



PROJECT

**STRATEGIES FOR TRAWL FISHERIES BYCATCH
MANAGEMENT (REBYC-II CTI)**

REPORT

**DATA COLLECTION OF TRAWL FISHERY
BYCATCH IN KIEN GIANG, VIET NAM in 2015**

Ha Noi, 2015

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Summary

This report presents the outcomes of catch and bycatch data collection in Vietnamese trawl fisheries within the framework of the project “Strategies for trawl fisheries bycatch management” (REBYC-II CTI). The study involved the on board catch sampling of the bottom otter trawl fishery and the pair trawl fishery in Kien Giang province in Vietnam.

Results show that trawl catches are composed of a large number of species and with a very high bycatch proportion (accounting for about 50% of the total catch). High amount of bycatch creates various difficulties in management perspectives and have to be addressed. It is proposed that a routine bycatch sampling and data collection scheme at Kien Giang province is established. In addition, better trawl fishery management regime, including the development and approval of trawl fishery management plan to reduce fishing effort on these fisheries, will be necessary.

1. Introduction

The Southeast Asia is one of the world's most biologically diverse, economically productive and potentially vulnerable marine zones. As a result of increasing populations and exploitation pressures, growing threats from pollution and major ecosystem change are a particular concern in the region. Also – as more widely in the global context – the non-targeted capture of fish and non-fish species, commonly called as bycatch, is an increasing concern. Bycatch includes fish, turtles, corals and other seabed fauna and flora. This part of the catch tends to be poorly monitored and not managed but could have an important impact on fishery resources, habitats and ecosystems. In some fisheries and regions, there is an increasing trend towards retention of the bycatch consisting of juveniles and small-sized fish for use as food for human consumption or for utilization as aquaculture feed. This is therefore a complex issue, requiring resource and biodiversity aspects to be tackled alongside human needs and involving a mix of policy, technical and community support measures.

The project “Strategies for trawl fisheries bycatch management” (REBYC-II CTI) was conceived based on the successes of the 2002-2008 FAO/UNEP/GEF global project “Reduction of Environmental Impact from Tropical Shrimp Trawling through the Introduction of Bycatch Reduction Technologies and Change of Management”. The REBYC-II CTI project has focused on multispecies bottom trawling, where bycatch issues are amongst the most serious, with potentially significant effects on ecosystems and livelihoods. The Project has aimed to address these challenges by promoting sustainable fishing practices and improved management. The REBYC-II CTI project was developed under the leadership of FAO (project implementing agency) in close collaboration with its partners: Southeast Asian Fisheries Development Center (SEAFDEC) and the governments of the participating countries Indonesia, Papua New Guinea, Philippines, Thailand and Viet Nam.

The REBYC-II CTI Project in Vietnam works closely with DECAFIREP and Provincial staff in Kien Giang Province, which is amongst the provinces with the highest number of trawlers in Vietnam. According to a recent report of local authority of Kien Giang province, there are a total 10,275 of fishing vessels registered in the province. The number of trawlers is 3,192, accounting about 26% of the total number of vessels. The total catch and catch composition in trawl fishery in Kien Giang and Vietnam in general is not known in adequate accuracy. There is a lack of operational-level data on the catches in Kien Giang, such as trends in catch rates, mainly due to difficulties in monitoring.

Although a national legal framework has been established to implement a logbook program requiring the cooperation of fishing communities, implementation has been weak due to the lack of compliance and

enforcement. The difficulty of catch monitoring task is exacerbated by the complex multi-gear nature of the trawl fisheries in Kien Giang province.

2. Objectives of the study

This report was prepared as result of activity “Data collection of trawl fisheries bycatch in Kien Giang waters of Vietnam”. Expected outputs of this activity are as follows:

- Total landings by selected trawl fishery fleets.
- Total bycatch by selected trawl fishery fleets (trash fish, juveniles and sharks, rays and coral fragments).
- Monthly species and size composition and volumes of catch and bycatch by selected trawl fishery fleets (by season, area, vessel type, gear type).

3. Overview of trawl fisheries in Kien Giang

3.1. Fishing activities

The total number of fishing vessels in Kien Giang province was 10,189 units in 2014 and increased to 10,275 units in 2015 (Table 1 and Table 2) with total fishing effort of 1,856,311 horsepower (hp) in 2014 and 2,077,887 hp in 2015. These vessels were licensed by Department of Capture Fisheries of Kien Giang. The major fishing gears used are bottom gillnet, pair trawl, squid handline, otter trawl, purse seine, pots and traps. Fishing fleets are concentrated in 15 districts of Kien Giang Province (Table 1). The major places where almost all fishing boats concentrate are: Phu Quoc, Rach Gia, Kien Hai, Kien Luong, Ha Tien, Hon Dat, Chau Thanh, An Minh and An Bien. Phu Quoc and Rach Gia have registered most of trawlers and accounted for 26.0% and 18.1% of total fishing boat of province, respectively (Table 1).

Table 1. Statistics of fishing units in number by districts and by total capacity (hp) of all fisheries in Kien Giang in 2014-2015.

No	District	Number of vessels				Total capacity (horsepower)			
		2014		2015		2014		2015	
		N	%	N	%	Capacity	%	Capacity	%
1	An Biên	234	2.3	245	2	38,562	2.1	49,014	2
2	An Minh	395	3.9	405	4	34,776	1.9	42,171	2
3	Châu Thành	404	4.0	424	4	189,367	10.2	223,954	11
4	Giồng Riềng	5	0.0	6	0	960	0.1	990	0
5	Gò Quao	4	0.0	7	0	451	0.0	1,411	0
6	Hà Tiên	940	9.2	909	9	104,381	5.6	100,547	5
7	Hòn Đất	742	7.3	787	8	235,440	12.7	271,974	13
8	Kiên Hải	1,476	14.5	1,452	15	145,264	7.8	168,100	8

No	District	Number of vessels				Total capacity (horsepower)			
		2014		2015		2014		2015	
		N	%	N	%	Capacity	%	Capacity	%
9	Kiên Lương	1,438	14.1	1,445	14	116,342	6.3	119,260	6
10	Phú Quốc	2,652	26.0	2,634	26	161,202	8.7	165,424	8
11	Rạch Giá	1,849	18.1	1,918	19	810,130	43.6	917,662	44
12	Tân Hiệp	20	0.2	18	0	9,966	0.5	9,824	0
13	Vĩnh Thuận	3	0.0	2	0	498	0.0	118	0
14	U Minh Thượng	2	0,0	2	0	204	0.0	204	0
15	Giang Thành	25	0,2	21	0	8,768	0.5	7,234	0
	Total	10,189	100	10,275	100	1,856,311	100	2,077,887	100

Table 2. Statistic of fishing unit in number by gears and horsepower (hp) of all fishing vessels in Kien Giang Province in 2015.

No.	Gear type	HP group							Sub-total
		< 20	20-45	45-90	90-150	150-250	250-400	>= 400	
1	Anchovy purse seine	0	2	3	8	47	138	44	242
2	Mackerel purse seine	0	0	1	1	6	98	4	110
3	Purse with light	0	0	0	0	0	0	0	0
4	Bottom gillnet	103	101	34	4	7	88	3	340
5	Gillnet	0	3	8	1	3	87	9	111
6	Shrimp gillnet	78	55	5	3	3	0	0	144
7	Small size trammel net	0	4	0	0	0	0	0	4
8	Sardine gillnet	99	40	1	0	0	0	0	140
9	Crab trammel net	1,329	1,043	317	17	75	18	4	2,803
10	Otter trawl	1	69	72	41	181	125	71	560
11	Pair trawl	0	0	1	10	56	406	2,159	2,632
12	Squid hooks and lines	743	620	72	23	39	11	2	1,510
13	Bottom longline	92	91	27	8	25	32	1	276
14	Crab trap	0	0	3	0	0	0	0	3
15	Cuttlefish trap	107	107	10	6	31	10	0	271
16	Set net	7	41	0	0	0	0	0	48
17	Logistic services	19	16	3	6	24	148	57	273
18	Others	112	359	161	73	89	14	0	808
	Sub-Total	2,690	2,551	718	201	586	1,175	2,354	10,275

During the period 2005 - 2015, the number of fishing boats and total fishing power in Kien Giang Province has gradually increased. It was about 7,700 units in 2005 and increased to a record high of 12,286 units in 2012. In 2015, total fishing boat is 10,275 units with total fishing power of 2,077,887 hp (**Table 1**).

In the past decade, the fishing fleet structure in Kien Giang had changed, especially in trawl fisheries. Number of otter trawls had gradually decreased; in contrast, number of pair trawl has increased (DARD Kien Giang 2015).

3.2. Fishing fleet and gear in Kien Giang province

The otter trawl fisheries includes shrimp otter trawling and fish otter trawling.. They operate both day and night with fishing trip of about 3-5 days. There are about 3-5 fishermen on smaller fishing boats and 7-8-fishermen on the larger vessels. In these fisheries, the fishing boats usually go for fishing together and alternatively deliver product to the shore.

The pair trawl consists of normal pair trawl and high speed pair trawl. The first one target on the demersal fish while the second one target on small pelagic fish. On smaller pair trawler, there is about 10 – 12 fisherman working and on the bigger vessels 18-20 fisherman.

According to statistics by the end of September 2015, the total number of trawlers was 3,192 with a total capacity of 1,546,812 hp, accounting for 31,1% in number and 76,1% in engine capacity respectively, the number of vessels with a capacity of over 400 hp accounting for 70% of the total trawlers (**Table 3**):

Table 3. Number of trawlers in five capacity categories and their total capacity (hp) in Quarter III 2015

Vessel size/capacity	Information	Fisheries		
		Otter trawls	Pair trawls	Total
<90hp	Number	142	1	143
	Total capacity	6476	74	6,550
90-150	Number	41	10	51
	Capacity	4,858	1,249	6,107
150-250	Number	181	56	237
	Total capacity	31,246	9,564	40,810
250-400	Number	125	406	531
	Total capacity	40,280	141,660	181,940
≥400	Number	71	2,159	2,230
	Total capacity	37,690	1,273,715	1,311,405
	Total number	560	2,632	3,192
	Total capacity	120,550	1,426,262	1,546,812

Trawlers are categorized into two groups: otter trawlers and pair trawlers. For management purpose, vessels are grouped into fleets based on the main engine capacity and fishing gear equipped. The fishing fleets are : otter trawl

< 45 hp, otter trawl 45-90 hp, otter trawl 90-150 hp, otter trawl 150-250 hp, otter trawl 250-400 hp, otter trawl > 400 hp, pair trawl < 45 hp, pair trawl 45-90 hp, pair trawl 90-150 hp, pair trawl 150-250 hp, pair trawl 250-400 hp and pair trawl > 400 hp.

According to statistic of Department of Capture Fisheries of Kien Giang in 2014, the otter trawl comprised of 560 units, of which, the fleet 150-250 hp , 250-400 hp and higher than 400 hp accounted for 31.3%, 20.5% and 12.8%, respectively (**Figure 1**). There are 2,632 pair trawl and most of them have engine capacity higher than 400 hp (**Table 3; Figure 2**).

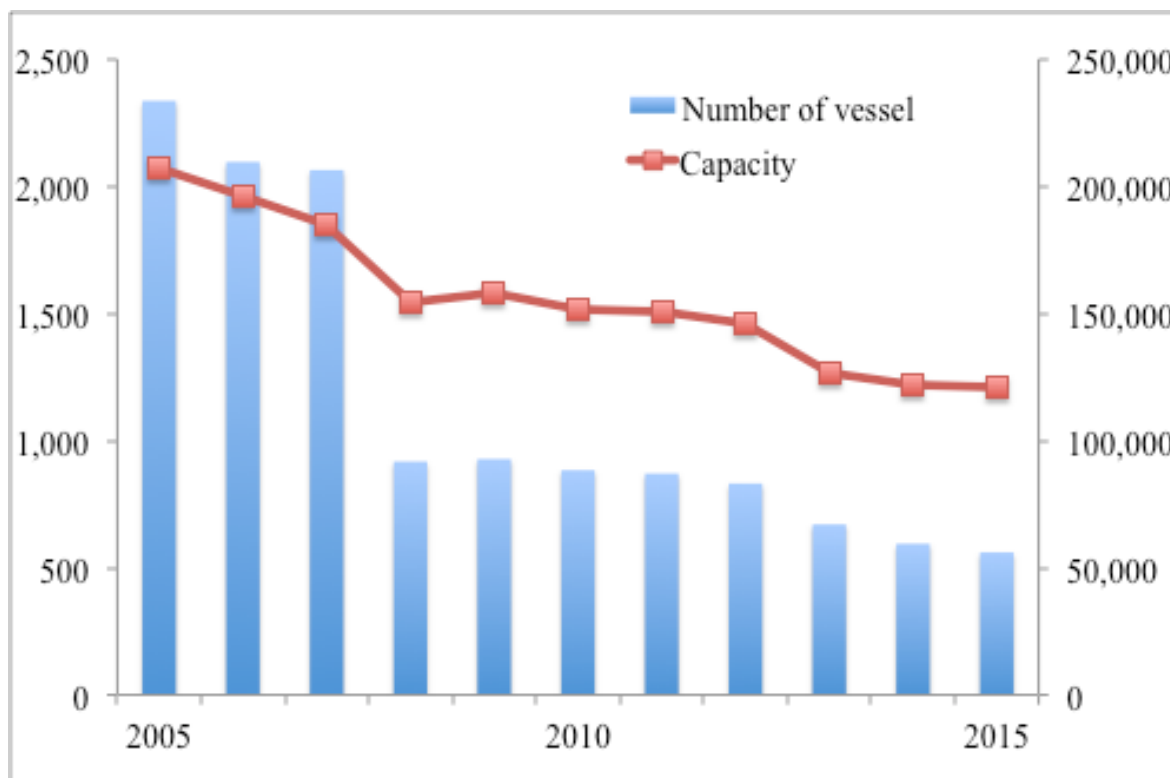


Figure 1. Fleet structure in otter trawl fishery in Kien Giang from 2005-2015. The capacity of vessels is expressed as the overall engine horse power (hp).

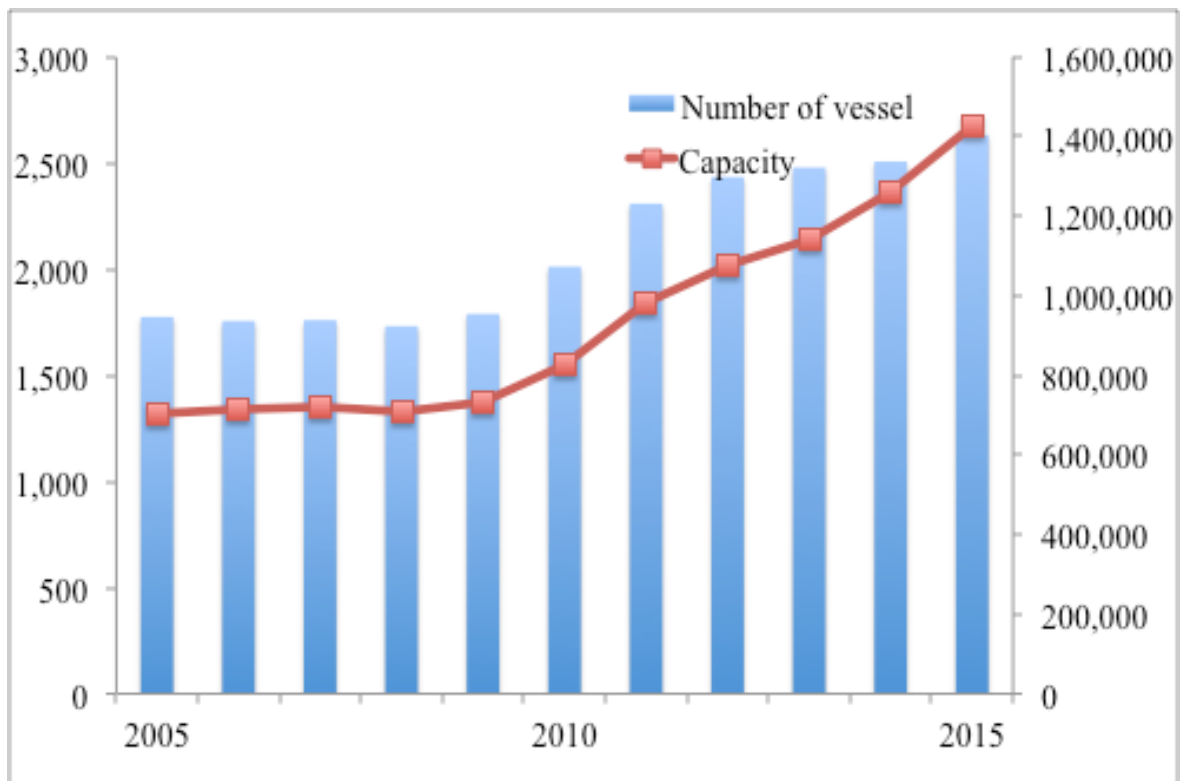


Figure 2. Fleet structure of pair trawls fisheries in Kien Giang from 2005-2015. The capacity of vessels is expressed as the overall engine horse power (hp).

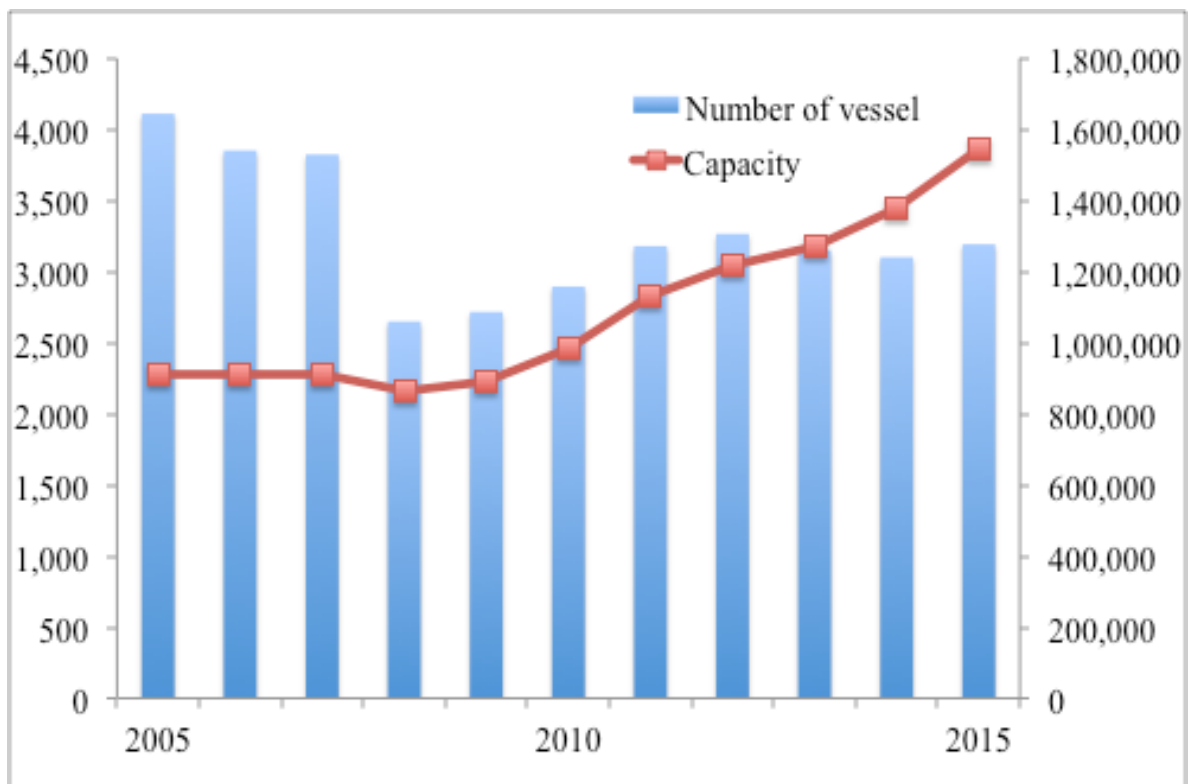


Figure 3. Fleet structure of all trawl fisheries in Kien Giang from 2005-2015. The capacity of vessels is expressed as the overall engine horse power (hp).

3.3. Fishing ground

In Kien Giang waters, the trawlers operates in a wider area covering the exclusive economic zone of Vietnam in the gulf of Thailand. The high catch rate of demersal species was in the westward of Ca Mau cape in the northeast monsoon season and an area stretched from Nam Du Islands to the south of Hon Khoai Islands. Small pelagic fish is distributed in high density in a region from the south of Phu Quoc Islands to Tho Chu Islands (**Figure 4**) (the left map indicates the fishing ground of otter trawl and the other indicates the pair trawl fisheries).

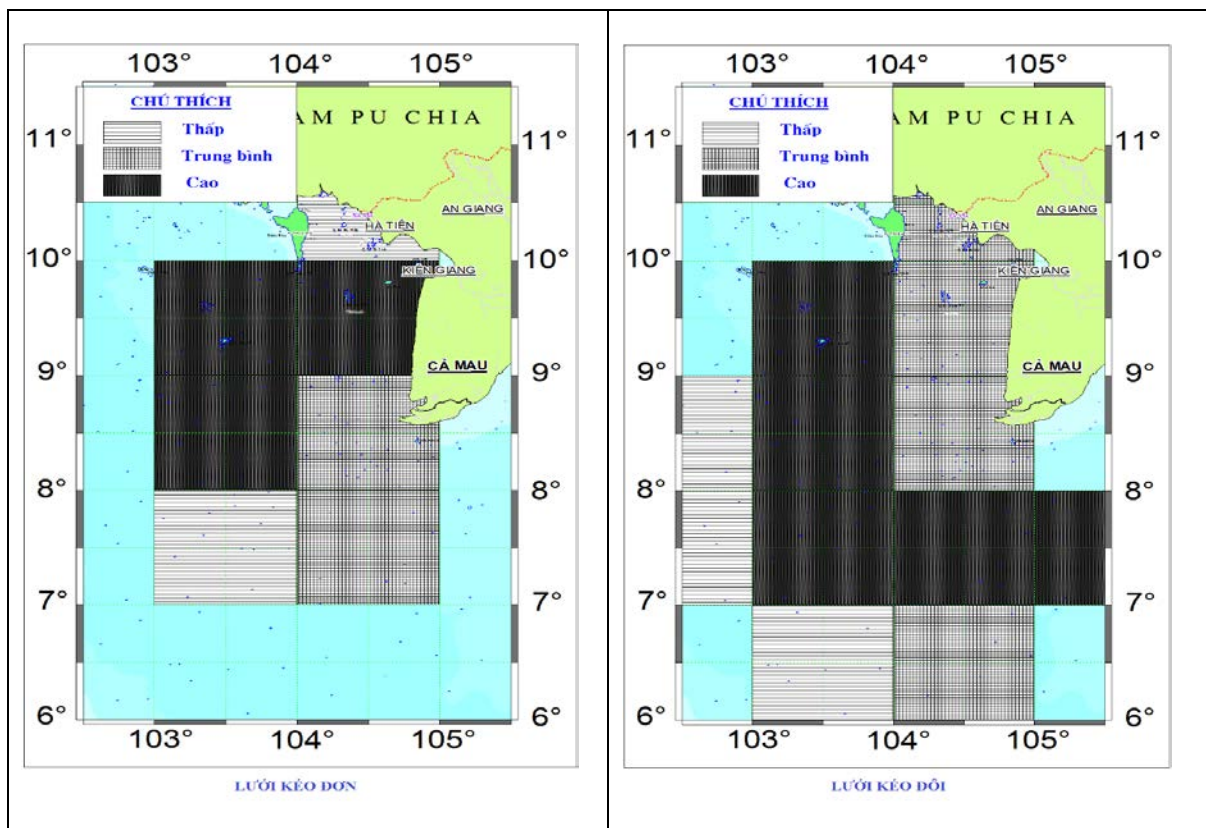


Figure 4. Fishing grounds of trawl fisheries in Kien Giang province

4. Materials and methods

4.1. Data collection

4.1.1. Logbook data collection

Logbook data for trawl fisheries in Kien Giang Province was collected monthly by local staff in Ha Tien, Kien Luong, Hon Dat, Kien Hai, Chau Thanh and Rach Gia district. The logbook was designed by Department of Capture Fisheries and sent directly to the local collaborators. The collaborators then distributed to the captains of fishing boat to record the fishing activities daily.

The logbook consists of the cover page and the logsheets. Information recorded in the cover page is: Province, landing site, vessel registration number, owner or captain, main engine horsepower, start day and landing day of the fishing trip. The logsheets consist of information about the fishing haul as: haul number, towing duration, date and time fish fishing haul, fishing ground, fishing position, depth of fishing ground and catch of each commercial group.

Captains were guided to record and then be responsible for recording all information related to fishing activities including fishing location, fishing time, catch of each commercial group and also discarded catches at sea. At the end of the month, local collaborators will collect the logbook for encoding and analysis (**Figure 5**).

Every month, 20 logbooks were distributed to 20 fishing boats of each category to record the fishing activity information.

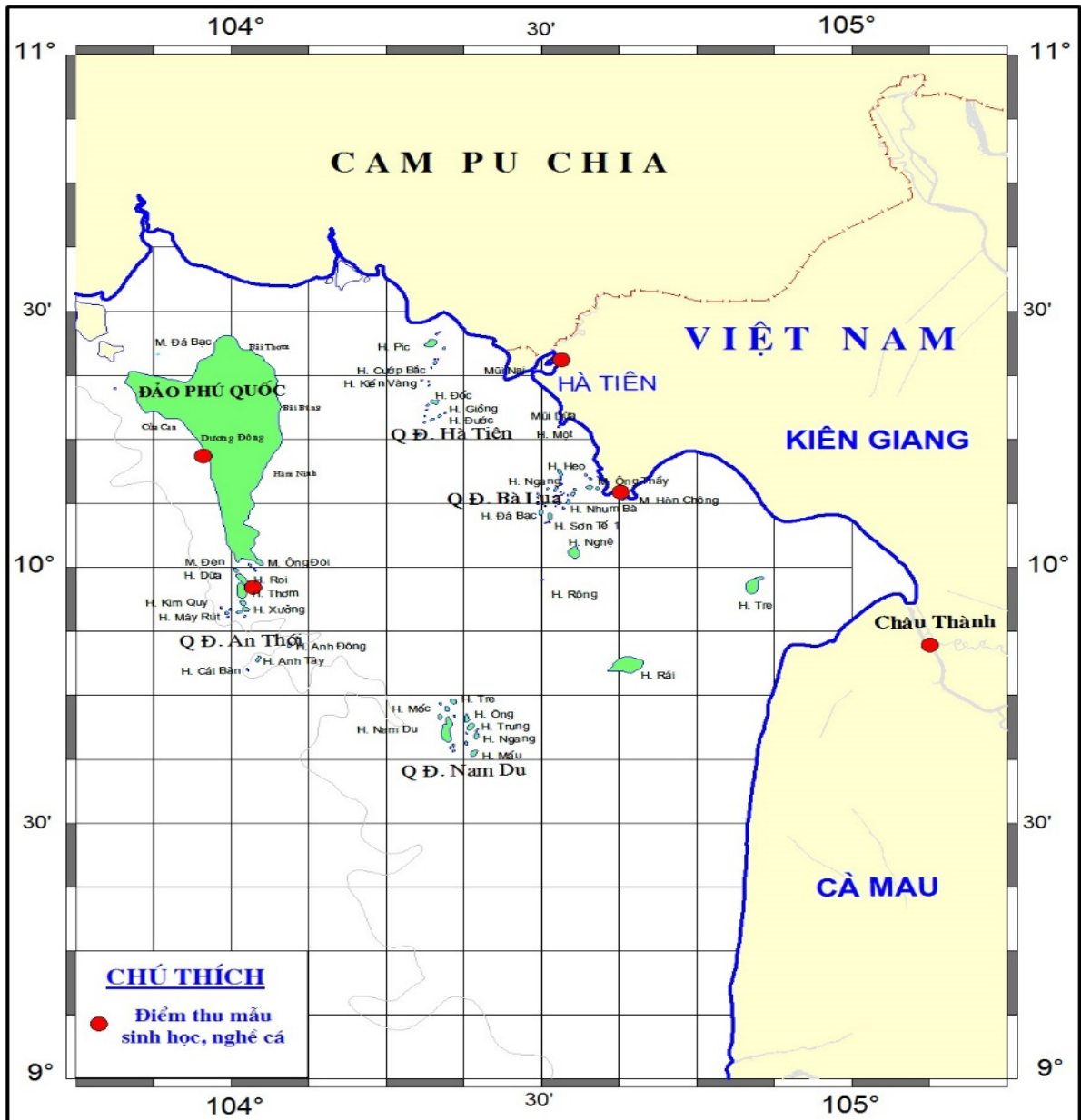


Figure 5. Sites (red points) for port sampling in Kien Giang Province.

4.1.2. Port sampling

Catch and effort data of trawl fisheries in Kien Giang Province were collected monthly at some selected landing sites of Kien Giang province such as Ha Tien, Kien Luong, Hon Dat, Kien Hai, Chau Thanh and Rach Gia districts in the framework of another national project conducted by Research Institute for Marine Fisheries (RIMF) in collaboration with Department of Fisheries of Kien Giang (Figure 6). The sampling approach in time and space was applied in this study (Constantine, 2002). Information was collected consisting of catch by trip, fishing efficiency, boat active coefficient (BAC), etc. In this method, local collaborators go to fisheries communities to interview fishermen about fishing activities as fishing ground, catch of each commercial group for each fishing trip, trip duration, number of trip per month, active vessel day per month. Each month, 32 forms will be collected from each

fishing fleet (minimum required samples). In this report, we divided fishing fleets of trawl fisheries into < 45hp, 45-90 hp, 90-150 hpP, 150-250 hp, 250-400 hp and > 400 HP for analysis and further estimation. This was applied for both otter trawl and pair trawls fisheries in Kien Giang province. Collected data were then sent to Directorate of Fisheries/RIMF for data encoding into the Fisheries Biology Database.

Species composition of the commercial group as trash fish, mixed fish, lizard fish, carrangids, anchovies and shrimps were also conducted monthly by RIMF staffs. The samples were randomly taken from catch in the certain commercial groups and then to be sorted by species or species groups using classification keys of FAO and Viet Nam (Nguyễn Hữu Phụng và Trần Hoài Lan, 1994, Nguyễn Hữu Phụng và Nguyễn Nhật Thi, 1994, Nguyễn Hữu Phụng và nnk, 1995, Nguyễn Hữu Phụng, 1997, Carpenter and Niem 1998, Carpenter and Niem 1999, Nguyễn Hữu Phụng, 1999, Carpenter and Niem 1999a, Carpenter and Niem 1999b, Carpenter and Niem 2001). After sorting, number of individual and their corresponding weights in the sample were counted and weighed separately. Some main commercial species in the catch of trawl fisheries were selected for length measurement such as shrimp (*Penaeus semisulcatus*), freckled goatfish (*Upeneus tragula*), bensasi goatfish (*Upeneus japonicus*), slender lizardfish (*Saurida elongata*), brushtooth lizardfish (*Saurida undosquamis*), fork-tail threadfin bream (*Nemipterus furcosus*), Lattice monocle bream (*Scolopsis taeniopterus*), Yellowstripe scad (*Selaroides leptolepis*), Yellowtail scad (*Atule mate*), Indian mackerel (*Rastrelliger kanagurta*), short mackerel (*Rastrelliger brachysoma*), shorthead anchovy (*Encrasicholina heteroloba*); Indian squid (*Loligo duvauceli*) and chinese squid (*Loligo chiensis*).

4.2. Data analysis

Trawl fisheries data in Kien Giang Province were analysed by fisheries indicators as introduced by FAO (Constantine 2002). These include fishing effort, average numbers of fishing days per month, number of fishing vessels, catch rate, catch composition, total catches and fishing grounds.

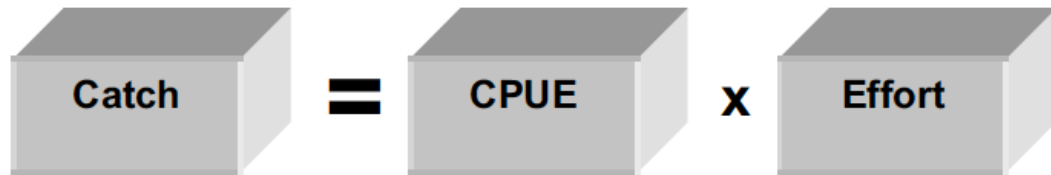
4.2.1. Catch composition and catch per unit of effort

Catch composition and catch per unit effort are analysed by each fishing fleet using descriptive statistic method. Catch composition is used to express proportion of catch of a commercial group to total catch of the fishing trip or proportion of catch of a species in total catch of a commercial group.

Catch per unit effort (CPUE, kg per fishing day) is analysed for each fleet as $CPUE_i = \frac{C_i}{D_i}$ and $\overline{CPUE}_i = \frac{1}{n} * \sum_{i=1}^n CPUE_i$, where C_i is the catch (kg) of the fishing trip D_i is number of fishing days in the trip i , respectively.

4.2.2. Catch estimates

Total catch of trawl fisheries is estimated by sum of the catches of each fleet (Constantine, 2002). Catches of each fleet then is estimated by sampled CPUE multiplied with estimated fishing effort using following equation (Constantine, 2002):



Where: The catch of fishing fleet i (Y_i) is calculated as $Y_i = CPUE_i * F_i * A_i$; Where F_i is number of fishing boats of fleet i and A_i is the mean active day per month of the fleet i . The mean active day per month is estimated as $A_i = \frac{\sum AD_i}{n_i}$; of those, AD_i is number of fishing days in the previous month of the fishing fleet.

4.2.3. Fishing ground

Fishing ground of trawl fisheries is identified for fishing fleet based on information from the logbooks (**Figure 6**). The main fishing ground is identified as the region where the fishing boats concentrated the fishing.



Figure 6. Area codes of fishing grounds defined in logbook data.

4.2.4. Length frequency and average size of selected species.

Length frequency and average size of selected species sampled in trash fish and mixed fish are analysed using the descriptive statistic method. The average size of species caught is calculated as

$$\bar{X} = \frac{1}{n} * \sum_{j=1}^m F_j * L_j \qquad n = \sum_{j=1}^m F_j$$

Where \bar{X} is means of fork length (in centimes) for fish or mean carapace length for shrimp, L_j is length group j (cm), F_j is number of individual of length group j and n is number of individual in sample.

5. Results and discussion

5.1. Fishing activities

The average trip duration of trawl fisheries in Kien Giang differed among the fishing fleets and between two sampled years. The trawl fishing fleet operated most actively of otter trawl with capacity of 150-250 hp and pair trawl with capacity higher than 400 hp. This is a similar trend for both two continuous years. A general trend observed was that the large fishing fleets have longer fishing day at sea that of those of smaller one in both otter trawl and pair trawl (**Table 4**). If the results analyzed with different periods within a year then there was a general trend that the trip duration of fishing fleets is longer in the last quarters the year (i.e. quarters III and IV).

Table 4. Average trip duration of trawl fleets (day) in Kien Giang waters in 2014 and 2015.

Fishing Fleet	Average trip duration of trawl fleets (day)	
	2014	2015
Otter trawl < 45 hp	3.50	3.70
Otter trawl 45-90 HP	11.97	8.45
Otter trawl 90-150 HP	25.00	21.56
Otter trawl 150-250 HP	13.10	16.23
Otter trawl 250-400 HP	17.00	15.20
Otter trawl > 400 HP	15.00	16.34
Pairtrawl < 45 HP	-	12.50
Pairtrawl 45-90 HP	8.27	10.23
Pairtrawl 90-150 HP	10.00	7.00
Pairtrawl 150-250 HP	8.17	11.50
Pairtrawl 250-400 HP	16.10	13.56
Pairtrawl > 400 HP	21.33	22.10

Note “-” denotes unavailable data

Investigations to estimate number of haul/day also indicated that there were differences on the average number of hauls/day between two years among different fleets. A general trend indicated that the number of hauls/day of 2015 was usually higher than of those of 2014 (**Table 5**). This indicator can be a negative signal on natural resources. The trawl fishing fleets enhanced their fishing capacity/effort to have more benefits due to lower resources status. This indicator can also be linked to fuel price to be higher in 2014 than 2015 and in term of economic return then fishers can conduct more hauls. In 2015, the otter trawl fleets operated from 2.5 to 3.7 hauls per day in average. According to investigation results, there was no change on towing time between 2014 and 2015. Both otter trawl and pair trawl fleets usually have the

towing duration around 4 hours per haul and that remained unchanged in 2014 and 2015.

Table 5. Average number of hauls per day of fishing fleets in Kien Giang Province in 2014 and 2015.

Fishing Fleet	Average number of haul per day of fishing fleets (hauls)	
	2014	2015
Otter trawl < 45 hp	3.20	2.50
Otter trawl 45-90 HP	3.43	3.52
Otter trawl 90-150 HP	2.00	2.60
Otter trawl 150-250 HP	3.10	3.21
Otter trawl 250-400 HP	3.50	3.69
Otter trawl > 400 HP	3.80	3.30
Pair trawl < 45 HP	-	3.32
Pair trawl 45-90 HP	2.13	2.45
Pair trawl 90-150 HP	2.00	2.67
Pair trawl 150-250 HP	2.43	2.68
Pair trawl 250-400 HP	2.70	2.85
Pair trawl > 400 HP	2.93	3.21

Note “-” is no information

The surveys also investigated the number of active days per month. The number of active day per month is a raising factor expressing total number of days of fishing activities during the month, i.e. it is calculated each month. Details investigation results of the active day per month appear in the **Table 6**.

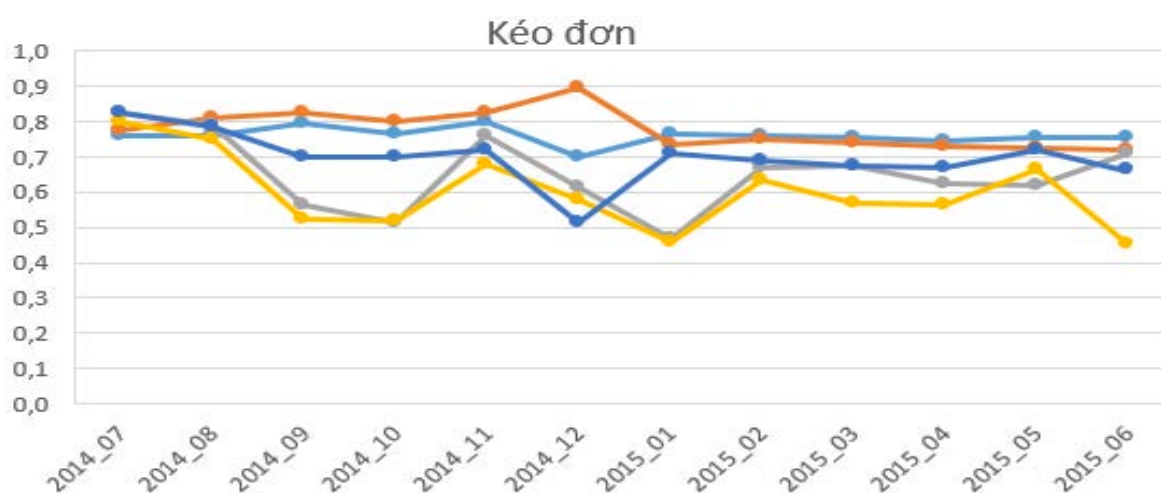


Figure 7. Share of active days per month of different otter trawl fleets (different colors) in Southwestern region between 2014 and 2015.

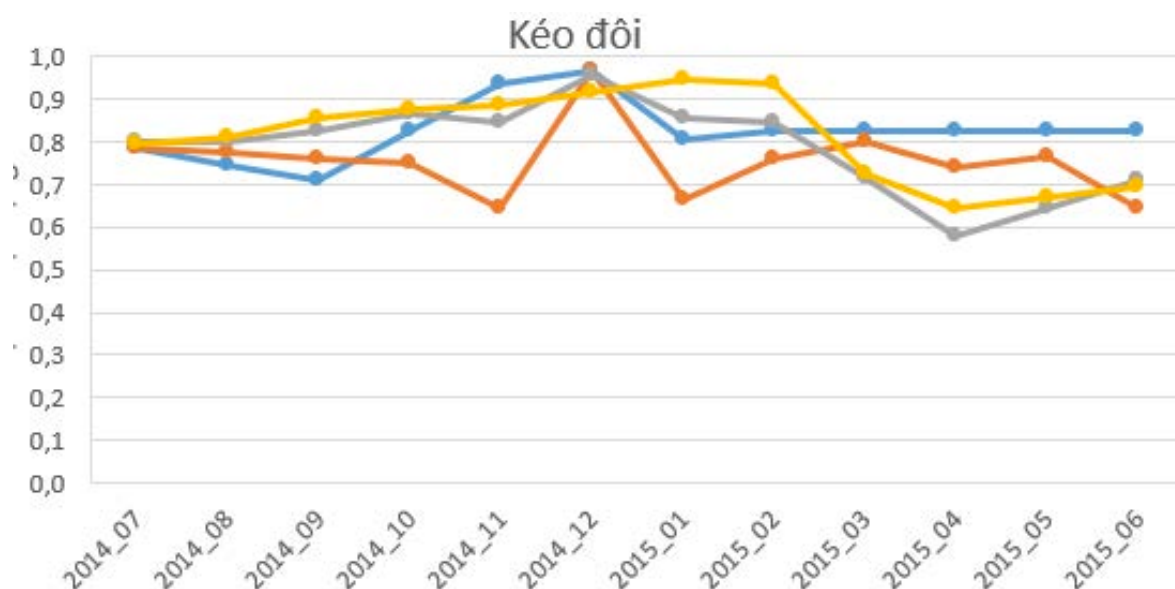


Figure 8. Share of active days per month of different pair trawl fleets (different colors) in Southwestern region between 2014 and 2015.

Table 6. Mean number of active fishing days per month of fishing fleets in Kien Giang Province in 2014 and 2015.

Fishing Fleet	Mean active day per month of fishing fleets (day)	
	2014	2015
Otter trawl < 45 hp	22.23	24.00
Otter trawl 45-90 HP	21.87	25.00
Otter trawl 90-150 HP	25.00	26.00
Otter trawl 150-250 HP	24.10	22.00
Otter trawl 250-400 HP	21.50	24.00
Otter trawl > 400 HP	22.25	25.00
Pair trawl < 45 HP	-	26.00
Pair trawl 45-90 HP	25.17	23.00
Pair trawl 90-150 HP	24.70	23.00
Pair trawl 150-250 HP	23.13	24.00
Pair trawl 250-400 HP	23.77	22.00
Pair trawl > 400 HP	22.83	26.00

Note “-” is no information

5.2. Catch per unit of effort

Catch per unit of effort of trawl fleets in Kien Giang province between 2014 and 2015 is indicated in **Table 7**. The similar trend found between the catch rate (CPUE) of otter trawl and pair trawl fleets in both 2014 and 2015. It is noted that the catch rate of the otter trawl fleets were much lower than of those of pair trawl fleets. In 2014, CPUE of otter trawlers varied from 77 to

400 kg/day, whereas this rate was around 700 to approximate 2000 kg/day for pair trawlers. In 2015, CPUE also fluctuated between fishing fleets and lower rates in otter trawl fleets. The CPUE of otter trawl fleets were between 75 to 385 kg/day and this rate for pair trawlers were from 287 to 1750 kg/day (**Table 7**). Interestingly, there was a downtrend of CPUE within fishing fleet between two different years. CPUE trend was lower in 2015 than of those of 2014. This can be an indicator of declined marine resources for trawl fisheries in Kien Giang province.

A similar trend was found on CPUE of fleet with capacity of 250-400 hp for both otter and pair trawlers of 2014 and 2015. The highest catch rate of otter trawl observed in fleet 250-400 hp was 397 and 385 kg/day in 2014 and 2015, respectively. In pair trawl, the highest catch rate was about 1.9 and 1.75 tons per day for fishing fleet of 250-400 hp in 2014 and 2015, respectively. Therefore, it is possible that investment on the fishing fleet from 250-400 hp can be a good choice in term of economic return.

Table 7. Catch per unit of effort of trawl fleets in Kien Giang Province in 2014 and 2015.

Fishing Fleet	Catch per Unit of Effort of trawl fleets (kg/day)	
	2014	2015
Otter trawl < 45 hp	77.3	75.7
Otter trawl 45-90 HP	211.0	215.6
Otter trawl 90-150 HP	218.0	198.4
Otter trawl 150-250 HP	112.7	156.4
Otter trawl 250-400 HP	397.0	385.3
Otter trawl > 400 HP	222.0	287.5
Pair trawl 45-90 HP	733.0	723.6
Pair trawl 90-150 HP	904.0	890.3
Pair trawl 150-250 HP	984.7	935.7
Pair trawl 250-400 HP	1905.7	1750.4
Pair trawl > 400 HP	1550.3	1679.5

Note “-” is no information.

5.3. Catch composition

Catch composition of trawl fisheries is indicated in Table 9. It is said that the catch composition of both otter trawl and pair trawl was different and depends on monsoon season.

Trash fish is the most dominant group in both otter and pair trawl fisheries catches (Table 8). The trash fishes are defined as a group with different species or groups including bycatch and other commercial groups that are

juveniles or of small size . Investigation results in 2015 indicated that trash fishes rate of otter trawlers were lower than of those of pair trawl fisheries with 42 and 57%, respectively. Catch composition of the trash fish in the studied in 2014 was higher than in 2015 for both otter trawl and pair trawl fleets, respectively (Table 8). In 2015, an independent study was also conducted to estimate catch composition of trawl fisheries in the South-Western region of Viet Nam. The study found that trash fish catch composition was also varied by fleets. These are 13.18-35.75% for single otter trawlers with capacity from 20-90hp; 52.17-81.4% for otter trawlers capacity higher than 90hp and accounted 57.52-67.68% for otter trawlers with capacity of < 90hp and 25.15-55.09% for pair trawlers with capacity of higher than 90hp.

For the mixed fish group, there were slight differences on the catch composition found. These rates varied from 15-19% for all trawl fleets between two years.

Shrimps were a very important group on otter trawls fleets especially for single otter trawl fleets higher than 90 hp. This catch of shrimp was approximately 30% in total catch of otter trawl fleets in 2014 and it slightly reduced to 21% in 2015. The pair trawlers were not catching this group (Table 8).

Table 8. The share(%) of some main groups of fish the catches of various trawl fisheries in Kien Giang in 2014 and 2015.

Fishing gear	Commercial group	Catch composition (%)				
		Q II/2014	Q III/2014	Q IV/2014	Mean 2014	Mean 2015
Otter trawl	Trash fish	61.4	39	28.7	39.3	42.5
	Mixed fish	2.2	20.2	24.0	17.9	15.7
	Rays	11.1	0.0	0.1	2.5	1.7
	Goatfish	9.4	0.0	0.9	2.5	2.9
	Mixed cephalopods	1.9	5.5	2.6	3.4	3.8
	Cuttlefish	1.7	1.8	0.3	1.1	0.8
	Green tiger prawn	4.7	1.4	3.5	3.1	2.9
	Mixed shrimp	5.1	29.7	38.0	28.0	21.0
	Others	2.5	2.4	1.9	2.2	8.7
Total		100	100	100	100	100
Pair trawl	Trash fish	56.8	41.4	70.3	56.9	57.3
	Mixed fish	26.9	18.8	13.2	19.2	18.8
	Threadfin Bream	3.1	6.0	1.4	3.4	2.8
	Lizardfish	1.0	3.0	1.1	1.7	2.3

	Croaker	0.2	5.5	0.0	1.8	1.6
	Bigeyes	1.1	2.8	0.4	1.4	1.7
	Squids	1.9	8.3	10.3	7.1	6.8
	Mixed cephalopods	7.8	10.5	1.5	6.3	7.3
	Cuttlefish	0.5	2.0	0.9	1.1	1.1
	Others	0.7	1.7	0.9	1.1	0.4
	Total	100	100	100	100	100

Table 9. The share (%) of species in the trash fish and mixed fish categories sampled in otter trawl fleets in Kien Giang Province in 2014 and 2015.

Latin name	Trash fish		Latin name	Mixed fish	
	2014	2015		2014	2015
<i>Acentrogobius caninus</i>	1.1	1.2	<i>Apogon truncatus</i>	1.9	1.5
<i>Apistus carinatus</i>	1.7	1.6	<i>Atule mate</i>	2.8	2.1
<i>Apogon semiornatus</i>	0.2	0.3	<i>Callionymus virgis</i>	0.7	0.1
<i>Apogon truncatus</i>	0.3	0.1	<i>Cociella crocodila</i>	0.3	0.1
<i>Apogonichthys ellioti</i>	0.5	0.7	<i>Cynoglossus arel</i>	0.9	0.7
<i>Bathycallionymus kaianus</i>	2.8	2.1	<i>Inegocia japonica</i>	1.2	2.4
<i>Callionymus virgis</i>	1	0.8	<i>Lagocephalus lunaris</i>	2	2.1
<i>Cynoglossus arel</i>	1.7	1.5	<i>Lutjanus lutjanus</i>	0.4	0.9
<i>Cynoglossus cynoglossus</i>	0.2	0.6	<i>Monacanthus chinensis</i>	0.5	1.1
<i>Cynoglossus interruptus</i>	3.6	2.5	<i>Mulloidichthys vanicolensis</i>	9.1	5.8
<i>Cynoglossus itinus</i>	0.9	1.3	<i>Muraenesox cinereus</i>	5.8	4.2
<i>Dactylopus dactylopus</i>	0.9	0.2	<i>Nemipterus furcosus</i>	2.2	1.7
<i>Dendrophysa russelii</i>	1	1.5	<i>Nemipterus mesoprion</i>	0.8	0.4
<i>Elates ransonnetii</i>	3.7	2.4	<i>Parapercis filamentosa</i>	1	0.4
<i>Euprymna morsei</i>	2.1	1.9	<i>Parapercis sexfasciata</i>	2.1	2.9
<i>Inegocia japonica</i>	1	1.6	<i>Pentapodus emeryii</i>	0.2	0.1
<i>Lagocephalus lunaris</i>	7.4	5.3	<i>Rastrelliger kanagurta</i>	0.6	0.9
<i>Lagocephalus wheeleri</i>	1.2	1.2	<i>Rogadius asper</i>	0.2	0.1
<i>Leiognathus berbis</i>	2.2	2.7	<i>Saurida elongata</i>	23.1	19.3
<i>Leiognathus brevirostris</i>	6	4.8	<i>Saurida tumbil</i>	1.8	2.4
<i>Leiognathus lineolatus</i>	3.7	3.9	<i>Saurida undosquamis</i>	5.8	2.8
<i>Loligo duvauceli</i>	0.8	1.2	<i>Scolopsis taeniopterus</i>	16	12.6
<i>Loliolus noctiluca</i>	1.1	1.6	<i>Selaroides leptolepis</i>	0.9	0.3
<i>Monacanthus chinensis</i>	1.4	1.8	<i>Sillago japonica</i>	0.3	0.3
<i>Mulloidichthys vanicolensis</i>	4.8	3.6	<i>Upeneus japonicus</i>	1.8	1.7
<i>Muraenesox cinereus</i>	0.6	1.7	<i>Upeneus moluccensis</i>	1.9	1.3
<i>Onigocia spinosa</i>	0.4	0.1	<i>Upeneus subvittatus</i>	1.8	2.8

<i>Ophichthus urolophus</i>	0.8	0.5	<i>Upeneus tragula</i>	2.4	1.6
<i>Parachaeturichthys polynema</i>	1.9	1.3	<i>Unidentified species</i>	11.5	27.4
<i>Paramonacanthus japonicus</i>	0.9	0.5	Total	100	100
<i>Parapercis sexfasciata</i>	0.7	0.3			
<i>Pseudorhombus levisquamis</i>	1.1	1.6			
<i>Pseudorhombus oligodon</i>	2.9	2.3			
<i>Repomucenus virgis</i>	1.7	1.5			
<i>Rogadius asper</i>	0.2	1.2			
<i>Saurida elongata</i>	3.6	2.8			
<i>Saurida tumbil</i>	1.4	1.2			
<i>Saurida undosquamis</i>	1.1	1.6			
<i>Scolopsis taeniopterus</i>	2.2	2.6			
<i>Selaroides leptolepis</i>	0.4	1.6			
<i>Sillago japonica</i>	0.8	1.8			
<i>Upeneus japonicus</i>	1.8	1.2			
<i>Upeneus tragula</i>	5.8	6.3			
<i>Yongeichthys thomasi</i>	1.3	2.9			
<i>Unidentified species</i>	19.1	20.6			
Total	100	100			

Table 10. The share (%) of species in the trash fish and mixed fish categories sampled in pair trawl fleets in Kien Giang Province in 2014 and 2015.

Latin name	Trash fish		Latin name	Mixed fish	
	2014	2015		2014	2015
<i>Clupanodon thrissa</i>	1.8	1.6	<i>Apogon truncatus</i>	0.4	0.7
<i>Encrasicholina heteroloba</i>	32.5	25.2	<i>Atule mate</i>	6.2	4.9
<i>Encrasicholina punctifer</i>	2.4	2.9	<i>Carangoides malabaricus</i>	0.6	1.6
<i>Escualosa thoracata</i>	2.3	2.1	<i>Chirocentrus dorab</i>	1.1	1.8
<i>Gerres filamentosus</i>	0.3	1.7	<i>Elates ransonnetii</i>	0.2	1.4
<i>Hypoatherina woodwardi</i>	1.4	2.7	<i>Gerres japonicus</i>	0.5	1.6
<i>Leiognathus brevirostris</i>	0.9	2.3	<i>Hyporhamphus unifasciatus</i>	0.6	1.2
<i>Leiognathus lineolatus</i>	4	2.6	<i>Inegocia japonica</i>	0.3	1.1
<i>Loligo duvauceli</i>	0.5	1.7	<i>Mulloidichthys vanicolensis</i>	11.9	15.1
<i>Mulloidichthys vanicolensis</i>	1.2	1.9	<i>Muraenesox cinereus</i>	1.8	2.5
<i>Paramonacanthus</i>	2.8	2.1	<i>Nemipterus furcosus</i>	3.7	2.6

<i>nipponensis</i>					
<i>Pelates quadrilineatus</i>	1.2	0.3	<i>Nemipterus mesoprion</i>	3.1	2.1
<i>Pseudorhombus oligodon</i>	0.7	1.8	<i>Parapercis filamentosa</i>	1.6	1.8
<i>Rastrelliger brachysoma</i>	3.4	2.6	<i>Pennahia anea</i>	0.6	1.7
<i>Rastrelliger kanagurta</i>	4.5	2.6	<i>Pentapodus setosus</i>	2.7	1.5
<i>Sardinella gibbosa</i>	3	2.7	<i>Rastrelliger brachysoma</i>	5.2	3.6
<i>Secutor ruconius</i>	1.9	2.8	<i>Rastrelliger kanagurta</i>	23	17.2
<i>Selaroides leptolepis</i>	2.9	1.5	<i>Saurida elongata</i>	6.7	5.3
<i>Sphyraena forsteri</i>	0.4	1.3	<i>Saurida undosquamis</i>	0.5	1.7
<i>Stolephorus commersonii</i>	3.8	2.7	<i>Scolopsis taeniopterus</i>	9.9	6.8
<i>Stolephorus indicus</i>	7.9	5.2	<i>Selaroides leptolepis</i>	3.7	4.7
<i>Stolephorus tri</i>	11	6.8	<i>Sillago aeolus</i>	0.4	1.5
Unidentified	9.2	22.9	<i>Sillago sihama</i>	0.4	1.2
Total	100	100	<i>Sphyraena obtusata</i>	3.5	2.9
			<i>Tylosurus acus melanotus</i>	0.5	0.2
			<i>Upeneus japonicus</i>	1.2	3.5
			<i>Upeneus moluccensis</i>	1	1.9
			<i>Upeneus sulphureus</i>	1.3	1.8
			<i>Upeneus tragula</i>	1.1	1.6
			Unidentified	6.3	4.5
			Total	100	100

5.3. Catch estimates

Total catch of trawl fisheries in Kien Giang Province in 2014 was estimated approximately 444 thousand tons with 95.04% exploited by pair trawl and 4.96% exploited by otter trawl (Table 11). This amount was increased in 2015 with total catch of trawl fisheries in 2015 of 454 thousand tons. Of those, 93% was contributed by pair trawlers and the rest of from otter trawlers. Interestingly, total catch by fishing fleet varied between two years for pair trawlers. In 2014, the pair trawl fleet with capacity higher than 250 – 400hp contributed about 328 thousand tons, accounting for 74% of total catch but this amount was increased in 2015 with total catch from this fleet of 339 thousand tons contributing 77% of total trawl fisheries catch (Table 11). The pair trawlers with capacity of 150 - 250hp contributed second highest amount in the total catch of trawl fisheries in Kien Giang province total catch of this fleet of more than 75 thousand tons contributing 16% of total catch (Table 11).

Table 11. Total catch (tons) of trawl fisheries in Kien Giang Province in 2014 and 2015.

Fishing fleet	2014		2015	
	Total catch (tons)	Proportion (%)	Total catch (tons)	Proportion (%)
Pair trawl	422,130	95.04	423,308.00	93.10
45 - 90 HP	786.00	0.18	1,228.55	0.21
90 - 150HP	6,312.00	1.42	7,545.08	1.29
150 - 250 HP	86,293.00	19.43	75,047.24	15.99
250 - 400HP	328,660.00	73.99	339,387.29	77.15
> 400HP	79.00	0.02	99.85	0.02
Otter trawl	22,047.00	4.96	31,351.36	6.90
< 45HP	1,284.00	0.28	-	-
45 - 90 HP	3,679.00	0.83	7,346.28	1.25
90 - 150HP	1,946.00	0.44	2,029.83	0.35
150 - 250 HP	4,917.00	1.11	5,979.88	1.02
250 - 400HP	7,049.00	1.59	11,097.22	1.89
> 400HP	3,172.00	0.71	4,898.15	0.84
Grand Total	444,177.00	100.00	454,659.36	100.00

Total catch of trawl fisheries divided by different groups is presented in Table 13. The trash fish dominated in total catch of trawl fisheries in Kien Giang with estimation of nearly 300 thousand tons including otter and pair trawl fisheries, contributing about 55% of total landing (Table 12). The mixed fish contributed 18.8% and 15.7% in total landing of pair and otter trawler, respectively and with total catch of over 80 thousand tons.

The economically valuable groups as cuttlefish and squids contributed negligible ratio in the landing. In 2015, total catch of cuttlefish was estimated at nearly 10 thousand tons, comprising of 1.2% of total landing and almost caught by the pair trawl.

Squids and cuttlefish were mixed into cephalopod group when its size is small. The large size squids and cuttlefish usually sorted out as squids and cuttlefish. Total landing of mixed cephalopods was 40 and 6.5 thousand tons in total catch of pair and otter trawls, respectively.

Total landing of mixed shrimps was 6.5 thousand tons, contributing a relative high ratio in catches of otter trawl while it was unknown in catches of pair trawl (Table 12).

Table 12. Total catch landing (tons) of some groups of trawl fisheries in Kien Giang Province in 2015.

Otter trawl			Pair trawl		
Group name	Proportion (%)	Total Catch	Group name	Proportion (%)	Total Catch
Trash fish	42.5	13,324	Trash fish	57.3	242,555
Mixed fish	15.7	4,922	Mixed fish	18.8	79,582
Rays	1.7	533	Threadfin Bream	2.8	11,853
Goatfish	2.9	909	Lizardfish	2.3	9,736
Mixed cephalopods	3.8	1,191	Croaker	1.6	6,773
Cuttlefish	0.8	251	Big eye	1.7	7,196
Green tiger prawn	2.9	909	Squids	6.8	28,785
Mixed shrimp	21	6,584	Mixed cephalopods	7.3	30,901
Others	8.7	2,728	Cuttlefish	1.1	4,656
	100	31,351	Others	0.4	1,693
				100	423,308

5.4. Mean length of selected species

Many fisheries scientists use simple indicators such as length of fishes to evaluate variation trend for stock management to support the decision they desire. Fish length can therefore be used in fisheries as one of the indicators to indicate stock status of trawl fisheries in Kien Giang. Here, we use fork length of some selected fish species to measure as indicated in the **Figure 9**. The fork length of 12 species were systematically measured during port sampling to see if there are any changes in these lengths. It can be seen from the **Figure 8** there were slight changes on mean fork lengths of 12 selected fish species. However, because of very short time (two years) sampling, it is very difficult to conclude that there is any significant changes on fish length on trawl fisheries in Kien Giang between 2014 and 2015.

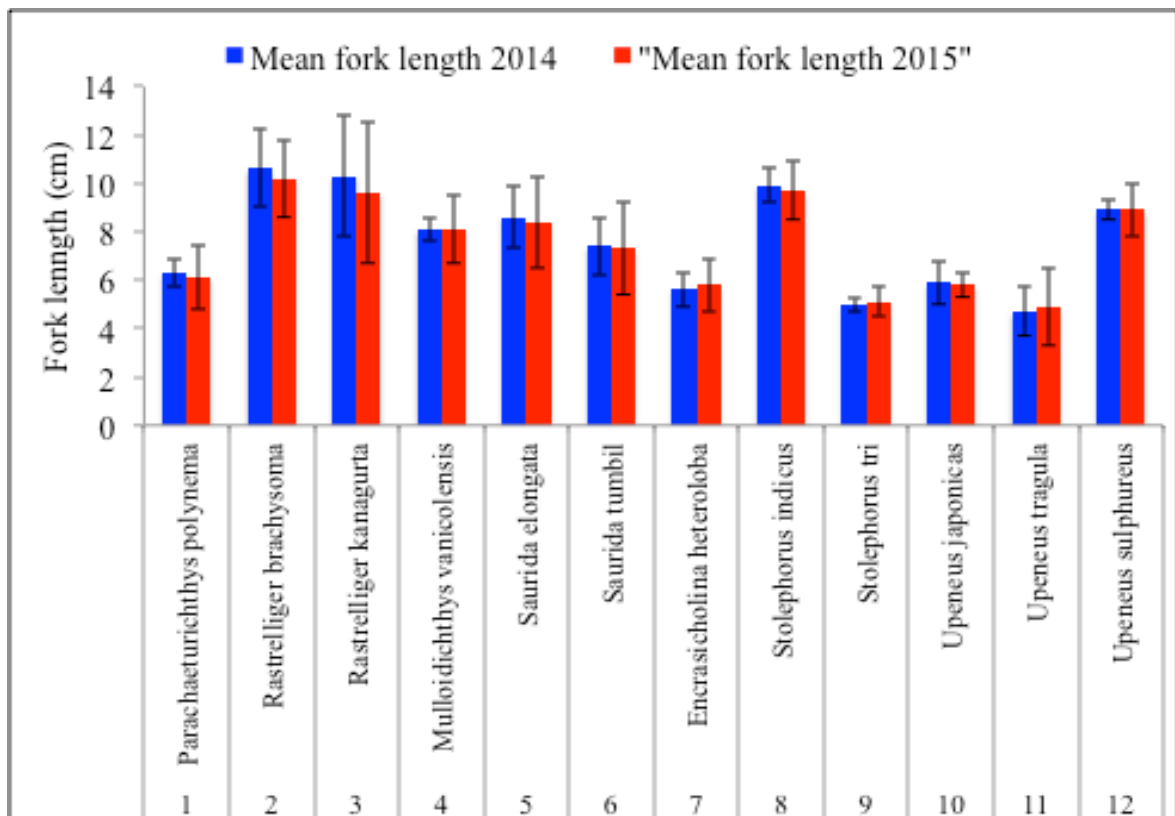


Figure 9. Mean fork length and Standard deviation (SD) of some selected fish species between 2014 and 2015.

1. 5. Conclusions

- Trawl fisheries plays an important role in socio-economic of in Kien Giang Province. However, this fisheries is considered a risk to fish stocks since its catch comprised a large proportion of juvenile fish.
- Total catch of trawl fisheries in Kien Giang in 2014 was estimated about 444 thousand tons and it slightly increased in 2015 (454 thousand tons). Catch of pair trawl accounted for the most significant amount (more than 95%) compared to the otter trawl. Trash fish accounted for about 50% of total catch for both 2014 and 2015. This should be taken into account when planning better management measures for trawl fisheries in Kien Giang province. In addition, the current implementation of freezing the fleet size f as a management measure can reduce the overall fishing effort of trawl fisheries in Viet Nam in general and in Kien Giang in particular. This can also lead to a significant reduction of bycatch in trawl fisheries.
- Catch composition analysis showed that there were a number of species in trash fish in the catches of trawl fisheries, including commercially valuable species in early life stage. Increasing the mesh of the trawl net would help to reduce the share of small size fish in catches.

- Length measurement of selected species indicated that fish in the catches was relatively small but there was no significant change on mean fork lengths of selected species. However, the studied period (two years) is too short for conclusions to reveal real changes as fisheries indicator (i.e. fish length).
- Strengthen the capacity of State management agencies in charge of the data collection at provincial, district and commune levels.
- Establish a mechanism for data collection for example, on the species composition of catches and landings of trawlers at the fishing ports and landing sites in the province.
- Develop a mechanism for coordination between the relevant units: Marine Coast Guard, marine police, fisheries surveillance to inspect, monitor and control trawl fisheries operations.
- Consider approving provincial trawl fisheries management plan to have a legal framework for trawl data collection at provincial level.

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Appendices

Appendix 1. Number of fishing boat and total horsepower of Kien Giang Province in period of 2005-2014.

Year	Number of fishing boat (units)	Total Horsepower (HP)
2005	7,700	1,170,446
2006	7,330	1,281,651
2007	7,268	1,195,419
2008	11,142	1,257,325
2009	11,650	1,321,049
2010	11,904	1,425,733
2011	12,286	1,586,848
2012	12,425	1,696,254
2013	10,726	1,737,215
2014	10,189	1,856,311
2015	10,275	2,077,887

Appendix 2. Changes in fishing fleet structure of trawl fisheries in Kien Giang Province in period of 2004-2015.

Year	Otter trawl		Pair trawl		Total	
	Number of vessel	Capacity	Number of vessel	Capacity	Number of vessel	Capacity
2005	2,335	207,032	1,775	703,957	4,110	910,989
2006	2,095	195,686	1,756	715,208	3,851	910,894
2007	2,063	185,341	1,760	723,171	3,823	908,512
2008	917	154,631	1,732	708,743	2,649	863,374
2009	927	157,742	1,789	735,452	2,716	893,194
2010	883	151,969	2,012	830,324	2,895	982,293
2011	870	150,228	2,309	979,448	3,179	1,129,676
2012	831	145,539	2,434	1,074,467	3,265	1,220,006
2013	670	126,691	2,479	1,141,547	3,149	1,268,238
2014	594	122,171	2,507	1,257,668	3,101	1,379,839
2015	560	120,550	2,632	1,426,262	3,192	1,546,812

Appendix 3. Catch rate of otter trawl fisheries from trawl survey entire Vietnamese waters by fishing seasons.

Scientific name	North-east monsoon	South-west monsoon	Grand Total
<i>Acanthocepola krussensterni</i>	0.20		0.20
<i>Acanthocepola limbata</i>	0.90		0.90
<i>Acentrogobius caninus</i>	0.15	2.60	0.97
<i>Alepes kalla</i>	0.10		0.10
<i>Anodontostoma chacunda</i>	0.40		0.40
<i>Apistus alatus</i>	0.20		0.20
<i>Apogon lineatus</i>	0.60		0.60
<i>Apogon quadrifasciatus</i>	0.25		0.25
<i>Apogon semilineatus</i>	0.00		0.00
<i>Apogon sp.</i>	1.15		1.15
<i>Apogon spp.</i>	3.10	0.30	2.40
<i>Apogonichthys ellioti</i>	0.35		0.35
<i>Ariomma indica</i>	4.80		4.80
<i>Arius sp.</i>	0.53	1.00	0.68
<i>Arius thalassinus</i>	0.80		0.80
<i>Atule mate</i>	8.40		8.40
<i>Bothidae</i>	0.10		0.10
<i>Bregmaceros japonicua</i>	0.00		0.00
<i>Broken biomass</i>	0.95		0.95
<i>Caesio sp.</i>	0.30		0.30
<i>Callionymus richardsoni</i>	0.30		0.30
<i>Callionymus sp.</i>	0.40	0.00	0.20
<i>Carangidae</i>	0.40		0.40
<i>Carangoides malabaricus</i>	0.28		0.28
<i>Carangoides sp.</i>	0.30		0.30
<i>Clupeidae</i>		3.25	3.25
<i>Coilia sp.</i>	3.33	0.50	1.44
<i>Congridae</i>	1.08	3.10	1.59
<i>Crabs</i>	0.10		0.10
<i>Cynoglossus robustus</i>	1.30		1.30
<i>Cynoglossus sp.</i>	6.46	22.51	11.81
<i>Dasyatis sp.</i>	2.18	4.70	3.44
<i>Dasyatis zugei</i>	3.00		3.00
<i>Decapterus macrosoma</i>	0.40		0.40
<i>Decapterus maruadsi</i>	0.00		0.00
<i>Dendrophysa russeli</i>	4.60	3.05	3.83
<i>Dussumieria elopsoides</i>	0.00		0.00
<i>Echeneis naucrates</i>	0.10		0.10
<i>Eleoteronema</i>		1.40	1.40
<i>Ephippus orbis</i>	0.30		0.30
<i>Epinephelus akaara</i>	0.10		0.10
<i>Epinephelus areolatus</i>	0.25	0.60	0.37
<i>Epinephelus awoara</i>	0.20		0.20
<i>Epinephelus fasciatus</i>	0.00		0.00

<i>Epinephelus sexfasciatus</i>	1.30		1.30
<i>Epinephelus sp.</i>	0.20		0.20
<i>Epphipus sp.</i>	0.30		0.30
<i>Evynnis cardinalis</i>	14.60		14.60
<i>Gazza minuta</i>	2.40		2.40
<i>Gerres abbreviatus</i>	0.58	0.50	0.56
<i>Gerres filamentosus</i>	0.30		0.30
<i>Gerres oyena</i>		0.40	0.40
<i>Glossogobius giurus</i>	0.20		0.20
<i>Gobiidae</i>	0.65		0.65
<i>Gymnocranius griseus</i>	1.30		1.30
<i>Harpadon nehereus</i>	1.00	0.20	0.60
<i>Holocentrus ruber</i>	0.30		0.30
<i>Ilisha indica</i>	0.20		0.20
<i>Ilisha sp.</i>	2.50		2.50
<i>Johnius belangerii</i>	1.07	15.30	6.76
<i>Kowalla coval</i>	1.10		1.10
<i>Lactarius lactarius</i>	0.20		0.20
<i>Lagocephalus scelleratus</i>	6.10		6.10
<i>Lagocephalus sp.</i>	0.50		0.50
LEIOGNATHIDAE	0.60		0.60
<i>Leiognathus bindus</i>	3.30		3.30
<i>Leiognathus elongatus</i>	4.70		4.70
<i>Leiognathus sp.</i>	0.28		0.28
<i>Leiognathus spp.</i>	0.00		0.00
<i>Lepidotrigla kishinouyi</i>	0.30		0.30
<i>Loligo chinensis</i>		0.90	0.90
<i>Loligo sp.</i>	0.23		0.23
<i>Lutjanus erythropterus</i>	0.10		0.10
<i>Lutjanus lutjanus</i>	0.00		0.00
<i>Lutjanus sanguineus</i>	0.00		0.00
<i>Lutjanus sp.</i>	0.10		0.10
<i>Lutjanus vita</i>	0.10		0.10
<i>Megalaspis cordyla</i>	7.00		7.00
<i>Metapenaeopsis barbata</i>	0.00		0.00
<i>Monacanthus sp.</i>	0.10		0.10
<i>Mugil affinis</i>		1.50	1.50
<i>Muraenesox cinereus</i>	3.99	25.00	10.99
<i>Nemipterus bathybius</i>	15.90		15.90
<i>Nemipterus furcosus</i>	0.60		0.60
<i>Nemipterus hexodon</i>	0.75		0.75
<i>Nemipterus japonicus</i>	16.00		16.00
<i>Nemipterus marginatus</i>	0.10		0.10
<i>Nemipterus mesoprion</i>	5.78		5.78
<i>Nemipterus nemathophorus</i>	11.40		11.40
<i>Nemipterus nemurus</i>	1.10		1.10
<i>Nemipterus peronii</i>	4.20		4.20
<i>Nemipterus sp.</i>	0.50		0.50
<i>Nemipterus spp.</i>	1.30		1.30

<i>Nemipterus tambuloides</i>	0.90		0.90
<i>Nemipterus virgatus</i>	12.70		12.70
<i>Nibea soldado</i>	6.41	18.90	12.65
<i>Nibea sp.</i>	3.60		3.60
<i>Octopus sp.</i>		0.35	0.35
<i>Odontamblyopus rubicundus</i>	0.62	1.13	0.87
<i>Onigocia spinosa</i>	0.20		0.20
<i>Ophisurus macrorhynchus</i>	0.40		0.40
<i>Otolithes ruber</i>	2.75	2.63	2.69
<i>Oxyurichthys microlepis</i>	0.23	0.15	0.20
<i>Oxyurichthys sp.</i>	0.20		0.20
<i>Pampus argenteus</i>	0.40	1.30	1.00
<i>Pampus chinensis</i>		2.00	2.00
<i>Parapercis filamentosus</i>	1.60		1.60
<i>Parasclopsis sp.</i>	1.00		1.00
<i>Parastromateus niger</i>	0.20		0.20
<i>Parupeneus heptacanthus</i>	0.90		0.90
<i>Pelates octolineatus</i>	0.30		0.30
<i>Pellona ditchela</i>	0.10	0.20	0.17
<i>Pennahia argentata</i>	3.11	2.30	2.79
<i>Pennahia macrocephalus</i>	0.30		0.30
<i>Pennahia macrophthalmus</i>	2.84		2.84
<i>Pennahia pawak</i>	3.18	0.35	2.23
<i>Pennahia sp.</i>	7.05		7.05
<i>Pentapodus setosus</i>	0.45		0.45
<i>Pentaprion longimanus</i>	0.10		0.10
<i>Platycephalus indicus</i>	0.60		0.60
<i>Platycephalus indicus</i>	2.65	0.60	1.97
<i>Plectorhynchus pictus</i>	1.60		1.60
<i>Plotosus angularis</i>		0.80	0.80
<i>Polynemus longipectoralis</i>	6.23		6.23
<i>Polynemus sextarius</i>	2.12	0.60	1.74
<i>Pomadasys argenteus</i>	0.10		0.10
<i>Pomadasys grunniens</i>	0.10	0.40	0.25
<i>Priacanthus macracanthus</i>	8.02		8.02
<i>Priacanthus tayenus</i>	14.10		14.10
<i>Pristipomoides multidentis</i>	0.70		0.70
<i>Psenopsis anomala</i>	0.80		0.80
<i>Psettina sp.</i>	0.50		0.50
<i>Pseudorhombus arsius</i>	1.50		1.50
<i>Pseudorhombus sp.</i>	0.30		0.30
<i>Pterois sp.</i>	0.10		0.10
<i>Rastrelliger brachysoma</i>	2.75	0.40	1.58
<i>Rastrelliger kanagurta</i>	0.60		0.60
<i>Sardinella gibbosa</i>	0.78	0.30	0.66
<i>Sardinella jussieui</i>	0.40		0.40
<i>Saurida elongata</i>	7.94		7.94
<i>Saurida tumbil</i>	6.90	0.80	5.68
<i>Saurida undosquamis</i>	9.97		9.97

<i>Sciaenidae</i>	8.18	30.50	15.62
<i>Scolopsis taeniopterus</i>	1.72		1.72
<i>Scolopsis vosmeri</i>	0.10		0.10
<i>Scomberomorus commersoni</i>	0.20		0.20
<i>Scomberomorus guttatus</i>	0.30		0.30
<i>Scorpaena sp.</i>	0.50		0.50
<i>Secutor ruconius</i>	0.00		0.00
<i>Selar crumenophthalmus</i>	0.45		0.45
<i>Selaroides leptolepis</i>	1.47		1.47
<i>Sepia inermis</i>	0.70		0.70
<i>Sepia sp.</i>	0.65		0.65
<i>Sepiella inermis</i>		0.10	0.10
<i>Sepiolidae</i>	0.05		0.05
<i>Siganus canaliculatus</i>	3.25		3.25
<i>Sillago sihama</i>	1.66	1.00	1.49
<i>Sirembo marmoratum</i>	0.00	0.50	0.25
<i>Sphyraena jello</i>	1.15		1.15
<i>Sphyraena obtusata</i>	1.15		1.15
<i>Squilla spp.</i>	0.00		0.00
<i>Stegostoma varium</i>	0.10		0.10
<i>Stolephorus commersoni</i>	0.00		0.00
<i>Stolephorus indicus</i>	0.40		0.40
<i>Stolephorus sp.</i>	0.20		0.20
<i>Symphurus sp.</i>	0.60		0.60
<i>Taius tumifrons</i>	0.20		0.20
<i>Therapon jarbua</i>	0.45		0.45
<i>Therapon theraps</i>	0.33	0.20	0.30
<i>Thryssa mystax</i>	2.85	0.45	1.89
<i>Thryssa sp.</i>	1.50		1.50
<i>Trachinocephalus myops</i>	0.40		0.40
<i>Trachurus japonicus</i>	0.00		0.00
<i>Trichiurus lepturus</i>	1.50	2.10	1.70
<i>Upeneus bensasi</i>	1.47		1.47
<i>Upeneus moluccensis</i>	3.15		3.15
<i>Upeneus sulphureus</i>	2.20		2.20
<i>Upeneus sundaicus</i>	0.10		0.10
<i>Upeneus tragula</i>	1.40		1.40
<i>Xiphocheilus typus</i>	0.50		0.50
<i>Zebrias zebra</i>	0.23	2.50	0.80

Appendix 4. Catch rate of pair trawl fisheries from trawl survey entire Vietnamese waters by fishing seasons.

Scientific name	North-east monsoon	South-west monsoon	Grand Total
<i>Acropoma japonica</i>	0.00		0.00
<i>Alectis ciliaris</i>	0.30		0.30
<i>Alepes kalla</i>	2.98		2.98
<i>Alepes melanoptera</i>	0.80		0.80
<i>Apistus alatus</i>	0.40		0.40
<i>Apogon carinatus</i>	1.30		1.30
<i>Apogon lineatus</i>	0.00		0.00
<i>Apogon quadrifasciatus</i>	0.05		0.05
<i>Apogon semilineatus</i>	1.90		1.90
<i>Apogon sp.</i>	0.23		0.23
<i>Apogon spp.</i>	0.10		0.10
<i>Apogonichthys ellioti</i>	1.10		1.10
<i>Ariomma indica</i>	0.70		0.70
<i>Arius sp.</i>	8.40		8.40
<i>Arius thalassinus</i>	0.10		0.10
<i>Atropus atropos</i>	0.25		0.25
<i>Atule mate</i>	14.85		14.85
<i>Branchiostegus japonicus</i>	1.55		1.55
<i>Bregmaceros japonicua</i>	0.00		0.00
<i>Broken biomass</i>	0.40		0.40
<i>Callionymus richardsoni</i>	0.10		0.10
<i>Carangoides chrysophrys</i>	0.40		0.40
<i>Carangoides malabaricus</i>	0.10		0.10
<i>Caranx djeddaba</i>	1.20		1.20
<i>Caranx malam</i>	8.00		8.00
<i>Caranx sexfasciatus</i>	0.25		0.25
<i>Caranx sp.</i>	0.50		0.50
<i>Champsodon capensis</i>	0.00		0.00
<i>Chirocentrus dorab</i>	6.20		6.20
<i>Congridae</i>	1.00		1.00
<i>Crabs</i>	0.10		0.10
<i>Cynoglossus sp.</i>	0.60		0.60
<i>Dactylopus dactylopus</i>	0.00		0.00
<i>Dasyatis sp.</i>	1.35		1.35
<i>Daya jerdoni</i>	0.00		0.00
<i>Decapterus macrosoma</i>	0.30		0.30
<i>Decapterus maruadsi</i>	0.90		0.90
<i>Decapterus russelli</i>	0.20		0.20
<i>Diploprion bifasciatum</i>	0.20		0.20
<i>Dussumieria elopsoides</i>	1.30		1.30

<i>Engraulis sp.</i>	0.00		0.00
<i>Epinephelus areolatus</i>	1.00		1.00
<i>Epinephelus awoara</i>	0.70		0.70
<i>Epinephelus fasciatus</i>	1.00		1.00
<i>Epinephelus sexfasciatus</i>	2.20		2.20
<i>Escualosa thoracata</i>	0.10		0.10
<i>Evynnis cardinalis</i>	1.50		1.50
<i>Fistularia petimba</i>	0.10		0.10
<i>Gazza minuta</i>	0.60		0.60
<i>Gerres filamentosus</i>	0.10		0.10
<i>Gerres sp.</i>	0.80		0.80
<i>Gnathodentex sp.</i>	0.10		0.10
<i>Gymnocranius griseus</i>	0.50		0.50
<i>Harpadon nehereus</i>	0.00		0.00
<i>Ilisha elongata</i>	0.20		0.20
<i>Ilisha indica</i>	2.20		2.20
<i>Johnius belangerii</i>	2.30		2.30
<i>Kowalla coval</i>	0.20		0.20
<i>Lactarius lactarius</i>	1.90		1.90
<i>Lagocephalus scelleratus</i>	7.80		7.80
<i>Larimichthys polyactis</i>	0.10		0.10
<i>Leiognathus bindus</i>	0.00		0.00
<i>Leiognathus elongatus</i>	0.30		0.30
<i>Leiognathus equulus</i>	0.50		0.50
<i>Leiognathus sp.</i>	1.00		1.00
<i>Leiognathus spp.</i>	0.30		0.30
<i>Lepidotrigla sp.</i>	0.80		0.80
<i>Loligo beka</i>	0.10		0.10
<i>Loligo sp.</i>	0.10		0.10
<i>Lutjanus chrysotaenia</i>	0.60		0.60
<i>Lutjanus erythropterus</i>	0.40		0.40
<i>Lutjanus lutjanus</i>	0.10		0.10
<i>Lutjanus malabaricus</i>	1.40		1.40
<i>Lutjanus sp.</i>	0.40		0.40
<i>Megalaspis cordyla</i>	0.20		0.20
<i>Muraenesox cinereus</i>	1.10		1.10
<i>Nemipterus bathybius</i>	3.40		3.40
<i>Nemipterus furcosus</i>	1.33		1.33
<i>Nemipterus japonicus</i>	1.03		1.03
<i>Nemipterus marginatus</i>	1.87		1.87
<i>Nemipterus mesoprion</i>	0.15		0.15
<i>Nemipterus nemathophorus</i>	14.60		14.60
<i>Nemipterus nemurus</i>	0.85		0.85
<i>Nemipterus peronii</i>	10.90		10.90
<i>Nemipterus sp.</i>	0.30		0.30

<i>Nemipterus tambuloides</i>	0.60		0.60
<i>Nemipterus virgatus</i>	3.45		3.45
<i>Netuma thalassina</i>	0.10		0.10
<i>Nibea soldado</i>	0.85		0.85
<i>Onigocia macrolepis</i>	1.10		1.10
<i>Onigocia spinosa</i>	0.10		0.10
<i>Otolithes ruber</i>	0.40		0.40
<i>Oxyurichthys microlepis</i>	1.60		1.60
<i>Pampus argenteus</i>	0.30		0.30
<i>Parapercis filamentosus</i>	0.00		0.00
<i>Parapristipoma trilineatum</i>	0.30		0.30
<i>Parastrumateus niger</i>	1.70		1.70
<i>Pennahia argentata</i>	0.83		0.83
<i>Pennahia macrocephalus</i>	4.35		4.35
<i>Pennahia macrophthalmus</i>	1.48		1.48
<i>Pennahia pawak</i>	2.29		2.29
<i>Pentapodus setosus</i>	0.20		0.20
<i>Platycephalus indicus</i>	1.63		1.63
<i>Platycephalus indicus</i>	2.50		2.50
<i>Plectorhynchus pictus</i>	0.90		0.90
<i>Plotosus angularis</i>	0.65		0.65
<i>Polydactylus sextarius</i>	0.20		0.20
<i>Pomadasys grunniens</i>	0.20		0.20
<i>Priacanthus macracanthus</i>	5.49		5.49
<i>Priacanthus tayenus</i>	7.90		7.90
<i>Pristipomoides typus</i>	0.50		0.50
<i>Psenopsis anomala</i>	1.60		1.60
<i>Psettina sp.</i>	0.10		0.10
<i>Pseudorhombus arsius</i>	0.00		0.00
<i>Pseudorhombus sp.</i>	0.35		0.35
<i>Pterocaesio chrysozona</i>	0.50		0.50
<i>Rachycentron canadum</i>	0.10		0.10
<i>Rastrelliger kanagurta</i>	1.18		1.18
<i>Sardinella gibbosa</i>	25.85		25.85
<i>Saurida elongata</i>	2.47		2.47
<i>Saurida tumbil</i>	3.88		3.88
<i>Saurida undosquamis</i>	6.39		6.39
<i>Scarus sp.</i>	0.20		0.20
<i>Scolopsis taeniopterus</i>	5.13		5.13
<i>Scolopsis vosmeri</i>	0.10		0.10
<i>Scomberoides lyzan</i>	0.10		0.10
<i>Scomberomorus guttatus</i>	2.10		2.10
<i>Secutor ruconius</i>	0.10		0.10
<i>Selar crumenophthalmus</i>	4.30		4.30

<i>Selaroides leptolepis</i>	1.38		1.38
<i>Setipinna taty</i>	0.10		0.10
<i>Siganus canaliculatus</i>	2.42		2.42
<i>Sillago sihama</i>	0.05		0.05
<i>Sirembo marmoratum</i>	2.00		2.00
<i>Sphyraena jello</i>	3.20		3.20
<i>Sphyraena obtusata</i>	0.93		0.93
<i>Sphyrna sp.</i>	1.50		1.50
<i>Stolephorus commersoni</i>	0.55		0.55
<i>Stolephorus sp.</i>	0.80		0.80
<i>Synodus hoshinonis</i>	0.65		0.65
<i>Synodus variegatus</i>	0.20		0.20
<i>Taius tumifrons</i>	0.40		0.40
<i>Therapon jarbua</i>	0.50		0.50
<i>Therapon theraps</i>	0.33		0.33
<i>Thryssa mystax</i>	2.15		2.15
<i>Trachinocephalus myops</i>	0.25		0.25
<i>Trachurus japonicus</i>	1.50		1.50
<i>Trichiurus lepturus</i>	3.80		3.80
<i>Trichiurus sp.</i>	2.20		2.20
<i>Upeneus bensasi</i>	1.40		1.40
<i>Upeneus moluccensis</i>	0.20		0.20
<i>Upeneus sulphureus</i>	3.98		3.98
<i>Upeneus tragula</i>	1.40		1.40
<i>Uranoscopus japonicus</i>	0.40		0.40
<i>Uranoscopus sp.</i>	0.10		0.10

Appendix 5. Mean fork length and standard deviations (SD) of some selected groups sampled in trawl fisheries in Kien Giang province

No	Species name	2014		2015	
		Mean fork length	SD	Mean fork length	SD
1	<i>Parachaeturichthys polynema</i>	6.3	0.6	6.1	1.3
2	<i>Rastrelliger brachysoma</i>	10.6	1.6	10.2	1.6
3	<i>Rastrelliger kanagurta</i>	10.3	2.5	9.6	2.9
4	<i>Mulloidichthys vanicolensis</i>	8.1	0.5	8.1	1.4
5	<i>Saurida elongata</i>	8.6	1.3	8.4	1.9
6	<i>Saurida tumbil</i>	7.4	1.2	7.3	1.9
7	<i>Encrasicholina heteroloba</i>	5.6	0.7	5.8	1.1
8	<i>Stolephorus indicus</i>	9.9	0.7	9.7	1.2
9	<i>Stolephorus tri</i>	5.0	0.3	5.1	0.6
10	<i>Upeneus japonicas</i>	5.9	0.9	5.8	0.5
11	<i>Upeneus tragula</i>	4.7	1	4.9	1.6
12	<i>Upeneus sulphureus</i>	8.9	0.4	8.9	1.1

