Review of the Trawl Fisheries in Prachuap Khiri Khan and Chumphon Province, Thailand

"Strategies for Trawl Fisheries Bycatch Management" (REBYC-II CTI; GCP/RAS/269/GFF)

Pavarot Noranarttragoon
Marine Fisheries Research and Development Bureau
Department of Fisheries,Bangkok
Thailand

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PREPARATION OF THIS PAPER

This document has been prepared as a part of the Strategies for Trawl Fisheries Bycatch Management Project (REBYC-II CTI; GCP/RAS/269/GFF) and aims to review the trawl fisheries and fisheries resources status in Prachuap Khiri Khan and Chumphon province. The provinces have been selected to implement the sea experiment to enlarge trawl's codend mesh size. Bycatch in trawl fisheries includes small economic fish which is not marketable size and sold as trash fish, true trash fish which is non-commercial species and unwanted invertebrate species such as echinoderms and crustaceans. Enlargement of the codend mesh size is an effective method to reduce bycatch among several methods. Fishing gear characteristic and existing information was reviewed in this paper in order to point out the previous status of trawl fisheries, be compared with the results of upcoming data and be used as base line information when enlargement of codend mesh size is implemented.

The paper is represented as a baseline report in trawl fishery biology in Prachuab Kiri Khan and Chumphon provinces which is one of the project site, REBYC-II CTI Thailand besides Indonesia, Papua New Guinea, Philippines and Viet Nam. This paper has been done under the Terms of Reference as following.

> "To carry out baseline data for trawl fisheries in Prachuap Khiri Khan and Chumphon (number of vessel, fleet composition, number and type of gear, characteristic of fisheries, trawl technical information, catch, fishing effort, fishing capacity, fishing ground, catch composition, bycatch composition, species size and composition, boat mobility, number of boats and fishers from statistic record in provinces and in DOF), etc."

11 April 2014

GLOSSARY

BT	Beam trawl
CHARM	Coastal Habitats and Resources Management Project
cm	Centimeter
CPUE	Catch per unit effort
DOF	Department of Fisheries
FAO	Food and Agriculture Organization of the United Nations
OBT1	Small-sized otter board trawl, overall length less than 14 m
OBT2	Medium-sized otter board trawl, overall length 14-18 m
MFRDB	Marine Fisheries Research and Development Bureau
MSY	Maximum sustainable yield
MEY	Maximum economic yield
PT	Pair trawl
SEAFDEC	Southeast Asian Fisheries Development Center

1. Introduction

Prachuap Khiri Khan and Chumphon Province are 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 the province waters; 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 3.23 km^2. The coast line is about 225 km. All eight districts open to the Gulf of Thailand (Fig. 1).

Figure 1 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_Khiri_Khan_Province

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 waters. 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 about 222 km. Six of eight districts open to the Gulf of Thailand (Fig. 2).

Figure 2 Chumphon Province with the districts (Amphoe) numbered
1) Mueang Chumphon, 2) Tha Sae, 3) Pathio, 4) Lang Suan, 5) Lamae,
6) 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 in terms of capture fisheries production. The areas of catch statistical data in the Gulf of Thailand are divided into five areas (Fig. 3). Area 3, the locality of Prachuap Khiri Khan, Chumphon and Surat Thani Province, contributed the highest production and value. In 2011, the catch of Area 3 was 333,115 tons comprising 306,950 tons of commercial fisheries and 26,165 tons of small scale fisheries. Area 3 accounted for almost one third of the Gulf of Thailand's production of 1,064,772 tons (DOF, 2013a-c).

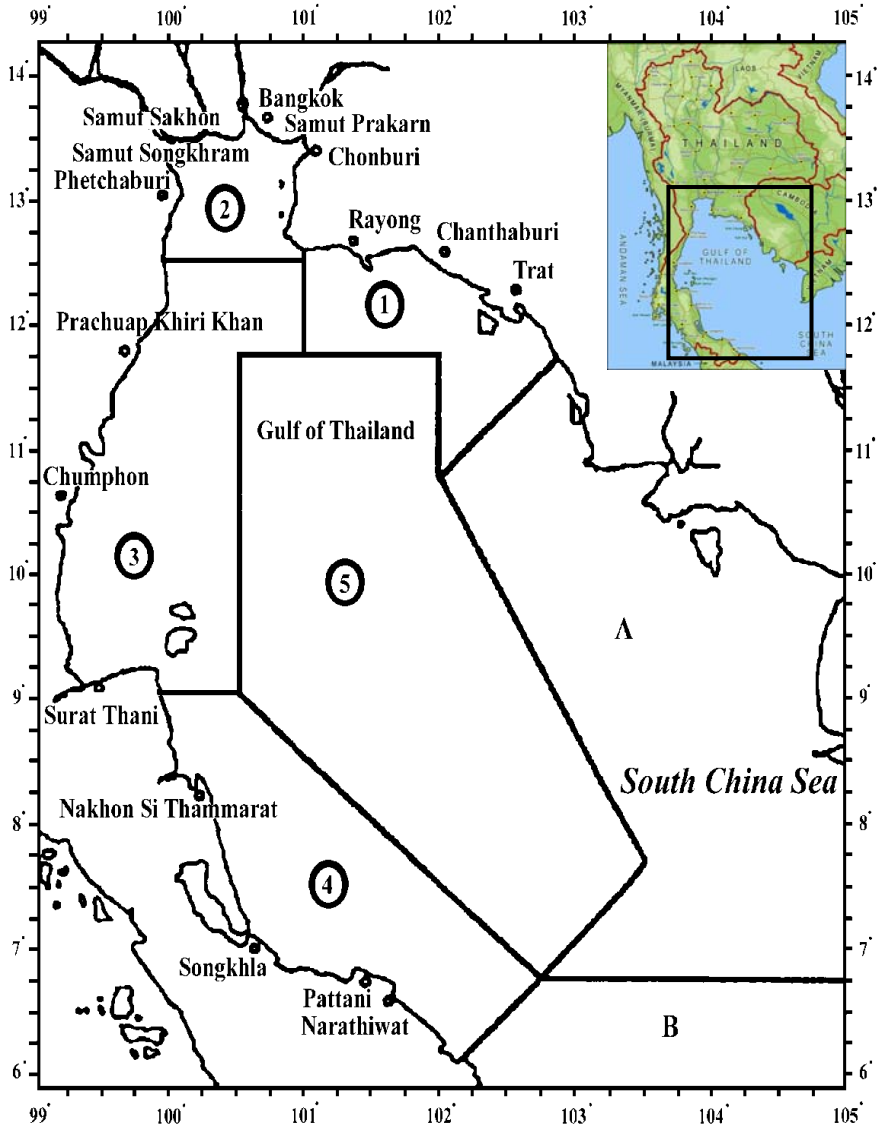

Figure 3 Statistical areas of catch data (Statistical record, DOF) in the Gulf of Thailand

Moreover, there is a well-known and most important fisheries management measure implemented in the Upper Western Gulf of Thailand. In 1984, a seasonal closure from 15 February to 15 May every year was declared in an area of approximately 26,400 km^2 in the locality of Prachuap Khiri Khan, Chumphon and Surat Thani Provinces (Appendix A). This was done so as to protect the important and valuable species as well as for the fertility and sustainable utilization of those species during their spawning season. Especially, the life cycle of short mackerel, which is the most economically important species of the country, has been well investigated and illustrated that the Upper Western Gulf of Thailand is a main breeding and nursing ground (Appendix B).

Consequently, most high efficiency and destructive fishing gear, including every kind of trawls, surrounding nets, gill nets and entangling nets used for catching mackerel, anchovy falling net and lift net with electricity generator and push nets, are not allowed in the said area and period (CHARM, 2005). The regulation was amended several times due to the fishers had adapted their fishing boat and method to avoid the regulation. The adaptations were to lessen the boat length and to deploy the net as zigzag shape instead circle shape. To diminish the small scale fishers' trouble was also the reason to amend this regulation, i.e., small scale

mackerel gill nets used with a motor vessel of less than 14 m or with a long-tailed boat were allowed. The last amended has been issued since 2007.

The last survey on number of fishers and fishery establishments in Thailand was done in 2000. In Prachuap Khiri Khan Province, the number of marine capture fishery establishments totaled 1,448 establishments making up 3.90% of the establishment along the Gulf of Thailand whereas the number of fishers during peak season was counted to 4,579 fishers calculated to 3.80% of the fisher along the Gulf of Thailand. Likewise, in Chumphon Province, the number of fishery establishments and number of fishers is moderately higher than Prachuap Khiri Khan, 2,275 establishments and 7,895 fishers estimated to 6.13% and 6.55% of the establishments and fishers in the Gulf of Thailand (Table 1; DOF, 2013b).

Table 1 Number of marine capture fishery establishments and fishers during peak season in Prachuap Khiri Khan and Chumphon Province

	Number of fishery establishments		Number of fisher	
Gulf of Thailand	37,098	100.00%	120,603	100.00%
Prachuap Khiri Khan	1,448	3.90%	4,579	3.80%
Chumphon	2,275	6.13%	7,895	6.55%

2. Trawl fisheries in the Upper Western Gulf of Thailand

Trawl fishing in the Gulf of Thailand is classified into three kinds; otter board trawl (including otter board with boom trawl), pair trawl and beam trawl. Among these, otter board trawl is the most widely operated gear in Thailand. These kinds of fishing gear are to use a bag-liked net operated with a motorized boat to pull the net during operation. The principle of these types of catching are to use the boat to pull the net that looks like a bag to move forward and to catch the fish that swimming at the same level of the mouth opening of the net. Fish get caught and further accumulated into the cod end of the net. Fishers haul the cod end after finishing their operations and open the cod end to collect fish on board.

During trawling operation, the mouth of the trawl net is widely expanded by three methods:

a) by two otter boards at mouth of the net to widely expand the mouth of net (otter board trawl; Fig. 4). Wooden or metal booms attached at both sides in the middle of the boat can be occasionally found for the purpose of further expanding the net so-called otter board with boom trawl (Fig. 5)
b) by two boats that operate together and keep a constant distance and speed between one and another all the time (pair trawl; Fig. 6).
c) by using a pair of beams to widely expand the mouth of the net (beam trawl; Fig. 7)

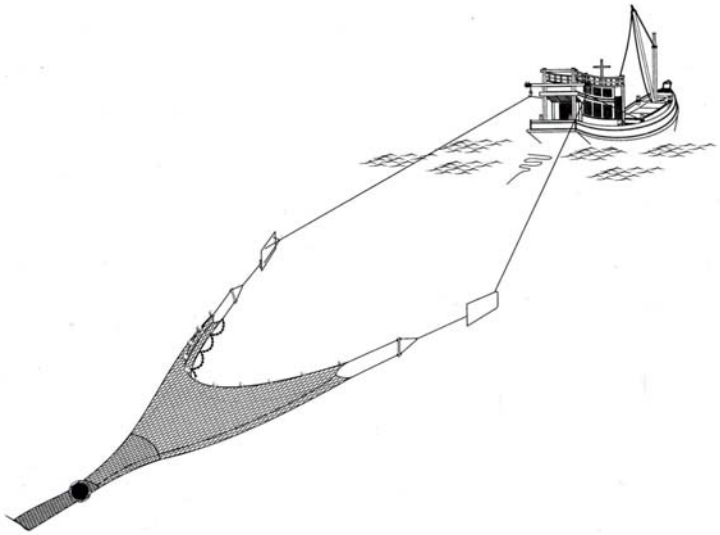

Figure 4 Otter board trawl

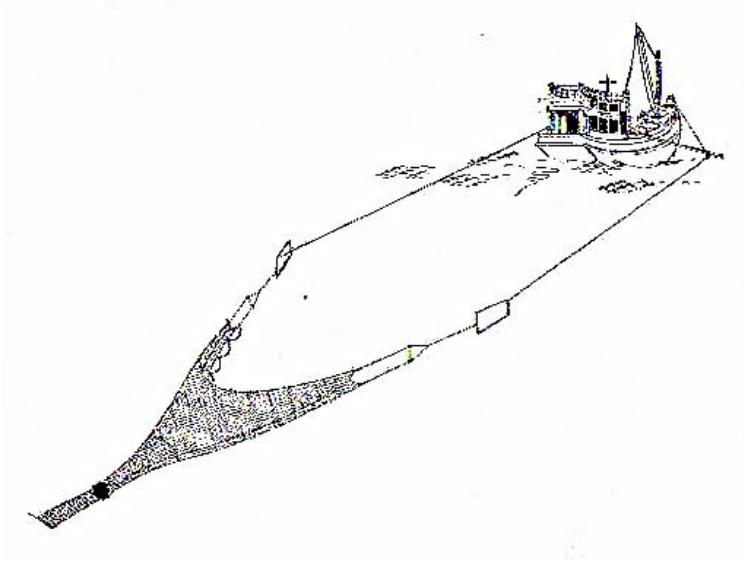

Figure 5 Otter board with boom trawl

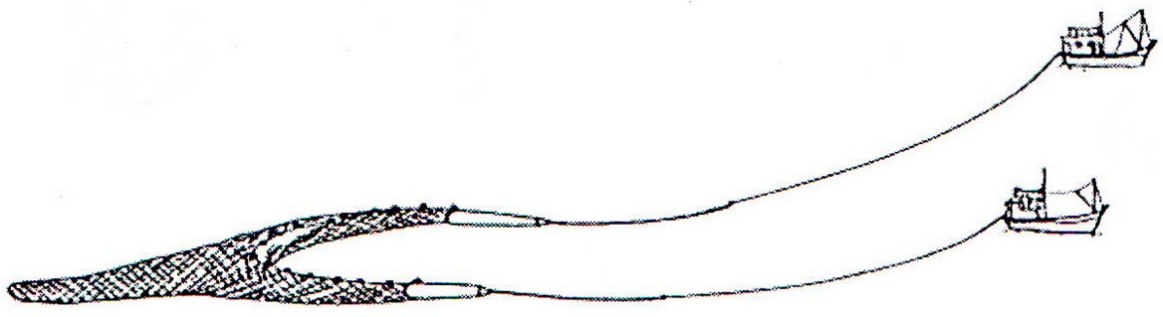

Figure 6 Pair trawl

Figure 4-8 adapted from SEAFDEC (2004)

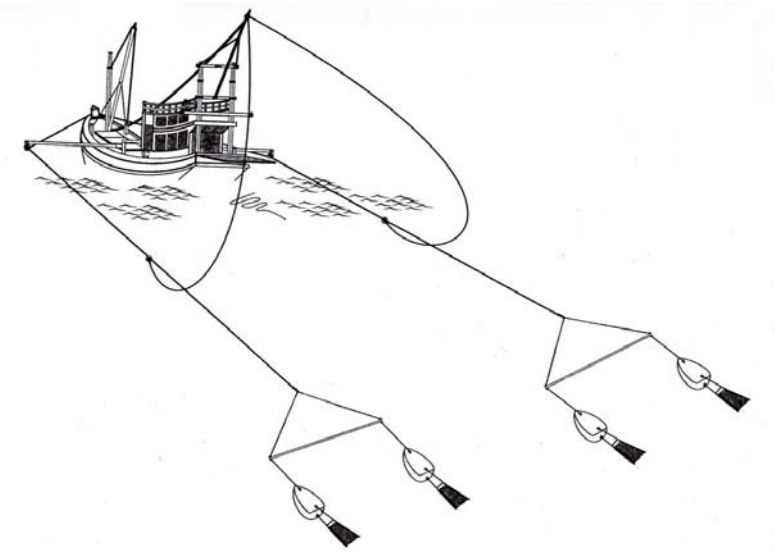

Figure 7 Beam trawl

Otter board trawls (OBT) are operated both during day and night times. Because of low capacity of engine power, small-sized OBT are pulled by trawlers which have overall length is less than 14 m, normally operated at night and targeting shrimps. Larger OBT is usually operated at daytime and targeting fishes and squids as these larger trawlers have higher trawling speeds. The cod-end mesh size of fish OBT is generally 2.5 cm while of shrimp OBT is mostly 2.0 cm.

Pair trawl (PT) is performed during day and night times. The cod-end mesh size is 2.5 cm. However, the cod-end mesh size of PT, particularly in the Upper Gulf of Thailand, which are targeting anchovies, has been modified to be 1.3-1.9 cm.

Push net is another kind of fishing gear used for catching demersal species (Fig. 8). The net of this gear is fastened to two poles which are made from bamboo or wooden or metal pipe and formed in inverted V-shape. Ending of the poles is attached with a pair of ski, made from wooden or iron or stainless steel, which slide along the sea bottom. The cod-end mesh is usually very small size, e.g., 1.5-2.5 cm for shrimp push net and 0.2-0.6 cm for Sergestid push net. Push net fishing is operated from motorized boat, either in daytime or at night upon the target species.

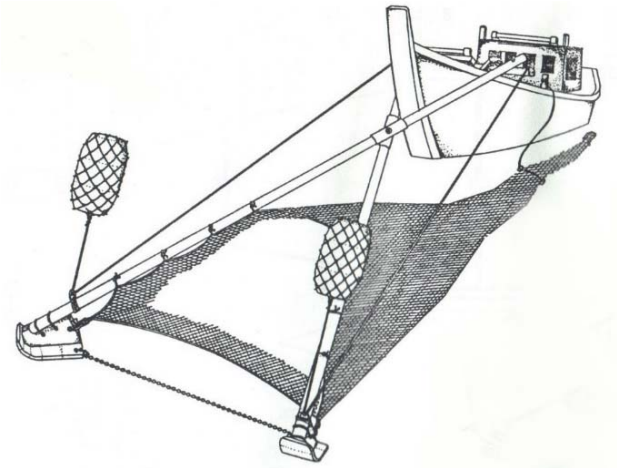

Figure 8 Push net

The catch of trawls is sorted by species or group of species and separated by sizes on board, and is divided into 2 main clusters, economic fish and trash fish. Economic fishes are sorted by species, genus, family or group, e.g., short mackerel, threadfin breams (Nemipteridae), and lizardfishes (Synodontidae), etc., which is almost the same size at each size category. Those fish are kept in the trays (wooden or plastic rectangle storage, 35-36 x 51-53 x 9-14 cm in width, length and height respectively) in order to be convenient for selling and transferring to fish market. Ice is used for keeping the fish fresh by pouring it upon the fish in each tray. The trays are layered in the fish storage room. When the storage room is full, ice is poured on the top before closing the room. On the other hand, trash fish, which may consist of juvenile economic fish, such as mackerel, threadfin bream, bigeye and true trash fish, such as, *Siganus* spp., *Leiognathus* spp., and cardinal fish, are sorted out from economic fish and kept non-punctiliously in the trays but with lesser ice than the economic fish.

Marine catch in the Gulf of Thailand is mainly harvested by trawls. In 2011, the total catch in the Gulf of Thailand was 1,064,772 tons of which 50.31 % were caught by trawls (Table 2). Trawl fisheries in Area 3 were 154,016 tons or 50.18% of the total catch of this statistical area and represented 28% of all trawl fisheries in the Gulf of Thailand.

Table 2 Marine catch (tons) in the Gulf of Thailand, 2011

	Gulf of Thailand	%	Area 3*	%
Total catch	1,064,772	100.00	306,950	100.00
Trawl catch	535,690	50.31	154,016	50.18
OBT (all size)	352,323	33.09	63,710	20.76
PT	181,136	17.01	89,661	29.21
BT	2,231	0.21	645	0.21

Source: DOF, 2013a-b

Remark: * Data gathered from commercial fisheries, i.e., otter board trawl, pair trawl, beam trawl, Thai purse seine, anchovy purse seine, king mackerel drifting gill net, mackerel encircling gill net and push net.

However, the catch of PT in Area 3 showed a higher percentage compared to OBT catch (Table 2). This is most probably due to the fact that in area 3 the main fishing ground is for mackerel which has high reproductive and fertility rates. There was also probably benefits from the three-month closed area measure. The fishing fleet from the Inner Gulf of Thailand, including Samut Prakan, Samut Sakhon and Samut Songkhram Provinces, normally move to fish in the Upper Western Gulf of Thailand particularly in a period after 15th May every year which is the opening season of the area closure.

Table 3 shows the catch per unit effort of trawls in the Gulf of Thailand and in Area 3. It is not surprising that CPUE of OBT in Area 3 was less than the average CPUE in the Gulf of Thailand. Although there is a closed area measure in the Upper Western Gulf of Thailand (see Page3, Appendix A), OBT which the overall length is less than 16 m are not prohibited during nighttime. Therefore, most OBT can be operated throughout the year in a most productive area in the Gulf of Thailand. Consequently, the CPUE of OBT less than 14 m and 14-18 m was only one half of the average CPUE in the Gulf of Thailand.

Although PT is prohibited according to the management measure in the Upper Western Gulf of Thailand; the CPUE of PT in Area 3 remained relatively high and at a similar level of the average CPUE for PT of 18 meters and was even larger PT over 18 meters. This may

probably be because of the 3 month closure of the Area 3 and the fact that PT were targeting the highly reproductive mackerel species.

Table 3 Fishing effort, catch and CPUE of trawls in the Gulf of Thailand, 2010

Fishing Gear	Fishing effort (hours)		Catch (tons)		CPUE (kg/hour)	
	Gulf of Thailand	Area 3	Gulf of Thailand	Area 3	Gulf of Thailand	Area 3
Otter board trawl (all sizes)	10,060,678	1,516,565	596,689	59,261	59.31	39.08
OBT less than 14 m length	2,402,203	268,220	75,140	4,226	31.28	15.76
OBT 14-18 m length	3,994,035	753,293	194,631	16,821	48.73	22.33
OBT 18-25 m length	3,321,138	495,052	258,057	38,214	77.70	77.19
Pair trawl (all sizes)	1,602,153	585,288	212,097	86,430	132.38	147.67
PT less than 18 m length	374,817	58,910	36,944	5,193	98.57	88.15
PT over 18 m length	1,227,336	526,378	175,153	81,237	142.71	154.33

Source: DOF, 2012

3. Number of fishing boats

Since 1990, the number of fishing boat registered as trawlers in the Gulf of Thailand has shown a decreasing trend (Fig. 9). The total number of trawlers in 1990 was 10,661 boats; then, it dropped to 2,922 boats in 2011. Recently, OBT is the main type of trawler used in Thailand accounted for 65-70% of the total number of trawlers. The number of PT also showed a reduction trend also and in 2011, some 966 boats were reported. On the other hand, beam trawls were very small numbers.

In Prachuap Khiri Khan Province, the number of registered trawlers presented the highest number in 1991 at 159 boats (Fig. 10). Then, the reduction in number has been observed. The last reported data showed that the number of trawlers was 22 boats in 2011 including 20 OBT. Whereas the number of PT was much less documented with two boats in the last two reported years. Beam trawl was rarely found and had not registered during the last seven years in Prachuap Khiri Khan Province.

OBT was the main type of trawlers in Chumphon Province. However, the number of OBT had fluctuated during 1990-2005 at 105-511 boats (Fig. 11). After that, the number of OBT has continuously decreased to 159 boats on the last recorded year. In addition, very little number of PT has been registered. Only two PT was recorded in 2011. Moreover, beam trawl were not registered in recent year.

However, the number of fishing boats regardless the fishing licenses was also investigated by MFRBD, DOF, in 2011. Some difference in number of registered boat and actual operating boat was discovered. The number of registered OBT, the most important boat in terms of number, in the Gulf of Thailand was recorded at 1,875 boats (Fig. 9) while the number reported by MFRDB was 2,034 boats (MFRDB, 2013). That means there are some non-registered boats or registered by other fishing licenses operated in the Gulf of Thailand. Therefore, in the fisheries management process, these numbers of fishing boats should be considered.

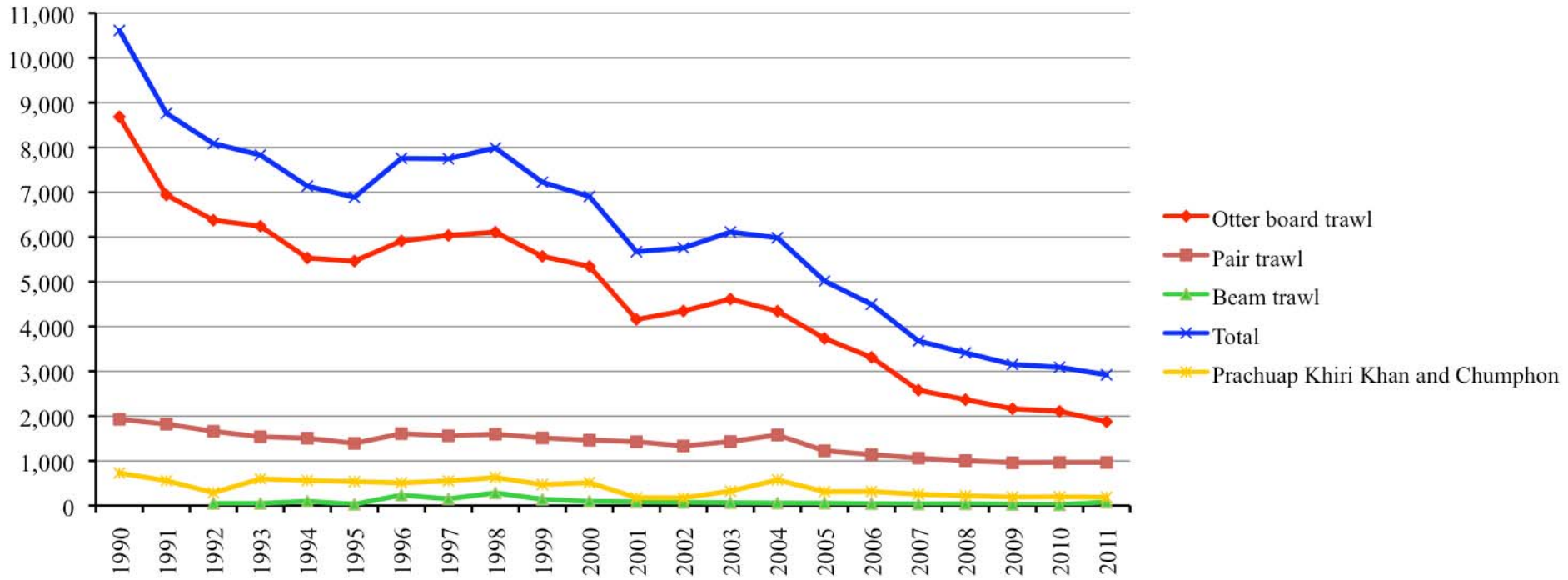

Figure 9 Number of fishing boat registered by trawlers in the Gulf of Thailand during 1990-2011 (Could you color label by orderly in the graph?)

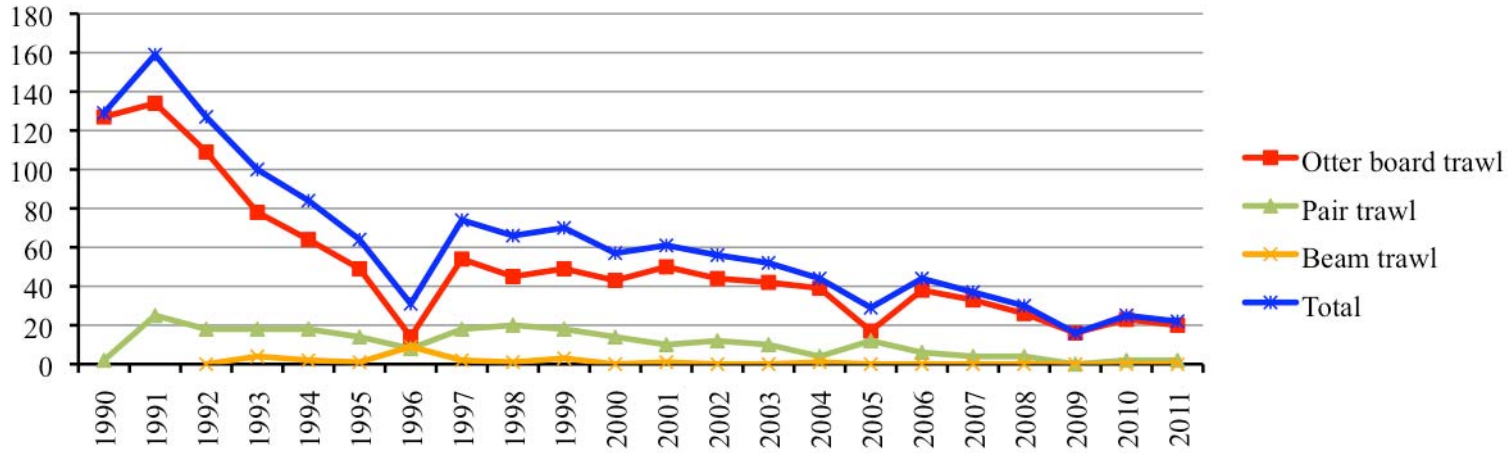

Figure 10 Number of fishing boat registered by trawls in Prachuap Khiri Khan Province during 1990-2011

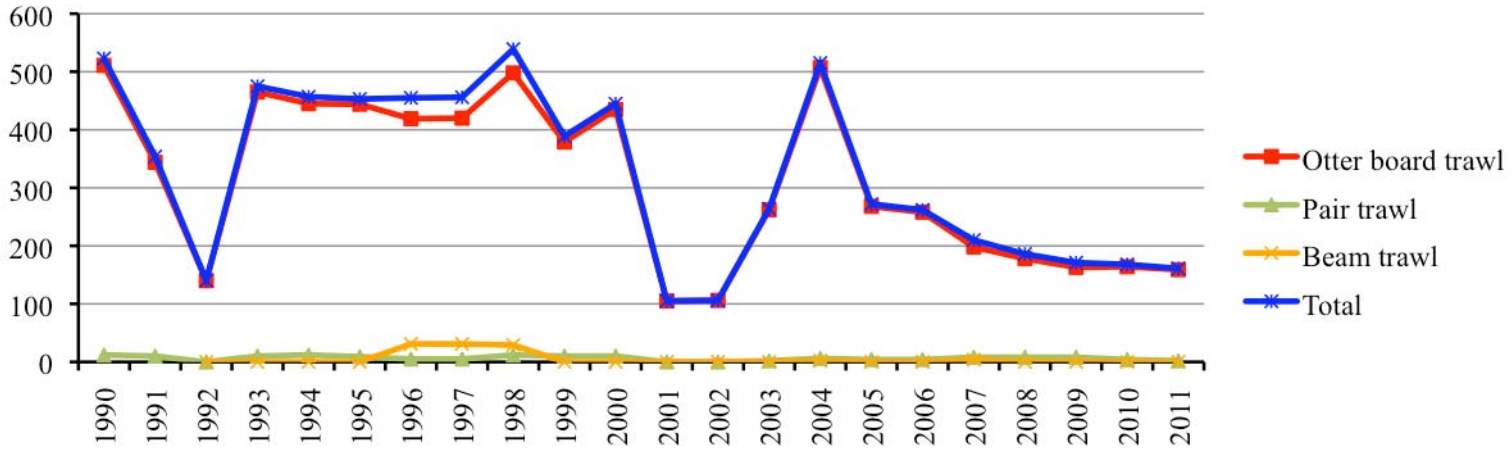

Figure 11 Number of fishing boat registered by trawls in Chumphon Province during 1990-2011

4. Fisheries resources status

Chuapun (2006) examined the catch rate and composition of OBT1, OBT2 and PT in the three-month closed season of Prachuap Khiri Khan, Chumphon and Surat Thani (see Page 3) in 1998. The results found that CPUE was 38.33, 22.00 and 354.51 kg/hr respectively and trash fish made up 72% for OBT1 and 47% for OBT2 and PT.

Kongprom *et al*. (2007) reported the CPUE of OBT1, OBT2 and PT in the Gulf of Thailand during November 2003 to September 2005 that was 23.64, 35.43 and 155.05 kg/hr respectively. Few years later, in 2007, the CPUE slightly decreased to 21.85, 32.66 and 121.07 kg/hr (Noranarttragoon, 2013). In addition, the CPUE in Area 3 showed a high level and was higher than the average CPUE. The CPUE of OBT1 and PT in Area 3 also presented the highest CPUE in the Gulf of Thailand (Table 4).

Table 4 Average CPUE (kg/hr) of trawls in the Gulf of Thailand by the statistical area in 2007

Gear	Catch statistical area					
	Area 1	Area 2	Area 3	Area 4	Area 5	Average
OBT1	12.529	12.886	34.588	16.881	-	21.85
OBT2	24.903	-	42.603	33.166	50.581	32.66
PT	161.185	90.829	166.617	148.14	112.75	121.07

Source: Noranarttragoon, 2013 (Cited after Statistic Record, 20XX, DOF- in this case you have not your own data)

Catch composition of trawls in 2007 was also revealed. The ratio between food fish and trash fish of OBT1 and OBT2 was roughly 55:45 and PT was 62:38. Shrimps were the main target group of OBT1, which made up more than a half of the total catch, while demersal fish were the target group of OBT2 and PT. Squids were also found at a high percentage in PT catch (Table 5).

Table 5 Catch composition (%) of trawls in the Gulf of Thailand Area 3 in 2007

Species/Group	OBT1		OBT2		PT	
	Food fish	Trash fish	Food fish	Trash fish	Food fish	Trash fish
Total	**100.000**	**100.000**	**100.000**	**100.000**	**100.000**	**100.000**
Sub-total fish	**28.564**	**86.553**	**49.591**	**86.048**	**74.661**	**92.769**
Sub-total pelagic fish	**1.192**	**4.454**	**6.942**	**2.296**	**35.272**	**39.901**
Short mackerel	0.056	0.138	0.272		11.286	5.333
Indian mackerel	0.060	0.133	0.821	0.088	2.701	2.547
Narrow-barred Spanish mackerel	0.042	0.056	0.157		0.887	0.085
Dorab wolf-herring	0.059		0.670		0.512	
Indian scad			0.007		0.349	0.343
Hardtail scad	0.025	0.023	0.736		0.476	0.344
Yellowstripe scad	0.252	1.414	0.056	0.065	6.624	2.199
Yellowtail scad	0.075	0.029	0.028		1.847	0.203
Bigeye scad	0.001		0.478		0.503	0.002
Other carangids	0.233	0.597	1.346	1.012	1.444	0.664

Goldstripe sardinella	0.006	0.087		0.167	4.259	0.789

Table 5 (Cont.)

Species/Group	OBT1		OBT2		PT	
	Food fish	Trash fish	Food fish	Trash fish	Food fish	Trash fish
Other sardines	0.014	1.392	0.020	0.463	0.581	0.176
Anchovies	0.055	0.349	1.432	0.181	0.380	25.791
Black pomfret	0.114	0.009		0.291	0.025	
Barracudas	0.181	0.214	0.823	0.029	1.975	1.114
Other pelagic fishes	0.019	0.013	0.096		1.423	0.311
Sub-total demersal fish	**27.372**	**37.893**	**42.649**	**23.186**	**39.389**	**19.117**
Croakers	1.254	0.781	2.414	0.974	4.194	0.294
Ornate threadfin bream	0.651	0.055	1.549	0.252	2.734	0.467
Threadfin breams	1.321	0.292	5.442	0.045	4.628	0.959
Slender lizardfish	3.812	0.682	6.697	0.957	2.506	0.766
Brushtooth lizardfish	1.383	0.263	2.560	0.729	1.184	1.453
Other lizardfishes	0.001	0.030		4.020	0.168	1.834
Hairtails	0.506	0.587	1.097	0.603		1.550
Snappers	0.339	0.077	0.589	0.060	0.715	0.257
Purple-spotted bigeye	1.790	2.224	7.986	0.564	9.607	2.662
Sea catfishes	0.038	0.041	0.797	2.002	0.105	0.152
Rays	0.790	0.070	0.771		0.203	
Sharks	0.009	0.003			0.105	
Flatfishes	2.721	1.738	1.858	0.739	0.099	0.111
Other demersal fishes	12.757	31.050	10.889	12.241	13.141	8.612
Trash fish		**44.206**		**60.566**		**33.751**
Sub-total crustacean	**53.104**	**11.236**	**21.124**	**11.032**	**0.718**	**2.239**
Metapenaeopsis spp.	18.686	0.249	15.864		0.044	0.288
Metapenaeus spp.	11.602	0.003	1.000		0.007	0.010
Parapenaeopsis spp.	2.555		0.255			
Penaeus spp.	1.599		0.809		0.024	
Trachypenaeus spp.	10.925	0.164	1.579		0.001	0.113
Other shrimps	4.781	3.512	1.042	4.775	0.090	0.885
Flathead lobster	0.107	0.200		4.709	0.077	
Mantis shrimp	0.199	3.199	0.013	1.128	0.033	0.395
Blue swimming crab	0.495		0.141		0.176	0.016
Other crabs	2.155	3.909	0.421	0.420	0.266	0.532
Sub-total mollusc	**18.332**	**2.211**	**29.285**	**2.920**	**24.621**	**4.992**
Squids	4.682	0.985	16.934	1.292	20.508	3.565
Cuttlefishes	10.243	0.441	9.169	0.339	1.831	0.300
Bigfin reef squid	0.134	0.000	0.473		0.376	0.046
Octopuses	2.392	0.006	1.435		0.658	0.028
Other cephalopods	0.682	0.616	1.217	1.289	0.378	0.945
Scallops	0.000	0.003			0.524	0.015
Other shellfishes	0.199	0.160	0.057		0.346	0.093

Source: Noranarttragoon, 2013

Remarks: Empty boxes signify zero value.
0.000 signify negligible value (< 0.0005).

In trash fish composition, juvenile economic fish sum up approximately 56%, 39% and 66% of OBT1, OBT2 and PT's trash fish while true trash fish made up 44%, 61% and 34% respectively. Concerning economic fish, demersal fish were mostly found in OBT1 and OBT2's trash fish whereas anchovies showed the highest percentage of PT's trash fish (Table 5). However, anchovies showed a significant percentage in Area 2, around 45%, because this kind of trawl targets anchovies. As a result, the codend mesh size of so-called anchovy trawler in Area 2 is somewhat smaller than other part in the Gulf of Thailand.

Regarding true trash fish, ponyfish (Leiognathidae) showed the highest composition followed by cardinalfish (Apogonidae), longfin mojarra (*Pentaprion longimanus*) and crabs (Table 6). Although, true trash fish has low economic value, it is important in terms of biodiversity and ecosystem integrity. Hence, in the Marine Fisheries Management Master Plan proposed by DOF, there is an objective stating that trash fish should be less than 20% of the total catch.

Table 6 True trash fish composition of trawls in the Gulf of Thailand during November 2003 – September 2005

Species	GEAR		
	OBT1	OBT2	PT
Apogonidae	11.20	8.37	10.24
Mene maculata	1.51	0.12	2.30
Leiognathus bindus	1.32	0.00	0.17
L. brevirostris	0.04	0.00	0.01
L. elongatus	0.03	0.00	0.00
L. leuciscus	0.01	0.00	0.01
L. splendens	0.19	0.00	0.52
Secutor insidiater	0.00	0.00	0.03
S. ruconius	0.13	0.00	0.05
Leiognathidae	35.68	47.94	54.00
Pentaprion longimanus	6.80	0.01	10.66
Pentapodidae	0.06	0.05	0.47
Callionymidae	1.52	1.23	3.64
Gobioidei	2.46	1.98	0.04
Elates ransonnetii	0.41	1.96	0.53
Bothidae	2.80	9.85	0.43
Pleuronectidae	0.28	0.20	0.00
Soleidae	1.05	1.17	0.05
Balistoidei	2.29	2.25	0.61
Tetraodontidae	2.72	3.13	4.02
Crabs (trash)	11.06	8.06	1.63
Miscellaneous trash fish	18.46	13.69	10.59
Total true trash fish	**100.00**	**100.00**	**100.00**

Source: Kongprom *et al*., 2007

Phoonsawat (2000) collected the fisheries resources and economic data from OBT1 at Hua Hin and Pran Buri fishing port, Prachuap Khiri Khan Province, and reported that the ratio of economic fish and trash fish was 61:39. Economic loss, which was arisen from juvenile economic species caught as trash fish, was estimated by comparing the value of juvenile economic species (sold as trash fish) and their marketable size. The result presented that economic loss was 74,458.78 Baht/boat/year. In addition, the annual income was less than the

annual fishing cost; as a result, a minus profit of 25,139 Baht/boat/year was given to the fishers.

Phoonsawat (2005) studied demersal fish resources caught by OBT1 at Pran Buri District, Prachuap Khiri Khan Province, and found that the CPUE declined from 21.949 kg/hr in 1997 to 20.122 kg/hr in 2002. Shrimps were the main target species estimated at 52% of the total catch or 76% of the economic fish. However, size of targeted shrimp, *Trachypenaeus malaianus*, decreased from 6.26 cm to 5.84 cm for male and 7.25 cm to 6.14 cm for female compared between 1995-1997 and 2002. In addition, in 2002, 32% of the total catch was trash fish comprising 31% economic fish and 69% true trash fish.

Chuapun *et al.* (2008) surveyed fisheries resources by DOF research vessel using otter board trawl in the Gulf of Thailand and Andaman Sea. The trawling station in Gulf of Thailand has been divided into nine areas (Fig. 12). The CPUE of true trash fish demonstrated that it was mainly caught in Area 4-6 which are the localities of Prachuap Khiri Khan and Chumphon Province. The total CPUE of true trash fish in the Gulf of Thailand ranged from 9.099-10.376 kg/hr while it varied from 8.454-15.754 kg/hr in Area 4-6 (Table 7). In addition, station 89, 103, 119 and 138, off Chumphon Province, showed a critical amount of true trash fish. The average three-year CPUE of true trash fish in those station were roughly 33, 46, 29 and 26 kg/hr respectively which were largely over average CPUE of true trash fish in the Gulf of Thailand.

Table 7 CPUE of true trash fish (kg/hr) in the Gulf of Thailand surveyed by DOF research vessel in 2003-2005

Year	Gulf of Thailand (Area 1-9)	Upper Western Gulf of Thailand (Area 4-6)
2003	9.585	15.754
2004	9.099	8.454
2005	10.376	13.506

Source: Chuapun *et al.*, 2008

Mean length of some target species of trawls caught in the Gulf of Thailand was smaller than size at first maturity. Mean length of purple-spotted bigeye, *Priacanthus tayenus*, was larger than the size at first maturity only few months in the studied year. Moreover, most of them were smaller than the smallest maturity size. Besides, mean length of lizardfishes, *Saurida elongata* and *S. undosquamis*, caught by all kind of trawls was smaller than the size at first maturity across the studied year. Squids also showed the same consequence that the mean length was smaller than the size at first maturity (Table 8). It is very important to note that this situation leads to recruitment overfishing which the spawning stock has come down to a very low level (FAO, 1992).

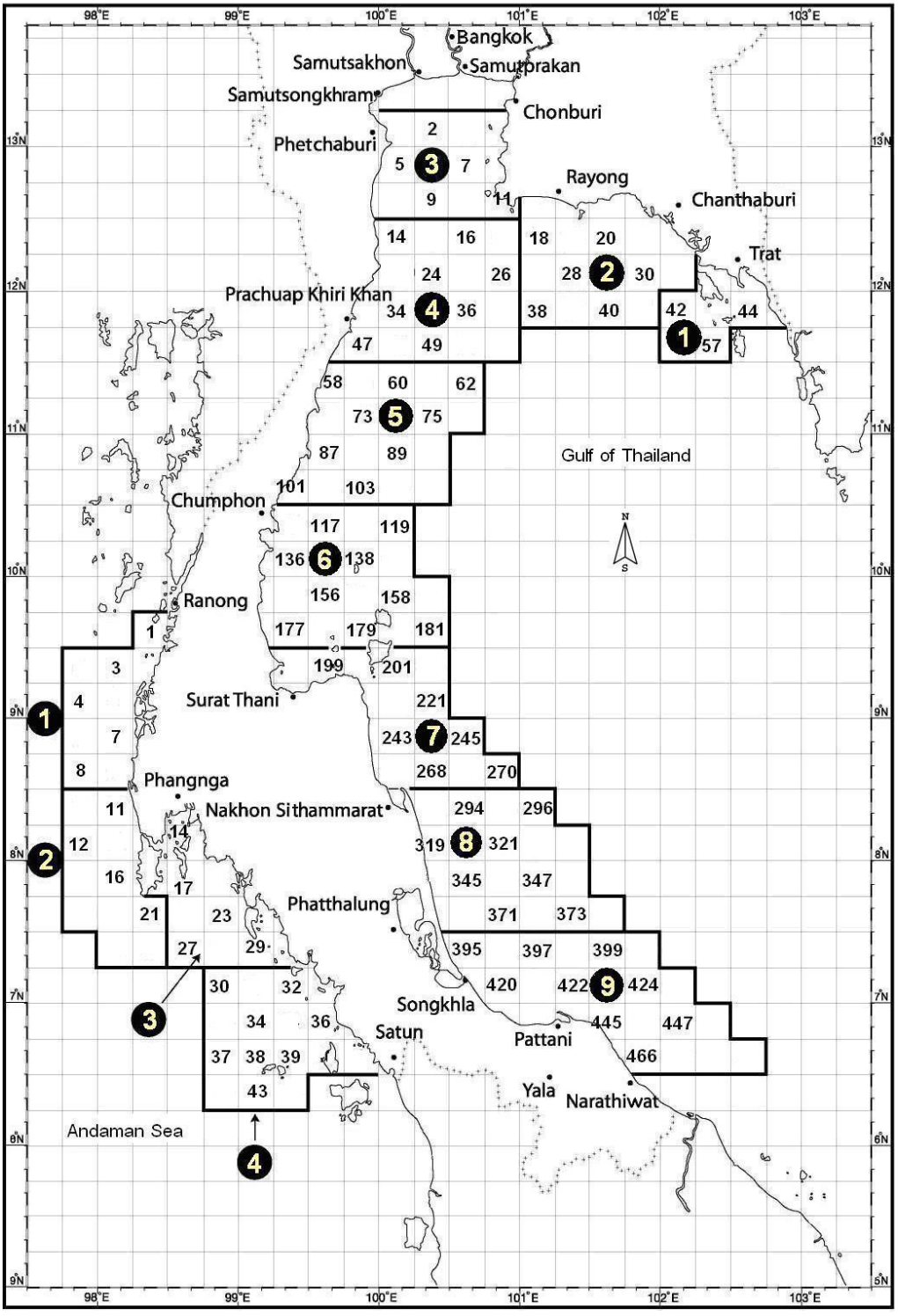

Figure 12 Survey station of DOF research vessel in the Gulf of Thailand and Andaman Sea
Source: Chuapun *et al.* (2008)

Table 8 Monthly mean lengths (cm) of some target species of trawls caught in the Gulf of Thailand compared to size at first maturity

Month	*Priacanthus tayenus* [1]			*Saurida elongata* [2]			*S. undosquamis* [2]			*Photololigo chinensis* [3]			*P. duvaucelii* [3]		
	OBT1	OBT2	PT	OBT1	OBT2	PT	OBT1	OBT2	PT	OBT1	OBT2	PT	OBT1	OBT2	PT
January	14.82	16.69	11.01	14.35	16.80	16.93	11.30	10.83	12.26	17.96	13.37	12.98	11.15	8.86	9.39
February	9.83	8.83	9.87	10.18	8.98	13.35	8.82	9.24	12.74	16.13	15.83	12.07	15.43	10.11	8.94
March	10.21	11.40	12.38	11.28	17.75	10.95	8.23	8.84	10.28	16.41	11.92	10.78	9.36	10.56	10.63
April	8.76	14.85	9.92	11.59	11.52	10.38	12.18	10.10	12.23	10.77	11.01	12.72	10.60	9.90	8.17
May	11.88	11.37	11.62	14.38	10.13	10.78	13.15	13.89	10.97	13.92	15.67	13.15	9.04	9.18	8.83
June	11.72	14.35	10.56	15.23	15.51	8.83	12.41	15.17	11.68	16.38	15.95	13.10	8.13	11.72	8.83
July	12.93	14.32	12.63	11.55	19.73	11.80	12.37	13.28	12.10	12.95	14.04	12.85	8.83	8.27	8.89
August	15.04	18.55	8.14	12.87	6.79	12.10	16.27	20.06	13.12	14.61	12.29	14.53	10.20	9.69	10.66
September	12.42	12.06	8.30	12.33	9.12	11.82	12.24	13.14	14.16	10.90	14.91	12.42	8.66	9.16	9.44
October	10.18	11.51	10.94	11.04	10.80	11.54	9.78	20.09	13.18	16.87	17.99	14.39	7.77	7.70	9.93
November	10.49	10.94	15.27	11.12	27.84	10.53	12.75	11.49	11.01	16.43	16.18	16.28	8.99	10.23	9.43
December	8.85	13.96	9.74	15.00	11.96	13.20	14.60	11.15	9.39	7.13	15.41	15.05	8.86	8.76	6.95
Yearly Average	11.21	11.72	9.93	11.61	9.67	11.10	10.24	11.20	11.25	12.98	14.00	13.01	9.33	9.57	9.17
Size at first maturity		F =14.19 [4]			F = 31.62 [5] M = 25.15			F = 28.26 [6] M = 20.48			F = 17.71 [7] M = 21.50			F = 9.04 [7] M = 13.89	
Smallest maturity size (cm)		13.10			15.75			15.75			7.30			6.00	

Remarks:
1 Kongprom *et al*., 2010a
2 Sinanun *et al*., 2012
3 Kongprom *et al*., 2010b
4 Krajangdara and Yakoh, 2005
5 Vibunpant *et al*., 2012
6 Vibunpant *et al*., 2011
7 Suppanirun *et al*. 2011

In addition, mean length of some economically important species caught by trawls in the Upper Western Gulf of Thailand was presented by Kongprom *et al*. (2007). Catch of trawls is usually sorted to food fish and trash fish. Table 9 shows the mean length of some economically important species both in food fish and trash fish component. The comparison between the mean length and the reported female size at first maturity found that mean length of economic species in the trash fish component was all smaller than the size at first maturity. Furthermore, mean lengths of food fish caught by OBT1 were all smaller than the size at first maturity, although mean lengths of few species caught by OBT2 and PT were larger than the size at first maturity.

Table 9 Mean length and female size at first maturity (cm) of some economic species caught by trawls in the Upper Western Gulf of Thailand during November 2003 to September 2005

Species	OBT1		OBT2		PT		Female size at first maturity
	Food fish	Trash fish	Food fish	Trash fish	Food fish	Trash fish	
Nemipterus hexodon	9.56	4.91	17.78	-	18.67	7.23	14.57 [1]
Saurida elongata	18.02	8.34	22.54	6.83	19.67	9.88	31.62 [2]
S. undosquamis	20.03	6.38	19.71	8.00	17.46	9.73	28.26 [3]
Priacanthus tayenus	9.93	8.75	15.69	11.42	16.23	7.95	14.19 [4]
Sepia aculeata	7.96	3.02	-	-	10.77	4.92	9.44 [5]
Metapenaeus affinis	6.68	-	12.69	-	-	-	12.18 [6]
M. ensis	8.62	-	11.88	-	-	-	11.24 [7]

Source: Kongprom *et al*., 2007

Remarks: [1] Pinputtasin *et al*., 2008
[2] Vibunpant *et al*., 2012
[3] Vibunpant *et al*., 2011
[4] Krajangdara and Yakoh, 2005
[5] Charoensombat *et al*., 2013
[6] Sritakon *et al*., 2012
[7] Pinputtasin *et al*., 2012

Although the number of fishing boats registered as trawls in the Gulf of Thailand, including Prachuap Khiri Khan and Chumphon Province, has decreased since 1990, fishing effort still need to be reduced. Several technical papers disclosed that current fishing effort was over MSY and MEY (Table 10). For instance, the fishing effort of lizardfishes, *Saurida elongata* and *S. undosquamis*, should be reduced by 80%.

Table 10 Scientific advice on reduction of fishing effort of some fish stocks in the Gulf of Thailand

Stock	Fleet	Reduce by	Reference
Priacanthus tayenus	OBT1	20%	Kongprom *et al*., 2010a
	OBT2	30%	
	PT	40%	
Saurida elongata and	OBT1	80%	Sinanun *et al*., 2012
S. undosquamis	OBT2	80%	
	PT	80%	

5. Conclusion

Although the number of fishing boats registered by trawls has continuously decreased during last decades, the demersal fish stocks are in declining state. Closed area in the Upper Western Gulf of Thailand, including Prachuap Khiri Khan and Chumphon Province, has been effective almost 30 years. However, it seems that it is not sufficient to sustain fisheries resources. Several issues demonstrating the decline of fisheries resources have been discussed in this paper. Huge amount of trash fish, overfishing, lower CPUE and sub-adult economic fish being caught are all signs that strong management actions are strongly needed. Enlargement of cod-end mesh size is a possible management measure to restore the resources and to ensure sustainable fisheries in the country.

6. Recommendation

Several fishing gear used in Thailand have been specified the net mesh size, e.g., 2.5 cm for Thai purse seine, 0.6 cm for anchovy purse seine, 3.2 cm for squid falling net and 2.5 inch for bottom part of crab trap. The net mesh size of trawls is however not decided; therefore, enactment of codend mesh size is possible and should be done based on scientific advice.

In addition, other fishing gear which mesh size regulation has been adopted should also be reconsidered that the mesh size is whether too small. For instance, small fish are regularly caught by Thai purse seine particularly short mackerel using small mesh sizes.

Although closed area measure has been in place of the Upper Western Gulf of Thailand in order to conserve spawning stocks and, recently, of the Inner Gulf of Thailand in order to conserve the juvenile fishes particularly short mackerel, there is a gap of 47 nautical miles between those two measures along the northern part of Prachuap Khiri Khan province which has not been protected. The gap is a part of migratory route of the mackerel. If there is scientific information, including biological and socio-economic aspects, to support the closure of the said opening area, almost entire life cycle of most valuable species will be protected and also beneficial to the ecosystem.

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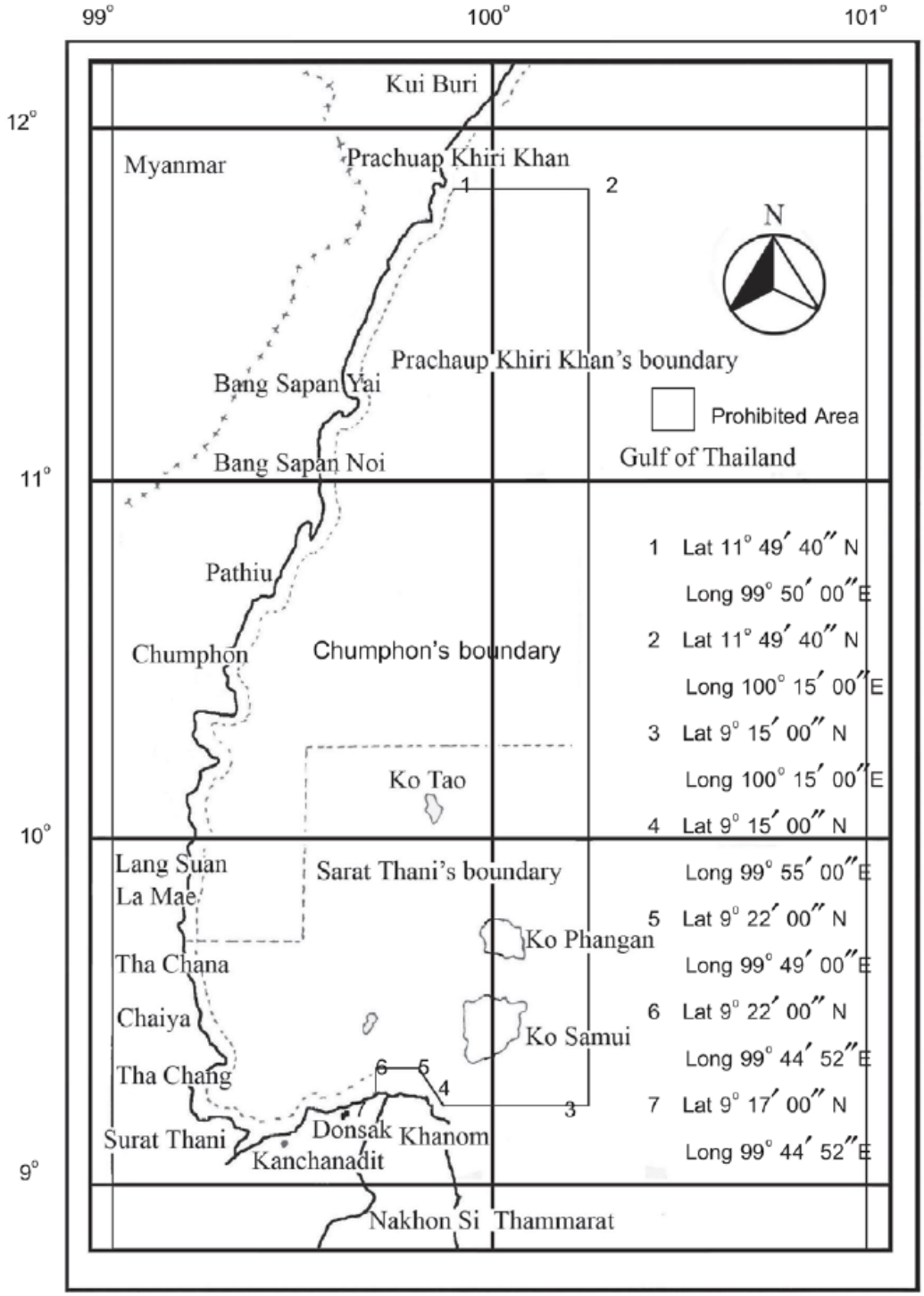
Appendix A

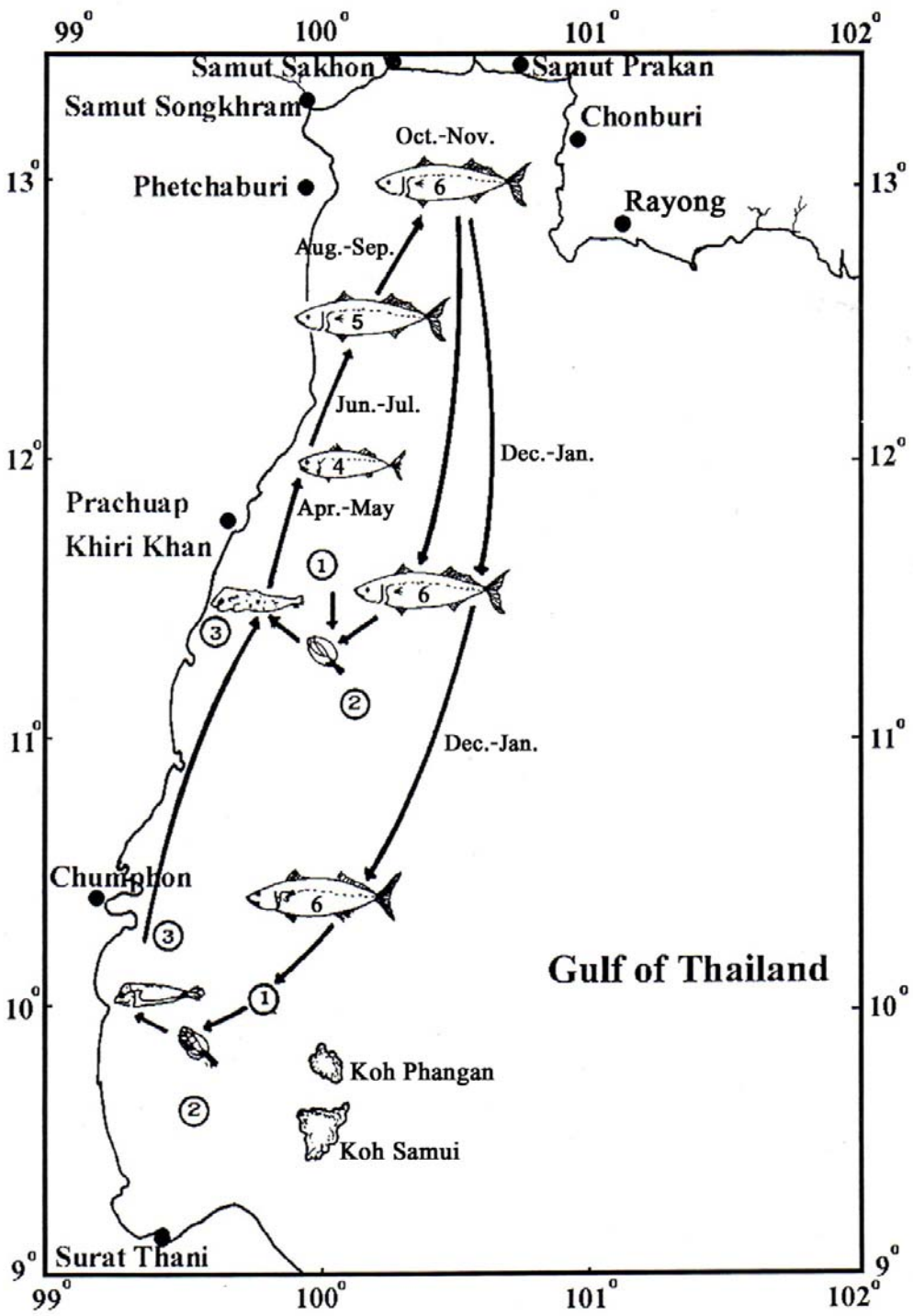
Map attached to Notification of the Ministry of Agriculture and Cooperatives
Re: Prohibition of Certain Kinds of Fishing Appliances in Spawning and Breeding Seasons in the Locality of Prachuab Kirikhan, Chumporn and Surat Thani Provinces
dated on 24 January B.E. 2550



Source: Coastal Habitats and Resources Management Project (CHARM, 2005)

Appendix B

Life cycle of short mackerel in the Gulf of Thailand



Remarks:

① Fertilized egg ② Larva ③ Juvenile

④ Young mackerel ⑤ Sub-adult ⑥ Spawning adult

Adapted from: FAO, 1997