



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

FISHERIES REFUGIA PROFILE AND LANDING SITE IN KOH KONG PROVINCE



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ABBREVIATION

CFi	Community Fisheries
CORIN	Coastal Resource Institute
DANIDA	Danish Agency for International Development
DFC	Department of Fisheries Conservation
DOE	Department of Environment
DOT	Department of Tourism
EEZ	Exclusive Economic Zones
FAO	Food and Agriculture Organization of United Nations
FFI	Fauna and Flora International
FiA	Fisheries Administration
FiAC	Fisheries Administration Cantonment
GDP	Gross Domestic Products
GEF	Global Environment Facility
HP	Horsepower
IUCN	International Union for Conservation of Nature
IUU	Illegal Unreported and Unregistered
ICM	Integrated Coastal Management
MAFF	Ministry of Agriculture, Forestry and Fisheries
MCC	Marine Conservation Cambodia
MFF	Mangroves for the Future
MFMA	Marine Fisheries Management Area
MOE	Ministry of Environment
MOP	Ministry of Planning
MOWA	Ministry of Women's Affairs
NCDM	National Committee for Coastal Development and Management
NGOs	Non-Government Organizations
NSDP	National Strategic Development Plan
NTFP	Non Timber Forest Product
SEAFDEC	Southeast Asian Fisheries Development Center
SPF	Strategic Plan for Fisheries
SEZ	Special Economic Zone
UNDP	United Nations Development Program
UNEP	United Nations Environment Programme

1. Background of Fisheries Refugia Sites

1.1 Geographical Features in Koh Kong province

Koh Kong province is a province located in South-West part with the distance of 290 Km from Phnom Penh. This province is bordered at the East with Preah Sihanouk ville and Kampong Speu provinces, the South with the Gulf of Thailand of Thailand country, and North with Pursat province (Koh Kong Provincial Administration, April 2020). That province has one city (3 comunes) and 6 districts, 26 communes, and 119 villages, in which cover the land area of 10,045.58 Km², and the density of living people in Koh Kong province is 12 persons /Km² (Figure1)

Koh Kong province covers coastline areas of 237km and has 23 islands namely Koh Kong, Koh Yor, Koh Moul, Koh Rong, Koh Kras, Koh Krasa Kandal, Koh Krasa Knong, Koh Krasa Kraov, Koh Andoeuk, Koh Totoeung, Koh Chhann, Koh Sdach, Koh Khmouch, Koh Ampel Thom, Koh Ampel Kandal, Koh Ampel Touch, Koh Smach, Koh Damlong, Koh Manors Knong, Koh Manors Kraov, Koh Tatem, Koh Chhlam, and Koh Khyang (Sam Arth, 2014).



Figure 1: Map of Koh Kong Provincial Administration
Source: Koh Kong Province, 2020

This province is also abundant of biodiversity such as coral reef, sea grass and mangrove forest, providing a main home of marine animal and fish species living and spawning. Some species are found in Koh Kong province such as Dolphin, Dugong, Sea Horse, Marine Turtle, Giant Mussel, and Giant Claim.

The coastline of Koh Kong province consists of rocky and sandy beaches with clean water quality in near shore environment, and moderate erosion areas (MoE, 2014). There are four rivers draining into the bay depositing suspended sediments mostly near the mouth which provides suitable substrate for mangrove, especially Peam Krasob area dominated by mangrove forest and wetlands (MoE, 2014).

Moreover, the Koh Kong is productive province of marine capture fisheries, contributing over 42% to the total marine capture fisheries production in the whole country in 2020.

1.2 Population

According to the population census report in 2019, the total population of Cambodia in 2019 is 15,288,489 individual (3,341,770 household) including the population living in coastal areas have a population of 1,061,148 which equals to 6.9% (Ministry of Planning, 2019).

Annual population growth rate in the whole country over this period comes to 1.2% meanwhile people living in the coastal area are in the growth rate of 0.9%. In contrast, the annual population growth rate in Koh Kong province is lower than in coastal area and the whole country, that account for 0.5% (Table 1).

As for Koh Kong province, it is the total population of 136,675 people in 2019 which equals to 0.89% of the total people in the whole country according to Ministry of Planning, 2019, and the province is 29,894 households including 21,183 females and 20,615 males. Moreover, population census in 2019 showed that in Koh Kong province, the size of household in average is 4.6 and annual population growth rate is 0.5%.

Table 1: Population Statistic in Koh Kong province in 2019

No.	Description	Number of People
1	The number of Households	29,894 household
2	The number of Total People	136,675 people
3	The number of Female	67,846 people
4	The number of Male	68,829 people
5	The size of Household	4.6/household
6	Annual population grow rate	0.5%

Source: the Ministry of Planning, 2019

1.3 Socio economic Aspect

1.3.1 Economic Aspect:

Economic developments in Koh Kong province are dependent on three sectors, including agricultural, industrial, and services sectors. Agricultural sector shares 57.4%, services contributes to 42.3%, and the rest of them are industrial sector (0.2%) (Koh Kong, 2020).

Those sectors promote the growth of provincial economic through providing people's employments to support the livelihood of people. According to Ministry of Planning, 2018, Growth Domestic Product (GDP) in Koh Kong province is USD dollar 234, which is equal to 0.9% of GDP of the country. If it is estimated of income per person, it is equal to US dollar 1.417 in 2017 and increased to US dollar 1.543 in 2018 (Koh Kong, 2020).

1.3.1.1 Agriculture Sector

The province paid attention for agriculture field, which is catalysis assisting the provincial economic growth. According to Koh Kong Provincial 5 year-Development Plan for 2020-2024, 57.4 percentages of total people are famers depending on agriculture sector, including 28.40% households in rice field, 5.5% households in long term cropping, 2.50% households in short term cropping, 1.80% households in vegetable growing, 3.50% households in animal raising, 1% households in NTFP harvesting, and 14.70% households in Fishing activity, which is primary sector to support local people subsistence.

1.3.1.2 Business and Service Sector

Business and service sectors play main roles in providing additional jobs, increasing incomes, and reducing poverty of people in the province, especially promoting the provincial economic growth.

At the present, Tourism field are core catalyst to promote provincial economic development through providing job opportunities, increasing income, and enhancing living standard of people. Those attractive sites are included such as cardamom highland areas, coastline areas, Archipelago areas, and main channels.

Domestic products development and markets are paid attention by provincial administration to enhance local product quality and seek markets through exhibition at national and regional level. Those products are natural shrimp past, dried shrimp, dried squid; *Scomberomorus* spp. dried, fish sauce, and so on.

1.3.1.3 Industrial and Handcraft Sector

The Royal Government of Cambodia set goals to promote Cambodia country as the country getting moderate income in 2030 and high income in 2050 based on National Development Strategy Plan for 2014 to 2018. The goal focuses on industrial, and small and medium scale enterprises, which are main factors to promote national economic growth.

Provincial industrial and handcraft sectors grew remarkably from one day to day due to private companies to invest in the province, including Textile Industrial, Electronics Company in special economic zone (SEZ) as well as many handcrafts outside of SEZ. According to Koh Kong, 2020, industrial and handcraft sectors increased from 27.7% in 2016 to 29.4% in 2018.

1.3.2 Social Aspect

The province paid attention for social affairs that are core jobs of the province in compliance with the policy of the Royal Government of Cambodia. The poverty situation in the province declined gradually from 14.12% in 2015 to 9.62% in 2018 based on 5-year provincial development plan from 2019 to 2024.

1.3.2.1 Education Situation

Educational sector is prime jobs for the province that is needed to attend and find all ways to enhance educational quality and effectiveness in order to achieve the national plan on education for all, especially to response market requirement in high quality condition and in term of 2030 vision as the country getting moderate income at high level and high income in 2050 as developed country.

According to 5-year provincial development plan, from 2108-2019, the Koh Kong province has 152 schools in the whole province, including 121 primary schools (total students of 16,725 and 8,053 female students), 19 secondary primary schools (total students of 4873 and 2487 female students), and 12 high schools (total students of 2522 and 1205 female students). It is observed that 59.63% students finished their studies at primary school, 34.3% students finished at secondary primary school, and 17.86% students ended at high school (Koh Kong, 2020).

1.3.2.2 Health Situation

Koh Kong province has 13 health centers in 2019, which contributing to caring human health in the province. Those centers are limited not to response people requirement coming to get public health services in the province.

In such situation, the province still takes care to better off people health in term of providing quality and equity health services to improve human health, especially focusing on poor people,

children, and vulnerable and old people. To achieve sustainable development goals set by the Royal Government as follow:

- Setting priority and preparing strategy plan for national policy implementation and instruction made by the Ministry of Health on health enhancement of people in the province
- Expanding the size of public health basis to provide service close to people, especially isolated areas and venerable people.
- Deploying and sharing human resources provided by the Ministry of Health based on geography and population in compliant with staff standard (CPA and MPA).
- Delivering the resources of materials, medicines, and medicine equipment, provided by the Ministry
- Controlling and monitoring safety foods, private service management, and eliminating illegal private service in the province.

In 2017 to 2019, it was observed that mother mortality rate during given birth/1000 births in Koh Kong province declined 12.62% in 2017 to 2.13% in 2018, but it increased to 14.60%. In contrast, childhood mortality rate/1000 births decreased 3.26% in 2017 to 1% in 2019 (Koh Kong, 2020). Number of household infected AIDs disease also dropped 137 households in 2017 to 96 household in 2019.

1.3.2.3 Gender and Vulnerability

In the Koh Kong province, gender is enhanced and taken care, especially poor women and venerable children. To response sustainable development goals in Cambodia 2015 to 2030, 6 points are raised by focusing on: 1) increasing women economic empowerments, 2) women and children educations, 3) behavior, health, food changes for women and children, 4) curbing and spreading AIDs diseases, 5) protecting legally for women and children, and women making decision, and 6) mainstreaming gender into reforms program of the Royal Government.

Besides, women also participated actively in building the development plan at local level, curbing family violation, women and child traffics. Although, women capacity in the province was limited in extension related to new crime code, the law on women and child traffics and on family violation curbing, as well as protection affaires of vulnerable people and other legislations to be limited, the province organized many training courses related to above mentioned subjects to upgrade women knowledge.

Vulnerable people in the province were observed to decline 69.53% in 2016 to 63.20% in 2018 (Koh Kong, 2020). For example, explosive mine disable people declined 70.26% in 2016 to 8.60% in 2018.

2. Importance of Coastal Fisheries Habitats

Coastal and marine habitats in the Koh Kong province are considered as marine ecological system, providing the refuge of animal and fish species for feeding, nursing, and spawning, and leading the plenty of biodiversity species such as green turtles, dolphins, sharks, coral reefs and seagrasses, mangroves, groupers, shrimps, tortoises (endangered and rare species) and dugongs (UNEP, 2005). The coastal and marine ecosystems including mangrove forests, coral reefs, seagrass beds, salt marshes and estuaries are extremely important to provincial economic development as well as local people.



Figure 2: Map of Main Marine Habitat in Coastal Areas of Cambodia

2.1 Mangrove Forest

Mangrove Forest is ecosystem in coastal areas and serves as habitat to the following endangered species such as Green Turtle, Blood Cockle, Migratory Dolphins, Mud Crab, Swimming Crab, Grouper, Kelee Shad, Chacunda gizzard Shad, Blue Spotted Maskray, Himantura spp. (sting ray), Javelin Grunter, and Deep body, Silver biddy (FiA. 2010). In term of mangroves species, 16 species were found in Cambodia (Si Tuan Vo et al, 2013). Mangrove forest in coastal areas covered 78405ha, including Koh Kong province covered about 80% (62000 ha) (FiA, 2010).

According to Ali Raza Rizvi, 2011, Mangrove forests are especially important to local communities given that more than 70% of the coastal population rely on their products and resources, however mangrove forests were threatened causing from salt farm, coastal developments, charcoal production, conversion to shrimp culture, and reclamation and infrastructure development (UNEP, 2008). In Koh Kong province, 840ha of mangrove forest were used for intensive shrimp farming in early 1994 and 1,240ha of mangrove forest had been converted for the purpose at the end of 1994 (Ali Raza Rizvi, 2011). In the same year, 1,439ha had been proposed for aquaculture development and 1,079ha had been established as fish farms.



Figure 3: mangrove forest

2.2 Coral Reef

Monica Reed et al, 2015 showed that coral reefs are complex, highly productive and biologically diverse ecosystems. UNEP, 2008 cited that coral reefs are an important marine ecosystem and habitat that provide nurseries and breeding grounds for coral reef associated species and some pelagic and migratory species. In term of coral reef species, Jan-Willem van Bochove et al, 2011 showed survey report in Koh Rong, Koh Kon, and Koh Touch, Preah Sihanouk province that the majority species are Porites massive (56.1%), followed Diploastrea heliopora 13.2%, Pavona decussate 4%.

Jan-Willem van Bochove et al, 2011 reported that the reef areas of 28 km² were estimated by the Government of Cambodia and 150km² estimated by global. Total area of coral reef in coastal sites was observed to cover 2800ha (FiA, 2010), including Koh Kong province covered over 21% (602 ha).

According to UNEP, 2008, threats and damage to coral reefs were seen due to overfishing, destruction fishing, sedimentation, population (Eutrophication), coral breaching.

Department of Fisheries Conservation/FiA collaborating with FFI and Koh Kong Fisheries Administration Cantonment will plan to assess the areas of coral reef in the whole province.



Figure 4: Pictures of coral reef living in Koh Kong province

2.3 Seagrass

Seagrass meadows are among the most diverse and highly productive coastal ecosystems in the world (Duarte et al. 2004). Monica Reed et al, 2015 cited sea grasses play an important role in the general health of the surrounding sea, and function as a habitat for many different species due to their ability to produce a huge amount of biomass out of solar energy. Seagrass beds are a crucial habitat for the larval stage of the blue swimmer crab, and are also consumed as director food source by a few species such as fish, dugongs, sea turtles and marine birds (Monica Reed et al, 2015).

According to Ouk Vibol, 2008, seagrass beds typically occur in water depths of 3 to 4m, with salinity ranging from 25ppt to 30ppt, and most seagrass areas have been damaged by trawl and push net fishing. The nine species of seagrass were found in Cambodia, including *Thalassia hemprichii*, *Halodule uninervis*, *Enhalus acoroides*, *Halophila decipiens*, *Cymodocea serrulata*, *Halodule pinifolia*, *Cymodocea rotundata*, *Syringodium isoetifolium*, and *Halophila ovalis*.

Total area of seagrass was estimated to cover 30,000 ha (10 year- Strategy Plan for Fisheries Conservation, 2019), including Koh Kong province covered over 13% (3993ha) found at Chroy Pros commune, Koh Kong district.

Department of Fisheries Conservation/FiA collaborating with FFI and Koh Kong Fisheries Administration Cantonment will plan to assess the areas of seagrass in this place and other sites in Koh Kong province.

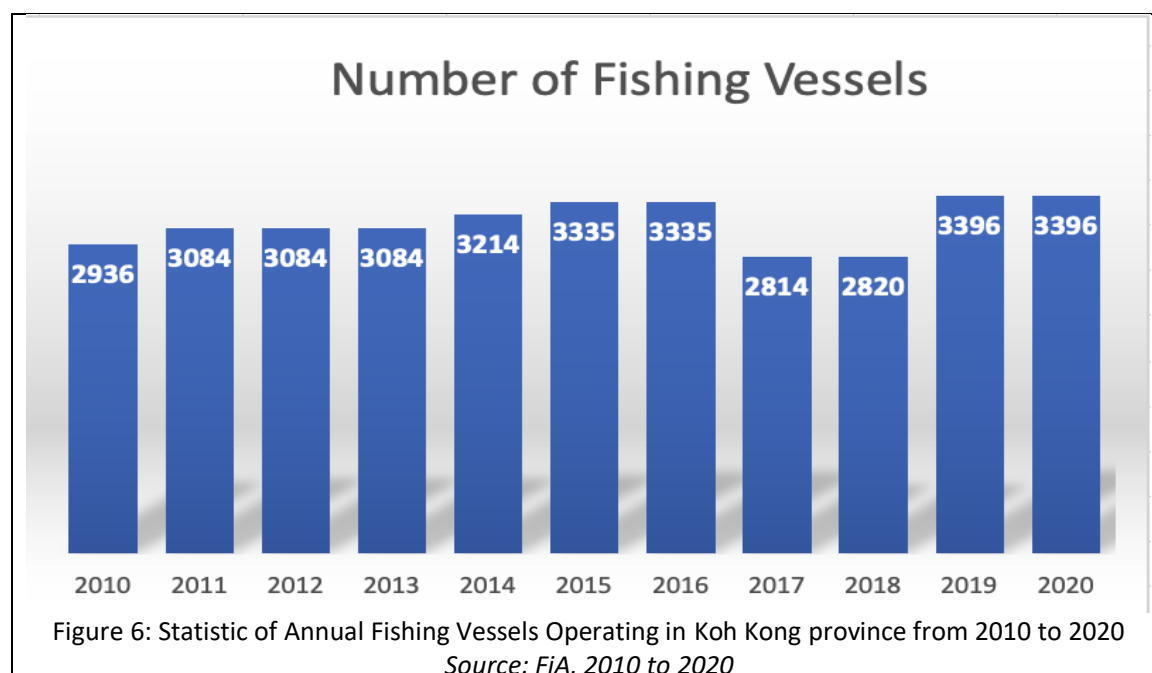


Figure 5: Picture of sea grass living in Kep province

3. Capacity of Fishing Operation in Koh Kong Province

3.1 Fishing vessels

The number of fishing vessels in Koh Kong province from 2010 to 2020 was presented in Figure 6, which is observed to increase from 2936 vessels in 2010 to 3396 vessels in 2020, but it decreased by 2814 in 2017 and by 2820 in 2018 (FiA 2010-2020).



3.2 Length of Fishing Vessel

Table 2 showed that fishing vessel length operating in Koh Kong province is classified into five categories, including 1) $\geq 24\text{m}$, 2) $18- < 24\text{m}$, 3) $12- < 18\text{m}$, 4) $6- < 12\text{m}$, and 5) $< 6\text{m}$. Three categories of fishing vessel length were recorded in high percentage, over 50% of fishermen operated the fishing vessels length from $6- < 12\text{m}$, followed by $< 6\text{m}$ (26.09%), and $12- < 18$ (20.79%), respectively. In contrast, the rest of them were recorded in low percentage, nearly 2% of fishers used vessel length from $18- < 24$ and 0.29% for vessel length of 24m .

Table 2: Classification of Fishing Vessel by the Length Operating in Koh Kong province in 2018

No.	Classification of the Length of Fishing Vessel	Number of Vessels (N=3396)	Percentage (%)
1	≥ 24	10	0.29
2	18- < 24	67	1.97
3	12- <18	706	20.79
4	6- <12	1727	50.85
5	< 6	886	26.09
Total		3396	100

Source: FiA, 2020

3.3 Engine Power of Fishing Vessel

Table 3 showed the engine power of fishing vessel operating in Koh Kong province is classified into five categories, including 1) < 50 hp, 2) 50 - 90 hp, 3) >90 - 180 hp, 4) >180- 270 hp, 5) >270- 540 hp. It is observed that nearly 90% of fishermen operated the engine power of vessels less than 50hp, followed by >90 - 180 hp (5.27%), 50 - 90 hp (4.62%), >180- 270 hp (1.68%), and >270- 540 hp (1.06), respectively.

Table 3: Classification of Fishing Vessel by the Engine Power Operating in Koh Kong province in 2018

No.	Classification of the Engine Power of Fishing Vessel	Number of Vessels (N=3396)	Percentage (%)
1	< 50 hp	2967	87.37
2	50 - 90 hp	157	4.62
3	>90 - 180 hp	179	5.27
4	>180- 270 hp	57	1.68
5	>270- 540 hp	36	1.06
Total		3396	100

Source: FiA, 2020

3.4 Number of Fishermen Per Fishing Vessel

Table 4 showed that the number of people per fishing vessels is observed to range from 1 to 10 individual. The most percentage of fishing vessels stored 2 to 5 individuals in 61.75% meanwhile 6-10 individual was recorded in 0.94%. However, one individual per fishing vessels is recorded in 36.07%, and more than 10 individuals in 1.24%.

Table 4: Distribution of Fishermen Number Operating/Fishing Vessel in Kep province in 2018

No.	Number of Fishermen Operating/Fishing Vessel	Number of Fishing Vessel (N=3396)	Percentage (%)
1	1	1259	36.07
2	2-5	2097	61.75
3	6-10	32	0.94
4	>10	42	1.24
Total		3396	100

Source: FiA, 2020

3.5 Types of Principal Fishing Gear Used

Fishing gears used in Cambodian's sea water has been divided into small scale and middle scale based on the MAFF's proclamation on setting the types of fishing gears operated in Cambodia dated 29 June 2015. Middle scale fisheries refer to those fishing activities, which have high

efficient fishing gears and have capacity to fish offshore and inshore using varieties of gear types, with exception of trawling in inshore water (Seafdec, 2007). Those fishing gears required to pay tax. After the government declared to reform fisheries sector in 2000, middle scale fishing gears did not pay tax for inland fisheries, but marine capture fisheries are required to pay tax as usual (SEAFDEC/UNEP/GEF, 2014).

Small-scale fisheries are those utilizing traditional and/or passive fishing gear, non-power boats, or power boats with a capacity lower than 5 HP. Generally, these fisheries operate in anywhere except in conservation areas and small-scale fishers are not required to pay tax (SEAFDEC/UNEP/GEF, 2014).

29 types of fishing gears are observed to operate in Koh Kong province (FIA, 2020). Table 5 showed five types of fishing gears are recorded in high percentage of fishermen using those fishing gears. 21.53% of fishermen practiced Crab trap, followed by Crab gillnet (19.17%), Fish gillnet (13.43%), Shrimp gillnet (9.78%), Trawl (9.69%), and Squid hook (6.33%), respectively. In contrast, low percentage of fishermen operating those fishing gears consist of Squid Horizontal Long Line Hook (2.74%), Push Net (2.71%), Fishing by Hand (2.62%), Fish Hook (1.91%), Anchovy Encircling Seine (1.59%), Spear (1.41%), Blood cockle Push Net (1.30%), Fish Trap (1.12%), Squid Trap (1.09%), respectively.

Table 5: Types of Fishing Gears Operating in Koh Kong province in 2018

No.	English Name	Khmer Name	No. of Fishing Gear (N=3396)	(%)
1	Trawl	Uon Os	329	9.69
2	Anchovy Encircling Seine	Uon Ka Keum	54	1.59
3	Purse Seine Net	Uon Tit	5	0.15
4	Encircling Gillnet	Mong Huom	1	0.03
5	Light Luring Fishing	Ka Nesart Doy Broeu Pleung	18	0.53
6	Crab Trap	Lop Kdam	731	21.53
7	Small Winged Set Bag	Pong Pang	3	0.09
8	Fish Trap	Lop Trey	38	1.12
9	Squid Trap	Lop Meuk	37	1.09
10	Snail Trap	On Tak Kchornng	2	0.06
11	Elongated Collapsible Trap	Lop Kon Tuy Kondol	2	0.06
12	Crab Gillnet	Mong Kdam	651	19.17
13	Fish Gillnet	Mong Peak	456	13.43
14	Lobster Gillnet	Mong Bang Korng Kondob	18	0.53
15	Shrimp Gillnet	Mong Bang Kear	332	9.78
16	Squid Hook	Santouch Meuk	215	6.33
17	Bottom Fish Hook	Santouch Trey Sro Tob Bat	18	0.53
18	Squid Horizontal Long Line Hook	Santouch Meuk Ro Nong Meuk	93	2.74
19	Horizontal Long Line	Santouch Ro Nong	13	0.38
20	Bottom Ray Horizontal Long Line	Santouch Ro Nong Bobel	6	0.18
21	Fish Hook	Santouch Trey	65	1.91
22	Fishing by Hand	Ka Nesart DoDay	89	2.62
23	Blood cockle Push Net	Chhip Run Kreng Chheam	44	1.30
24	Push Net	Chhip Run	92	2.71
25	Crab Scoop net	Kontrong Dous Kdam	13	0.38
26	Crab Push Net	Chhneang Dous Kdam	6	0.18
27	Spear	Snor	48	1.41
28	Oyster Collector	Much Rok Oi Steu	3	0.09
29	Salt Water Shrimp Push Net	Chhip Run Ky	14	0.41
Total			3396	100

Source: FIA, 2020

3.6 Fishing Vessel Length with Fishing Gears

Relation between fishing vessel length and fishing gears was presented in Table 6 that Trawl in Koh Kong province was observed to operate with fishing vessel length from 6 - <24m, the biggest number (167 trawls) practiced with fishing vessel length in 6-<12m and then 12-<18m in 131 trawls. The less number (31 trawls) operated with vessel length in 18-<24m.

Anchovy Encircling Seines was observed to operate with fishing vessels length from 6- \geq 24 m, including 24 Anchovy Encircling Seines with vessel length in 18- < 24 m, 13 Anchovy Encircling Seines with vessel length in 12- <18 m, 10 Anchovy Encircling Seines with vessel length in \geq 24 m, and 7 Anchovy Seines with vessel length in 6- <12 m.

Crab Trap was recorded to use with vessel length from less than 6 - <24m. The biggest number (472 Crab traps) was recorded to operate with vessel length in < 6m meanwhile the less number (2 crab traps) was recorded in vessel length from 18- < 24 m. However, Crab trap was observed to practice with vessel length in 6- <12 m (182 crab traps) and 12- <18 m (75 crab traps).

Crab Gillnet was observed to practice with vessel length from less than 6 - <24m, including from 6- <12 m in 438 crab gillnet, < 6 m in 136 crab gillnet, from 12- <18 m in 76 crab gillnet, from 18- < 24 m in crab gillnet.

Fish Gillnet was observed to use with vessel length from less than 6 - <24m, including from 6- <12 m (268 fish gillnet), from 12- <18 m (126 fish gillnet), <6m (59 fish gillnet).

Shrimp Gillnet was recorded to practice with vessel length from less than 6 - <18m, including from 6- <12 m (210 shrimp gillnet), from 12- <18 m (36 squid hook), and <6m (5 shrimp gillnet)

Squid Hook was recorded to operate with vessel length from less than 6 - <18m, including from 6- <12 m (176 squid hook), from 12- <18 m (117 shrimp gillnet), and <6m (3 squid hook).

Squid Horizontal Long Line Hook was recorded to practice with vessel length from less than 6 - <18m, including from 6- <12 m (38 Horizontal Long Line Hook), from 12- <18 m (51 Horizontal Long Line Hook), and <6m (4 Horizontal Long Line Hook).

Table 6: Distribution of Fishing Gear Types by Fishing Vessel Length in Koh Kong province in 2018

No.	Types of Fishing Gears	Classification of the Length of Fishing Vessel (m)				
		\geq 24	18- < 24	12- <18	6- <12	< 6
1	Trawl		31	131	167	
2	Anchovy Encircling Seine	10	24	13	7	
3	Purse Seine Net		3	2		
4	Encircling Gillnet				1	
5	Light Luring Fishing			10	8	
6	Crab Trap		2	75	182	472
7	Small Winged Set Bag				1	2
8	Fish Trap		2	16	13	7
9	Squid Trap			9	28	
10	Snail Trap			1		1
11	Elongated Collapsible Trap					2
12	Crab Gillnet		1	76	438	136
13	Fish Gillnet		3	126	268	59

14	Lobster Gillnet			7	11	
15	Shrimp Gillnet			117	210	5
16	Squid Hook			36	176	3
17	Bottom Fish Hook			3	8	7
18	Squid Horizontal Long Line Hook			51	38	4
19	Horizontal Long Line			4	3	6
20	Bottom Ray Horizontal Long Line			1	5	
21	Fish Hook			4	24	37
22	Fishing by Hand			1	18	70
23	Blood cockle Push Net			12	31	1
24	Push Net			11	73	8
25	Crab Scoop net					13
26	Crab Push Net					6
27	Spear				1	47
28	Oyster Collector				3	
29	Salt Water Shrimp Push Net			1	10	3
Total		10	66	707	1724	889

Source: Fisheries Administration, 2020

4. Role of fisheries refugia in Production in Koh Kong province

4.1 Annual Marine Capture Fisheries Production in Koh Kong province (2010-20)

Annual marine capture fisheries productions in Koh Kong province was observed to increase from 34,600 ton in 2010 to 52,549 ton in 2020 as showed in Figure 7.

Thus, Koh Kong province was estimated to share over 42% to the total marine capture fisheries production in 2020.

Yields (Tons)

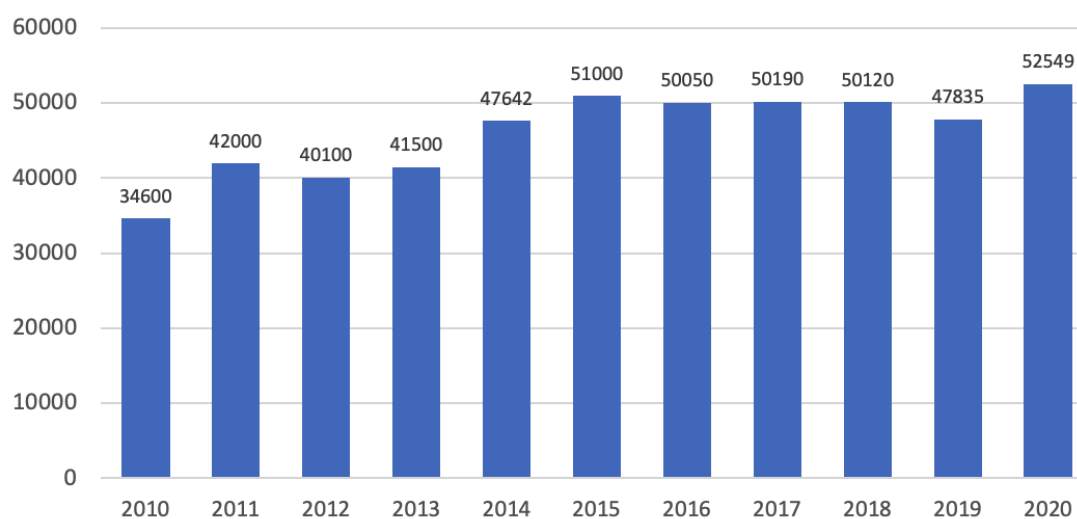


Figure 7: Annual Marine Capture Fisheries Production in Koh Kong province from 2010 to 2020

Source: FiA from 2010 to 2020

4.2 Annual Short Mackerel Production in Koh Kong province

Figure 8 showed annual mackerel production in Koh Kong province from 2010 to 2020. It is observed that annual mackerel production increased from 650 ton in 2010 to 2295 ton in 2014, but this production declined gradually from 1076 ton in 2015 to 667 ton in 2019. This decreasing was caused from increasing in fishermen and destructive fishing gears as well as climate change. However, it is observed to see mackerel production increasing from 667 ton in 2019 to 997 ton in 2020 due to well management measurement, including MAFF's Proclamation on Establishment of Management Area of Mackerel Refugia at Peam Krasob, Koh Kong dated on 16 September 2019 and Creation of Technical Working Group for Marine Fisheries Resource Management dated on 2 February 2020 as well as making patrolling group from community fisheries and natural resource management community.

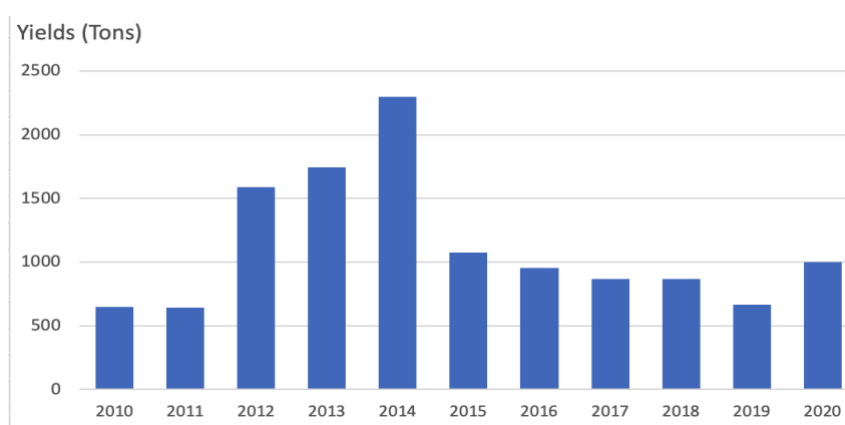


Figure 8: : Annual Production of Short mackerel in Koh Kong province from 2010 to 2020.

Source Fisheries Administration, 2010 to 2020

4.3 Annual Marine Capture Fisheries Production with Fishing Gears in Koh Kong province

According to field survey, 2020, five types of fishing gears are selected for the calculation of annual marine capture fisheries production, harvesting marine capture fisheries at fishing grounds such as Koh Yor, Koh Moul, Koh Kong Krao, Koh Touch, Peam Krasob, Bak Klorng, Koh Cod, and Koh Sdach.

Those fishing gears are 1) Crab gillnet, 2) Crab trap, 3) Small winged set bag, 4) Mackerel gillnet, and 5) Trawl. Table 7 showed three types of fishing gears are estimated to catch the big quantity of fisheries products, including Trawl (8,001,280 kg), Mackerel gillnet (892,702 kg), Crab Gillnet (851,315 kg). In contrast, two types of fishing gears can catch small number of fisheries, including Crab Trap and Small winged set bag in 580,688 kg and 8,400 kg, respectively.

Table 7: Distribution of Annual Capture Fisheries Production by Fishing Gear in Koh Kong province 2020.

No.	Types of Fishing Gears	Yields (kg)	Percentage (%)
1	Crab gillnet	851,315	8.24
2	Crab trap	580,688	5.62
3	Small winged set bag	8,400	0.08
4	Mackerel gillnet	892,702	8.64
5	Trawl	8,001,280	77.42
Total		10,334,385	100

Source: Field survey, 2020

Figure 9 showed percentage of fishing gears sharing annual marine capture fisheries in Koh Kong province in 2020. Nearly 80% of total marine capture fisheries was shared by Trawl, followed by Mackerel gillnet (8.64%), and Crab gillnets (8.24%), respectively. The rest of them were contributed by Crab trap and Small Winged Set Bag in 5.62% and 0.08%, respectively.

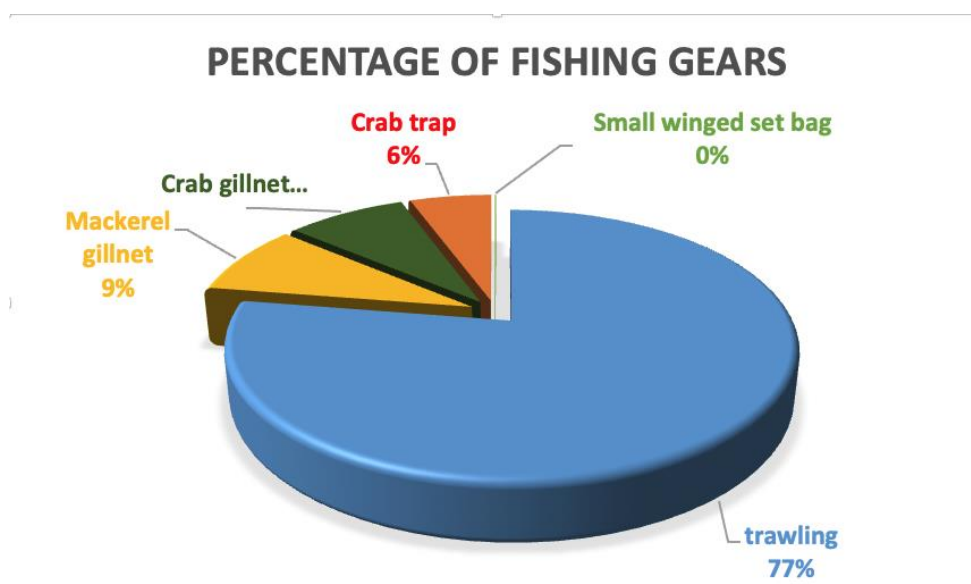


Figure 9: Percentage of Fishing Gears Sharing Annual Capture Fisheries Production in Koh Kong province in 2020

Source: Field survey, 2020

4.4. Calculation of CPUE in Koh Kong province

Table 8 showed the calculation of CPUE based on the 5 types of fishing gears, including Mackerel gillnet, Crab trap, Crab gillnet, Long Line Hook, Small Winged Set Bag, and Trawl. Catch rate is different based on the type of each fishing gear, vessel length, horsepower, and size/length of net used as well as fishing periods.

Mackerel gillnet was recorded in 32.17kg of fish/day and 3.02kg/hr with mean fishing period of 10.65hrs, mean gillnet of 1237m, mean engine power of vessel of 17.46hp, and mean vessels length of 11.74m.

Crab gillnet was recorded in the crab of 8.67kg/day and 0.78kg/hr with the mean fishing periods of 11.11hrs, mean gillnet length of 2580m, mean vessel length of 9.43m, and mean engine power of vessel of 14.98hp.

Crab trap was recorded in the crab of 10kg/day and 0.91kg/hour with the mean fishing periods of 11hours; crab 200 traps in average, mean vessel length of 10.5m, and mean engine power of vessel of 13hp.

Small Winged Set Bag was recorded in the fisheries of 50kg/day and 4.55kg/hr with the mean fishing periods of 11hrs; the mouth of net length of 20m in average, mean vessel length of 11m, and mean engine power of vessel of 18hp.

Trawl was recorded in the fisheries of 121.60kg/day and 10.13kg/hr with the mean fishing periods of 12hrs; the mouth of net length of 133m in average, mean vessel length of 11.33m, and mean engine power of vessel of 64hp.

Table 8: Identification of CPUE Indicator per Used Fishing Gear Types in Koh Kong province in 2020

Type of Fishing Gears	Status of Fishing Vessel (m)		Mean Size/Length of used fishing gears	Mean Duration of Fishing /day (hr)	Number of Day/Trip (day)	Total Catch/Trip (kg)	CPUE Indicator	
	Mean Length (m)	Mean Horsepower (hp)					Per day (kg)	Per hour (kg)
Mackerel Gillnet	11.74	17.46	1237m	10.65	1	32.17	32.17	3.02
Crab Gillnet	9.43	14.98	2580m	11.11	1	8.67	8.67	0.78
Crab Trap	10.5	13	200trap	11	1	10	10	0.91
Small Winged Set Bag	11	18	20 m	11	1	50	50	4.55
Trawler	11.33	64	133 m	12	10	121.60	121.60	10.13

Source: Field survey, 2020

5. Number of fisheries communities in Koh Kong province

According to Department of Community Fisheries Development of FiA, 2019, there are 5 existing community fisheries in Kep province, including Okrasar CFI, Phum Thmey CFI, Kep CFI, Kampong Tralach CFI, and Angkoal CFI, which cover the coastline areas in 3031 ha and 1025 members of CFIs. Those CFIs are set up by Department of Community Fisheries Development of FiA and Kampot* Fisheries Administration Cantonment since 2005 (Table 9).

Table 9: Number of fisheries communities in Koh Kong province

No.	Name of Community Fisheries	Location	CFI's Area (Ha)	CFI's Member (person)	Date of CFI Establishment
1	Chroy Svay CFI	Chroy Svay commune, Sre Ambel district	13,443	2886	2005
2	Koh Khchorng CFI	Chi Kor Krom commune, Sre Ambel district	6,462	404	2002
3	Kandal CFI	Khum Kandal commune, Botum Sar Kor district	2,560	1817	2010
4	Ta Meak CFI	Ta Meak village, On Doung Ttek commune, Botum Sar Kor district	9,394	362	2005
5	Thmor Sar CFI	Thmor Sar commune, Botum Sar Kor district	11,220	829	2005
6	Sam Ros Koh Sdach CFI	Koh Sdach commune, Kiri Sarkor district	16,158	589	2013
7	Pnhy Meas CFI	Pnhy Meas commune, Kiri Sarkor district	4,808	249	2010
8	Prek Schach CFI	Prek Schach commune Kiri Sarkor district	9,738	280	2005
9	Chroy Bros CFI	Chroy Bros commune, Koh Kong district	11,085	290	2004
10	Peam Krasob CFI	Peam Krasob commune, Mondol Sema district	2,272	270	2013
Total			87,140	7,976	

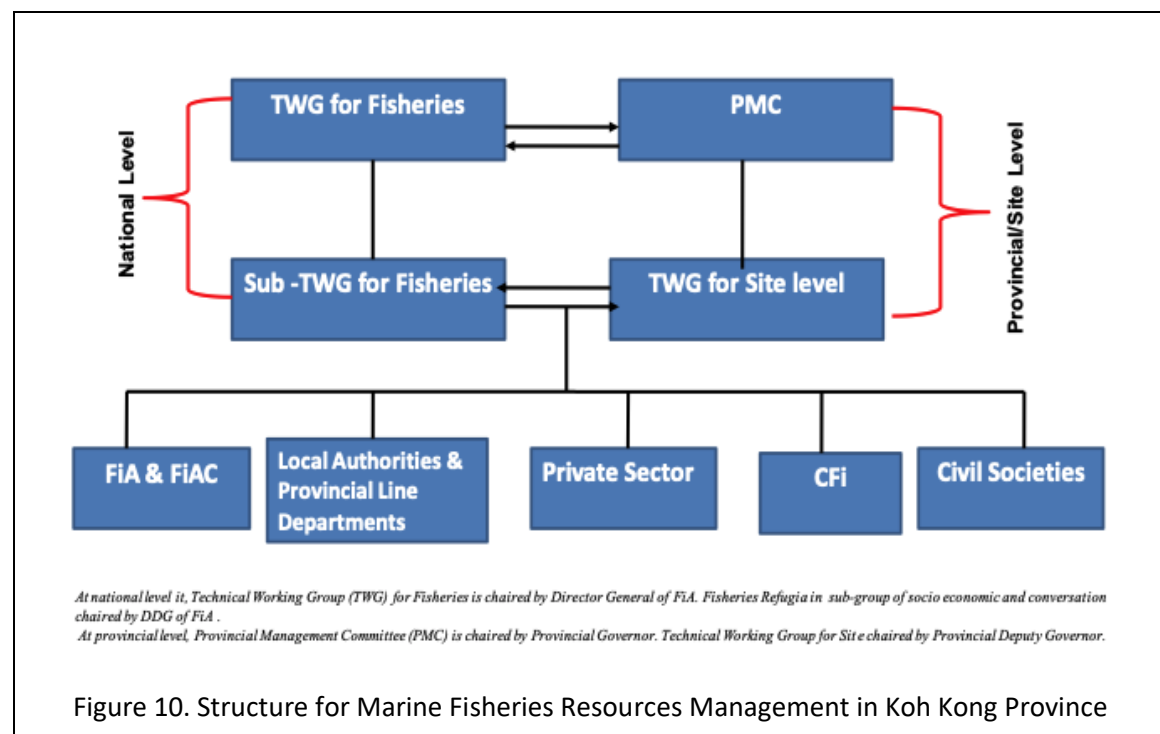
Source: Department of Community Fisheries Development of FiA, 2019

6. Existing Fisheries Management Measure in Fisheries Refugia Sites

Currently, the measures of mackerel management in Koh Kong province were made based on the closing season and size limitations of nets. The notice letter of closed fishing season of mackerel are made and issued by Koh Kong Provincial Administration Hall starting from 01 December to 31 March every year according to MAFF's proclamation on Establishment of Management Area of Mackerel Refugia in Peam Krasob, Koh Kong province on 16 September 2019.

Department of Fisheries Conservation/FiA collaborating with Koh Kong FiAC disseminated MAFF's proclamation on Establishment of Management Area of Mackerel Refugia in Peam Krasob, Koh Kong province, funded by SEAFDEC/UNEP/GEF, through producing material extensions and meeting with CFIs and local authorities as well as fishermen. Moreover, Koh Kong FiAC collaborating with local authorities and CFIs patrolled and cracked down illegal fishing activities in refugia sites during closed season of mackerel fishing.

In particular, committee for marine fisheries resource management at provincial level are established to facilitate and address all issues happening in Mackerel refugia sites in order to ensure management and utility of sustainable mackerel resources. The committees is called as Technical Working Group for Marine Fisheries Resource Management is chaired by deputy governor of Koh Kong province and the member of TWG are from FiA, provincial line department, provincial army forces, district and commune authorities, and NGOs involved (See **Figure 10** and Annex 1).



7. Habitats for Endangered Marine Species

Koh Kong is a province to see abundant marine biodiversity and ecosystem, providing spawning, feeding, and nursing habitat for endangered animal and fish species such as green turtles, dolphins, sharks, tortoises and so on.

The Royal Government of Cambodia issues sub-decree on endangered animal species management dated on 12 August 2009 in order to ensure the population and stock of endangered

species. The sub-decree catching from wild and distribution including selling, buying, transporting, processing, and stocking is banned. These endangered animal species described in table 10 as follow:

Table 10: Endangered fish and other aquatic species in Cambodia.

No.	Local name	Scientific name	Common name
1	Krapeu Samot	<i>Crocodylus porosus</i>	Estuarine crocodile
2	Chruk Toek or Poyung	<i>Dugong dugon</i>	Dugong
3	Trey Sekbok	<i>Cheilinus undulates</i>	Humphead Wrasse
4	Balen Krabei	<i>Pseudorca crassidens</i>	False killer whale
5	Belen Kbalthom	<i>Globicephala macrorhynchus</i>	Short-finned pilot whale
6	Psoat Chramos Dorb Champus Khlei	<i>Tursiops aduncus</i>	Indo-Pacific bottlenose dolphin
7	Psoat Kbal Traloak	<i>Orcaella brevirostris</i>	Irrawaddy dolphin
8	Psoat Chramos Dorb Champus Veng	<i>Tursiops truncatus</i>	Common bottlenose dolphin
9	Psoat Khleach	<i>Sousa chinensis</i>	Indo-Pacific hump-backed dolphin
10	Psoat Chhnoat Pnek	<i>Stenella longirostris roseiventris</i>	Dwarf spinner dolphin
11	Psoat Ouch	<i>Stenella attenuata</i>	Pantropical spotted dolphin
12	Psoat Et Pruy Knong	<i>Neophocaena phocaenoides</i>	Finless porpoise
13	Psoat Kmao Leung	<i>Dolphinus capensis tropicalis</i>	Long-beaked common dolphin
14	Lmich	<i>Chelonia mydas</i>	Green turtle
15	Krass	<i>Eretmochelys imbricata</i>	Hawksbill turtle
16	Lmich Pruy Bei or Lmich Speu	<i>Dermochelys coriacea</i>	Leatherback turtle
17	Lmich Kbal Thom	<i>Caretta caretta</i>	Loggerhead turtle
18	Lmich Praphes	<i>Lepidochelys olivacea</i>	Olive ridley turtle
19	Krum Yeak	<i>Tridacna squamosa</i>	Fluted giant clam
20	Krum Yeak	<i>Tridacna maxima</i>	Elongate giant clam
21	Krum Yeak	<i>Tridacna crocea</i>	Crocus giant clam
22	Krum Yeak	<i>Tridacna gigas</i>	Giant clam
23	Kyong Koad	<i>Trochus niloticus</i>	Commercial top
24	Kyong Kuch or Kyong Prak	<i>Turbo marmoratus</i>	Green turbo or green snail
25	Ses Samut (fish)	<i>Hippocampus spp.</i>	Sea horse
26	Pkar Thmor	<i>Anthozoa spp.</i>	Corals and sea anemones
27	Pralaing Kas	<i>Tachypleus gigas</i>	Traingular-tail horseshoe crab
28	Kachoar	<i>Carcinoscorpius rotundicauda</i>	Mangrove horseshoe crab
29	Trey Banon Kingkork	<i>Rhincodon typus</i>	Whale shark

8. Biological Review of Short Mackerel

8.1 Scientific, Common, and Local Name

Scientific name of short mackerel or Indo-Pacific mackerel (common name) is *Rastrelliger Brachysoma* (Bleeker, 1851) belong to the Phylum Animalia, Class Chordata, Order Actinopterygii, Family Scombriformes, and Genus Scombridae. Local name of this species is called as Trey Kamom Kluan Kley.



Figure 11: Indo-Pacific mackerel, *Rastrelliger brachysoma*

8.2 Morphology

Rastrelliger brachysoma is body very deep, its depth at posterior margin of opercle 3.7-4.3 times in fork length; head equal to or less than body depth; spinous dorsal fin yellowish with a black edge, pectoral and pelvic fins dusky, other fins yellowish (Figure 11).

8.3 Distribution

Rastrelliger brachysoma is found in Central Indo-West Pacific from the Andaman Sea east to Thailand, Indonesia, Papua New Guinea, Philippines, Solomon Islands and Fiji (*Fish Base, 2004*). (Figure 12).

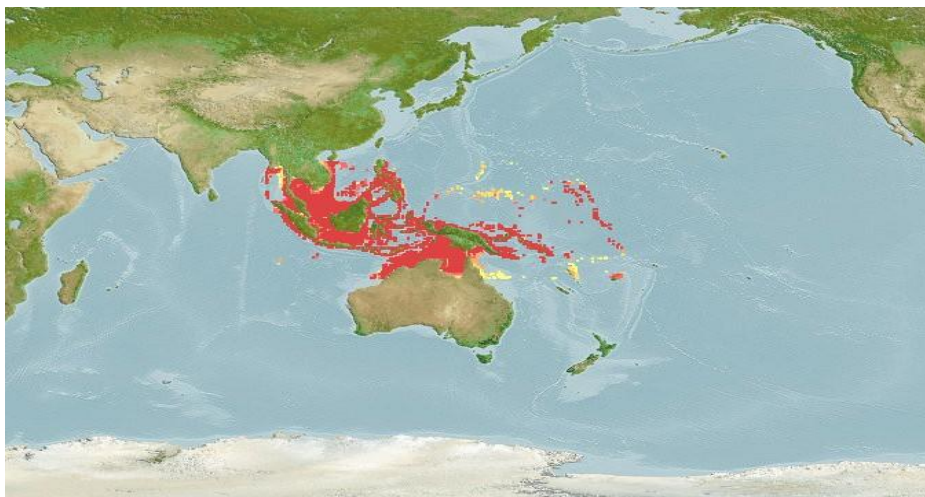


Figure 12: Distribution of *R. brachysoma*
Source: *Fish Base, 2004*

8.4 Life cycle and mating behavior

According to survey of larvae collection in Koh Kong province from March 2019 to March 2020 (Table 11), many Scombridae family was found near inshore at Peam Krasob, Chroy Pros, and Koh Yor (Thai water border) in Koh Kong province during juvenile starting from November to March, but a little scombridae family was found in April and May. That scombridae family was not harvested in June and July; they may be move back to the Gulf of Thailand to find feed and grow up there (Table 12).

During adults (brood stock), they migrate back from the Gulf of Thailand to spawn in Cambodia water at Peam Krasob, Chroy Pros, and Koh Yor (Thai water border) in August.

Table 11: Survey station positions in Koh Kong province

Station	Latitude_(N)	Longitude_(E)	Note
1	0280658	1268881	Peam Krasaop
2	0274835	1274167	Peam Krasaop
3	0273056	1283297	Koh Yor
4	0273540	128641	Peam Krasaop
5	0270809	1281513	Koh Yor
6	0287417	1258595	Chrouy Pras
7	0280697	1271240	Peam Krasaop
8	0287208	1252491	Chrouy Pras

Source: Field survey, 2019 to 2020

Table 12: the peak period of Scombridae Family in Koh Kong province

Month	Families	Total (individuals)	Percentage (%)
Mar-19	Scombridae	16	10.88
Apr-19	Scombridae	1	0.68
May-19	Scombridae	2	1.36
Sep-19	Scombridae	24	16.33
Oct-19	Scombridae	8	5.44
Nov-19	Scombridae	2	1.36
Dec-19	Scombridae	17	11.56
Jan-20	Scombridae	49	33.33
Feb-20	Scombridae	21	14.29
Mar-20	Scombridae	7	4.76

Source: Field survey, 2019 to 2020

8.5 Length at first maturity of short mackerel

According to study of short mackerel gonad stage in Koh Kong province from February 2019 to March 2020, *R. brachysoma* starts to develop gonad stage at first maturity in August with the total length from 16.26 for female, and from 15.77cm for male.

8.6 Gonado somatic index and size frequency

Short mackerel's gonad or sperm development stage was divided into 5 stages based on the Leaflet of SEAFDEC/UNEP/GEF/PCU, 2019 on Five-point Maturity Scale for Partial Spawners. The development stage of fish was detailed as follow:

1. Ovary and testis about 1/3 length of body cavity. Ovaries pinkish, translucent; testis whitish. Ova not visible to naked eye.
2. Ovary and testis about ½ length of body cavity. Ovary pinkish, translucent; testis whitish, more or less symmetrical, and Ova not visible to naked eye.
3. Ovary and testis is about 2/3 length of body cavity. Ovary pinkish-yellow color with granular appearance, testis whitish to creamy and No transparent or translucent ova visible.

4. Ovary and testis from 2/3 to full length of body cavity. Ovary orange-pink in color with conspicuous superficial blood vessels, Large transparent, ripe ova visible, and Testis whitish-creamy soft.
5. Ovary and testis shrunken to about ½ length of body cavity. Walls loose. Ovary may contain remnants of disintegrating opaque and ripe ova, darkened or translucent, and Testis blood shot and flabby.

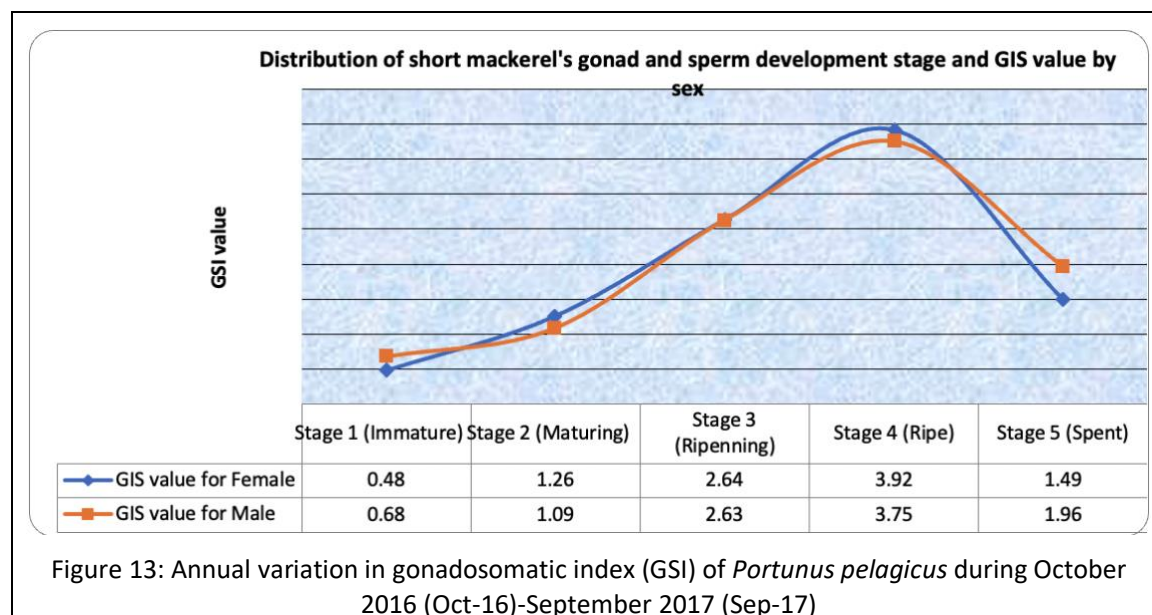
According to Table 13, the gonad or sperm development stage of fish was found mostly in the stage 3 and 4 that account for 23.25% (239 individual) and 36.58% (376 individual), respectively, following the stage 5 accounted for 21.11% (217 individual). The minor percentage is in the stage 1 and 2 that accounted for 11.48% (118 individual) and 7.59% (78 individual).

Table 13 : Percentage of Short Mackerel's Gonad or Sperm Development Stage by Sex in Koh Kong province

No.	Development Stage	Female		Male		Total	
		N=521	%	N=507	%	N=1028	%
1	Stage 1 (Immature)	63	12.09	55	10.85	118	11.48
2	Stage 2 (Maturing)	44	8.45	34	6.71	78	7.59
3	Stage 3 (Ripening)	122	23.42	117	23.08	239	23.25
4	Stage 4 (Ripe)	213	40.88	163	32.15	376	36.58
5	Stage 5 (Spent)	79	15.16	138	27.22	217	21.11
Total		521	100.00	507	100.00	1028	100.00

Source: Field survey, 2019-2020

GSI value plays a main role in setting the immaturity, maturity and spawning period of fish. Figure 13 showed the relation of the gonad or sperm development stage of fish and GSI value. Highest GSI value is recorded in the stage 4 (3.92 for female and 3.75 for male) while lowest GSI value is recorded in the stage 1 (0.48 for female and 0.68 for male). After that, the stage 3 was recorded in GSI value (2.64 for female and 2.63 for male) while the stage 2 was recorded in GSI value (1.26 for female and 1.09 for male). The stage 5 was recorded in GSI value (1.49 for female and 1.96 for male).



8.7 Area of habitat in each stage of short mackerel

R. brachysoma is found to be abundant from August to May to find spawning habitat in Koh Kong province after migrating back from the Gulf of Thailand during August. This species was found during larval and juveniles from September to March at Koh Kapi, Koh Kong Krao, Peam Krasob, Chroy Pros, Boeung Kachang, Peam Bak Klorng, Koh Nou, and Koh Yor (Thailand water border).


Food and feeding habits of *Rastrelliger brachysoma* was Diatoms, which were the most dominant food. According to Dr. Kornrawee Aiemsomboon, 2019, Diatom is a group of phytoplankton and Copepod is a group of zooplankton that are dominant composition in Koh Kong province, contributing to 68.31% from Diatom, copepod and zooplankton (19.06%), Dinoflagellate (7.62%), and other (5.01%). Therefore, diatoms, dinoflagellates, and copepods were the main food items in the diet of *R. brachysoma*.

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ANNEX 1

Decision on the Establishment of Technical Working Group for Marine Fisheries Resource Management in Koh Kong Province

 <p style="text-align: center;">Kingdom of Cambodia Nation Religion King</p>			
<p>Koh Kong Administration No. 005/20 SorSorRo</p>			
<p>Decision on Establishment of Technical Working Group for Marine Fisheries Resources Management in Koh Kong province</p>			
<p>Koh Kong Governor</p>			
<ul style="list-style-type: none"> - Having Seen the Constitution of the Kingdom of Cambodia - Having Seen the Royal Decree No. NoSor/RoKorMo/0508/017 dated on 24th May 2008 declaring to use the law on the Administrative Management of Municipal, Provinces, Capital, District, and Khan - Having Seen the Royal Decree No. NoSor/RoKorMo/0506/011 dated on 21st May 2006 declaring to use the law on fisheries - Having Seen Royal Decree No. NoSor/RoKoTor/0167/507 dated on 16th June 2017 by the King on the nomination of the governor of Koh Kong - Having seen Sub-Decree No.216 OrNo.KroBoKo dated on 14th December 2009 on the roles, duties, and job relation of the council of provincial, municipal, and district governor - Reference to Proclamation No. 400 Broko. KorSorKor dated on 16th September 2019 on Establishment of Management Area of Mackerel Refugia at Peam Krasob, Koh Kong province - Reference to Proclamation No. 133 Broko. KorSorKor dated on 6th June 2019 on Establishment of Management Area of Royal Turtle and Crocodile at Sre Ambil Channel, Koh Kong province - Reference to FiA letter No. 3374 dated on 26 November 2019 of the Ministry of Agriculture, Forestry, and Fisheries - Based on needed of Koh Kong Administration. 			
<p>DECISION</p>			
<p>Article 1: The establishment of Technical Working Group for Marine Fisheries Resources Management in Koh Kong province, which have following composition:</p>			
+			
1	Mr. Sok Sothy	Deputy Governor of Koh Kong	Chair
2	Mr. Ouk Vibol	Director of Department of Fisheries Conservation	Vice Chair
3	Mr. EE Meang Leang	Director of Provincial Agriculture, Forestry, and Fisheries	Vice Chair
4	Mr. Lim Savan	Director of Koh Kong Provincial Administration	Member
5	Mr. Chhor Bun Chhung	Acting Director of Fisheries Administration Cantonment in Koh Kong province	Permanent Member
6	Mr. Leng Sy Vann	Deputy Director of Department of Fisheries Conservation	Member
7	Mr. In Hul	Deputy Director of Department of Fisheries Conservation	Member
8	Mr. Ros Viravuth	Director of Provincial Department of Land, Construction, and Cadastral	Member

9	Mr. Morn Phalla	Director of Provincial Department of Environment	Member
10	Mr. Chhun Som Khyth	Acting Director of Provincial Department of Tourism	Member
11	Brigadier General Min Raksmeay	Vice Commander of Provincial Police	Member
12	Colonel Sin Daro	Commander of Maritime Police No. 269	Member
13	Lieutenant Colonel Phorn Sothun	Vice Commander of Provincial Military Police	Member
14	District Authorities Involved	District Governor Involved	Member
15	Orung Som Oreun	Director of Inter-Sector Division	Member
16	Kao Monirith	Deputy Director of Inspectorate of Marine Fisheries Administration	Member
17	Kim Sokha	Director of Fisheries Conservation Division/DFC	Member
18	Hor Thu	Director of Law Management and Public Safety Division	Member
19	Commune Authorities Involved	Head of Commune Council Involved	
20	Representative of NGO	Representatives of FFI, WCS, and IUCN	Member

Article 2: The working group has following duties:

- Prepare 5 years management plan for marine fisheries resource management;
- Promote and monitor the implementation of action plan;
- Solve other conflicts happening marine fisheries management area;
- Facilitate and collaborate with neighbor countries to exchange the experiences of fisheries resources management;
- Seek supports from NGOs, development partner, private sectors as well as the establishment of budget management mechanism to ensure sustainably in the implementation of action plans; and
- Organize a meeting every 3 months or based on needed at invitation of the working group head.

Article 3: The working group has a right to revise its composition through the decision made by Koh Kong Provincial Administration

Article 4: The working group has a right to use subordinate officers and to create the teamwork for implementation.

Article 5: The working group has a right to use the Koh Kong provincial administration's stamp for the implementation of duties

Article 6: Any decision meaning against this decision shall be null and void.

Article 7: Director of provincial administration, directorate, the unit head under provincial structure, the director of provincial departments, involving institutes/authorities around the province-governor of city or district, and themselves as mentioned in Article 1, must follow this decision effectively starting to sing it from now.

Koh Kong, 26th February 2020
Koh Kong Governor

Mithona Phouthorng