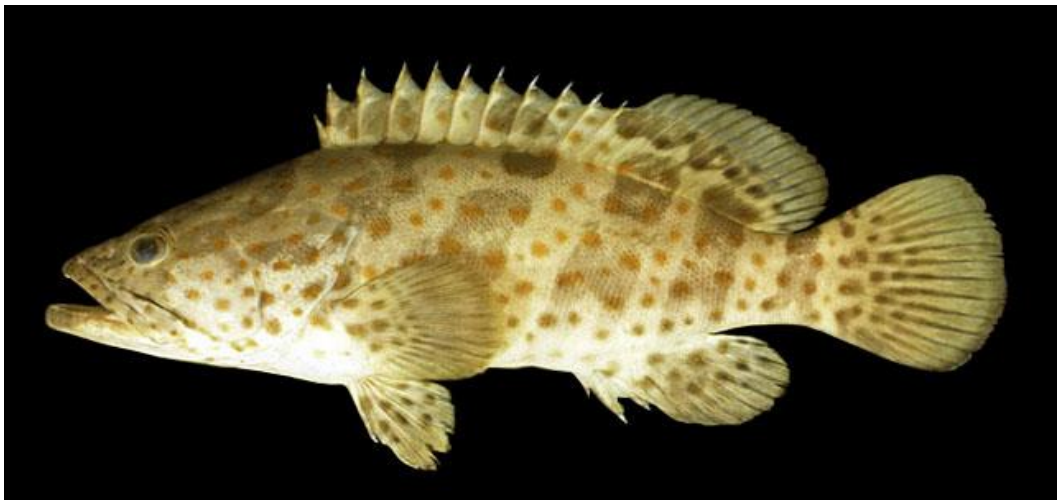
Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand

FISHERIES REFUGIA PROFILE AND LANDING SITE IN KAMPOT PROVINCE



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ABBREVIATION

ADB	Asian Development Bank
ADB GMS	Asian Development Bank Great Mekong Subregion
BSC	Blue Swimming Crab
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
SEAFDEC	Southeast Asian Fisheries Development Center
SPF	Strategic Plan for Fisheries
UNDP	United Nations Development Program
UNEP	United Nations Environment Programme

1. Background of Fisheries Refugia Sites

1.1 Geographical Features in Kampot province

Kampot province is a province in south-west part of the country and is joined boundary by Kampong Speu to the north, Takeo to the east, Kep and Vietnam as well as a long coastline on the Gulf of Thailand to the south and Preah Sihanouk to the west (Figure1). This province has 7 districts and one city, 93 communes, and 488 villages, and covers the total land areas of 4873.2Km2.

The Kampot province also covers the coastline areas of 67km, which stretches from the borders of the Hatieng District of Vietnam to Sihanoukville Province, and has two islands, namely Koh Ses, and Koh TraNgoul(SamAth, 2014). These promote a high potential ecological system, including coral reef (953ha), seagrass bed (25000ha), and mangrove forest (1900ha), providing spawning, nursing, and feeding habitats for variety of marine species, especially endangered animal and fish species (FiA 2019).

Ecosystem in Kampot Bay is characterized by swampy, sandy and rocky habitats with little freshwater influence. Salinity near the shore varies between 30.5 ppt and 32 ppt during the rainy season, and increases up to 32.5 ppt to 33.4 ppt during dry season (Sam Ath, 2014).

Moreover, the Kampot is the productive province of marine fisheries captures, contributing over 19% to the total marine fisheries capture production in the whole country in 2019.

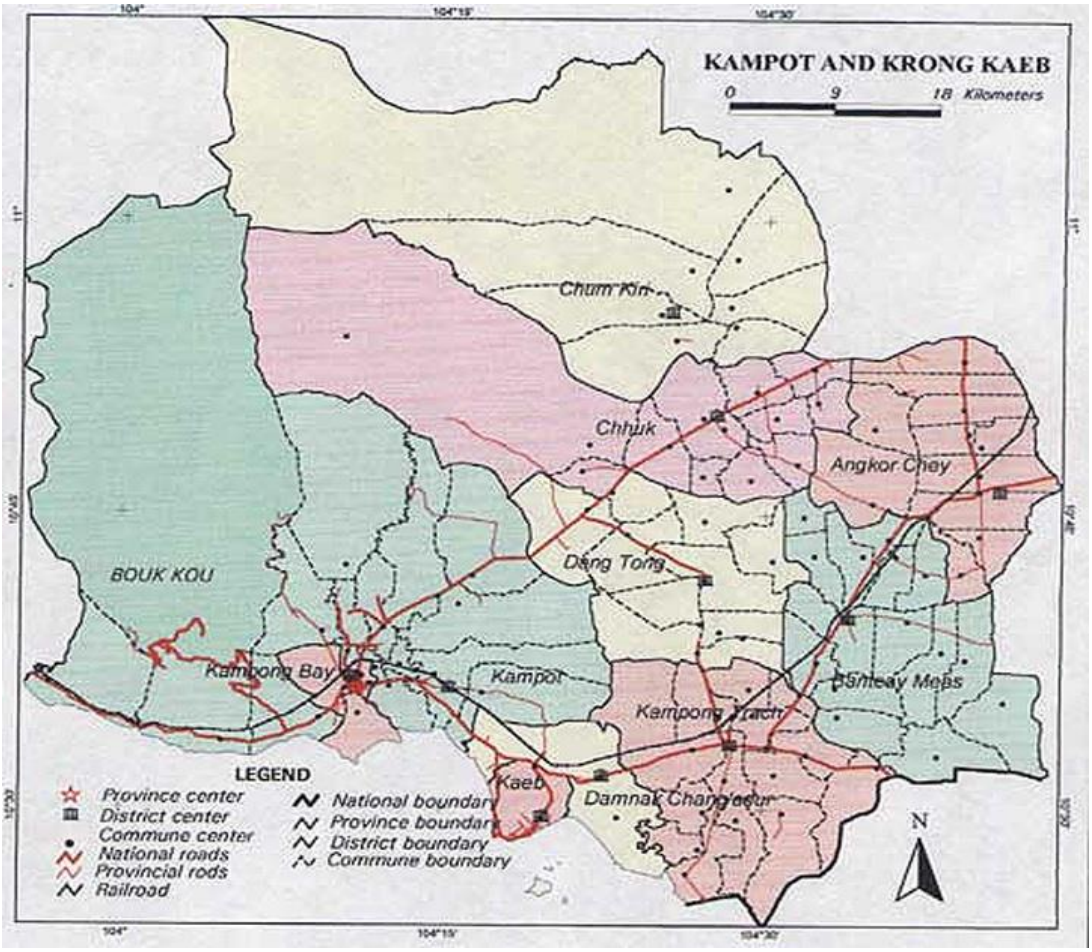

Figure 1: Administration Map of Kampot province
Source: Google Image of Kampot province, Cambodia

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 sees 0.9%. As for Kampot province, its annual population growth rate is very low that account for 0.1%.

Kampot province is the total people of 592,845 in 2019 which equals to 3.88% of the total people in the country (Table 1). In term of household, the province is 138,374 households, including 312,308 females and 280,537 males. Moreover, the size of household in average is 4.3 when the average size of household in the whole country is around 4.6 (Table 1).

Table 1: Population Statistic in Kampot province in 2019

No.	Description	Number of People
1	The number of Households	138,374 individuals
2	The number of Total People	592,845 household
3	The number of Female	312,308 individuals
4	The number of Male	280,537 individuals
5	The size of Household	4.3/household
6	Annual population grow rate	0.1%

Source: the Ministry of Planning, 2019

1.3 Socio economic Aspect

1.3.1 Economic Aspect:

Provincial economic growths are dependent on agricultural, businesses, industrials, tourisms, services, and investment sectors. These sectors contribute to the enhancement of people livelihood and economic development in the province. 73.9% of main occupation in Kampot province was shared by agricultural activities, followed by business and services activities (25.6%), and industrial and handicraft activities (0.5%) in 2020 (Kampot Provincial Administration, 2020).

1.3.1.1 Tourism Sector

Kampot is a province, which endowed with nature recourses, national parks, and historical resorts as well as patrimonial constructions. Those are attractive in national and international tourists to visit in the Kampot province, providing job opportunities and increasing income to enhance the living quality of people in the province. There are 17 eco-tourisms areas and 4 patrimonial sites in Kampot province. Kampot provincial administration will plan to develop tourism sports and construct support infrastructures to attract further national and international tourists to visit there. In 2019, there were 1,505,649 national tourists and 172,767 international tourists, using local labor forces in 6,316 people including 4276 females (Kampot Provincial Administration, 2020).

1.3.1.2 Agriculture Sector

Agricultural sector is core target to promote the economic development in the province because Kampot province is favorable geographical feature in rice crop, orchards, animal husbandry, and marine fisheries resources. According to GSID, 2020, agricultural land areas shared 45% of total land areas in Kampot province in 2011, and labor force participation rate in

the whole province in 2008 accounted for 81.5% while about 85% of labor force was engaged in agricultureactivities.

According to Kampot Provincial Administration, 2020, total land areas of wet rice season in 2020 is 140,190ha, which harvested rice production in 434,589 ton (3.1ton/ha), and total land area of dried rice season is 9,560ha, which harvested rice production in 40,343ton (4.22 ton/ha). Secondary crop covered total land areas in 1,540ha and industrial crop covered total land area of 1,210ha.

1.3.1.3 Business and Service Sector

People in Kampot province make a business for their subsistence in small and medium scales. Provincial business products increased and extended in techniques, quantity, and quality manner to supply market demands. In particular, domestic products including rice, crops, fruits, and fish are exported to neighbor countries to contribute to the enhancement of living standard of people in the province. Business and service sector shared 25.6% to provincial economic development

1.3.1.4 Industrial and Handcraft Sector

Industrial and Handcraft sector contributed to economic development in Kampot province and shared 0.5% to economic growth in the province. Kampot province sees factories in big scale and the enterprise and handicraft in medium and small scales. The labor force engaged in industrial activities in the province will grow by up to 9% in 2020, and in 2030 will represent 19.6% of the total labor force (GSID, 2020).

Factories in big scale are 24 factories in Kampot province, absorbing labor forces in 8847 people in total (4892 females). Enterprises in medium and small scales are 29 big and medium scale enterprises, using labor forces in 1042 people (373 females). Handicrafts are 2828 handicrafts, providing labor forces in 7605 people (3081 females)

Enterprise of Salt Production covered total land area of 3675.94ha, which is divided into 192 producer groups and those producer groups are classified into 6 producer units, including BoeungRoung 1 and 2, Ses Sor, Troeuy Koh, BoeungTouk, and Kampong Trach. Salt production farm can produce 83969.06ton in 2020, however the salt production farms met some problems such as limited salt quality and the lack of capital and labor forces.

1.3.2 Social Aspect

1.3.2.1 Education Situation

Education situation of Kampot increase equitable access to education at all levels. From 2000-2015, the number of pre-schools, primary, secondary, and high schools has significantly increased (GSID, 2020).

According to 5-year development plan from 2020-2024, Kampot province has 999 buildings (4576 rooms) for studies, including 192 kindergartens, 311 primary schools, 76 secondary schools, 24 high schools, and two universities. In addition, there are 14 private schools for general knowledge.

Kindergartens covered 220 teachers (217 females) and there were 6866 kids in total including 30303 girls. Primary Schools covered 2827 teachers (1278 females) and there were 78422 students in total including 37958 females. Secondary Primary Schools are 1202 teachers (766 females) and there were 18447 students in total including 9376 females. High School are 1341 teachers (488females) and were 24994 students in total including 12814 females

The government of Cambodia aims to increase the net enrollment rate in primary school in Kampot to 98.5% by 2023 with a projected completion rate of 86.2% (GSID, 2020). In 2019, enrollment rate of students at primary school level increased from 94.2 % to 95.1% and female

students increased from 90.6% to 93.6% and the rate of study graduation declined from 81.% to 80.5% and female students dropped from 85% to 80% for their study end.

1.3.2.2 Health Situation

To ensure and provide good health services to people in Kampot province, the provincial department of health developed 5 year strategy plan from 2016-2020, focusing on 1) health enhancement in reproduction, fatality rate reduction of women, infant, and children, lack of food for children and women, 2) reduction of illness and the death of contagious disease, 3) reduction of illness, the death of no contagious disease, and other public health issues, and 4) health system in accountability and replying to health requirement.

To achieve these strategy plans, the province is 64 health centers, 81 doctors, and 1096 health officers to support and provide health services to people in the province. According to Kampot Provincial Administration, 2020, newborn service rate increased from74% to 84% in 2019, women fatality rate after born (0- 1 month age) per 1000 born was by 0.2, and infant fatality rate (0-1 month age) per 1000 infants was by 0.5.

1.3.2.3 Gender and Poverty

Kampot province is provincial department of women affair, which is responsible in the promotion of gender and children status. Women have opportunities to participate in social to find incomes for family supports through working in agriculture, enterprises, and industrials sector. There are 51.13% of women in Kampot province, which participate provincial development (Kampot Provincial Administration, 2020).

Moreover, Kampot provincial administration provides priority to women to have chances to serve their jobs in the structure of provincial leaders to join and make decision to address other issues such as family violation and vulnerable people, curbing women and children trade, and combating against human trade. However, some of women do not have experiences in leadership, public and political affairs.

Poverty status in Kampot province decreased from 14.4% in 2016 to 13.2% in 2020 and disable people increased from 6090 individual in 2016 to 6,458 individual in 2020 (Kampot Provincial Administration, 2020

2. Importance of Coastal Fisheries Habitats

Coastal and marine habitats in the Kampot province are considered as marine ecological system to be rich of seagrass and mangrove forest, 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, groupers, shrimps, tortoises (endangered and rare species) and dugongs (UNEP, 2005).

Coastal marine ecosystems support social, economic, and ecological processes and provide myriad ecosystem services (WEA, 2020). Kampot's marine habitats have been observed to become increasingly exploited and degraded by illegal fishing and incompatible coastal development, threatening ecosystem function, coastal resilience, and fisheries (WEA, 2020).

To restore marine ecosystem and habitat, Department of Fisheries Conservation/FiA collaborating with Kampot Fisheries Administration Cantonment and national organization (WEA) will plan to establish marine fisheries management area in Kampot and the creation of this area is processing with Kampot Provincial Administration so far.

2.1 Mangrove Forest

Mangrove forests play an essential role in protecting the coastline, a self-maintenance of buffer zone against storm, strong winds, and reducing coastal erosion. Moreover, they become

main habitats for animal and fish species, and other marine organisms for living, feeding, nursing, and spawning. According to Lee *et al*., 2014, WEA, 2020, mangrove forests act as important nurseries for coral reef and seagrass dwelling fish species, helping to increase fish abundance and diversity on coral reefs and seagrass meadows, and mangrove forests and seagrass meadows also protect coastlines from natural hazards like storms and erosion. Therefore, protecting and expanding connectivity between marine habitats is essential for supporting productive fisheries and resilient coastlines (Unsworth *et al*., 2008, WEA, 2020).

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

In term of mangrove forest areas, the mangrove forest in Kampot is estimated about 1900ha, contributing about 3% to the total mangrove forest areas in the country (FiA, 2010). In term of species, mangrove forest is recorded 16 species in the country (FAO, 2007, Si Tuan Vo *et al*., 2013) meanwhile TrapaingSangkeCFi in Kampot showed 21 species in the leaflet of mangrove forest (Table 2).

In term of the restoration of mangrove forest, 383 participants from national and sub-national institutions, and local NGOs were mobilized to plant 19,150 mangrove trees (among the total seedling 47,350) in Trapaing Sangke, Trapaing Ropov, Kampong Samaki and Kep Thmey commune in 2012. Community Fisheries themselves collaborated with the Fisheries Administration Cantonment to replant the mangrove forest in 66 ha in 2017 (Mr. Chap Sopanha, 2019).

Table 2: List of Mangrove Forest in Kampot province

No.	Name of Scientific Species	Local Name
1	Acanthus ebratetus	Deum Trocheak Kranh
2	Acrostichum speciosum	Deum Brorng
3	Aegiceras floridum	Deum Krachork Neang
4	Avicennia alba	Deum Klbanh Sor
5	Avicennia officinalis	Deum Basak Khmao
6	Bruguiera cylindrica	Deum Basak Sor
7	Bruguiera gymnorhiza	Deum Basak Krahorm
8	Bruguiera sexangula	Rom Phlong/ Basak Sor
9	Ceriops tagal	Deum Sme Krahorm
10	Ceriops decandra	Deum Sme Sor
11	Excoecaria agallocha	Deum Chheu Chor
12	Heritiera littoralis	Deum Semoan Samut
13	Lumnitzera racermosa	Deum Kranheb Sor

14	Lumnitzera littorea	Deum Kranheb Krahorm
15	Nypa fruiticans	Deum Chak
16	Rhizophora apiculata	Deum Korng Kang Slek Touch
17	Rhizophora mucronata	Deum Korng Kang Slek Touch
18	Scyphiphora hydrophylacea	Deum Kranhek Chhmol
19	Sonneratia alba	Deum Ampo Thmor
20	Sonneratia ceseolaris	Deum Ampo Krahorm
21	Sonneratia ovata	Deum AmPea

Source: Leaflet of mangrove forest in Trapaing sangke Community Fisheries, Kampot province

Figure 3: Picture of mangrove forest occurring in Kampot province

2.2 Coral Reef

Monica Reed *et al*, 2015 showed that coral reefs are complex, highly productive and biologically diverse ecosystems. UNEP, 2008 cited those 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 by *Diploastrea heliopora* (13.2%), *Pavona decussate* (4%).

Jan-Willem van Bochove *et al*, 2011 reported that the reef areas of 28 km^2 were estimated by the Government of Cambodia and 150km^2 estimated by global. Total area of coral reef in coastal sites was estimated about 2800ha (UNEP, 2007, Si Tuan Vo *et al*., 2013) and Kampot shared about 34% (953ha) of total areas of coral reef in the country in Trapaing Ropoav, Prek Thnaot, and Chhorng Horn villages, Prek Thnaot Commune.

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

Figure 4: Picture of coral reef living in Kampot province. *Source: WEA, 2020*

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. In term of species, it was found that the nine species of seagrass occure in Cambodia, including Thalassiahemprichii, Haloduleuninervis,, Enhalusacoroides,, *Halophila decipiens*, *Cymodocea serrulata*, *Halodule pinifolia*, *Cymodocea rotundata*, *Syringodium isoetifolium*, and *Halophila ovalis*.

Total area of seagrass in the country was estimated about 30000ha (10 year- Strategy Plan for Fisheries Conservation, 2019), Kampot province shared over 80% of the total areas of country seagrass. Those areas of seasgrass in Kep province are mostly located around the Trapaing Ropaov, Prek Thnaot, Chhorng Horn village, Prek Thanot commune until Prey Nob district, Preah Sihanouk province. However, some areas of sea grass are not estimated in Kampot province, Department of Fisheries Conservation/FiA collaborating with MCC, WEA, and Kampot Fisheries Administration Cantonment will plan to assess the areas of seagrass other sites supported from EU budget.

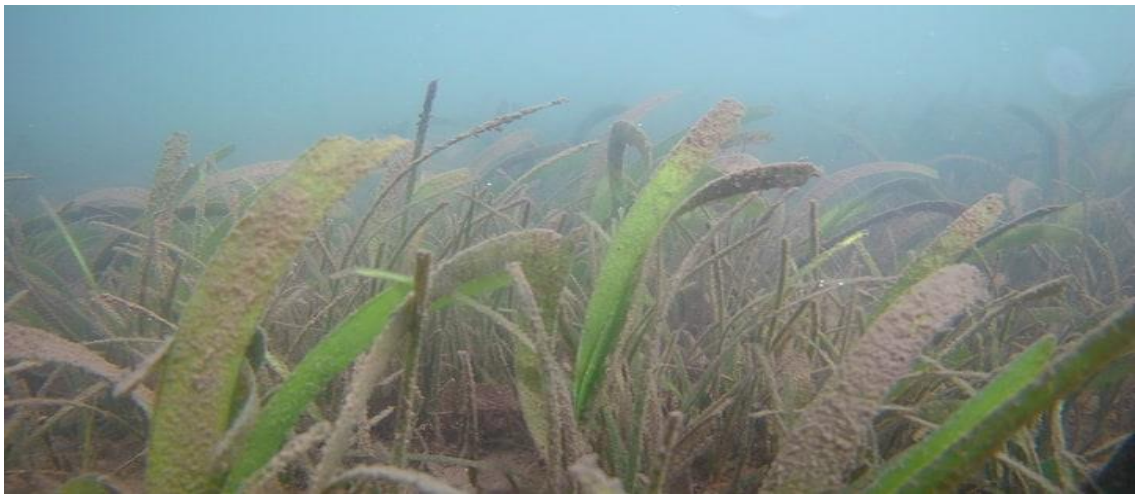

Figure 5: Picture of seagrass living in Kampot province
Source: WEA, 2020

3. Capacity of Fishing Operation in Kampot Province

3.1 Fishingvessels

Number of fishing vessel in Coastal area of Cambodia fluctuates from province to another province, depending on the abundances of marine fisheries resources and the coastline area of each province. The most of fishing vessel was observed to operate in small scale. In the case of Kampot province, numbers of fishing vessel operating in Kampot province declined from 1093 vessels in 2010 to 1039 vessels in 2020, and dramatically decreased 421 vessels in 2017 as showed in Figure 6

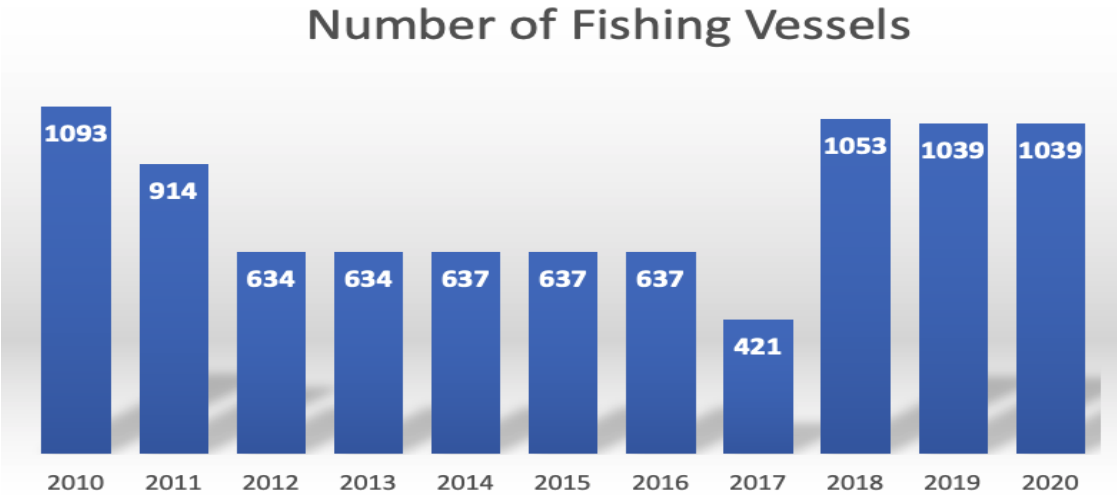

Figure 6: Statistic of Annual Fishing Vessels Operating in Kampot province from 2010 to 2020
Source: FiA, 2010 to 2020

3.2 Length of Fishing Vessel

The length of fishing vessels in Kampot province are classified into 4 categories such as less than 6m, 6m - <12m, 12m - <18m, and 18m - <24m as presented in Table 3. Table 3 showed that two types of fishing vessel length are recorded in high percentage, including 6m - <12m (69.10%) and 12m- <18m (29.93%). In contrast, the rest of them are recorded in low percentage, including 18m - <24m (0.58%) and <6m (0.38%).

Table 3: Classification of Fishing Vessel by the Length Operating in Kampot province in 2018

No.	**Classification of the Length of Fishing Vessel**	Number of Vessels (N=1039)	Percentage (%)
1	18m - < 24 m	6	0.58
2	12m - <18 m	311	29.93
3	6m - <12 m	718	69.10
4	< 6 m	4	0.38
Total		**1039**	100

Source: FiA, 2020

3.3 Engine Power of Fishing Vessel

Engine power of fishing vessels in Kampot province is classified into three categories, including less than 50hp, 50-90hp, and >90-180hp (FiA, 2020). Table 4 showed that about100% of fishing vessels are observed to operate with engine power in less than 50hp, followed by 50-90hp (0.67%), and >90-180hp (0.38%).

Generally, fishing vessels in Kampot province was observed to operate in inshore area because of limited capacity of fishing exploitation.

Table 4: Classification of Fishing Vessel by the Engine Power Operating in Kampot province in 2018

No.	Classification of the Engine Power of Fishing Vessel	Number of Vessels (N=1039)	Percentage (%)
1	< 50 hp	1028	98.94
2	50 - 90 hp	7	0.67
3	>90 - 180 hp	4	0.38
Total		1039	100

Source: FiA, 2020

3.4 Number of Fishermen Per Fishing Vessel

According to FiA 2020, the number of fishermen carried per fishing vessels in Kampot province was classified into three categories, including one person, 2-5 people, and 6-10 people. Table 5 showed that about 90% of fishing vessels carried from 2-5 people, followed by one person (14.24%), and 6-10 people (0.10%).

Table 5: Number of Fishermen Distribution Carried per Fishing Vessel in Kampot province in 2018

No.	Classification of number of person/Fishing vessel	Number of Vessels (N=1039)	Percentage (%)
1	1	148	14.24
2	2-5	890	85.66
3	6-10	1	0.10
Total		1039	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).

According to FiA, 2020, 15 types of fishing gears are observed to operate in Kampot province, including 1) Trawl, 2) Beach Seine, 3) Encircling Seine, 4) Encircling Gillnet, 5) Crab Trap, 6) Fish Trap, 7) Squid Trap, 8) Elongated Collapsible Trap, 9) Crab Gillnet, 10) Fish Gillnet, 11) Shrimp Gillnet, 12) Squid Horizontal Long Line Hook, 13) Fish and Squid Hook, 14) Push net, and 15) Oyster Collector.

Table 6 showed that four types of fishing gears operating in Kampot province were recorded in high percentage, including Trawl (31.09%), Elongated Collapsible Trap (24.35%), Fish Gillnet (16.84%), and Crab trap (8.76%).

However, the lowest percentage was recorded in some fishing gears such as Encircling Gillnet (0.48%), Fish and Squid Hook (0.38%), Squid trap (0.29%), and Beach seine (0.10%).

Besides, some of fishing gears operating in Kampot province were recorded in moderate percentage, including Squid Horizontal Long Line Hook (5%), Shrimp Gillnet (2.89%), Oyster Collector (2.31%), Push Net (2.21%), Crab Gillnet (2.21%), and Encircling Seine (2.12%),.

In general, Trawl, Elongated Collapsible Trap, Fish gillnet, and Crab trap are such fishing gears, sharing marine capture fisheries products in huge quantity to the total marine fisheries productions of Kampot province.

Table 6: Types of Fishing Gears Operating in Kampot province in 2018

No.	English Name	Khmer Name	Number of Fishing Gear (N=1039)	Percentage (%)
1	Trawl	Uon Os	323	31.09
2	Beach Seine	Uon Khov	1	0.10
3	Encircling Seine	Uon Huom	22	2.12
4	Encircling Gillnet	Mong Huom	5	0.48
5	Crab Trap	Lop Kdam	91	8.76
6	Fish Trap	Lop Trey	10	0.96
7	Squid Trap	Lop Meuk	3	0.29
8	Elongated Collapsible Trap	Lop Kon Tuy Kondol	253	24.35
9	Crab Gillnet	Mong Kdam	23	2.21
10	Fish Gillnet	Mong Peak	175	16.84
11	Shrimp Gillnet	Mong Bang Kear	30	2.89
12	Squid Horizontal Long Line Hook	Santouch Meuk Ro Nong Meuk	52	5.00
13	Fish and Squid Hook	Santouch Trey	4	0.38
14	Push Net	Chhip Run	23	2.21
15	Oyster Collector	Much Rok Oi Steu	24	2.31
Total			1039	100

Source: FiA, 2020

3.6 Fishing Vessel Length with Fishing Gears

Fishing vessel length with fishing gears was presented in Table 7 that there were two types of fishing vessel length (6-<12m and 12-<18m) in Kampot province practicing with 14 types of fishing gears.

For the fishing vessel length of 6-<12m, over 40% of fishermen was recorded in operating with Trawl, followed by Fish gillnet (18.02%), Elongated Collapsible Trap (15.64%), and Crab Trap (10.06%). In contrast, the small percentage of fishermen was recorded in Crab Gillnet (2.79%), Shrimp Gillnet (2.79%), Encircling Seine (2.09%), Push Net (1.96%), Oyster Collector (1.82%), Squid Trap (0.42%), and Squid Horizontal Long Line Hook (0.28%).

For the fishing vessel length of 12-<18m, more than 40% of fishermen was recorded in practicing with Elongated Collapsible Trap, followed by Fish Gillnet (17.67%), Squid Horizontal Long Line Hook (15.77%), Crab Trap (5.99%), and Trawl (3.79%). In the contrast, the small percentage of fishermen was recorded in Oyster Collector (3.47%), Shrimp Gillnet (3.15%), Push Net (2.84%), Encircling Seine (2.21), Crab Gillnet (0.95%), and Beach Seine (0.32%).

Table 7: Length of Fishing Vessel with Fishing Gears in Kampot Province in 2018

No.	Types of Fishing Gears	Length of Fishing Vessel (m)			
		12- <18 m (N=317)	Percentage (%)	6- <12 m (N=716)	Percentage (%)
1	Trawl	12	3.79	311	43.44
2	Beach Seine	1	0.32		
3	Encircling Seine	7	2.21	15	2.09
4	Encircling Gillnet			5	0.70
5	Crab Trap	19	5.99	72	10.06
6	Elongated Collapsible Trap	141	44.48	112	15.64
7	Squid Trap			3	0.42
8	Crab Gillnet	3	0.95	20	2.79
9	Fish Gillnet	56	17.67	129	18.02
10	Shrimp Gillnet	10	3.15	20	2.79

12	Squid Horizontal Long Line Hook	50	15.77	2	0.28
13	Push Net	9	2.84	14	1.96
14	Oyster Collector	11	3.47	13	1.82
Total		**317**	**100**	**716**	**100**

Source: FiA, 2020

4. Role of fisheries refugia in Production in Kampot province

4.1 Annual Marine Capture Fisheries Production in Kampot province

Kampot is the productive province of marine fisheries captures, contributing over 19% to the total marine fisheries capture production in the whole country in 2019. Annual marine capture fisheries in Kampot province increased from 10,300 ton in 2010 to 23,309ton in 2019, but decreased by 20,300ton in 2020 as presented in Figure 7.

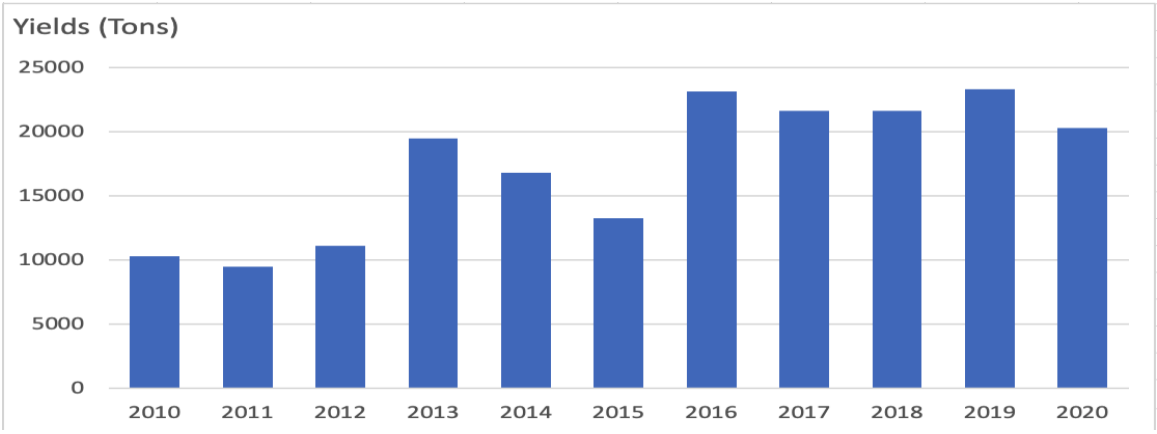

Figure 7: Annual Marine Capture Fisheries Production in Kampot province from 2010 to 2020

4.2 Annual Grouper Production in Kampot province

Figure 8 showed grouper production in Kampot province from 2010 to 2020. The grouper yield increased from 12 ton in 2010 to 50 ton in 2014, but this yield started declining by 30 ton in 2015, and continued to move up to 34 ton in 2016 and 36 ton in 2020. If it was compared with other coastal provinces in 2020, the grouper production in Kampot was lower than 3 times in Koh Kong province (106 ton), but higher than two times in Kep province (18 ton) (FiA, 2020).

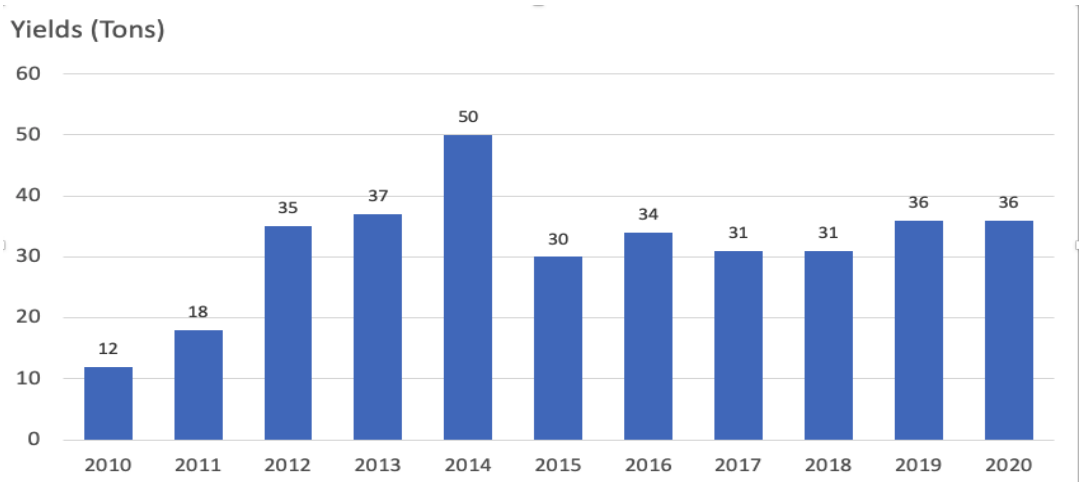

Figure 8: Annual Grouper Production in Kampot from 2010 to 2020 (ton)
Source: FiA from 2010 to 2020

4.3 Annual Marine Capture Fisheries Production with Fishing Gears

According to filed survey, 2019, 5 types of fishing gears were recorded to share annual marine capture fisheries production in Kampot province in 2019, including Push net, Fish gillnet, Crab gillnet, Crab, trap, and Trawl.

Table 8 showed three types of fishing gears were recorded to share the huge quantity of annual marine capture fisheries production in Kampot province, including trawl 2,862,166 kg, followed by Fish gillnet 776,250 kg, and Crab trap 329,663kg. In contrast, two types of fishing gears were recorded to share the small amount of annual marine capture fisheries production; including Push net 29,404 kg and Crab gillnet 61,308 kg.

Table 8: Annual Marine Capture Fisheries Production by Fishing Gears in Kampor province in 2019

No.	Types of Fishing Gears	Yields (kg)	Percentage (%)
1	Push net	29,404	0.72
2	Fish gillnet	776,250	19.13
3	Crab gillnet	61,308	1.51
4	Crab trap	329,663	8.12
5	Trawling	2,862,166	70.52
Total		**4,058,791**	**100**

Source: Field Survey, 2019

Figure 9 showed the percentage of fishing gears sharing annual marine capture fisheries in Kampot province. Over 70% of annual marine capture fisheries productions was shared by Trawl, followed by Fish gillnet 19.13%, and Crab trap 8.12%. The rest of them were Push net and Crab trap, sharing 0.72% and 1.51%, respectively

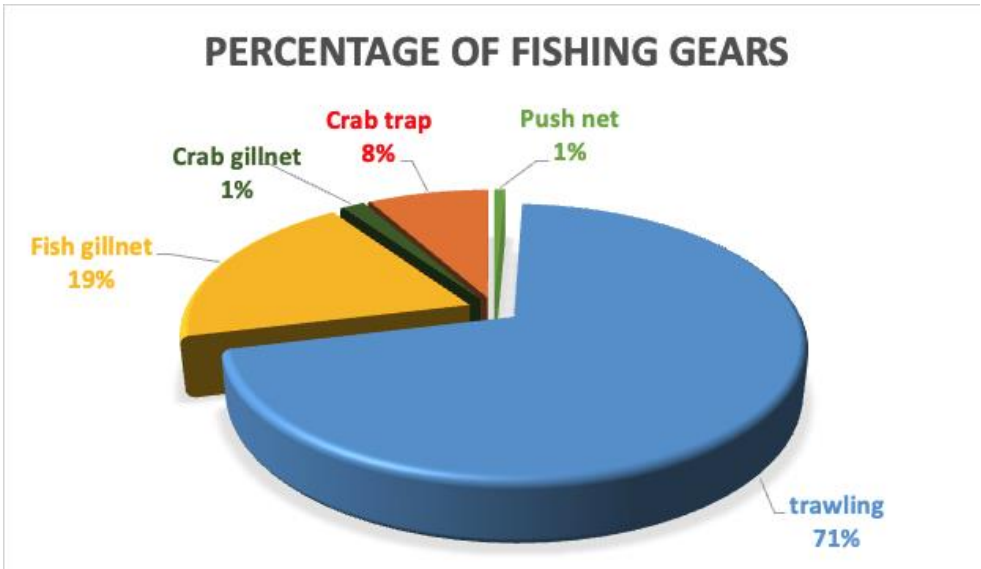

Figure 9: Percentage of Types of Fishing Gears in Marine Capture Fisheries Production in Kampot province in 2019

Source: Field Survey, 2019

4.4 Calculation of CPUE in Kampot province

According to field survey, 2019, the figure of CPUE was observed to fluctuate based on status of fishing vessels, the types of each fishing gear, fishing period, and the number of fishing days.

These are main factors to be used for the calculation of CPUE in Kampot province. Thus, the calculation of CPUE was presented in Table 9 as follow:

Push net can catch the fish of 7.12kg/day and 0.95kh/hour in average, with fishing period of 7.46hours, mean length net of 22.18m, mean fishing vessel length of 8.64m, and mean engine power of 15hp.

Fish gillnet can catch 21kg/day in fish and 1.65kg/hour in average, with fishing period of 13hours, mean gillnet length of 2500m, mean fishing vessel length of 10.57m, and mean engine power of 24.57hp.

Crab gillnet can harvest the crab of 11.73kg/day and 0.92kg/hour in average, with fishing period of 12.73 hours, mean gillnet length of 1930m, mean fishing vessel length of 10.32m, and mean engine power of 22.25hp.

Crab trap can catch the crab of 17kg/day and 1.76kg/hour in average, with the mean fishing period of 9.67 hour, mean fishing vessel length of 10.68m, engine power of 23.50hp, and 1950 traps in average.

Trawl can catch the fisheries of 51.11kg/day and 4.14kg/hour in average, with mean fishing period of 12.33hour, mean fishing vessel length of 11.33, engine power of 47.11hp, and mean length of the mouth of trawl in 38.12m.

Table 9: Calculation of CPUE Indicator per Used Fishing Gear in Kampot province in 2019.

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 Horse Power (hp)					Per day (kg)	Per hour (kg)
Push Net	8.64	15	22.18m	7.46	1	7.12	7.12	0.95
Fish Gillnet	10.57	24.57	2500m	13	1	21	21	1.65
Crab Gillnet	10.32	22.25	1930m	12.73	1	11.73	11.73	0.92
Crab Trap	10.68	23.50	1950 trap	9.67	1	17	17	1.76
Trawl	11.33	47.11	38.12m	12.33	1	51.11	51.11	4.14

Source: Field survey, 2019

5. Number of fisheries communities in Kampot province

According to Department of Community Fisheries Development of FiA, 2019, there are 10 community fisheries in Kampot province, including TrapeangRopovCFi, PrekThnoatCFi, Chhorng Horn CFi, KepThmeyCFi, ToTeungThaNgeiCFi, ChhumKrielCFi, Kampong Samaki CFi, Koh KrasnaCFi, and LorkCFi. Those CFis are set up by Department of Community Fisheries Development of FiA and Kampot Fisheries Administration Cantonment since 2001 (Table 10).

Table 10: Number of fisheries communities in Kampot province

No.	Name of Community Fisheries	Location	CFi's Area (Ha)	CFi's Member (person)	Date of CFi Establishment
1	Trapeang Ropov CFi	Trapeang Ropov village, Prek Thnaot Commune, Tek Chhou District, Kampot province	1251	537	2001
2	PrekThnoatCFi	Prek Thnaot village, Prek Thnaot Commune, Tek Chhou District, Kampot province	1168	91	2000
3	Chhorng Horn CFi	Chhorng Horn village, Prek	1338	603	2002

		Thnaot Commune, Tek Chhou District, Kampot province			
4	Kep Thmey CFi	Boeung Touk commune, Tek Chhou District	683	129	2005
5	ToTeungThaNgeiCFi	Boeung Touk commune, Tek Chhou District	776	147	2005
6	ChhumKrielCFi	N/A	N/A	357	2013
7	TrapeangSankeCFi	TrapeangSanke commune, tekChhou district	337	1097	2009
8	Kampong Samaki CFi	Koun Sat commune, Tek Chhou district	577	431	2002
9	Koh KrasnaCFi	ReusseyKhang Lek commune, Kampong Tralach district	238	375	2003
10	LorkCFi	ReusseyKhang Lek commune, Kampong Tralach district	324	470	2004
Total			6692	4237	

Source: Department of Community Fisheries Development of FiA, 2019

6. Existing Fisheries Management Measure in Fisheries Refugia Sites

According to fisheries law, marine fisheries management are divided into 4 zones, including 1) Coastal Area: For small-scale and medium-scale fishing operations, and extends from shoreline up to less than 20 m water depth line also called “Fishing Zone One”; 2) Offshore Area: For commercial-scale fishing operations, and extends from 20 meter depth up to the EEZ) also called “Fishing Zone Two”; 3) Sanctuary Area: Consists of coral reef areas and sea grass beds reserved for habitats of marine aquatic animals and plants; and 4) Mangroves Protected Area: Mangrove and forest areas which are covered with tidal water and important feeding, spawning and breeding habitats for marine aquatic animals and inundated protected area.

Management measures in refugia sites are taken to focus on: 1) Closed fishing season or spawning season; 2) Limitations on the type of fishing gears, including the number of gears and the mesh size used; 3) Limitations on the type or number of fishing vessels and vessels engaged in fishing related activities.

At the present, Community fisheries play a main role in patrolling and reporting to local authorities and KampotFiAC when there were illegal activities happening. Moreover, CFis pay attention in fostering raising awareness of significance of fisheries resources management due to supporting budget, materials, and technical from national and international organizations such as WEA, SAMAKY, BCV, CWDCC, and SEAFDEC/UNEP/GEF.

To ensure and restore the stock of marine fisheries resources, especially endangered animal species, Department of Fisheries Conservation/FiA collaborating with Kampot Fisheries Administration Cantonment as well as working partner with WEA has a plan to establish Marine Fisheries Management Area including grouper refugia in Koh Touch and PrekThnoat commune. These areas are main habitats for spawning, nursing, and feeding for endangered animal species Irrawaddy dolphin, dugong, sea turtles and sea horses, as well as containing coastal habitats such as coral reefs, seagrass beds and mangrove forests.

7. Habitats for Endangered Marine Species

Kep is a province to be rich of marine biodiversity and ecosystem, providing spawning, feeding, and nursing habitat for endangered animal and fish species such as green turtles, dolphins, sharks, tortoises, and dugongs 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 states that catching from wild and distribution including selling, buying, transporting, processing, and stocking is banned. These endangered animal species described in table 11 as follow:

Table 11: Endangered fish and other aquatic species in Cambodia

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

8. Biological Review of Grouper Species

8.1 Scientific, Common, and Local Name

Scientific name of Oranges spotted Grouper (common name) is *Epinephelus coioides* (Hamilton, 1822) belong to Kingdom Animalia, Phylum Chordata, Class Actinopteri, Order

Perciformes, Family Epinephelidae, and Genus Epinephelus (IUCN, 2018). Local name of this species is called as Trey Tek Ke Kao

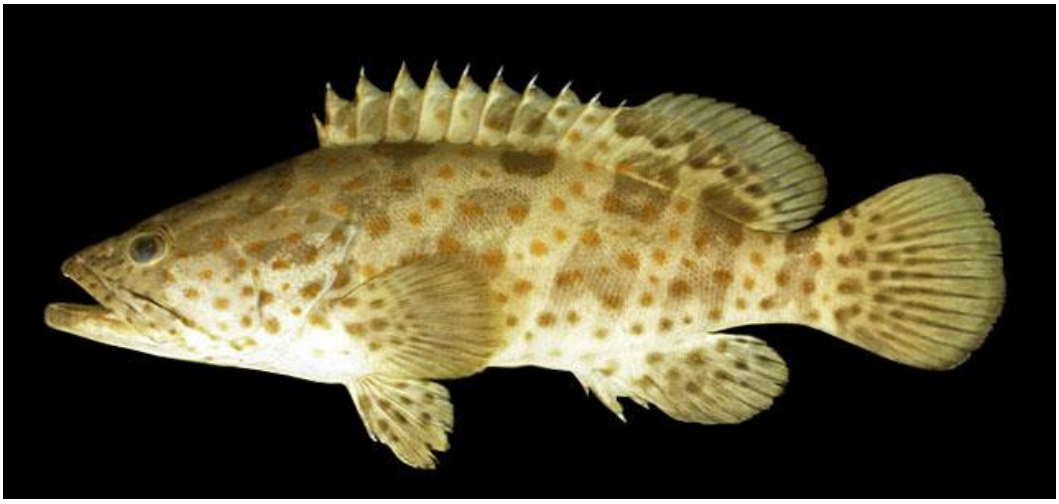

Figure 10: Picture of *Epinephelus coioides*
Source: Randall, J.E., 1997 from FishBase, 2004

8.2 Morphology

Epinephelus coioides is distinguished by following characters (Fish Base, 2004):

- Head and body is full color with brownish orange spot in head to caudal fin,
- Elongated body with greatest body depth at 2.9-3.7 in SL (for specimens 10-78 cm SL); head length 2.3-2.6 in SL. interorbital width 5.0-6.2 in HL; preopercle with enlarged serrae at angle and a broad shallow notch just above angle; and
- Gill rakers of first gill arch 8-10 + 14-17; pyloric caeca 50-60; lateral body scales rough, with minute auxiliary scales (body scales ctenoid except for nape, back, thorax, abdomen and above anal-fin base with cycloid scales); lateral-line scales 58-65; lateral-line tubes of anterior scales branched in adults.

8.3 Distribution

This species is distributed in the Indo-Pacific Ocean from Durban, South Africa; north along East Africa, including Madagascar, Reunion and Mauritius, to the Red Sea and Persian Gulf; east to Palau and Fiji; north to the Ryukyu Islands, Japan; and south to the Arafura Sea and northern Australia (Heemstra and Randall 1993, IUCN, 2018). It has also migrated through the Suez Canal to the eastern Mediterranean (Randall 1995, IUCN, 2018).

According to IUCN, 2018, *Epinephelus coioides* occurs in countries such as Australia; Bahrain; Bangladesh; Brunei Darussalam; Cambodia; China; Disputed Territory (Paracel Is., Spratly Is.); Djibouti; Egypt; Eritrea; Fiji; French Southern Territories (Mozambique Channel Is.); Hong Kong; India; Indonesia; Iran, Islamic Republic of; Iraq; Israel; Japan; Jordan; Kenya; Kuwait; Macao; Madagascar; Malaysia; Mauritius; Micronesia, Federated States of ; Mozambique; Myanmar; Oman; Pakistan; Palau; Papua New Guinea; Philippines; Qatar; Réunion; Saudi Arabia; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Sudan; Taiwan, Province of China; Tanzania, United Republic of; Thailand; Timor-Leste; United Arab Emirates; Vanuatu; Viet Nam; and Yemen.

Figure 11: Map of *Epinephelus coioides* distribution occur in countries
Source: Amorim *et al*., 2018

8.4 Life cycle and mating behavior

Epinephelus coioides was seen to inhabit inshore habitats from estuaries during juveniles and adults move to live in coral reef along continental coastlines and large islands (Carpenter *et al*. 1997, Grand court *et al*. 2005, Amorim *et al*., 2018). According to Kailola *et al*. 1993, Randall *et al*. 1997, Amorim *et al*., 2018), Juveniles often occur in estuaries over sand, mud and gravel substrate and amongst mangroves.

During adults, *E. coioides* consumes fishes, shrimps, crabs and other benthic crustaceans as primarily feeds (Grand court *et al*. 2005). Female age at first maturity is four years at 34 cm total length and Males reach maturity at 67.5 cm and 7.5 years (Amorim *et al*., 2018)

During spawning stage, *E. coioides* changes sex from female to male as a transition phase occurring at a size of 79 cm and a weight of 6,500g and the spawning peak season of the species is from May to July (Dewi S. Achmad *et al*. 2019)

A spawning aggregation of 1,000 to 5,000 individuals has been reported in the muddy/sandy bottom of a large shallow bay for three to four days in every month of the year. At night, the fish sleep partially buried in the mud (Hamilton 2003, Amorim *et al*., 2018).

Generally, *E. coioides* species changes its sex, which is caused by three factors such as age, social control, and body weight (Dewi Shinta Achmad *et al*. 2021). *E. coioides* sex change from female to male in the age range of 7-12 years (Renones *et al*., 2010; Geba, 2015, Dewi S. Achmad *et al*. 2019)and the weight of the male brood stock supply was above of 7,000 g and of females' above 3,000g (Dewi S. Achmad *et al*. 2019). Furthermore, female fish will turn into males when the population of males in nature is very small (Coleman *et al*., 1996, Dewi S. Achmad *et al*. 2019).

8.5 Length at first maturity

According to D S Achmad *et al*. 2019 studied estimating the catchable size of orange-spotted grouper in Indonesia, the mean size length of orange-spotted grouper (*Epinephelus coioides*) reaching first maturity is 40 cm. D S Achmad *et al*. 2019 also reported, there are several factors that can affect the size at maturation such as environmental conditions and fishing pressure. This species is protogynus hermaphrodites during mature as females convert to males as they grow larger. Their main diets are shrimp and smaller fish predominate during adult.

8.6 Gonado somatic index and size frequency

According to D S Achmad *et al*. 2019, there are 5 stages of gonad developments of E. coioides, stage 1, stage 2, stage, stage 4, and stage 5. GSI value of *E. coioides* varied less than 1 to 20 based on gonad development stage, including Stage 1 (less 1), stage 2 (1- 5), stage 3(5-10), stage 4 (10-20), and stage 5 (>20) (Table 12)

Table 12: Relationship between the gonad index and maturity stages (Tan & Tan 1974)

Gonad index	Maturity stage	
Lower than 1	Immature gonad	I
1.0-5.0	Maturing gonad	II
5.0-10.0	Maturing gonad	III
10.0-20.0	Mature gonad	IV
Higher than 20	Advanced mature gonad	V

Source: D S Achmad et al*. 2019*

8.7 Area of habitat in each stage

Epinephelus coioides was found to inhabit inshore habitats from estuaries during juveniles and move to live in coral reef along continental coastlines and large islands during adults (Carpenter *et al*. 1997, Grand court *et al*. 2005, IUCN, 2018). According to Kailola *et al*. 1993, Randall *et al*. 1997, Amorim *et al*., 2018), Juveniles often occur in estuaries over sand, mud and gravel substrate and amongst mangroves.

According to kruszynski *et al*. 2012, during adults, they live on reef and migrate to spawn into water column. Female usually lives in the deep ocean, largest females spontaneously become males. Adult groupers gather at spawning aggregation based on lunar cycles. During spawning, eggs drift in currents and larvae hatch from eggs to drift in current for 30-80days, and feed on other plankton drift toward coast. During juveniles, they hide in mangrove habitats and live in nursery areas at mangrove roots and seagrass bed, and then migrate to coral reef when juveniles are older.

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