, the estimated value was calculated by multiplying the fish weight with fish price called expected value. So, the losses are the difference between this value and the value of small sized economic fish in form of trash. The expected gains were calculated by multiplying the increased weight if left to reach market size of the excluded fish with the fish price.



Use current net mesh size caught small sized economic fish sold as trash fish. We got the financial losses.

Current mesh size

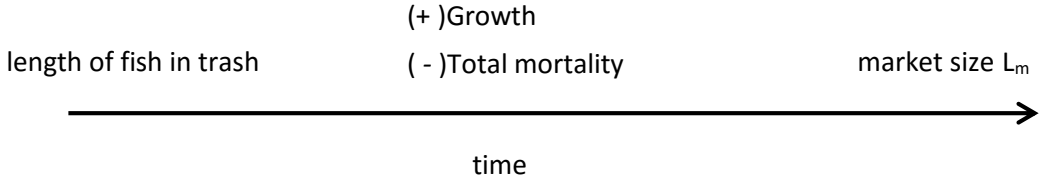


All fish in cover net was released to the sea, All of them will grow up to reach at the marketable size.

We will get financial gains.

Enlarged mesh size

However, in natural, the growth of fish to reach the market size, on the one hand has the mortality as a negative factor. The mortality of fish comprises Natural mortality (M) and Fishing mortality (F) which together is the Total mortality (Z). On the other hand, the growth (K) is the naturally positive factor. Particular species consume the time to increase their sizes and weights to reach the market size but they may decrease because of the natural mortality and fishing mortality. This phenomenon can be shown as following diagram



Pair trawl

The catch of trash fish from 1.8 cm codend net was 1,054 kg/haul. It comprised of the small sized economic fish of 512 kg/haul (49%) and true trash fish for 542 kg/haul (51%). This trash fish was sold at the price of 5.10 Baht/kg. Fishers derived totally 5,374 Baht/haul. However, fishers will derive 7,738 Baht/haul if these fish sold out at the price of market size. So, the economic loss of these fish in the form of trash fish was 2,364 Baht/haul (Table 19). The interview data indicated that, in a year, fishers have 234 fishing days and trawl for 3 hauls a day. Thus, fishing of pair trawlers results in the lost value of economic fish in the form of trash fish for 1,659,204 Baht/vessel/year.

In the case of trawling with the 4 cm codend, the small fish was released at 433 kg/haul. They included small sized economic fish at 281 kg/haul (65%) and the true trash fish at 152 kg/haul (35%). The escaped fish will grow up to reach at marketable size. So, financial gains will be 2,932 bath/haul.

Table 19: Comparison of calculated financial losses from utilization of small sized economic fish and true trash fish in pair trawl using codend mesh sizes of 1.8 cm and 4 cm.

Group of fish	Codend mesh size 1.8 cm (Baht/haul)			Codend mesh size 4 cm (Baht/haul)
	Value at trash	Value at marketable size	Financial losses	Financial gains
Pelagic fish	1,621.23	2,323.73	702.51	2,014.83
Demersal fish	641.19	783.15	141.97	352.11
Cephalopod	312.16	4,628.96	4,316.80	564.78
Shrimp	1.60	2.07	0.47	0.76
Crab	32.23	0	- 32.23	0
Other	2.00	0	- 2.00	0
True trash fish	2,763.98	0	- 2,763.98	0
Total	5,374.38	7,737.92	2,363.54	2,932.48

Remark: 1 Baht = 0.028 USD
Source: Phoonsawat *et al*. (2015**)**

Otter board trawl

The catch of trash fish from the 1.25 cm codend was 65 kg/haul which included small sized economic fish for 16 kg/haul (25%) and true trash fish for 48 kg/haul (75%) These trash fish were sold at the price of 5.1 Baht/kg. Fishers derived totally 330 Baht/haul. However, fishers will derive 542 Baht/haul if these fish were sold out at the price of market size. So, the calculated financial loss of these fish in the form of trash fish was 194 Baht/haul (Table 20). The interview data indicated that, in a year, fishers have on average 208.5 fishing days and are doing on average four trawl hauls per day. Thus, the fishing of otter board trawler results the in loss of value of economic fish in the form of trash fish at 161,413 Baht/year/vessel.

In the case of trawling with the 4 cm codend, the fish escaping were small fish and the average quantity was 63 kg/haul. They included small sized economic fish of 25 kg/haul (40%) and the true trash fish for 37 kg/haul (60%). These catch are usually sold out at the price of 5.1 Baht/kg. The fisher will get 330 bath/haul if they sell them as trash fish. If the fish were allowed to grown up to reach the marketable size, financial gain of these fish would be 493 Baht/haul or 411,056 Baht/vessel/year.

Table 20: Comparison financial losses from utilization of small sized economic fish and true trash fish as trash fish and financial gains of otter board trawl using codend mesh size of 1.25 cm and 4 cm.

Group of fish	Codend mesh size 1.25 cm (Baht/haul)			Codend mesh size 4 cm (Baht/haul)
	Value at trash	Value at marketable size	Financial losses	Financial gains
Pelagic fish	6.02	7.32	1.30	11.55
Demersal fish	69.78	509.42	439.64	446.93
Cephalopod	0.09	0.89	0.79	5.02
Shrimp	4.48	5.79	1.32	29.38
Crab	1.97		-1.97	
Other	1.26		-1.26	
True trash fish	246.28		-246.28	
Total	329.88	523.42	193.54	492.87

Remark: 1 Baht = 0.028 USD

Source: Phoonsawat *et al*. (in press)

Review previous research on enlarged codend mesh size of trawler by DoF

The study on enlarged codend mesh size was conducted in 1977 by Eiamsa-ard (1979). The trawl trial with different codend mesh size i.e. 2.5, 4.0, 5.0 and 6.0 cm and cover with 1.0 cm mesh size were done in GoT, the result showed as follows:

1. Total catch was reduced when the mesh size was increased.
2. Total catch of demersal fish was reduced when the mesh size was increased.
3. The percentage of escapement increased related to the mesh size enlargement (Table 21).
4. The percentage of escapement by species was not dependent on mesh size enlargement but depended on shape of fish (Table 22).
5. The size of fish that escaped from smaller mesh size was smaller than the larger mesh size (Table 23).
6. The appropriate codend mesh size for trawler was 4.0 cm.

Table 21: Percentage of escapement from different codend mesh size of trawler.

Mesh size (cm)	Escape (%)
2.5	0.00
4.0	19.69
5.0	45.86
6.0	64.17

Source: Eiamsa-ard (1979)

Table 22: Escape (%) from codend mesh size of 4.0, 5.0 and 6.0 cm.

Species	Mesh size (cm)		
	4.0	5.0	6.0
Saurida spp.	18.4	15.6	4.0
Nemipterus spp.	48.7	43.1	32.6
Carangid	5.3	1.4	7.8
Selar spp.	7.1	3.8	4.9
Squids	20.5	26.0	50.6

Source: Eiamsa-ard (1979)

Table 23: Average total length of main escaped species from codend mesh size of 4.0, 5.0 and 6.0 cm.

Species	Mesh size (cm)		
	4.0	5.0	6.0
Nemipterus spp.	9.0	11.0	14.0
Carangid	10.0	14.0	16.0
Selar spp.	6.0	7.0	11.0
Squids	4.0	6.0	9.0

Source: Eiamsa-ard (1979)

Sinoda *et al*. (1987) analyzed data from different codend mesh size of trawler that operated fishing in GoT, to compare with trawlers that operated fishing around South China Sea and GoT. The results showed that the appropriate codend mesh size for trawler was 5.0 cm. In addition, the size of demersal fish derived from codend mesh size 2.5 was significantly smaller than the codend mesh size 5.0 cm (Table 24).

Table 24: Length of commercial species and trash fish caught by trawler with codend mesh size 2.5 and 5.0 cm.

Mesh size (cm)	Commercial species (cm)	Trash fish (cm)
2.5	3.0-18.0	3.0-13.0
5.0	8.0-18.0	7.0-13.0

Source: Sinoda *et al*. (1987)

Thubthimsang (1989) studied on percentage of escapement from trawlers that used different codend mesh size (3, 4 and 6 cm) and different tow duration (1, 4 and 6 h). The trawl trial was done around the Eastern Gulf of Thailand with depth 10-40 m and

The results showed that the percentage of escapement increased when both mesh size and tow time were increased (Table 25).

Table 25: Escape (%) from codend mesh size 4.0, 5.0 and 6.0 cm.

Tow time	Codend mesh size (cm)		
(h)	3.0	4.0	6.0
1	6.42	5.45	30.33
2	1.09	19.52	21.39
4	19.75	28.06	47.20

Source: Modified from Thubthimsang (1989)

In 2013, MFRDD conducted the participatory trawl trial with stakeholders. The trawl trial was focused on the percentage escapement from trawler with codend mesh size 4 cm. in both otter board trawler and pair trawler in GoT. The result from 12 trawl trials for each type had shown that the escapement of OBT and PT was 21% and 52%, respectively.

6.2.8. The socio-economic condition of trawl fisheries

The study area of the REBYC-II CTI for trawl fisheries management is in Prachuap Khiri Khan Province and Chumphon Province. The study was carried out to investigate the "Socio-Economic Status of Trawlers in Prachuap Khiri Khan Province and Chumphon Province, Thailand". The specific objective of this study was to review existing socio-economic condition of trawlers in Prachuap Khiri Khan and Chumphon Provinces.

Information on existing socio-economic condition of fishery households (FH) that operated trawler in Prachuap Khiri Khan and Chumphon Provinces was collected and collated from the statistical records of Thai Department of Fisheries (DoF) and from other relevant agencies. Socio-economic data included the number of fishers and fishing vessels, landing sites, fish prices, and related socio-economic data of FH.

The survey on socio-economic condition of FH and trawlers was carried out at 3 fishing ports: Ao Noi Fishing Port, Mueang Prachuap Khiri Khan District; Pak Nam Chumphon Fishing Port, Mueang Chumphon District and Pak Nam Lang Suan Fishing Port through interview questionnaire. The interview schedule included three sections: 1) general background information on the respondents; 2) fishing activities, catch, income, and cost of trawl fishing in the last year; and 3) respondent's perceptions of fisheries resources conditions, threats, laws and regulations and participation in decision making, and their trawl fishing in the future. The interviews were conducted by the officers of CMDEC during September to November 2014. Most respondents were interviewed at fishing ports in Chumphon (80%) and the remaining respondents were interviewed in Prachuap Khiri Khan (20%). The results from this study are listed below.

- According to the price statistics of existing DoF data reviewed, an increase in trash fish price in Thailand can be considered as one of the challenges of the DoF when implementing the measure on enlargement of trawls' codend mesh size. According to the questionnaire survey results, an average price of trash fish per kg was 5.5 Baht. The otter board trawlers may lose some part of their incomes (13,365 Baht per trip). The average trash fish catch by OBT was recorded as 2,430 kg per trip. The pair trawlers may lose some part of their incomes (110,000 Baht per trip). The average trash fish catch by PT was 20,000 kg per trip. This income loss from trash fish catch should be considered when implementing such measure in the country.
- The results show that 70% of respondents were vessel owners who operate fishing by themselves, which may contribute to the level of reliability of the data collected during the survey and used for analysis in this study. The respondents are likely to have good knowledge of fishing activities in their provinces.
- Most of the respondents (70%) had no second occupation. Based on this, when the government introduces any measures that might impact on their trawl fishing activities, the

government should prepare alternatives for their livelihoods, compensation or any mitigation measures that can reduce the impacts of proposed measures.

- According to the National Council for Peace and order (NCPO)'s Order No. 24/2558 for the additional measures for combating the IUU fishing issued by the NCPO and entered into force on 5th August 2015, the possession of the trawl net with codend of mesh sizes less than 5 cm was prohibited as it was considered a destructive fishing gear. According to the Notification of DoF, Thailand promulgated in the Royal Thai Government Gazette on 30th December 2015, this law was revised from 5 cm to 4 cm However, the mesh size of codend of the net of most respondents (87%) in this study was less than 4 cm (min = 2 and max = 4 cm) and as a consequence they will have to adjust their codend mesh size to comply with this new law in order to support the government plans to combat IUU fishing. The enlargement of their codend mesh size would also help to reduce the percentage of trash fish on each trip.
- The highest operating cost of trawl fishing is fuel (67% of total cost). Any measures that reduce this cost would therefore benefit the trawlers.
- Most of the respondents were satisfied on the returns from the trawl fishing. This result is consistent with the last question about the future of their trawl fishing. Most of the respondents (77%) said that they can continue with their trawl fishing activities. This confirmed that the trawl fishing activities in the study area still provide benefits to the local community.
- In general, the condition of fisheries resources was not good and the main threats to these resources were mainly marine pollution and illegal fishing. The rehabilitation measures for fisheries resources in addition to measures that prevent the impacts of these threats should be considered, implemented or strengthened.
- The issues of law enforcement and participation in decision making should be addressed in order to sustain management of trawl fisheries in the study area.

6.2.9. Results from stakeholder consultation

Four stakeholder consultation meetings were conducted under the project as follows;

1. The By-catch Management for Trawl Fisheries in Prachaub and Chumphon Provinces on 7 November 2013. The objectives were as follows.
   1.1. To make fishers, stakeholders, local officials know about the REBYC-II CTI project in detail.
   1.2. Plan and set together operational details with fishers to take up on enlarged codend mesh size for trawlers.
   1.3. Select fisher volunteers to accompany and part of demonstration of the sea trial experiments.
2. Consultation on Trawl Mesh Size Enlargement Experiments on 23 September 2014. The objectives were as follows.
   2.1. Assess the impacts of enlarging the trawl codend mesh size from 2.5 cm to 4 cm mesh size in the Chumphon area of the Gulf of Thailand.
   2.2. Presentations for fishers about fisheries biology, socio economics and law and regulation of trawl fisheries.
   2.3. Provide fishers an understanding of scientific analysis results of the mesh size experimentation and experience in trawl fisheries co-management, through planning and working with the DoF.
3. Joint Local Meeting with Chumphon Province on "Trawl Fisheries and bycatch management on 28 July 2015. The objectives were as follows.
   3.1. To strengthen local fisher knowledge on trawl fisheries and bycatch management.
   3.2. To introduce the concept of codend mesh size of 4.0 cm for trawlers.
   3.3. To consult with local fishers on using other measures for trawl fisheries and bycatch management.

4. Public Hearing on "Trawl fisheries and bycatch Management" on 3 August 2015. The objectives were as follows.
   4.1. To raise fisher awareness of the present status of trawl fisheries.
   4.2. To hear fisher opinions about the DoF's plans to implement a 4.0 cm minimum mesh size for trawl codend.
   4.3. To hear fisher opinions about the DoF's plans for other trawl fisheries and bycatch management measures.

An average of 155 participants participated in the four meetings which included trawl fishers, fish processors, fish dealers, fishers organizations in GoT and ADS, Provincial Administrative Organization (PAO), Sub district Administrative and Organization (SAO) in Prachuap Khiri Khan and Chumphon Provinces and government officials from DoF, DMCR, NGOs, SEAFDEC RFU. In the 1st meeting, Representative of CMDEC presented the status of fishery resources in Prachuap Khiri Khan and Chumphon Provinces and proposed some ideas to manage the fisheries resources through enlarging trawl cod-end mesh size. The demonstration of the trawl trial experiments (OBT and PT) was conducted in cooperation with fishers, stakeholder, DoF officials and SEAFDEC RFU to get best results and acceptance.

The Fisheries Society of Paknam Chumphon provided OBT and PT vessels from Samut Sakorn, Samut Prakarn and Samut Songkram which were used for fishing experiments in Prachuap Khiri Khan and Chumphon waters. SEAFDEC RFU provided technical assistance for trawl fishing gear design.

After the 1st meeting, CMDEC and consultants of the project conducted experimental survey on trawl trial, marine resources and socio-economic condition of fishers. The results of the studies are summarized in the previous parts. During the 4 meetings, other information was supplemented. The results from the several experiments done by DoF on cod-end mesh size enlargement of trawler, the mesh size of cod-end used in foreign countries, law and regulation related to trawler were all presented.

In the 4th meeting, CMDEC Trawler fishers suggested DoF to do as follows:

Representatives of the fishers accepted the idea of enlarged mesh size but they requested to use 3.0-3.5 cm mesh size and apply a gradual, stepwise, increase.

Public Hearings should be held in many places to cover all stakeholders.

Participants of the meeting should show their licenses to exclude those who were fishing illegally.

The DoF should use media for spreading data and information of codend mesh size enlargement for widespread announcement beforehand.

The DoF should be clear and effective in enforcing action the illegal types of fishing gear.

The size of fishing vessel (Engine power) should be considered in licensing.

The DoF should note and take into account that each type of trawler has not the same target species (there are fish trawler, shrimp trawler, pair trawler, otter board trawler), and it should be noted that each province has different areas and fish composition. Mesh size measures for different areas should not be the same.

7. Review of Thai laws in relation to trawl fisheries

The Fisheries Act B.E 2490 (1947) is the principal legislative instrument dealing with fisheries and the cultivation of aquatic animals. Although various efforts have been made over the last decade to draft and adopt new fisheries legislation, the Fisheries Act is currently still in force. The Act is administered by the Ministry of Agriculture and Cooperatives (MOAC). The Department of Fisheries (DoF) is the principal government agency responsible for managing and developing fisheries and aquaculture.

The Fisheries Act is further implemented at the provincial and district level. The Royal Decree on Administration sets out the authority of both the Provincial Fishery Officer (each province has a Provincial Fishery Officer) and the District Fishery Officers. The District Office and the officers therein report to the Provincial Officer. The Tambol Administrative Organization Act B.E. 2537(1994) empowers local communities, at the sub-district level, to manage and conserve natural resources and the environment in their localities. But these powers still prohibit local communities from issuing local regulation in their areas with respect to fishery management. This is because the Fisheries Act 2490 (1947) does not provide authority to the local government to issue local provisions in this regard. The Provincial Administrative Organization Act B.E. 2540 (1997) empowers the Provincial Administrative Organization to formulate provincial development plans, coordinate and cooperate with Tambol Administrative Organizations, allocate budgets to Tambol Administrative Organizations, protect and conserve natural resources and environment in their territories.

7.1. Fisheries Act B.E. 2490 (1947)

The principal legal instrument is the Fisheries Act B.E. 2490 (1947), later amended in 1953 and 1985. It is composed of 73 sections and directed primarily to the freshwater fisheries (inland fisheries) and the collection of fees for the use of certain fishing gear. The Act provides for the adoption of regulations (instruments that require cabinet's approval) and notification (instruments that can be issued directly) pursuant to the Fisheries Act. There are 19 notifications of the Ministry of Agriculture and Cooperatives and 4 provincial notifications which have been issued regarding trawl and push net fisheries.

The fundamental purpose of the B.E. 2490 (1947) Fisheries Act is that whoever wants to fish may fish subject to paying a fishing fee, subject to certain restrictions on season, area, types of gear and mesh sizes.

Section 25 of the Act provides that the Minister can make notifications requiring that all persons engaged in fishing or trade in fishery products be registered and apply for permission before undertaking the activity. Failure to comply with such a notification gives rise to a minor penalty under Section 63. Ministerial regulations and notifications have been issued under Section 25 of the Fisheries Act with respect to coastal shrimp aquaculture.

Section 26 provides that the Minister can issue a notification requiring owners or possessors of any kind of fishing implement (fishing gear) to have the gear registered. The failure to comply with a notification gives rise to a minor penalty under Section 63.

Section 28 provides that a person is "entitled" to use a licensed fishing implement when a license has been issued and the fishery fee paid. A licensed fishing implement is defined as a fishing implement specified by Ministerial Regulation. Use of a fishing implement without a license gives rise to a fine three times the fee due.

Section 32 provides that the Minister and provincial governor have made the regulation and notifications that are relevant to marine capture fisheries and trawl fisheries.

The Minister or provincial governor in his jurisdiction and with the approval of the Minister is empowered to make the notification determining:

1. *the size of mesh and dimension of every kind of fishing implement, size, kind, number and parts of fishing implement, which is permitted in fisheries;*
2. *Any kind of fishing implements which is absolutely forbidden to be used in fisheries;*
3. *The distance between each stationary gear;*
4. *The methods of using every kind of fishing implement;*
5. *The spawning and breeding seasons, fishing implement and methods of fishing in fisheries during the said season;*
6. *The kind, size and maximum number of aquatic animals the fishing of which is permissible;*
7. *Certain kinds of aquatic animals, the fishing of which is absolutely forbidden.*

It seems to be that the Minister has the authority to deal with all kinds of gear restrictions, open and closed seasons, and to establish quotas. It is also recognized that a fishing implement includes a fishing vessel. Section 32 gives Ministerial regulatory power with respect to the number of vessels (hence control on entry into the fishery).

The Ministerial Regulation, Notification and Provincial Notification that has been issued pursuant to Section 32 of the Fisheries Act fall into several categories as follows:

1. From B.E. 2523 (1980), 2539 (1996) Ministerial Regulations were adopted to control the number of fishing trawl and push nets.
2. From B.E 2496 (1953), 2518 (1975), 2550 (2007), and 2551 (2008), Ministerial Regulations were adopted to prohibit the use of trawl nets and push nets during the spawning and breeding season of certain commercially important species.
3. From B.E. 2515 (1972), Ministerial Regulations were adopted to prohibit the use trawl and push nets from the area within 3 km of the shoreline. And in B.E. 2550 (2007), 2551 (2008), 2552 (2009), and 2554 (2011) Ministerial Regulations were adopted to prohibit the use of trawl, push nets from the area within 5.4 km of the shoreline in 10 provinces.
4. From B.E 2535 (1992), 2541 (1998), 2542 (1999), 2543 (2000), and 2546 (2003), Ministerial Regulations and Provincial Regulations were adopted to prohibit the use of trawl and push nets from specific areas in each province.
5. From B.E. 2534 (1991), 2543 (2000), and 2544 (2001), Ministerial Regulations were adopted mesh size limitations for specific fishing gear (purse seine, anchovy and squid light luring fishing gear). But there is still no mesh size limitations for fishing by trawl and push nets.
6. From B.E 2550 (2007), Ministerial Regulations were adopted for the creation of closed seasons, certain closed areas and the regulation of fishing trawl and push nets. It will control fishing during 15 February to 15 May of each year. As the blockade, the Department of Fisheries will control the fisheries in Prachuap Khiri Khan, Chumphon and Surat Thani, covering an area of about 26,400 km^2. From B.E. 2551 (2008), it will also control the fishing along the Andaman coast for a period of three months: from April 15 - June 15 which covers an area of 4, 696 km^2, in the four provinces of Phuket, Phang Nga, Krabi and Trang. These two Ministerial Regulations have been adopted for more than 30 years, and have been recently adapted due to fishermen having modified their gear to fish in the prohibited areas, resulting in the Department of Fisheries developing the regulations several times, and lastly in B.E 2550 (2007) and 2551 (2008) to prevent their fisheries within the areas.

In B.E 2556 (2013), Ministerial Regulation was adopted which created closed seasons, certain closed areas, and the regulation of fishing trawl and push nets in the Upper Gulf of Thailand from 1 June to 31 July of each year. This blockade covers an area about 6,075 km^2, in 8 provinces: Prachuap Khiri Khan, Phetchaburi, Samut Songkhram, Samut Sakhon, Bangkok, Samut Prakan, Chachoengsao, and Chonburi.

A number of notifications have been implemented regarding trawl and push net fisheries, as set forth in the table below:

Control Number of Trawl and Push Nets	Issuer of Notification	
	National	Local
1. Notification of the Ministry of Agriculture and Cooperatives regarding the use of trawl and push nets with motorized vessels No. 3 (2523), dated March 26, B.E. 2523 (1974).	X	
2. Regulation of the Ministry of Agriculture and Cooperatives regarding implementation procedures on controlling the number of trawl and push nets, dated September 17, B.E.2539 (1996).	X	

Control Number of Trawl and Push Nets	Issuer of Notification	
	National	Local
Prohibit the use of Trawl and Push Nets during the spawning and breeding season of certain commercially important species		
1. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of trawls attached with nets and push nets in fishing in Chonburi province, dated June 26, B.E. 2518 (1975)	X	
2. Notification of Ministry of Agriculture and Cooperatives regarding prohibition on the use of certain kinds of fishing appliances in fishing in the spawning and breeding season in Prachuap Khiri Khan, Chumphon and Surat Thani Provinces during the determined period, dated January 24, B.E. 2550 (revised update, 2007).	X	
3. Notification of Ministry of Agriculture and Cooperatives regarding prohibition on the use of certain kinds of fishing appliances in fishing in the spawning and breeding season in Phuket, Phangha, Krabi, Trang Provinces during the determined period, dated October 24, B.E.2551 (revised update, 2008).	X	
4. Notification of Ministry of Agriculture and Cooperatives regarding prohibition on the use of certain kinds of fishing appliances in fishing in some fishing areas in Prachuap Khiri Khan, Phetchaburi, Samut Songkhram, Samut Sakhon, Bangkok, Samut Prakan, Chachoengsao, and Chonburi Provinces during the determined period, dated August 13, B.E.2556 (2013)	X	
Prohibition on the use of Trawl and Push Nets from the area within 3 km and 5.4 km of the shoreline		
1. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels, dated July 20, B.E.2515 (1972).	X	
2. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Trang Province, dated October 9, B.E. 2550 (2007).	X	
3. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Krabi Province, dated October 9, B.E. 2550 (2007).	X	
4. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Prachuap Khirikhan Province, dated October 9, B.E. 2550 (2007).	X	
5. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Rayong Province, dated January 3, B.E. 2551 (2008).	**X**	
6. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized	X	

Control Number of Trawl and Push Nets	Issuer of Notification	
	National	Local
vessels in some fishing areas in Narathiwat Province, dated January 3, B.E. 2551 (2008).		
7. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Pattani Province, dated January 3, B.E. 2551 (2008).	X	
8. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Satun Province, dated January 29, B.E. 2552 (2009).	X	
9. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Nakornsithamrat Province, dated July 17, B.E. 2552 (2009).	X	
10. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Chumphon Province, dated April 11, B.E. 2554 (2011).	X	
11. Notification of the Ministry of Agriculture and Cooperatives regarding prohibition of using trawl and push nets with motorized vessels in some fishing areas in Chantaburi Province, dated December 11, B.E. 2555 (2012).	X	
Prohibition on the use of Trawl and Push Nets from specific areas in each province		
1. Notification of Trang Province regarding the prohibition of using certain fishing gear in the sea grass in designated areas, dated 16 May, B.E. 2535 (1992).		X
2. Notification of the Ministry of Agriculture and Cooperatives regarding the prohibition of using trawl and push nets in fishing in Phangha Bay, dated 14 December, B.E. 2541 (1998).	X	
3. Notification of Chonburi Province regarding the prohibition of using beam trawls with motorized vessels, fishing in local Chonburi, dated 23 March, B.E. 2542 (1999).		X
4. Notification of Prachub Khirikhan Province regarding prohibiting the use of certain fishing gear in designated areas, dated 19 October, B.E. 2542 (1999).		X
5. Notification of Trat Province regarding prohibiting the use of trawl nets, push nets and clam rake tool fishing in Channel Island of Koh Chang, Trat, dated 28 March, B.E. 2543 (2000).		X
6. Notification of the Ministry of Agriculture and Cooperatives regarding the prohibition of using push nets with motorized vessels in fishing in certain areas in Pattani Province, dated 17 July, B.E. 2546 (2003).	X	

7.2. Thai Vessels Act B.E.2481 (1938)

Besides the Fisheries Act, there is another Act which has relevance to trawl fisheries matters, Thai Vessels Act B.E. 2481 (1938). Under this Act, fishing vessels in Thailand must register with the Marine Department, and may be allowed to do fishing (with a License) from the Department of Fisheries, which is in a different Ministry. This makes the control of number of fishing vessels inefficient to match with of the aquatic resources carrying capacity.

Under the Thai Vessels Act B.E. 2481 (1938), the Marine Department is responsible for fishing vessels. The procedures of the Department are as follows.

Section 6: Thai ships must register with the Registrar of Ships.

Section 8: For fishing, non-motorized vessels of all sizes and motorized vessels ranging in size from 6 GT are to be registered as a Thai fishing vessel from the Marine Department by filling out a registration form at the Marine Department or harbour district vessel owners domiciled.

An application for a fishing license must be submitted to the Department of Fisheries under Fisheries Act Section 25 which provides that the Minister can issue notifications requiring that all persons engaged in fishing or trade in fishery products be registered and apply for permission before undertaking the activity. The license applicant shall submit an application to the local district (local district fisheries office).

The cabinet resolution dated January 31, 2555 (2012) stated that currently in the approval of registered fishing vessels, these must only be approved by the Marine Department under Ministry of Transport. However, due to the large number of approved registered fishing vessels, the number of ships that are appropriate to the volume of aquatic resources must be considered, too. Thus, the registration of fishing vessels must earn approval from both of the Departments of Fisheries, Ministry of Agriculture and Cooperatives, and Marine Department, Ministry of Transport. The cabinet has assigned the Ministry of Agriculture and Cooperatives and the Ministry of Transportation to work in coordination regarding the implementation of the registration of fishing vessels. The applicants for registration of vessels and fishing vessel category must have a notice from the Department of Fisheries that they are allowed to enroll the fishing vessels and show such notice before registration of vessels with the Marine Department.

7.3. The Command Center for Combating Illegal Fishing (CCCIF)

Command Center for Combating Illegal Fishing or CCCIF was established by the National Council for Peace and Order (order no. 10/2015) to counter illegal, unreported, and unregulated fishing dated 28 April 2015. This is the special mission center reporting to prime minister and the chief of staff of the royal Thai navy is the commander of CCCIF. Tangible progress on regulating IUU fishing has been made in 5 aspects: development and amendment of related laws, development of key systems, law enforcement, international cooperation, and assistance provided to victims of IUU fishing.

1. Amendment and development of related laws: The Fisheries Act, B.E. 2558, has been into force on November 14, 2015 with the aims to address the problem of IUU fishing and to promote fishing industry in a sustainable manner. Five measures were implemented under the Act: licensing system, inspection of fishing vessels, traceability system, efficient law enforcement, and execution of laws. The 5 measures were implemented by 28 Port in - Port out Control Centers, Fishery Department, Ministry of Labor, Marine Department, and law enforcement multidisciplinary teams. In order to promote better understanding, the Government published and disseminated "Fishermen Version" of the manual on Fisheries Act.
2. Development of key systems: The Government set up the following systems:
    2.1. Monitoring, Control and Surveillance (MCS) at CCCIF and the Fishery Department. Vessel Monitoring System (VMS) has also been installed in 2,076 out of 2,216 vessels with 60 gross tonnage and above (about 93.7%) which helps enhance monitoring of fishing vessels in an efficient manner.

2.2. Traceability System: the system enables authorities and consumers to trace whether fishing products are from the act of IUU fishing. Traceability system with E-License was launched on 30 March 2016. Vessel management system / real time and online vessel licensing system have also been launched since December 2015. The first training of Observer on Board was held on December 4, 2015, and was ready for operation in January 2016. There are also a number of capacity enhancement programs, such as staff training, and publication of staff operation manual.

3. Law enforcement on fishing vessels and seafood processing factories: With regard to fishing vessels, integrative task forces were assigned to perform interdisciplinary task in vessel inspection and law enforcement in compliance with EU requirement. As of now, 474 vessels with 60 gross tonnage and above (about 21.5%), and 53 out of 73 overseas fishing vessels have been inspected, out of which 90 vessels were caught and prosecuted for IUU fishing. Prohibition of marine animal transport at sea for 180 days from December 25, 2015 was also announced. In addition, migrant workers are urged to register themselves by February 2016 as part of the Government's effort to legalize the workers (over 35,000 have already registered). On January 12, 2016, the cabinet also approved in principle draft ministerial act on prohibition of child labour under 18 years of age, and draft Act on Human Trafficking Court Procedure.
4. International Cooperation: Thailand is fully aware that close collaboration with foreign friends, international organizations, and non-government organizations are crucial in fighting against IUU fishing. MoUs on fishery and labour have been signed or under negotiation with 13 countries, ranging from the neighboring countries to the Pacific Islands, and EU member states. Thailand also signed MoUs on bilateral cooperation in labour import with Cambodia and Vietnam, and on agriculture and fishery with Fiji. International organizations, such as the Greenpeace, EJF, and ILO acknowledged Thailand's effort in addressing IUU fishing, as well as its priority placed in development of VMS, and promotion of labour standard.
5. Assistance to affected fishermen and labours in fishing industry: The Thai Government strives to provide assistance to victims of human trafficking, for instance, in the case of helping 1,398 Thai fishermen to return to Thailand of which 54 were victims of human trafficking. It also categorized fishing vessels in terms of fishing purposes (commercial and local fishing vessels) in a bid to assist local fishermen for them to be able to continue with their occupation. Out of 873 local fishing vessels that made a request for Government's subsidies, 70% have been provided, while the Government has rushed to help out the rest. These measures are aimed to promote legal and sustainable fishing activities. The Thai Government strives to work closely with all stakeholders, including the private sector and civil society, in combating against IUU fishing and encouraging participation of all sectors in addressing the issue. The evaluation of EU is beyond the Government's control, and regardless of the result, Thailand commits to fight against IUU fishing in order to protect, and sustain marine resources, as well as promote sustainable fishery for the next generations to come.

A number of notifications have been implemented regarding trawl fisheries by CCCIF, as set forth in the table below:

	Issuer of Notification	
	National	Local
1.National Council for Peace and Order regarding prohibition of trawler operated fishing with codend mesh size less than 5 cm, dated 5 August, B.E. 2558 (2015)		
2. CCCIF notification regarding prohibition of using trawler operate fishing in date 3-5 and 11-12 in September, October and November B.E. 2558, dated 5 August, B.E. 2558 (2015)	X	

3. CCCIF notification regarding prohibition of using trawler operate fishing in date 3-5 and 11-12 in September, October and November B.E. 2558, dated 5 August, B.E. 2558 (2015)	X	
4. CCCIF notification regarding prohibition of using trawler operate fishing in date 3-5 and 16-17 in every month for trawler that LOA less than 30 GT and prohibition of using trawler operate fishing for 5 days per month in every month for trawler that LOA equal and more than 30 GT, dated 29 November, B.E. 2558 (2015)	X	

7.4. Royal Ordinance on Fisheries B.E.2558 (2015)

The Royal Ordinance on Fisheries B.E. 2558 (2015) came into force on 14 November 2015, replacing the recently amended Fisheries Act B.E. 2558 (2015).

The new legislation amounts to a fundamental and comprehensive reform of the legal framework governing Thai fisheries. The provisions of this Royal Ordinance aims to reorganize fisheries in Thailand and in waters at large with a view to preventing IUU fishing in order to preserve aquatic animal resources as a sustainable source of food for humanity and preserve the environment in an appropriate state along the line of approaches, criteria and standards recognized internationally, as well as to protect the welfare of seamen and prevent all forms of forced labor in the fisheries sector, with due regard to the following objectives:

1. Achieving good governance in the management and conservation of aquatic resources and the fisheries sector, and ensuring that complete and accurate data thereof are collected;
2. Protection of special interests of artisanal fisheries and local fisheries communities;
3. Fulfilment of Thailand's international obligations with regard to the conservation and management of aquatic resources;
4. To provide effective means for preventing, deterring and eliminating IUU fishing, as well as unlawful labour practices in the fisheries sector.
5. Use of best available scientific evidence to achieve long-term economic, social and environmental sustainability, in line with the ecosystem based approach and precautionary approach, to ensure that fisheries resources are maintained or restored to a level that can produce the maximum sustainable yield;
6. Prevent and eliminate overfishing and overcapacity and ensure that the level of fishing effort does not undermine the sustainability of fisheries resources;
7. Implementation of systematic measures for the application of this Royal Ordinance;
8. Cooperation with other states, private agencies, as well as international organizations, with a view to achieving the objectives under this Royal Ordinance;
9. Ensure legal working conditions and welfare of workers in all areas of the fisheries sector;
10. Ensuring effective monitoring, surveillance and control of fishing activities;
11. Implementation of an effective traceability system from fishing operations to ultimate consumers;
12. Imposing proportional and deterrent administrative and criminal sanctions.

The new legislation includes important new principles related to trawl fisheries management, such as:

1. The demarcation of marine fishing in the waters of Thailand into two areas.

"Coastal seas" means the seas lying within the Kingdom extending up to three nautical miles from the baselines. In light of exigencies based on purposes related to aquatic resource management, a Ministerial Regulation may be issued to determine the expanse of coastal seas in any area to cover a distance starting from the baseline shorter or further than three nautical miles as appropriate. Any such adjustment shall not result in a distance off the baseline of less than one point five nautical miles

nor of further than twelve nautical miles. In any such case, a map delineating the areas prescribed thereby shall be attached to any such Ministerial Regulation.

"Offshore seas" mean the seas located in the Kingdom beyond the coastal seas up to either the extreme bounds of the exclusive economic zones pursuant to the Notification on the exclusive economic zones of the Kingdom of Thailand or the extreme bounds of the continental shelves under the sovereignty of the Kingdom of Thailand, the further boundary of either being the line to prevail.

2. Marine fishing is classified into two types.

"Artisanal fishing" means fishing operations in coastal seas in which a fishing vessel is used or in which a fishing gear is used without a fishing vessel, but in any case does not include commercial fishing.

"Commercial fishing" means fishing operations using a fishing vessel of a size from ten GT or a fishing vessel fitted with an engine of a horse power as prescribed by the Minister.

The demarcation of marine fishing area into 2 zones and classification of marine fishing cause trawler which were classified as "Commercial fishing" cannot operate fishing in "Coastal seas" (three nautical miles from the baselines).

3. More effective fisheries management and stakeholders' involvement.

A National Fisheries Committee, chaired by the Prime Minister and comprising relevant public officials, private sector representatives and fisheries experts, is established to formulate policies and control measures concerning fisheries, both inside and outside Thai waters, and fisheries related industries. Such policies are to be approved by the Council of Ministers.

A Provincial Fisheries Committee, comprising provincial government officials and experts from local fishing community organizations, is established in each designated province. Its main task is to propose to the National Fisheries Committee policy recommendations concerning fisheries development and resolution of fisheries problems in the province.

Provincial Fisheries Committee allows public participation in the management, maintenance, conservation, and utilization of aquatic resources. It will result in better long-term aquatic resources management that will allow the state to define management measures consistent with the area and the needs of the people which the existing law has not explicitly stated.

Provincial Fisheries Committee shall have the power to issue notifications regarding fishing gears according to their forms, fishing methods, fishing areas, the size of fishing vessels used in fishing operation and other conditions that are prohibited from fishing operations in fishing grounds.

4. Improved oversight of fishing operations.

All commercial fishing vessels, which are of 10 GT or above or fitted with an engine of a certain horse power prescribed by the Minister, are required to have valid fishing licenses and licenses valid for 2 years. The issuance of fishing licenses is subject to fishing capacity and maximum sustainable yield as stipulated in the Marine Fisheries Management Plan.

All commercial fishing vessels must record their fishing operations in the fishing logbook and report every port-in and port-out operation to the Port In - Port Out Control Center. Commercial fishing vessels of above 30 GT must install a vessel monitoring system (VMS) on board. They are not allowed to fish in coastal seas.

5. Enhanced traceability system

The mandatory submission of fishing logbook and marine catch transhipment document by fishing operators is designed to enhance traceability of the catch.

Fishing ports and fish markets are required to record data on every fishing vessel berthed at port, as well as prepare a marine catch purchasing document (MCPD) for a buyer and submit a copy to the Department of Fisheries. The MCPD is also required for every subsequent transaction involving the

catch. In addition, the producer or processor of aquatic animals must prepare evidence for traceability purposes.

6. Deterrent sanctions

The law introduces proportional and deterrent administrative and criminal sanctions. The issuing authorities may suspend a vessel's fishing license or permit for a period of up to 90 days, if the licensee or permit holder fails to comply with the Royal Ordinance and subordinate laws. If the licensee or permit holder re-commits a violation of the law, his or her license or permit may be revoked. Transhipment registration may also be cancelled in case of non-compliance with the requirements specified by the Royal Ordinance and subordinate laws.

A number of "serious infringements" are defined in the Royal Ordinance, such as the use of a stateless vessel and a prohibited fishing gear, fishing without a fishing license, failure to prepare a fishing logbook, use of false documents and violation of transhipment at sea rules.

Deterrent administrative sanctions are applicable to these serious infringements. The Director-General may, inter alia, order a seizure of the catch or fishing gear, prohibition of fishing activity until full compliance is achieved, suspension of fishing license, revocation of fishing license, inclusion of the vessel into the IUU list, and detention of the vessel.

Criminal sanctions are designed to be deterrent and proportional for different sizes of fishing vessels, with a maximum fine of 30 million Baht (approximately 780,000 Euros) or five times the value of the catch obtained from the fishing operation, whichever case is higher. If a serious infringement is re-committed within a period of five years, the penalty prescribed shall be doubled.

Ten notifications have so far been implemented regarding trawl fisheries under the Royal Ordinance on Fisheries B.E.2558 (2015), as set forth in the table below:

	Issuer of Notification	
	National	Local
1. Notification of the Department of fisheries regarding port in port out rules and procedures for commercial fishing boat, dated 25 December, B.E. 2558 (2015)	X	
2. Notification of the Department of fisheries regarding determine criteria and the duration for fishing operation of commercial fishing boats, dated 25 December, B.E. 2558 (2015)	X	
3. DoF notification regarding prohibition of using trawl net with codend mesh size under 4 cm, dated 25 December, B.E. 2558 (2015)	X	
4. Notification of the Department of fisheries regarding prescribed format of fishing logbook, the timing and procedures for reporting for commercial fishing boat, dated 28 December, B.E. 2558 (2015)	X	
5. Regulation of the Ministry of Agriculture and Cooperatives regarding the prohibition of using certain fishing gear in "Coastal seas", dated 12 February, B.E. 2559 (2016)	X	
6. Notification of the Ministry of Agriculture and Cooperatives regarding the measures for the management of fisheries resources, dated 12 May, B.E. 2559 (2016).	X	
7. Notification of the Ministry of Agriculture and Cooperatives regarding the size of a commercial fishing boat must be controlled and monitored, dated 10 May, B.E. 2559 (2016).	X	

8. Notification of the Department of fisheries regarding the rules of how to installation Vessel Monitoring System (VMS) and VMS must be function any time No.2, dated 4 May, B.E. 2559 (2016)	X	
9. Notification of the Department of fisheries regarding the rules of how to installation Vessel Monitoring System (VMS) and VMS must be function any time No.2, dated 28 September, B.E. 2559 (2016)	X	
10. Notification of the Department of fisheries regarding port in port out rules and procedures for commercial fishing boat, dated 20 September, B.E. 2559 (2016)	X	

8. Lessons Learned

This section highlights some of the lessons learned by staff of DoF through the REBYC-II CTI project. The lessons learned were shown under the 4 components of the project as follows:

8.1. Policy, legal and institutional frameworks component

Resource management plans must respond to prioritized issues identified by communities and harmonized with national and provincial legislation, policy and plans. Management process must be participated by stakeholders in every step for encouraging acceptance and strengthen the management plan implementation.

8.2. Resource management and fishing operations component.

Accurate and up-to-date knowledge on fisher numbers, gear types, fish landing quantity, fishing activities, resource mapping, socio-economics of fisher, law and regulation etc., in fisheries is the key of the management planning. Fisheries administration agencies and communities should have a common understanding on fisheries and fisheries resources for improving fisheries management program. For implementing any fisheries management measures, such as seasonal and area closure, fishing gear restriction, etc., it should be supported by scientific evidences that are monitored and evaluated continuously.

In 2015, Thailand has significantly improved registration system of fishing vessels and fishing licenses for both small scale and commercial scale fisheries. This improvement may provide a reliable number of fishing vessels and fishing licenses which can be used for research and management.

The enumerators who will conduct interviews should have a good clear understanding on small scale and commercial fisheries. In this study, all enumerations were carried out by the officers of EMDEC and CMDEC. These officers have good background knowledge on fishing activities in the study area. From enumerations, it was found that the enumerators who are scientist were not familiar with socio-economic interviewing.

It should be kept in mind that, in fisheries management, we have to manage the fishers who exploit the resources, not just fisheries resources. Therefore, the understanding on socio-economic conditions of the fishers is the key factor for successful management.

8.3. Information management and communication component

One of the key factors to achieve a success in every step of participatory fisheries management process is the inter-intra relationships among fishing communities, government agencies and other

institutions which should be taken into account. Knowing these relationships will lead to obtaining reliable data and information collection.

The relationships can be created through data gathering and discussion of the results, where all stakeholders should be involved or at least to be consulted. However, in practice, it takes a long time for data collection, planning process, community consultation as well as developing training mechanisms, training, data, analysis etc. This can hardly be completed within limited time frame of a short project.

8.4. Awareness and knowledge component

Fisheries department staff may have good experience on scientific finding, but they are not familiar with social interactions. From this project, the staff got more experiences on social interactions through stakeholder consultations, meetings that they play an important role as trainers or resource persons. In addition, in order to encourage awareness of the stakeholders, continuous campaigns and wide spread public hearing should be done.

9. Conclusions

The marine demersal resources in the Gulf of Thailand are overexploited. The fishing effort in 2014 of demersal resources was greater than the optimum level by about 33%. These resources are caught mainly by trawl gear and the catch comprises of trash fish almost up to half of the catch landed. These trash fish comprised of juveniles of economic fish up to 5%. To find solutions to "bycatch" problem, work was done in 2 pilot sites, i.e. in Trat and Prachuap Khiri Khan and Chumphon Provinces in the Gulf of Thailand. Based on evidence found in the project, the management of trash fish (bycatch) should be carried out in participation with fishers and other key stakeholders, and in close collaboration with all relevant agencies.

Fisheries resources in Trat, Prachuap Khiri Khan and Chumphon Province are in declining state. Average total length of some key economic species showed a critical status – specimen caught are smaller than in the past. CPUE of research vessel trawl show continuous decline in the resources.

Several issues demonstrating the decline of fisheries resources were discussed under REBYC-II CTI project such as huge amount of trash fish, overfishing, reduction of CPUE and small size economic fish being caught, which are all signs that fisheries management actions are not effective. Effective fisheries management measures widely accepted by stakeholders are urgently needed.

To address the issues, EMDEC and CMDEC of DoF conducted research activities in Trat and Prachuap Khiri Khan-Chumphon Provinces for the purpose of demarcation of conservation zone for juvenile fish and breeding stocks in the area of Trat Province and experiment on enlarging trawl codend mesh size in the Prachuap Khiri Khan-Chumphon Provinces.

The project activities in REBYC-II CTI project were implemented under participatory fisheries management concept as specified in Royal Ordinance on Fisheries B.E.2558 (2015) to formulate proposed action plan are as follows:

1. Review existing data and analyse the collected data such as fishery resource status, socio-economic, and fish larvae distribution, including local knowledge, to formulate proposed action plan.
2. Propose information for fisheries management plan in Consultation meeting.
3. Public hearing with fishers and other stakeholders.
4. Propose agreed management plan to the Provincial Fisheries Committee.
5. Propose approved management plan to the DoF.

6. DoF to further submit it to the Minister of Agriculture and Co-operatives to issue the Ministerial Notification.
7. It is to be announced in the Royal Gazette, to become effective.
8. Awareness campaign for the new fisheries management measures, through seminars meeting and media.

Three year research project was done to find the effective information i.e. status of fisheries resources, socio-economic of fishers, fish larvae distribution, enlarging trawl cod-end mesh size and Thai Laws in Relation to Trawl Fisheries. The research projects were done in collaboration of stakeholders to achieve the acceptance of the results. The outcome of the research was used to support decision making by both governors and stakeholders.

9.1. Trat Province site

The results of research studied during the project in Trat project site showed that the CPUE of OBT was 23 kg/hour of which 64% was food fish and 36% was trash fish. The trash fish comprised of small economic species to the extent of40 %. Fish larvae abundance and distribution study revealed the dominance of Gobiidae, Carangidae and Clupeidae which were on average 37, 21 and 20 individuals/1,000 cubic meters. The result showed that the density of fish larvae depend on the monsoon season or breeding and spawning season. The northeast monsoon season in March is the most abundant fish larvae season and both commercial and true trash fish larvae had highest abundance in proposed fisheries management area of Trat (zone 1 and zone 2).

The socio-economic study investigated differences in fishing activities, income, and cost, and other major differences between small-scale fishery households and medium to large-scale fishing households. Main fishing gears used, main fishing zones, and incomes (before deducting cost) were different for the two groups of respondents. The main fishing gears used by small-scale households were shrimp trammel nets, crab gillnets, and crab traps while for medium to large-scale households, push nets, trawls, and purse seines were more common. The fishing grounds of small-scale households were close to the shore. While medium-large-scale households had their fishing grounds further from the shore. Incomes before deducting the cost of fishing were higher for medium to large-scale households than for small-scale fishers, by a factor of 7 times (1,000 and 7,000 Baht per day). To demarcate fishery conservation zone, there is a need to consider these fishing grounds. Banning fishing gears, in particular the main fishing gears used by the two groups, should be considered carefully to assess the possible impact of any ban. Loss of income during closed season would result in negative impacts to the livelihoods of fisheries households.

9.2. Prachuap Khiri Khan-Chumphon Provinces project site

The catch per unit effort (CPUE) of OBT1, OBT2 and PT were 48.21, 27.78 and 150.02 kg/hour, respectively. The proportion of food fish and trash fish were 36:64, 58:42 and 46:54, respectively. In trash fish group, small-sized economically important species showed significantly high percentages of 78% (OBT1), 64% (OBT2) and 74% (PT) of total trash fish whereas the remaining were true trash fish.

9.3. Experiment on trawl trial

For Pair Trawl (PT), experiment to clarify the escape rate was carried out by trawling with the 4 cm mesh size codend which was covered by the 1.8 cm mesh size cover net. The total number of trawl hauls was 5 hauls. The trawling duration of each haul was 5 hour and the speed of vessel was on average 2.5 knots. The lowest catch rate was 449 kg/haul and the highest 1,880 kg/haul. The result showed that the escape rates were in the range of 24-50 %. The average escape rate was 34%. The escaped fish in the cover net were commonly sold as trash fish.

For Otter Board Trawl (OBT), experiment to clarify the escape rate was carried out by trawling with the 4 cm mesh size codend which was covered by the 1.25 cm cover net. The total number of trawl

haul was 11 hauls. The trawling duration of each haul was 5 hour and the speed of vessel was 2.5 knots. The lowest catch rate was 85 kg/haul and the highest 239 kg/haul. The result showed that the escape rates were in the range of 11-67 %. The average escape rate was 43%. The escaped fish in the cover net were commonly sold out as trash fish.

9.4. Consultation meetings

Eight consultation meetings were convened for sharing and discussing results of the studies and knowledge on fisheries management, and to encourage awareness. In addition, proper management measures for solving trash fish problems were introduced and explained. The other objectives of the meetings were to encourage stakeholders for participation in fisheries management process and collaboration in data collection procedures. There were 1,113 participants represented from trawlers, fish processors, fish dealers, fisher organizations in GoT and ADS, Provincial Administrative Organization (PAO), Sub district Administrative and Organization (SAO) in Prachuap Khiri Khan and Chumphon Provinces and government officials from DoF, DMCR, NGOs, SEAFDEC RFU etc.

In the 4th meeting of Trat Province, more than 80% of stakeholders agreed on the proposed demarcation of conservation zones. That was focused on gear prohibition i.e., 1) trawlers, 2) purse seiner with purse line, 3) encircling gill netter and 4) gillnetter with mesh size larger than 4.5 cm operated in areas of Ao Trat and area from Laem Nam to Cambodia territory, western boundary is parallel to the coastline with distance around 14 km and the total area is 970 km^2 (Figure 13) to the Provincial Fisheries Committee.

For the enlarging of trawl codend mesh size in Prachuap Khiri Khan and Chumphon Provinces, trawl fishers suggested DoF the following:

1. Representative of the fishers accepted the idea of enlarged mesh size but they requested to use 3.0-3.5 cm mesh size and apply a gradual, stepwise, increase.
2. Public Hearings should be held in many places to cover all stakeholders.
3. Participants of the meeting should show their licenses to exclude those who were fishing illegally.
4. The DoF should produce media of data and information of cod-end mesh size enlargement to announcement widespread beforehand.
5. The DoF should be clear and effective in enforcing the illegal types of fishing gear.
6. The size of fishing vessel (engine horse power) should be considered in licensing.
7. The DoF should note and take into account that each type of trawlers are not targeting the same species (there are fish trawler, shrimp trawler, pair trawler, otter board trawler), and it should be noted that each province has different areas and fish composition. Mesh size measures for different areas should not be the same.

10.Recommendations

Appropriate and research-based seasonal closures and codend mesh size enlargement for trawler are effective measures to reduce trash fish in trawl catches. To encourage stakeholders to understand, discuss and consider the scientific evidence, they should be provided with adequate fisheries data and socio-economic information through consultation meetings. That will build trust and acceptance, and strengthen the management planning. Department of Fisheries (DoF) should disseminate the lessons learned that were obtained in the two project pilot sites to other areas in Thailand that have a similar type of critical problems on trawl bycatch and trash fish.

The enlargement of codend mesh size to 4 cm for trawlers in Thai water was announced in 17 January 2016 under the Royal Ordinance B.E.2558 (2015). The measure affected directly all trawl fishers. The seasonal closure, on the other hand, affects differently on various fisheries. Therefore, the effects of management measures should be investigated and considered carefully with collaboration from stakeholders. Local knowledge should be included to improve acceptance and strengthen the plan and to increase confidence in decision making.

Capacity development on fishery governance and social interactions with fisheries officers and stakeholders was one of the key success factors for the preparation of a fisheries management plan.

Management measures should be periodically reviewed to ensure that they continue to meet goals and objectives. Clearly defined monitoring and evaluation procedures, as well as a set of indicators, are required to benchmark the sustainability of fisheries management.

Widely published information about the status of fisheries resources and fisheries as well as fisheries management plan increased the awareness and acceptance by stakeholders.

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Appendix I Number of registered trawler in the Gulf of Thailand, 1970-2016

year	Otter board trawl	Pair trawl	Beam trawl	Total Trawler
1970	2,210	442	430	3,082
1971	2,472	522	614	3,608
1972	3,185	702	599	4,486
1973	4,480	824	533	5,837
1974	4,074	854	343	5,271
1975	3,816	852	294	4,962
1976	4,088	832	284	5,204
1977	4,962	906	420	6,288
1978	5,110	854	489	6,453
1979	7,038	1,172	537	8,747
1980	8,131	1,230	1,060	10,421
1981	6,021	1,008	496	7,525
1982	9,358	1,406	711	11,475
1983	7,796	1,266	328	9,390
1984	7,769	1,166	196	9,131
1985	6,968	1,218	139	8,325
1986	6,226	1,084	97	7,407
1987	6,129	1,164	50	7,343
1988	5,766	1,132	50	6,948
1989	10,436	2,193	482	13,111
1990	10,256	2,193	456	12,905
1991	8,117	2,037	144	10,298
1992	7,538	1,876	51	9,465
1993	7,213	1,749	123	9,085
1994	6,482	1,708	156	8,346
1995	6,321	1,576	98	7,995
1996	6,840	1,843	285	8,968
1997	6,886	1,804	195	8,885
1998	7,050	1,820	291	9,161
1999	6,441	1,734	149	8,324
2000	6,154	1,682	172	8,008
2001	4,897	1,640	152	6,689
2002	4,952	1,544	179	6,675
2003	5,172	1,634	143	6,949

year	Otter board trawl	Pair trawl	Beam trawl	Total Trawler
2004	4,896	1,410	133	6,439
2005	4,344	1,232	60	5,636
2006	3,306	1,257	42	4,605
2007	2,574	1,056	37	3,667
2008	2,329	1,000	39	3,368
2009	2,161	954	29	3,144
2010	2,103	964	18	3,085
2011	1,865	960	80	2,905
2012	1,796	936	115	2,847
2013	1,705	900	71	2,676
2014	1,560	862	115	2,537
2016	1,645	493	954	3,092

Appendix II Respondents' perception on measures and options for fisheries management in Trat Province

Measures/options for fisheries management in Trat*	Small	Medium-large	Total
1. No fishing in zone 1, 2, and 3 permanently	1.51	1.51	1.51
2. No fishing in zone 1, 2, and 3 in some seasons	2.33	2.11	2.29
3. No fishing in zone 1 and 2 permanently to conserve *Rastreliger brachysoma*, endangered species e.g., dolphin, and mangroves	1.97	1.94	1.96
4. No fishing in zone 1 and 2 in some seasons (Alternate with opened-closed seasons between zone 1 and zone 2)	2.58	2.11	2.50
5. No use of some fishing gears in zone 2 and zone 3 in May - Oct to conserve *Rastreliger brachysoma*, swimming crab, and short necked clam	3.01	2.43	2.91
6. *Rastreliger brachysoma*: No fishing in spawning season in zone 3 in Feb-May to conserve *Rastrelliger brachysoma*	3.16	2.62	3.07
7. *Rastrelliger brachysoma*: No use of any fishing gears having net mesh size smaller than 4.5 cm. in Mar-May to conserve *Rastrelliger brachysoma*	3.07	2.52	2.99
8. Dolphin: Promote of dolphin watching tourism in Trat	3.60	3.46	3.58
9. Fish larvae: Publicity campaign for no take fish larvae	3.49	3.24	3.45
10. Sea turtle: reserved feeding and spawning area for sea turtle	3.38	3.38	3.38
11. Sea grass: Reserve existing area and new planting for suitable species	3.39	3.32	3.38
12. Promote more and maintain crab bank project	3.74	3.42	3.69
13. Squid eggs: Promote squid egg hatching bank by training fishery community and establish squid egg bank	3.43	3.52	3.44
14. Mussel: Increase area for mussel culture in allowed areas, and placed artificial reef in the areas not allow	2.94	3.04	2.95

*Option 2-14 was proposed by fishers during the first stakeholder meeting organized by Rebyc II-CTI Project on 29 Oct 2013.

1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree

Appendix III Length at first capture and probability of capture of the economic fish caught by pair trawl and otter board trawl use codend 4 cm

	Lc (cm.)		Lm (cm.)	Probability of capture at L_m (percent)	
	Pair trawl 4 cm	Otter board trawl 4 cm		Pair trawl 4 cm	Otter board trawl 4 cm
Atule mate	12.11	-	21.25	85.77	-
Encrasicholina spp	7.81	-	6.44	5.63	-
Clupeidae	12.11	13.20	10.35	11.66	7.84
Rastrelliger brachysoma	16.64	15.37	17.95	84.72	90.01
R. kanagurta	13.05	-	17.12	92.80	-
Selaroides leptolepis	-	13.53	11.73	-	21.06
Nemipterus. hexodon	12.31	10.35	14.57	69.00	83.46
N. peronei	17.95	-	14.57	11.20	-
N. mesoprion	-	12.60	-	-	92.75
N. japonicus	-	11.41	-	-	78.61
Saurida undosquamis	12.45	-	22.44	88.94	-
S. elongata	18.72	20.91	28.85	99.63	74.08
Photololigo duvaucelii	8.48	11.52	17.71	99.95	99.91
Sepioteuthis lessoniana	10.58	-	13.67	89.41	-
Penaeus merguiensis	-	14.52	14.14	-	39.60
P. japonicus	-	13.95	-	-	55.22
Portunus pelagicus	-	9.32	9.47	-	55.01