



Report on the JTF Project

Enhancement of Sustainable Management of the Blue Swimming Crab Fisheries in Kep Province, Cambodia





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Southeast Asian Fisheries Development Center

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Foreword

The Southeast Asian Fisheries Development Center (SEAFDEC) has been working closely with the ASEAN to ensure that the provisions in the ASEAN-SEAFDEC Resolution and Plan of Action are appropriately addressed. Towards this end and with funding support from the Japanese Trust Fund, the SEAFDEC Training Department (SEAFDEC/TD) implemented the project “Promotion of Sustainable Fisheries Resources Enhancement Measures in Critical Habitats/Fishing Grounds in Southeast Asia” in 2015-2019. The Project was aimed at developing and promoting fishery resources enhancement and habitat conservation measures for Southeast Asia; and developing the capacity of human resources to implement such fishery resources enhancement and habitat conservation measures suitable for respective countries in Southeast Asia. Moreover, the Project also aimed to provide technical assistance and capacity building to target stakeholders on the rehabilitation of economically-important fishery resources as well as their habitats and fishing grounds.

In many countries in the Southeast Asian region, blue swimming crab (*Portunus pelagicus*) is a major fishery resource and its fishery is a major source of income for local fishers. While the sustainable fisheries of the blue swimming crab is already well developed in some countries, e.g. Thailand, in other countries this has not yet been the case, as their blue swimming crab resource had been severely decreasing not only in size but also in the quantity caught. This was specifically true for the blue swimming crab resource in Kep Province of Cambodia, where crab fisheries is the main livelihood of local fishers.

Therefore, through the aforesaid Project, SEAFDEC/TD provided assistance to boost the effort of Kep Province in strengthening the resource management of the blue swimming crab by implementing the pilot Project activity from 2017 to 2019, which focused on the development of measures to conserve and manage the blue swimming crab resources to stop the possible depletion of this economically important resource in Kep Province. Various efforts have been made under this Project activity to ensure the sustainable management of the blue swimming crab resource, one of which was aimed at re-investigating the management of blue swimming crab resource in Angkaol Village in Kep Province, considering that the local fishers in this Village depend mainly on blue swimming crab fisheries for their livelihood. This included the revival of the crab bank system which was established in this Village in mid 2000s but had stopped operations because of management concerns.

Results of the Project activity, which have been compiled into this report, include the establishment of a suitable hatchery and stocking system, similar to that of the crab bank system promoted in other provinces of Cambodia, as well as the development of the ways and means of ensuring that the blue crab resource in the Province is sustainably managed. The success of the implementation of the Project activity in Kep Province was mainly due to the active participation of the fishers in the planning, implementation and monitoring of the relevant activities, making sure that management of the crab resources is in place. The approach advocated through the Project had resulted in positive effects on the management of the blue swimming crab resources in Kep Province, and could therefore be promoted as a small-scale fishery resource management method in other parts of the country and in the whole Southeast Asian region.

The SEAFDEC/TD Team is thankful to the Japanese Trust Fund for the support in the implementation of the Project and also to those who provided assistance in the implementation of the Project. More specifically, the assistance of *Professor Dr. Matsuishi Takashi Fritz* of Hokkaido University in Japan and his team is highly acknowledged, especially in the analysis of the results of the survey and other relevant activities of the Project.



Ms. Malinee Smithrithee
SEAFDEC Secretary-General and
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List of Acronyms

BDS	Business Development Service
B.O.	Boat Owner
BSC	Blue Swimming Crab
CFi(s)	Community Fisheries/Communities Fisheries
CW	Carapace Width
DC/AC	Direct Current/ Alternating Current
DOF	Department of Fisheries
EU	The European Union
FAO	Food and Agriculture Organization of the United Nations
FCA	Fisheries Cooperative Association
FiA	Fishery Administration in Cambodia
FiAC	Fisheries Administration Cantonment
FishMAT	Fishery Management Assessment Tool
JTF	Japanese Trust Fund
Hp	Horsepower
IFReDI	Inland Fisheries Research and Development Institute
IUU fishing	Illegal, Unreported, and Unregulated fishing
L.F.	Labor Fisher
MAFF	The Ministry of Agriculture, Forestry, and Fisheries
MARDeC	Marine Aquaculture Research and Development Centre
MCS	Monitoring, Control, and Surveillance
MCSA	Management, Control, Surveillance and management, Activity
MFMA	Marine Fishery Management Area
MFRoDI	Marine Fisheries Research and Development Institute
MPA(s)	Marine Protected Areas
MSC	Marine Stewardship Council
M.T.	Middle Trader

NGOs	Non-governmental Organizations
PWC	Project Working Committee
SEAFDEC	Southeast Asian Fisheries Development Center
SEAFDEC/TD	Southeast Asian Fisheries Development Center, Training Department
SMEs	Medium-sized Enterprises
SPR	Spawning Per Recruit
YPR	Yield Per Recruit

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Executive Summary

1. Project purpose and an outline of the outputs

Blue Swimming Crab (BSC) is one of the most economically important aquatic species for Cambodian fishers, and crab fisheries has been their major source of income. Besides, BSC is also known as a favorite food for travelers visiting the coastal areas as well as in other parts of Cambodia.

There had been significant reductions in BSC catch in Cambodian waters since 2000 as reported by Chap *et al.* (2012) and Tong (2013). Crane and Vandy (2015) also stated that the number and size of BSC captured from the waters of Cambodia had been decreasing. It has therefore become necessary to conserve and manage such resources for sustainable utilization by the fishers. This project was carried out with the objectives of enhancing the natural stock of blue swimming crab and ensuring the livelihoods for fishers dependent on blue swimming crab fisheries

2. Baseline survey on socio-economic and marketing with gender dimension in Angkaol village, Kep Province, Cambodia

Baseline survey, comprising socio-economic and market survey, was conducted to examine the real situation of the BSC fisheries in Cambodia focusing on Angkaol Village in Kep Province as a pilot site. The socio-economic data were obtained from the fishers at Angkaol Village, while the marketing survey of the BSC involved the middle persons and retailers. The survey items for the socio-economic survey include basic social information (population, number of households, property, and assets, etc.), finances and fishing. Fisheries information (income and expenditures, fishing gear, fisheries production, fisheries concerns, and fisheries management) were also collected. Gender analysis (access and control to resources and assets, role of women and men in fisheries, and participation of women and men in fisheries) was also carried out, and the perspectives of fishers on the natural resources and livelihood, etc. were also analyzed and reported.

Analysis of the results of the socio-economic and market survey exhibited the following aspects:

- Blue Swimming Crab (BSC) fisheries is a major source of income for fishers in Angkaol Village, where the fishers are also engaged in agriculture as a secondary occupation
- Fishers own the basic facilities for living, such as televisions, washing machines, refrigerators, mobile phones, motorcycles, etc., indicating good living standards
- Men are engaged in fisheries while the women take charge of selling the fish including the BSC catch
- More than one-half of the fishers are happy with their present condition
- The major concerns in BSC fisheries include the fact that: the fisheries cannot be operated during storms and in the rainy season; fishing gears could be stolen; fishing

- gears could be lost because of presence of trawl fishing; and the quantity of BSC catch had been decreasing
- Fishers are aware of the need to conserve and manage the sustainable utilization of the BSC resources
 - Sale of BSC catch is directed towards the tourists in Kep Province through the main distributor serving as middle person

3. Catch statistics survey and stock assessment

To ascertain the actual quantity of BSC catch in Kep Province and to analyze the status of the stock of the BSC resources, catch statistics survey was conducted. The catch data were collected from three landing places of the BSC, such as in Angkaol, Thmei (crab market) and in Ou Krasar.

Results of the survey showed the two-year catch trends of BSC resources caught by fishers from Kep Province. The stock status of BSC was analyzed by calculating the Yield per Recruit (YPR) using the weight, length, and width of the carapace of the BSC catch. The results also showed that the current fishery of BSC in Kep Province could be sustainable, fully utilizing the productivity but not to the extent of over-fishing. Moreover, increasing the fishing effort should be avoided, which implies that it is necessary to capture the larger individuals than the smaller ones, as currently being caught, in order to sustain the utilization of the BSC resources.

4. Propagation of Blue Swimming Crab (BSC) resources using hatchery system

In order to sustain the stocks of BSC resources in Kep Province, propagation of BSC resources was promoted through the establishment of suitable hatchery and nursery system, which is similar to that of the crab bank system being practiced in other Southeast Asian countries, and also in other parts of Cambodia.

The project facilitated the construction of the facility for hatching and nursery of crab larvae at the sea area fronting the Angkaol Village, which is also being managed by the fishers themselves. The facility had been constructed in such a way that gravid female crabs collected from fishers could be raised for a few days to hatch their eggs into larval crabs. A number of hatchery tanks were set up with aeration supplied through a solar cell panel system that has been installed to provide the electrical power required.

Gravid female crabs, voluntarily donated by the local fishers, spawn in the hatching tanks. The larvae crabs hatched from the eggs are kept in the nursery system for a few days until they reach the zoea stage, after which these are released to the conservation area which has abundant seagrasses. The hatching and stocking system is managed by the fishers in Angkaol Village free of charge.

The main reason for the successful management of the hatching/stocking system is because the fishers have been very active and are much concerned with the conservation and propagation of the BSC resources. The most important factor that this project activity has been promoting is for the fishers to show their active commitment in propagating the BSC resources in order to sustain the stock of BSC resources in their area.

5. Strengthening of the management of Blue Swimming Crab (BSC) resources

● Status of fishery resources management on BSC in Kep Province

It is important to understand and be clarified of the real fisheries situation of an area to be able to conduct fisheries management effectively. The current situation of fisheries management of the BSC resources in Kep Province was therefore evaluated using the Fishery Management Assessment Tool (FishMAT) (Terashima *et al.*, 2016).

Using the FishMAT method, the success of the management of the BSC resources in Kep Province was assessed, and the results showed that the achievement was contributed by the following factors that scored more than one-half of the success level. These are:

- Basic information on the current situation (53%)
- Maintenance rehabilitation of the ecosystem (60%)
- Human and organizational capability (73%)
- Assessment and analysis capacity (71%)

On the other hand, there were other factors that scored less than one-half of the success level that tended to impede the achievement of the activity, and such factors should be improved through the strengthened efforts of the fishers in managing the resources/ These factors include:

- Management of effort: input-control (36%)
- Management of efforts: output-control (17%)
- Business improvement (13%)
- Post-harvest treatment/processing (13%)

In conducting the harvest control effectively, information should be collected on the amount of catch and the number of vessels for each fishing type. However, there is no accurate information/data on these aspects at present. Moreover, several activities towards business improvement and post-harvest/processing ventures had been conducted only at the country or provincial level, but not at the local level targeting the local people. Such activities should therefore be promoted at the local level by the Community Fisheries (CFis), Kep Province, and the Fisheries Administration of Cambodia (FiAC).

Although regulations for the management of fisheries are in place in Cambodia, cases of ineffective compliance with such regulations were noted because of the non-functioning surveillance system. It is therefore necessary to introduce or enhance the surveillance system to ensure that the stakeholders comply with the regulations for the sustainable management of the fisheries.

Focusing on the findings supporting the success categories as indicated in the foregoing, it is necessary to enhance the knowledge and awareness of the CFis on the opportunities to strengthen communications among the CFis, Kep Provincial Government, and FiAC to ensure that their concerted efforts contribute to addressing the management issues and sustainable utilization of BSC resources in the future.

● **Strengthening of the conservation of Blue Swimming Crab (BSC) resources**

➤ Installation of buoys to demarcate the conservation area

The conservation area of Angkaol CFi is a protected area for the restoration of habitats of the fishery resources, including BSC and seagrass beds, among others. The Angkaol CFi conservation area covers an area which is approximately 100 hectares (one square kilometer), which was declared by the local government authorities to the community as the conservation area. Twelve (12) buoys have been set up to identify this conservation area from the sea. The installation of the buoys has clarified the demarcation of the conservation area and has enabled the local fishers to spot and locate the conservation area from the sea.

➤ Installation of the signboards to recognize the location of the fishing conservation area

Signboards indicating the location of the conservation area had been set up in Angkaol Village to address the claim of fishers that they do not clearly notice the conservation area, and also to relay the information that fishing operations are prohibited in the conservation area. Disseminating the information about the conservation area to the local fishers broadly, is important in ensuring that fishers are not doing any fishing activity in the conservation zone.

➤ Conduct of study tours to enhance knowledge on BSC resource management measures

The Project also facilitated the conduct of a study trip in October 2019 for strengthening the exchange of technical information and assistance among the stakeholders, as well as for enhancing the capacity and awareness of researchers and fishers from Cambodia on the BSC fishery resources rehabilitation in seagrass fishing grounds. Involved in the study trip were members of the FiA, FiAC, and fishers from Cambodia who visited five (5) fishing villages in Thailand, namely: 1) Tong Tom Yai Village in Chumphon Province, 2) Phru Jood Village in Trang Province, 3) Lampho Community in Chai Ya District, Surat Thani Province, 4) Pak Nam Pran Village, Prachuap Khiri Khan Province and 5) Lam Phak Bia Crab Bank Group in Phetchaburi Province. In these villages, the study team from Cambodia learned the BSC fishery resource management measures undertaken in different areas. They were also able to exchange views with the fishers from Thailand in the aspect of local crab bank systems and resource management initiatives. Through this study trip, the fishers from Angkaol Village were able directly obtain information on the measures for BSC conservation and management system in Thailand, which they could take up and apply in Kep Province towards attaining the sustainable utilization of the BSC resources in the future.

Province except for the 16 km of sea coast on the southern side fronting the Gulf of Thailand and the Vietnamese island of Phu Quoc. The western limit is 20 km from the town of Kampot. The eastern limit is some 20 km from the Vietnamese border. It is about 148 km from Phnom Penh via the national road No 3.

In Kep Province, there are five (5) community fisheries where some of them have not yet been officially registered by The Ministry of Agriculture, Forestry, and Fisheries (MAFF). Those community fisheries are namely 1) Ou Krasar CFi, 2) Kampong Tralarch CFi, 3) Phum Thmei CFi, 4) Phum Kep CFi, and 5) Angkaol CFi. Specifically, in Angkaol CFi, there are 239 members and 11 committee members.

➤ The Project period of implementation: 3 years (2017-2019).

1.3 Project objective, output, and activities

1.3.1 Objective

Enhancing the natural stock of the BSC resources and ensure the livelihoods for fishers depending on the BSC fishery in community fisheries

1.3.2 Output and activities

1) Output 1

To strengthen regulations for catch data collection system, for the catch prohibition in the conservation area and small size crabs /gravid crabs catch restrictions.

Activities 1.1

To formulate periodical catch data collection system at the landing sites

Activities 1.2

To strengthen the management of conservation area with signboards/posters and with setting up of buoys at the boundary of the conservation area.

2) Output 2

To strengthen fishery surveillance on illegal fishing in Angkaol areas

Activities 2

To implement the periodical surveillance activities at the Angkaol area (landing sites and conservation area) by Kep FiAC and CFi.

3) Output 3

To improve the crab bank system

Activity 3.1

To improve hatching facilities: selection and introduction of hatching technology, selection of sites, design, and construction of the hatching facilities.

Activity 3.2

To formulate sustainable gravid crabs supply and juvenile crabs stocking system, fishers provide gravid crabs and hatch/stock juvenile crabs to the conservation area.

Activity Plan on Enhancement of Sustainable Management of the Blue Swimming Crab Fisheries

Problem	Objective	Specific measures	Activities	Examples of Indicators to be selected(Evaluated annually)
<p>Diminishing size of harvested crabs (Concern about the decrease of the Blue Swimming Crab resources)</p>	<p>Enhancing the natural stock of the BSC resources and ensure the livelihoods for fishers depending on the BSC fishery in community fisheries</p>	<p>To strengthen regulations for catch data collection system, for the catch prohibition in the conservation area and small size crabs /gravid crabs catch restrictions.</p>	<p>(1)To formulate periodical catch data collection system at the landing sites (2)To strengthen the management of conservation area with signboards/posters and with setting up of buoys at the boundary of the conservation area</p>	<p>*Number of the newly applied regulation has increased. *Number of installation for the signboards/posters, buoys in conservation area</p>
		<p>To strengthen fishery surveillance on illegal fishing in Angkaol areas</p>	<p>(3)To implement periodical surveillance activities at Angkaol area(landing sites, conservation area) by Kep FiAC and CFI.</p>	<p>*Number of the date of the surveillance has increased.</p>
		<p>To improve the crab bank system</p>	<p>(4)To improve hatching facilities: Selection and introduction of hatching technology, selection of sites, design and construction of the hatching facilities</p>	<p>*Data statistic scheme which annually publishes the catch data has been formulated.</p>
			<p>(5)To formulate sustainable gravid crab supply and juvenile crab stocking system, fishers provide gravid crabs and hatch/stock juvenile crabs to the conservation area</p>	<p>*Amount of the crabs release in the conservation area has increased</p>

Working Plan for Study on Enhancement of Sustainable Management of the Blue Swimming Crab Fisheries				
Activities	Concrete Activities	2017	2018	2019
(1)To formulate periodical catch data collection system at the landing sites	(1-1) To formulate the data collection scheme (team) and prepare the logbook at Kep FiAC (including the entrust scheme to CFI)			
	(1-2) To collect the data, assess the resources and report to PWC			
(2)To strengthen the management of conservation area with signboards/posters and with setting up of buoys at the boundary of the conservation area	(2-1) To prepare the posters and maps to enlighten fishers the importance of the conservation areas			
	(2-2) To design the buoys, schedule to construct them and construct them			
	(2-3) To seminar to enlighten fishers the importance of the conservation areas			*
(3)To implement periodical surveillance activities at Angkaol area(landing sites, conservation area) by Kep FiAC and CFI.	(3-1) To formulate the surveillance scheme (team) and prepare the surveillance logbook at Kep FiAC			
	(3-2) To plan the surveillance schedule			
	(3-3) To conduct the surveillance and periodically report to PWC			
	(3-4) To conduct mothly meeting to discuss and resolve the problem has been faced.			
	(3-5) To prepare the posters and Phamflet to enlighten fishers the regularion of catch size restriction			
(4)To improve hatching facilities: Selection and introduction of hatching technology, selection of sites, design and construction of the hatching facilities	(4-1) To select hatching technology (including defensive artificial reef in the conservation area)			
	(4-2) To select of hatching facility sites and cage of crab bank			
	(4-3) To design and schedule (including defensive artificial reef in the conservation area)			
	(4-4) To construct the hatching facilities and cage of crab bank			
(5)To formulate sustainable gravid crab supply and juvenile crab stocking system, fishers provide gravid crabs and hatch/stock juvenile crabs to the conservation area	(5-1) To formulate the crab bank team			
	(5-2) To formulate sustainable crab bank scheme and schedule			
	(5-3) To train team members to strengthen hatching technologies			
	(5-4) To conduct the crab bank (Crab hatchery and cage of crab bank)			
	(5-5) To meeting on dissemination of crab bank system scheme to the crab bank members, fishers and stakehodors.			*

2. Baseline survey on socio-economic and marketing with gender dimension in Angkaol village, Kep Province, Cambodia

Kep Province is composed of five (5) Community Fisheries (CFi) where some of them have not yet been officially registered by MAFF. These community fisheries are the following 1) Ou Krasar CFi, 2) Kampong Tralarch CFi, 3) Thmei CFi, 4) Phum Kep CFi, and 5) Angkaol CFi. Specifically, in Angkaol CFi, there are 239 members and 11 committee members. This CFi will be directly involved in the crab bank project implementation. The other CFi is in Kep Province was selected as a project site for the implementation of crab bank activities if the tentatively selected site is not appropriate. According to SEAFDEC program on Capacity building on theory and methodology of fisheries resource enhancement and habitat conservation measures, with activity on technical assistance led by pilot project sites and capacity building on the rehabilitation of fisheries resources and habitats/fishing grounds, Project Fisheries Resources Enhancement Measures in Critical Habitats/fishing Grounds in Southeast Asia, Hence, the Study on Enhancement of Sustainable Management of the Blue Swimming Crab Fisheries in Kep Province, Cambodia was conducted.

The project site is located in Angkaol village, Angkaol commune, Damnak Chang Aeur District, Kep Province was tentatively selected as the pilot site of this project. Kep is the smallest province of Cambodia covering 336 km², with a population of 40,280. It is the province that separated Kep municipality from the province of Kampot by the Royal Decree on 22 December 2008. The territory of Kep is surrounded by Kampot Province except for the 16 km of sea coast on the southern side fronting the Gulf of Thailand and the Vietnamese island of Phu Quoc. The western limit is 20 km from the Vietnamese border. It is about 148 km from Phnom Penh via the national road No. 3.

2.1 Objectives

- To collect data on socio-economic, environmental trends, patterns, the value and context of coastal resources in the area
- To collect data on BSC Market in Kep Province

2.2 Methods

The survey was conducted in July 2019. Sixty fishers from 30 percent of total fishers in Angkaol village are respondents for the individual interviews on socio-economic data collecting. And 15 respondents were interviewed for a marketing survey in three (3) landing sites, as the following Angkaol (3 persons), Ou Krasar (2 persons), and Thmei Market (10 persons). Both surveys were collected through a gender dimension by accidental sampling survey. The data from surveys use descriptive analysis to explain the situation of fishing in Angkaol village and the structure of marketing in Kep Province. The semi-structure interview was used to collect data from both respondents (**Appendix 1 and 2**).

2.3 Results

The results of data collecting were divided into four (4) parts, as the following: Actual Situation of Angkaol Fishing Communities, Fisheries at Angkaol village, Social Capital, and human network in Angkaol village, and Crab Marketing in Kep Province.

2.3.1 Actual situation of Angkaol fishing communities

1) General information of fisher at Angkaol village

Almost all of the respondents are men and all of them are Buddhist. Their ages are high in middle age from 31 to 40 years old. The education level is high in primary school and many of them are illiterate. The family in Angkaol still a big family as the result shown that family member is high in four (4) to six (6) persons.

Table 3. Demographic information

Information	No .of respondents	%
<u>Sex</u> :1 .Male	53	88.3
2.Female	7	11.7
<u>Age</u> :1 .≤20 years old	1	1.7
2 .21-30 years old	18	30.0
3 .31-40 years old	27	45.0
4 .41-50-year old	10	16.7
5 .51-60 years old	4	6.6
<u>Educational level</u> :1 .Illiterate	20	33.3
2 .Primary School	30	50.0
3 .Junior high school	9	15.0
4 .Bachelor	1	1.7
<u>Number of family's member</u>		
1 .1-3 persons	8	13.3
2 .4-6 persons	43	71.7
3 .from 7 persons	9	15.0
<u>Religion</u> :Buddhist	60	100.0

2) Occupation, income, and expenditure

The major occupation in Angkaol is fisheries as it can be confirmed by its monthly income is 1,431,667 Riels (358 USD). Fishers also have agriculture on rice fields for household consumption. Another job opportunity is processing and tourism. The monthly expenditure of each household started from less than 100,000 to 1,000,000 Riels or 573,895 Riels (143 USD) on average.

Table 4. Occupation, income, and expenditure

Major occupation	Counts	%
Major occupation (n=60)		
Fisheries	60	100.0
Income/month (n=60)		
≤1,000,000	32	53.3
1,000,001-2,000,000	24	40.0
2,000,001-3,000,000	3	5.0
≥3,000,000	1	1.7
Mean = 1,431,667		
Supplementary occupation (n=60)		
Processing	30	50.0
Income/month (n=30)		
≤500,000	23	76.7
500,001-1,000,000	6	20.0
1,000,001-10,000,000	1	3.3
Mean = 439,000		
Supplementary occupation (n=60)		
Tourism	7	11.7
Income/month (n=9)		
≤100,000	3	42.8
100,001-200,000	2	28.6
200,001-300,000	2	28.6
Mean = 156,571		

3) Asset and household goods to facilitate their livelihood

To identify the quality of life of fishers at Angkaol, the asset and goods need to show to know what facilities that fisher own. The study showed that all fishers have a basic asset and goods to comfort their daily life. Fisher here just lacks luxury goods and assets.

Table 5. Asset and household goods to facilitate their livelihood

Household Asset and goods	% Have	% None
1. Fishing boat	100.0	
2. Land	100.0	
3. Livestock	16.7	83.3
4. House	100.0	
5. TV	45.0	55.0
6. Washing machine		100.0
7. Refrigerator		100.0
8. Microwave		100.0
9. Air condition		100.0
10. Electric fan	46.7	53.3
11. Mobile phone	83.3	16.7
12. Motorbike	85.0	15.0
13. Car		100.0
14. Home theater		100.0
15. DVD player		100.0
16. Computer		100.0

4) Access and control of asset, money, and fishing

There are equal access and ownership of land, water supply, borrowing money and education for men and women in Angkaol but for borrowing money, women control it. Under fisheries-related equipment, fishing license, and the use of transportation are completely accessed by men.

Table 6. Access and control of asset, money, and fishing

Access and control	Access (can use)			Ownership (can own formally or legally)			Control (can independently make decisions over (e.g., have rights to share/sell/alienate, sell, consume, improve)		
	M	W	Equal	M	W	Equal	M	W	Equal
	Land	-	-	100.0	-	-	100.0	-	-
Water Supply	-	-	100.0	-	-	100.0	-	-	100.0
Borrow money from Bank	-	-	-	-	-	100.0	-	65.0	35.0
Borrow money from community group	-	-	100.0	-	-	100.0	-	65.0	35.0
Borrow money from private loan	-	-	100.0	-	-	100.0	-	65.0	35.0
Fisheries inputs: fishing gear, boats, boat engines, storage facilities	100.0	-	-	-	-	100.0	53.3	-	46.7
Fishing license	100.0	-	-	-	-	100.0	100.0	-	-
Transportation (boats, trucks, other vehicles)	100.0	-	-	-	-	100.0	-	33.3	66.7
Education/training Skill development, etc.	-	-	100.0	-	-	100.0	-	-	100.0

5) Domestic roles in fishing household

The results are clearly shown that women work for the household daily task as for childcare, care for elderly and sick family members, cooking, cleaning, and Food security and nutrition (e.g. home gardening, livestock, and gleaning). While men work for heavy jobs as water collection, fuel collection or energy production, and building a house. Anyway, both men and women participated in community activities.

Table 7. Domestic roles in fishing household

Domestic Roles	Men	Women	Both
Childcare	-	95.0	5.0
Care for elderly and sick family members	-	100.0	-
Cooking	-	100.0	-
Cleaning	-	100.0	-
Water collection	100.0	-	-
Fuel collection or energy production	100.0	-	-
Food security and nutrition (<i>e.g.</i> home gardening, livestock, gleanings)	-	100.0	-
Community activities	-	-	100.0
Building a house	100.0	-	-

2.3.2 Fisheries at Angkaol village

1) Fishing gear at Angkaol village

There are 189 fishers at Angkaol villages from the list of community fisheries. Average Experiences on fishing of fisher in Angkaol for about 10 years. Fishing boat in the Angkaol 100 percent is an outboard engine from wood made by average length is 11 meters. There are two (2) kinds of fishing gear and these are crab trap (85%) and crab gillnet (15%). The fishing grounds are Pou Island, Rabbit Island and Ach Ses Island. Both types of fishing gear have been operated in the same fishing season, fishing hours, fishing day, fishing trip and fishing ground. Including both of them, it can provide the same amount of income to fishers.

Table 8. Fishing gear in Angkaol village

Type of fishing gear	No. of fishing gear	Fishing Season (month)	No. of fishing day per month	Fishing hours a day	No. of haul per fishing trip	Average Cost of Fishing (Riels)
Crab gill net (15%)	240-2,500 meters	All year round	15-25	8-10	1-2	111,222 (28 USD)
Crab Trap (85%)	250-2,000 Traps	All year round	10-27	6-14	1-2	110,049 (27.5 USD)

BSC is the main target species to catch in Angkaol village. It catches almost sell to the middlemen or direct sell in the local market. To sell Blue Swimming Crab to middle persons, there are two ways of transportation, first, fisher brings crabs by motorbike to middle persons' place (21.7%) and the middle persons come to pick up the crabs at the landing site (78.3%).

Table 9. Fisheries product and utilization at Angkaol village

Type of fish species	Utilization (%/trip)		Total Quantity (kg/trip)	Price (Riel/kg)	Total income (Riel/trip)
	Family consumption	Sale			
BSC	0-10 %	90-100%	Less than 10-50	18,000-25,00 (4.5-6.25 USD)	395,116 (98.78 USD)

Labor for fishing needed at least 1 person to 4 persons based on the size of the fishing boat and how far the fishing ground from shore and all of them are men. Most of the labors in Angkaol came from the village who are household's family, relatives, fisher fellow, and neighborhood.

Table 10. Number of labor and relationship with boat owner

Labor	Counts	Percentage (%)
Number of labors		
1 person	17	28.3
2 persons	35	58.3
3 persons	7	11.7
4 persons	1	1.7
Relation with labor (n=60)		
Household family	11	18.3
Relative	21	35.0
Fisher' fellow	27	45.0
Neighborhood	1	1.7

2) Roles of women and men in fisheries

Productive Roles related to fisheries were completely divided that men fishing at sea, fishing gear preparing, and post-harvest production, while women work for marketing/selling.

Table 11. Productive roles of women and men in fisheries

Productive Roles	Men	Women	Both
Fishing (subsistence/HH level) - Capture fisheries (caught fish, prawns, crabs, or shellfish)	100.0	-	-
Preparing fishing gear	100.0	-	-
Post-harvest production	100.0	-	-
Marketing/Selling	-	100.0	-

3) Problems in fishing

There is 75 percent of fishers mentioned the problem related to their fishing, the main problem with weather condition that caused them difficult to go fishing with difficult to manage. Another problem that they mentioned which can be managed is fishing gear lost or destroyed by a trawler, the fishing gear was stolen, and a small amount of catch while 25 percent of fishers are feeling that there is no problem related to their fishing.

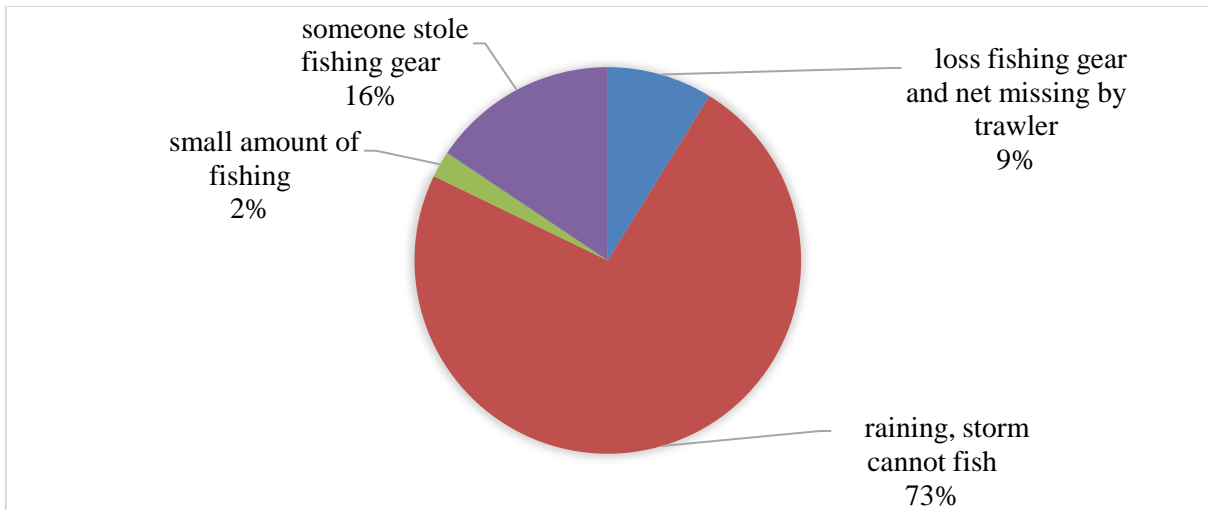


Figure 2. Graph of problems in fisheries at Angkaol village

4) Suggestion for fisheries management

The suggestion on fisheries management came from 75 percent of respondents are eliminating illegal fishing gear, eliminating long trap fishing gear, patrolling at night, saving habitat areas, setting protection zone for BSC, reconducting crab bank, and zoning for small and large scale (e.g. Zoning for a trap, gill net, and trawler).

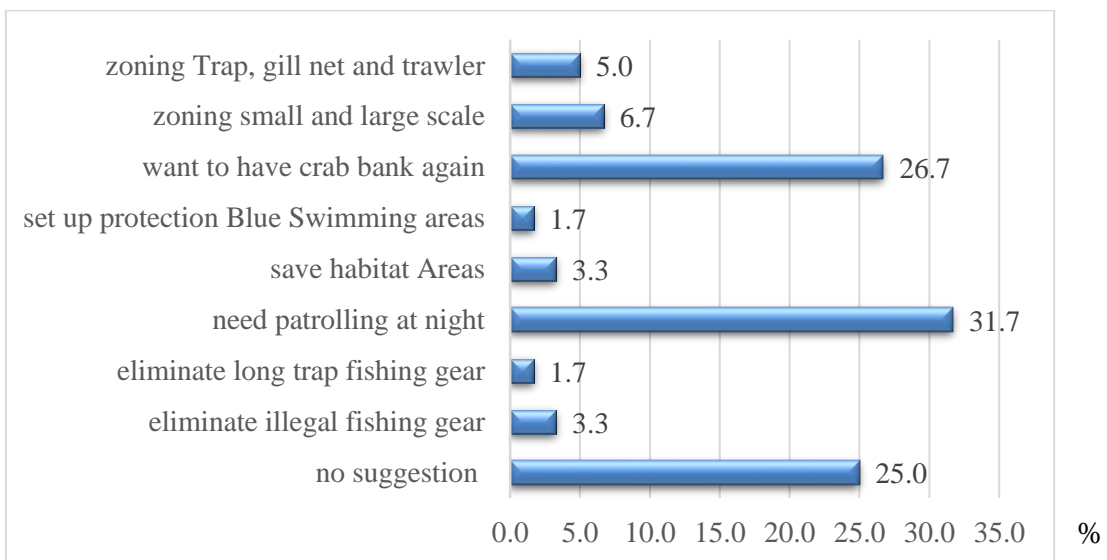


Figure 3. Graph of suggestion activities to manage fisheries at Angkaol village

2.3.3 Social Capital and human network in Angkaol village

1) Human network

Only one (1) group was established at Angkaol village. The Communities Fisheries (CFi) which is common in Cambodia followed the law for all fishing communities. Anyway, only 10 percent of respondents are members of CFi while 90 percent of them are not a member of the group. All the fishers should be a member of CFi. The participation of CFi found that all the group members participated in the meeting at least 2 to 5 times per year.

Table 12. Participation in group

Item	Counts	Percentage
Member of any organization in the community (n=60)		
Communities Fisheries (CFi)	6	10.0
Not member of any Group	54	90.0
Participation in Group meeting		
3 times/year	2	33.3
4 times/year	2	33.3
5 times/year	2	33.3

2) Social relationship

The need for help each other are very important in social, at Angkaol mostly people still rely on relative this is shown the local relationship that people will ask help from relative first in case of any helping need are borrowing money, recovery from the natural disaster, and chores such as babysitting and laundry.

Table 13. Asking help in specific cases

Cases	Counts	Percentage
You need help to pay for a medical operation of a family member.		
Relative	36	60.0
Neighbor	9	15.0
Fisher friend	6	10.0
Middlemen	9	15.0
Recovery from the natural disaster		
Relative	42	70.0
Neighbor	8	13.3
Fisher friend	7	11.7
Middlemen	3	5.0
Chores such as babysitting and laundry		
Relative	60	100.0

3) Human well-being

More than half of respondents feeling uneasiness or anxiety in their present life which causes on unable or shortage of income, the hopelessness of the present job, insufficient of children’s education, and health condition of the family.

Table 14. Feeling uneasiness or anxiety on fisher’s present life

Feeling any uneasiness or anxiety in your present life	Counts	Percentage
Yes	37	61.7
No	23	38.3
Causes of uneasiness and anxiety		
Unable or shortage of income	28	75.6
Hopelessness of present job	1	2.7
Insufficient of children’s education	6	16.2
Health condition of the family	2	5.4

Haft of them feeling neither happy nor unhappy in the present life while almost half feeling happy only one of the respondents is unhappy.

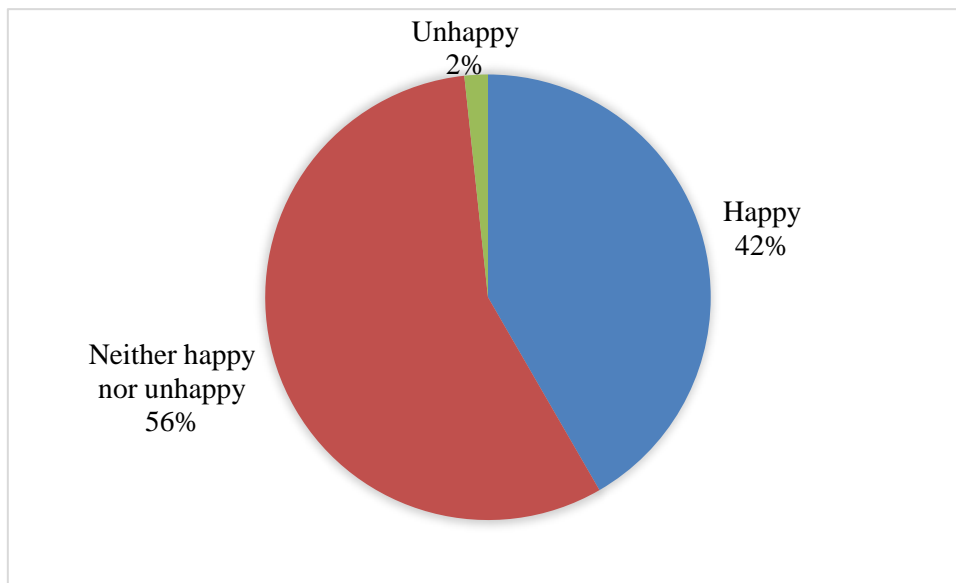


Figure 4. Graph of the feeling of happiness of fisher at Angkaol village

4) The perspective of a fisher on natural resources and livelihood

The idea about rich natural resources are very important for maintaining your job absolutely of them feel that rich natural resources are most important by their own point of view is protecting the environment should be given priority, even if it causes slower economic growth and loss of jobs.

Table 15. Natural resources and job maintaining opinion

Perspectives	No.	Percentage
Yes	60	100.0
Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs.	60	100.0

2.3.4 Blue Swimming Crab marketing in Kep Province

The Blue Swimming Crab market at Kep Province were caught from 1 to 100 kg in low season while high season tis product is about 1 to 250 kg. Buyers will buy crabs from fishers at the following prices:

- 7-8 crabs/kg price 40,000-50,000 Riels
- 10-15 crabs/kg price 25,000-40,000 Riels
- 15-17 crabs/kg price 15,000-25,000 Riels
- Other crabs small size 20-30 kg (30-40 crabs/kg) price 6,000-7,000 Riels

Catch of crabs are not different among the high season (rainy season between May to June and October to December) and the low season (dry season, between January to April and July to September), it confirmed that The BSC fishing can operate whole year-round.

Table 16. Buying system

Item	High season	Low Season
Quantity (kg/day) (n=15)		
1-50	33.3	66.7
51-100	33.3	33.3
101-150	20.0	
151-200	6.7	
201-250	6.7	
Buying place (n=14)		
Local Market	71.4	71.4
Landing site	21.4	21.4
Fisher house	7.2	7.2
Business category of the seller (n=14)		
Fishers	78.6	78.6
Middleman	7.1	7.1
Fishers and Middleman	14.3	14.3
How to sell Crab? (n=15)		
Live	100.0	100.0

BSC will directly sell to the retail sellers, guests, villagers, tourists as the main customer. The wholesale market is the second big market for BSC. Another market is processing and restaurant.

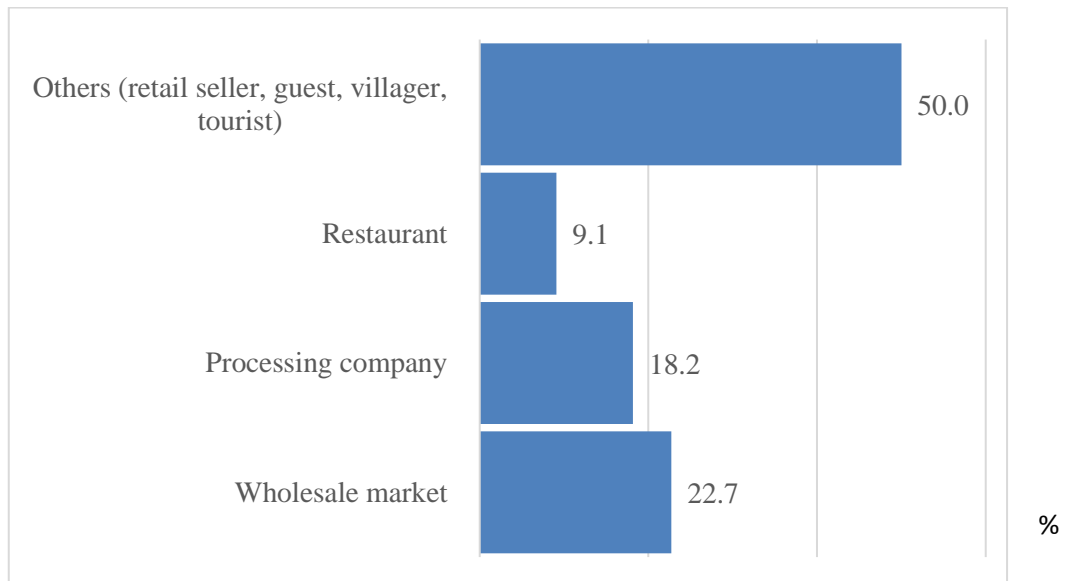


Figure 5. Graph of Blue Swimming Crab market at Kep Province

There are seven (7) places that the BSC in Kep Province were distributed, namely: Lok and VN, Kampong Trach and Lok market, Lok, Drek Tanam Vill, Phnom Penh, Ou Krasar market, along the beach in Kep Province, and Kep market which is the main market of Seafood from Kep fishing.

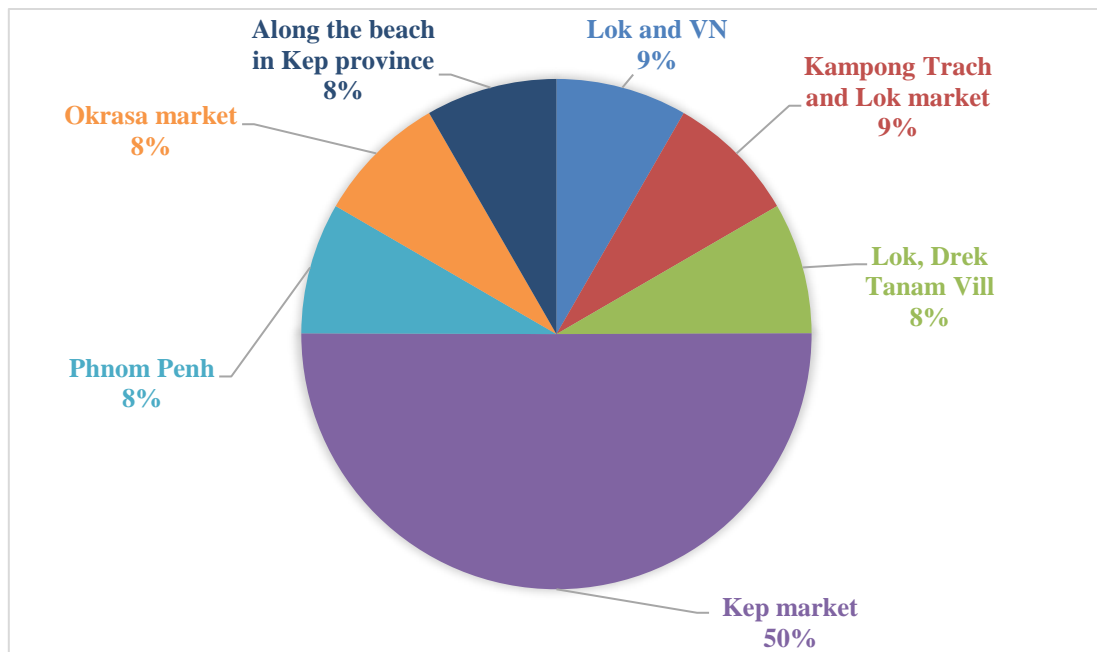


Figure 6. Graph of place to sell Blue Swimming Crab from Kep Province

2.4 Conclusions

The purpose of this case study is to show the actual situation of a coastal community in Angkaol village to be baseline information of the Study on Enhancement of Sustainable Management of the Blue Swimming Crab Fisheries in Kep Province, Cambodia.

The demographic result showed that fishers in Angkaol village have fishing as their main job and agriculture for supplementary occupation. Angkaol village is a Buddhist community and the main occupation is fishing. Moreover, fishermen in Angkaol village have fundamental facilities for their living *e.g.* television, washing machine, refrigerator, fan mobile phone, and motorbike. This information shows that fishermen have basic facilities to use and entertain themselves and their families. This case study, the indicator that tells how good the standard of living of human well-being was based on their source of income and the different facilities they have in their households.

The gender roles are found that there is a separate task between husband and wife that women focus on household chores while men work for fishing activities.

BSC is the main product of Kep Province, especially in Angkaol. All fishermen use the Crab trap and Gill net for fishing. A natural phenomenon is an obstacle and problem of fishing in Angkaol. The decrease in fisheries production is not a problem here.

The BSC market at Kep Province mainly sells to the direct customer especially tourists at Kep Market which is the biggest seafood market at Kep Province. Crabs from Angkaol too were sent to the Kep market by middle persons.

The results from the study emphasize that the BSC is important for the livelihood of villagers at Kep Province then it needs to remain stock for long sustainable utilization overthought fisher perception is not a problem on its product.

3. Catch statistics survey and stock assessment

3.1 Catch statistics survey

3.1.1 Objective

To understand the current status of utilization and trend of BSC resources in Kep Province, catch statistics of BSC were collected during the project.

3.1.2 Method

1) Target Landing Sites for Collecting Catch Data

The landing sites of BSC

- Site No.1: Crab market (Thmei village)
- Site No.2: Ou Krasa village
- Site No.3: Angkaol village

2) Type of catch data and method for collecting data

- Frequency of survey: 1 time/week at 3 sites, 4 times/month (3 sites × 4 times × 12 months = 144 times/year)
- Data collection method:
 - Interview to fishers and traders
 - The measure of total weight, sampling weight by boat, individual weight, a carapace width and carapace length of sampling crab.
- Item of catch data
 - a: Number of fishing boat landed (number of landing) per day and week
 - Information from fishers or crab traders at each landing site (Interview to fishers and traders)
 - b: Amount of catching average/one boat during the week
 - Information from fishers and traders in landing site (Interview to each fisher and traders)
 - c: Amount of catch and number by boat
 - Random sampling with a 10% sampling rate (2-5kg) by crab landed by fishes (before the sorting by size)
 - To measure the total number of crabs caught (out of sorting)
 - d: Weight, carapace width and carapace length by sex.
 - Sampling from survey c:
 - To collect the sample at least ten (10) pieces by boat to measure the weight and carapace width, and carapace length of a crab by male and female
- Estimation/calculation method:
 - a: The total amount of catch per week:
(Average of amount caught a fishing vessel/week) x (Number of landing times boat)
 - b: An average number of crabs per 1 kg:
(Total number of crabs caught a fishing vessel per landing)/(Total catch weight a fishing vessel a landing)
 - c: Analysis of the relationship between the weight, a carapace width and a carapace length of BSC, and resource stock condition:

【Form 3】

Sampling of Weight and Length of Carapace

Site:

Date/ month/ Year.....

Number of sample	Sex (M/F/Gravid crab)	Weight (g.)	shell width (cm) (1 decimal)	length of carapace (cm) (1 decimal)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Report by.....

3.1.3 Results

1) BSC catches status at the three (3) landing sites in Kep Province

The data collection period was from July 2018 to December 2019, and there were three target landing sites for data collection: Angkaol, Thmei, Ou Krasar.

The average landing quantity a landing/a fishing vessel was Angkaol: 9.3kg, Thmei: 60.9kg, and Ou Krasar: 16 kg. Thmei, which has a crab market, the center of crab landing, has the highest volume in three landing sites.

The average number of crabs caught per kg was Angkaol: 11.4, Thmei: 13.0, and Ou Krasar: 11.2, and Thmei has a large percentage of small crabs caught. The number of crabs caught per kg did not exceed the regulated number of "20 crabs per kg" at any landing site.

The percentage of male and female crabs caught was 50% range for males and 40% range for females, with a higher percentage of males than females at all landing sites.

Table 17. Number of data collected from the catch statistics survey

Survey items	Angkaol	Thmei	Ou krasar
Period of data collection	July 2018 - December 2019	July 2018 - December 2019	July 2018 - December 2019
Number of data			
Format 1(Data of "Amount of catch at landing site")	284	274	241
Format 2(Data of "Number of crabs caught per kg")	654	276	563
Format 3(Data of "Sampling of weight and carapace length")	412	375	317
Average catch per a landing /a fishing vessel (kg)	9.3	60.9	16.0
Average number of crabs caught per kg	11.4	13.0	11.2
Average number of male / female crab caught per kg			
Male (%)	55.6	51.7	57.4
Female (%)	44.4	48.3	42.6

2) The changes of BSC catches

➤ Landing quantity per landing/fishing vessel

vessel

The landing quantity per fishing vessel was compared at three landing sites: Angkaol, Thmei, and Ou Krasar.

Fishing vessels cannot land crabs in stormy weather, so changes in weather affect landed quantity.

Of the three landing sites, Thmei has the largest crab market in the Kep region, so the BSC has the highest landing quantity. Thmei has the largest number of fishing vessels in the three landing sites because fishing vessels from other areas land at Thmei, with a large number of traders.

At Angkaol and Ou Krasar, only local fishing vessels land with a few crab traders.

At Angkaol, landings per vessel fluctuated strongly throughout the year. In particular, the landing quantity from April to August 2019 was the lowest.

At Thmei, landings per fishing vessel fluctuated in the range of 30-50 kg. The landing quantity per fishing vessel was the largest in the three sites. The landed quantity per fishing vessel in 2019 tended to increase compared to 2018.

At Ou Krasar, the landing quantity per fishing vessel was relatively stable throughout the year, with low levels in June 2019, but changed in the 15-20 kg range in other months.

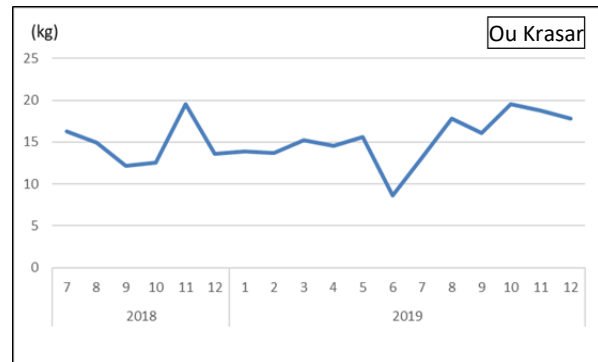
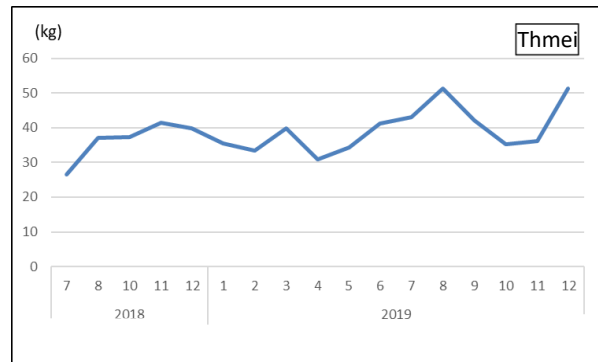
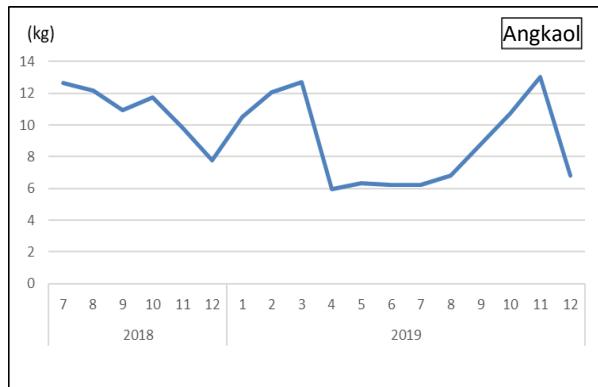


Figure 7. Landed quantity a landing/fishing vessel in three landing sites

➤ **Number of crabs caught per kg**

The number of crabs caught per kg did not change largely throughout the year, varying ranged from 7 to 14 crabs caught per kg and never exceeding the regulated number of 20 crabs at any landing site.

At Angkaol, the number of crabs caught per kg ranged from 8 to 14 crabs, and did not fluctuate significantly from 11 to 12 crabs between June and December 2019.

At Thmei, the number of crabs caught per kg varied ranged from 10 to 14 crabs throughout the year and was stable ranged from 12 to 14 crabs between October 2018 and December 2019.

Small-sized crabs were the most landed at Thmei of the three landing sites.

At Ou Krasar, relatively large crabs were caught ranged from 7 to 8 crabs per kg in September, October, December 2018 and January 2019,

From March to December 2019, it fluctuated ranged 12 to 14 crabs per kg.

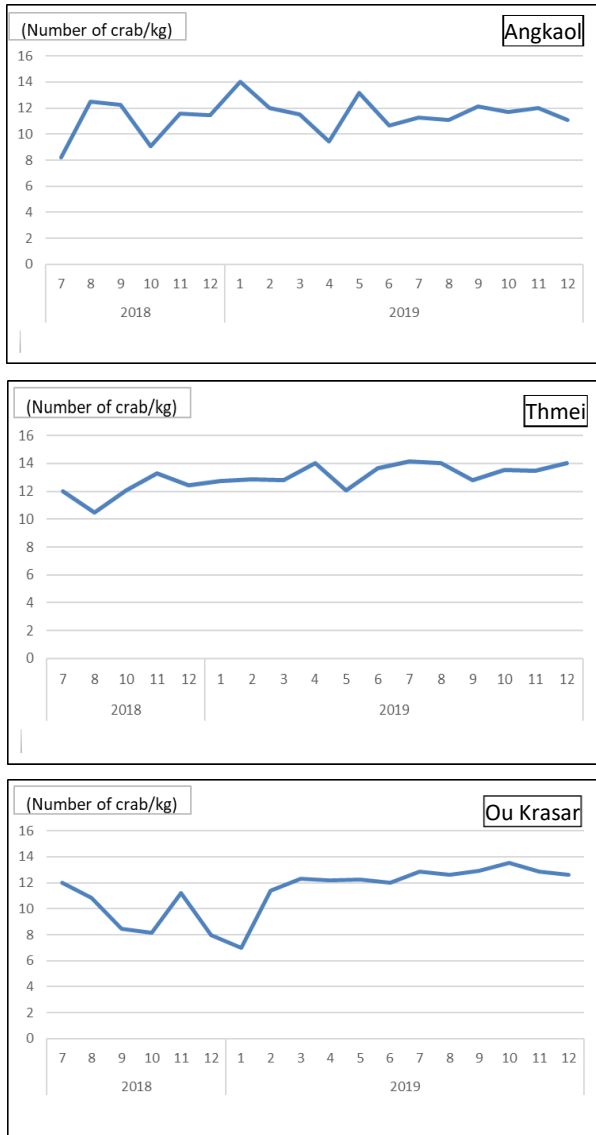


Figure 8. Number of crabs caught per kg in three landing sites

3.2 Stock Assessment

Biological study and stock assessment of blue swimming crab (*Portunus pelagicus*) from Kep Province, Cambodia using yield per recruit and spawning per recruit analysis

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3.2.1 Introduction

Blue swimming crab (*Portunus pelagicus*) is one of the important commercial crab species in the Southeast Asian region which consumed in several countries. Cambodia is one of the consumer countries for this crab species; they catch this crab species as daily household consumption and sell as income-generating. Since the species has considered being under threat of overfishing by small and medium scale fishery without proper monitoring systems, a stock assessment has been required. During the 2018-2019, the Southeast Asian Fisheries Development Center (SEAFDEC) and the Southeast Asian Fisheries Development Center, Training Department (SEAFDEC/TD) will provide technical assistance through the financial support under the ASEAN-SEAFDEC ASSP and FCG Mechanism. This program aimed to enhance the sustainable management of the blue swimming crab and ensure the livelihood of fishers who depend on these natural resources. This study aimed to

1. To determine the total number of blue swimming crabs landed in Kep Province by month
2. To determine the stock status of blue swimming crabs in Kep Province.

3.2.2 Materials and methods

Data are derived from the surveys from the three (3) study sites, namely: Thmei, Angkaol and Ou Krasar in Kep Province of Cambodia. All of the crabs were caught using a crab trap. The measurement data from 1104 specimens (587 males and 517 females) as carapace width (CW, cm.), weight (g.) and sex were analyzed. The sample sizes for each sex by area by month provided in **Table 18**.

Table 18. Number of crabs sampled by sex for each month

Area	Angkaol		Thmei		Ou Krasar	
	Male	Female	Male	Female	Male	Female
Jul-18	22	22	22	22	24	12
Aug-18	22	26	12	26	14	22
Sep-18	34	14	25	19	20	15
Oct-18	28	20	21	16	17	12
Nov-18			ND			
Dec-18			ND			
Jan-19	21	23	23	21	19	13
Feb-19	24	20	23	17	18	13
Mar-19	27	17	19	21	16	10
Apr-19	24	20	21	23	16	14
May-19			ND		21	10
Jun-19	22	26	15	29	17	14
Total	224	188	181	194	182	135

*ND: No data

The total landing was estimated assuming that the landing activities existed daily with 30 days/month. Total monthly biomass will be estimated incorporating with exploitation ratio (6). Since there were significantly different between sex observed from Ou Krasar (*p-value*: 0.004). Therefore, the total catch amount will be separated assumed equal fishing and natural mortality. Outliers were observed from raw data by direct observation. Regarding no clear relation trend of CW and weight from Ou Krasar, the data from Ou Krasar will not be involved for length–weight relationship analysis.

Length–weight relationship used to determine the growth pattern of blue swimming crab and data validation, the equation as provided in (1)

$$W = qCW^b \dots\dots\dots(1)$$

where *W* is weight of individual crab (g.), *CW* is carapace width (cm.), *q* and *b* are constant.

For statistical test of sex ratio, χ^2 was provided in equation (2)

$$\chi^2 = \sum_{i=1}^2 \frac{(O_i - E_i)^2}{E_i} \dots\dots\dots(2)$$

where χ^2 is χ^2 statistics, O_i is observed number of crab each sex ($i=1,2$) and E_i is expected number of crab in each sex i.e. $E_1 = E_2 = \frac{O_1 + O_2}{2}$.

Growth parameters were collected from Nilrat *et al.* (2018). Von Bertalanffy's growth equation used in this study was shown in (3)

$$CW_t = CW_\infty (1 - e^{-K(t-t_0)}) \dots\dots\dots (3)$$

where t is the age of crab (year), CW_t is carapace length (cm) at age t , CW_∞ (cm), K (year^{-1}), and t_0 were growth curve parameters.

Total mortality was estimated by using Jones and van Zalinge's equation as follows in (4)

$$\ln C(CW, CW_\infty) = a + \frac{Z}{K} \ln(CW_\infty - CW) \dots\dots\dots (4)$$

where $C(CW, CW_\infty)$ is cumulative of catch in number from each length class, Z is total mortality rate (year^{-1}), and a is constant. The total mortality was estimated from liner regression between $\ln C(CW, CW_\infty)$ and $\ln(CW_\infty - CW)$, assuming the growth curve parameter K was given.

Natural mortality was estimated by using Pauly' natural mortality estimation (Pauly, 2007) as (5)

$$\ln M = -0.0066 - 0.279 \ln CW_\infty + 0.6543 \ln K + 0.4634 \ln T \dots\dots\dots (5)$$

where T is average habitat temperature ($^{\circ}\text{C}$). In this study, the average habitat temperature was determined as 29°C (Kusuma *et al.*, 2017).

Fishing mortality was estimated as (6)

$$F = Z - M \dots\dots\dots (6)$$

where F is fishing mortality (year^{-1}).

Rate of exploitation was estimated as shown in (7)

$$C/N = F/Z (1 - e^{-Z}) \dots\dots\dots (7)$$

where C is catch in number and N is number of species in sea

Therefore, the total catch also can be estimated assumed constant mortality by using (7) as well

Total biomass can be estimated by multiplying (8) with average weight of crab as shown in (8)

$$TB = \bar{W} \times N \dots\dots\dots (8)$$

where TB is total biomass (kg), \bar{W} is average weight of catch (kg) and N is total crab in number from (7)

Yield per recruit analysis was conducted by using equation (9)

$$\frac{Y}{R} = FW_\infty e^{-M(t_c-t_r)} \times \sum_{n=0}^3 \frac{A_n e^{-nK(t_c-t_0)}}{F+M+nK} \left\{ 1 - e^{-(F+M+nK)(t_\lambda - t_c)} \right\} \dots\dots\dots (9)$$

$$\begin{cases} n & = & 0, & 1, & 2, & 3 \\ A_n & = & 1, & -3, & 3, & -1 \end{cases}$$

where W_{∞} is average maximum weight (g.), t_c is age at first captured (year), t_r is age at first recruitment (year), and t_{λ} is longevity of crab (year).

Spawning per recruit analysis was conducted by using equation (10) and (11)

If $t_c \leq t_m$,

$$SPR = w_{\infty} e^{-M(t_c-t_r)-(F+M)(t_m-t_c)} \sum_{n=0}^3 A_n e^{-nK(t_m-t_0)} \left\{ \frac{1-e^{-(F+M+nK)((t_{\lambda}-t_m)}}}{F+M+nK} \right\} \dots\dots\dots (10)$$

If $t_c > t_m$

$$SPR = w_{\infty} e^{-M(t_m-t_r)} \sum_{n=0}^3 A_n e^{-nK(t_m-t_0)} \left\{ \frac{1-e^{-(M+nK)((t_c-t_m)}}}{M+nK} \right\} + w_{\infty} e^{-M(t_c-t_r)} \sum_{n=0}^3 A_n e^{-nK(t_c-t_0)} \left\{ \frac{1-e^{-(F+M+nK)((t_{\lambda}-t_m)}}}{F+M+nK} \right\} \dots\dots\dots (11)$$

$$\begin{cases} n = 0, 1, 2, 3 \\ A_n = 1, -3, 3, -1 \end{cases}$$

3.2.3 Results and discussions

Length – weight relationship was analyzed using the relationship between carapace width (cm, CW) and total wet weight (g). Without sex separation, the CW and weight from 768 specimens were analyzed. The result provided the power equation as shown in equation (1).

$$W = 0.1818CW^{2.5683}$$

where W is the weight of individual crab (g) and CW is carapace width (cm).

Total landing estimation provides that approximately 151 tons of blue swimming crab were landed in Kep Province. Total landing provided that Thmei occupied the highest catch (46.25 tons) followed by Ou Krasar (34.57 ton) and Angkaol (24.25 ton) as provided in **Table 19**. The maximum landing was estimated from the crab market in February 2019, total landing estimated as 7.75 tons while the minimum landing was observed in November 2018 from Angkaol as 1.52 tons. The result provided in **Tables 20**.

Table 19. Total landing of Blue Swimming Crab in Kep Province

Area	Total Landing (ton)	%
Angkaol	24.25	23
Thmei	46.25	44
Ou Krasar	34.57	33

Table 20. Monthly total landing of Blue Swimming Crab in Kep Province in tons

Month/Area	Angkaol	Thmei	Ou Krasar
Jul-18	2.92	7.57	2.83
Aug-18	2.38	5.62	3.77
Sep-18	3.75	ND	4.25
Oct-18	1.97	5.67	3.54
Nov-18		ND	
Dec-18		ND	
Jan-19	2.23	2.65	4.40
Feb-19	2.59	7.75	3.52
Mar-19	2.75	6.97	3.48
Apr-19	2.59	3.88	3.17
May-19		ND	3.76
Jun-19	1.54	6.14	1.84

*ND: No data

The sex ratio was tested by using chi-square statistics. The analysis was conducted by using all specimens for males and females from every month pooled by the total landing. Results provide that sex ratio between male and female blue swimming crab for Kep Province was 1:0.78 and has a significant difference to the equal sex ratio 1:1 ($p < 0.01$, χ^2 test).

Mortalities estimation were conducted by using Jones – van Zalinge method for total mortality (Z), Pauly method for natural mortality (M) at assumed water temperature at 29°C (Kusuma *et al.*, 2017) and fishing mortality (F) from relation $F = Z - M$. The catch selectivity was estimated from the probability of captured calculated from the length frequency and the growth curve. Also, the age at first capture was estimated from Size at 50% capture and growth curve. The results were provided in **Table 21**.

Table 21. Growth, mortality, and selectivity estimation for Blue Swimming Crab in Kep Province

Parameters	Value
Average maximum size (CW_{∞} , cm)	18.99
Growth rate (K , /year)	1.30
Total mortality (Z , /year)	4.44
Natural mortality (M , /year)	2.50
Fishing mortality (F , /year)	1.94
Exploitation ratio	0.43
Size at 50% capture (CW_C , cm)	7.88
Size at 25% capture ($CW_{25\%}$, cm)	7.19
Size at 75% capture ($CW_{75\%}$, cm)	8.57
Age at first capture (t_c)	0.37
Size at first maturity (CW_M , cm)	8.00 – 9.84

* *Size at first maturity using the reference from Nilrat et al. (2018)*

Estimated total blue swimming crab in number and total biomass in fishing ground provided in **Tables 22 and 23**. Result show However, the result was provided by area (Angkaol, Thmei and Ou Krasar, respectively) considering unclear fishing ground.

Table 22. Total Blue Swimming Crab in Kep Province in number

Sex/Area	Angkaol	Thmei	Ou Krasar
Male	83,190	80,543	92,438
Female	43,823	86,324	68,572
Total	127,013	166,867	161,010

Table 23. Total biomass of Blue Swimming Crab in Kep Province in tons

Sex/Area	Angkaol	Thmei	Ou Krasar
Male	5.85	5.67	6.50
Female	3.15	6.21	4.93
Total	9.00	11.88	11.44

**At average body weight of male and female were 71.20 and 72.74 g, respectively*

Yield per recruit (YPR) was used to assess the current fishing status for blue swimming crab, comparing to the biological reference points for avoiding growth overfishing such as $F_{0.1}$ to the current fishing mortality. The YPR result as shown in **Figure 9**.

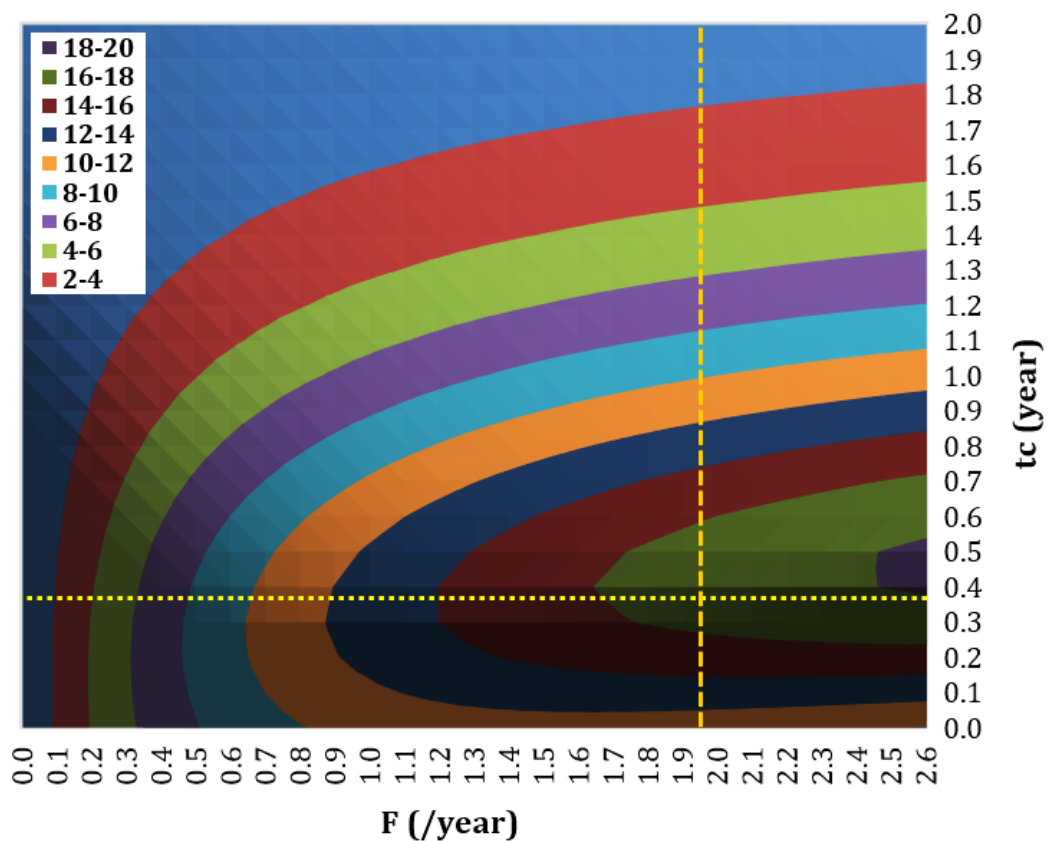


Figure 9. YPR result for Blue Swimming Crab in Kep Province. The purple area ion the right shows the highest YPR and blue area ion the left show the lowest YPR. Orange dash indicate current F (1.94 /year) and yellow dot indicate current age at first capture $t_c = 0.37$ year

Spawning per recruit (SPR) was also calculated for provided the limit of recruitment overfishing. F at SPR 30% ($F_{30\%}$) were used for the reference point (Mace, 1994). **Figure 10** and **Table 24** shows the result of YPR and SPR at the current t_c (0.37 year).

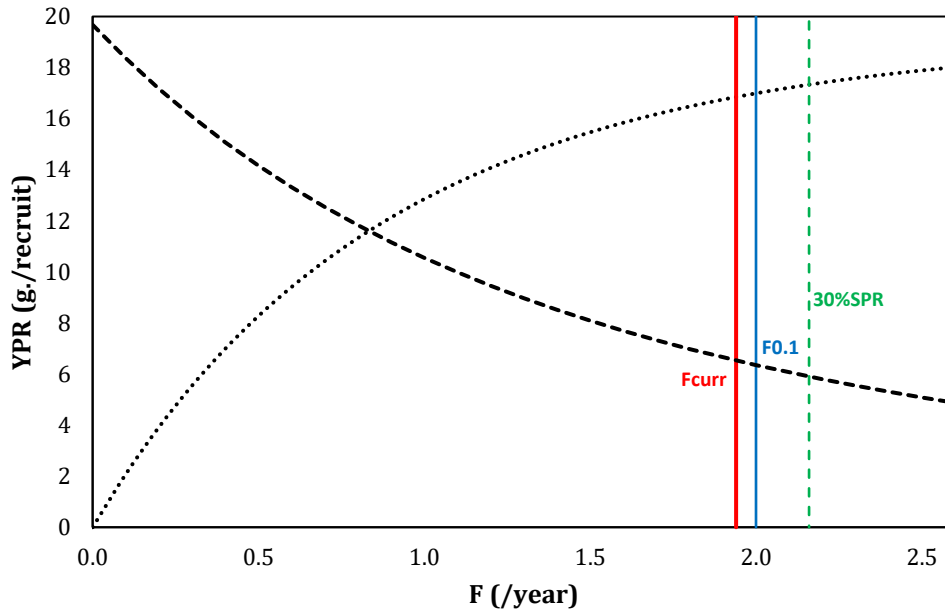


Figure 10. Comparison of results from YPR (thin dash black line) and SPR (thick dash black dash) with current fishing situation (red line), $F_{0.1}$ (blue line) and 30% SPR (green dash), respectively.

Table 24. Summary table for reference points from YPR and SPR

Parameters	Results	% different from F_{current}
F_{current} (/year)	1.94	
$F_{0.1}$ (/year)	2.00	+3.09
$F_{30\%}$ (/year)	2.16	+11.34

In conclusion, the result showed that the current fishery of blue swimming crab in Kep Province can be sustainable and fully utilizing the productivity. However, the current fishing mortality is close to the biological reference points which shows the thresholds for growth and recruit overfishing ($F_{0.1}$ and $F_{30\%}$, respectively), it is very important to avoid increasing the fishing effort anymore. If market demand biases to larger crab, fishing effort reduction, and enlargement of size at first capture should be considered.

For further study, monitoring of the stock status should be continued for observing the size composition and stock status of the stock. Moreover, economical measurements such as size dependence of the price can reveal the optimum economical fishing mortality, which also can help the implementation of the fisheries management with precautionary consideration.

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4. Propagation of blue swimming crab resources using hatchery system

Crab banks have been developed as a strategy to enhance crab stocks and to ensure the sustainable use of crab resources by allowing gravid female crabs to spawn before or instead of being sold, to improve local livelihoods and livelihood security. Simultaneously, the crab bank projects also focus on strengthening community-based management institutions (Jöhl, 2013).

A crab bank system is a form of community-based fisheries resource management. The origin of the term “crab bank” is not clear, but can be found in the documents produced by SEAFDEC and later utilized by other Non-governmental Organizations (NGOs) and the FiA in Cambodia. Originally, “crab bank” referred to the stock enhancement and not to micro-finance aspects. The primary aim of this approach is to manage crab resources sustainably and to increase stocks by allowing gravid females caught by fishers to release their zoea before being marketed. (Sopanha *et al.*, 2012)

According to SEAFDEC, the concept was originally introduced by the Bay of Bengal Program to Phang-Nga Province, Thailand, in the second half of the 1980s. In 2002, SEAFDEC, the Department of Fisheries (DOF) Thailand and a local NGO revitalized the crab bank approach in Chumphon Province. The approach used in Thailand was similar to the one developed by a Fisheries Cooperative Association (FCA) in Hyogo Prefecture, Japan, also in 1980.

In the Japanese model, gravid female crabs are purchased by the cooperative and the carapace is marked before being released back into the sea. Later, if a fisher catches a marked female crab, she will be released back into the sea. After spawning several times, the female crab molts and becomes a marketable product. This system is based on the cooperative’s funds and trust among the crab fishers. It is also aligned with regulations on legal minimum crab size which state that crabs smaller than a certain carapace length have to be released (Sopanha *et al.*, 2012).

Sopanha *et al.* (2012) identified the crab bank model into four (4) basic model approaches like the following;

1. Japanese model: the cooperative purchases the gravid female crabs from the fishers, marks them on their carapace and releases them back to the sea. When fishers catch marked crabs, they return them to the sea. Female crabs generally molting after spawning several times, making the marks disappear. Crabs with less than 12 cm carapace length and with soft-shells should not be harvested and should be returned to the sea once caught. The major advantage of this scheme lies in the high survival rate of gravid crabs and zoea (Suanrattanachai *et al.*, 2009).
2. Donation of gravid crabs to a crab bank; the fishers donate the gravid female crabs to a ‘crab bank’, managed by a committee or members of the community fisheries. The gravid crabs are kept in rearing cages until they spawn, after which the zoeae are released to the sea. The female crabs can then be sold, and the income of the sale is generally used for the maintenance and operation of the crab bank as the Chumphon Province Model, Thailand (Jöhl, A., 2013).
3. Purchase of gravid crabs by the crab bank; the crab bank purchases the gravid female crabs from the fishers instead of relying on voluntary donations. Like in the donation model, the gravid crabs are then kept in crab bank cages until they spawn like the crab

bank in Prey Nop II (2008), Preah Sihanouk Province and Kampong Samaki (2008), Kampot Province, Cambodia (Sopanha *et al.*, 2012)

4. Loan model; Angela Jöhl (2013) found evidence of five (5) crab banks based on the loan model, all implemented by CORIN in Kep, Kampot, and Koh Kong provinces, Cambodia. The loan model can notably be found in Phum Thmei, Kep Province, where “CORIN applied a model based on access to loans as an incentive to get fishers involved in the development of crab banks in 2009 (CORIN-Asia, 2009).

4.1 Objective

To enhance the natural stock of blue swimming crab and ensure the sustainability of the blue swimming crab resources for livelihoods of fishers who depending on blue swimming crab fishery in community fisheries.

4.2 Methods

The crab bank is the main activity of this project to enhance the blue swimming crabs in the Angkaol village to secure the crab fisheries livelihood. The idea of a crab bank is such that the gravid female crab could be kept in cages or hatching tanks for a few days until they spawn. After releasing the eggs, they are fattened and sold to the market.

For the present crab bank activities in Angkaol CFi (2018), SEAFDEC strongly suggested and recommended for the voluntary donation of the gravid female crabs to a crab bank instead purchase of gravid crabs and loan model approach by following the guidelines for the blue swimming crab fisheries resource enhancement on how to implement the crab bank project activity as the following procedures;

1. Select a suitable site for crab bank project implementation. The fishers suggested that the project should be operated at the village level and located close to the suitable fisheries habitat for nursing the blue swimming crab at the earlier stages such as the seagrass beds area in the Angkaol CFi Conservation zone.
2. Explain the rationale and objectives of the project. SEAFDEC recommended that Kep FiAC should be the main organization to assess the BSC stock enhancement project and transfer necessary information to the fishers.
3. Establish fisher groups for the implementation of all activities of the project. The head of the established groups should be the head of the village or any of the fishers elected by the members of groups. The consultant or adviser of the group should be from the Kep FiAC fisheries officers.
4. Arrange workshop and training about gravid female BSC hatching and releasing of crab larvae and clarify the methods to the members of the group.
5. Set up a meeting for the working procedure and assign working groups, the Project Working Committee (PWC) established.
6. Suggested for the operation of BSC crab bank. The equipment or financial support of the project should come from Kep FiAC and BSC trader in the community. Kep FiAC is the main responsible organization which should directly deliver manageable and sustainable strategies for Kep fishery and coastal resources.
 - a. Set up the hatching equipment such as plastic containers, aerators, and tubes. It was suggested that the equipment should be placed near the fish landing site

- because the fishers usually go to the places immediately after finishing their fishing trip.
- b. Collection of gravid female BSC by willing and voluntary fishers.
 - c. Hatching the BSC.
7. Releasing the crab larvae to suitable habitat in the Angkaol CFI Conservation Area. The local fishers should bring and release the crab larvae during their fishing trip.
 8. Management of the female BSC after hatching. It is agreed to selling the BSC females to the market for covering the expenditure for crab bank activities concerned.

4.3 Results

A very long discussion has been taken since 2017 to identify the efficiency and effective system model approach for Angkaol CFI, came up with the agreed-on the crab bank hatchery house system might be the most appropriate approach for this area. In November 2018, the hatchery system was agreed from all project working committees to use as a hatchery's tank system with the stock cage supporting system. The idea is that the members will voluntarily donate the gravid female crabs in the crab bank until the eggs were hatched then free released of the zoea crab stage into the seagrass beds area at the Angkaol CFI conservation zone, therefore, the hatchery house was built and constructed around seagrass beds area which was located close to the landing site at the approximately 1 m depth while observed at the low-tide period. Ten (10) hatcheries tanks were set-up with the aeration supplying; the solar cell panel system has been introduced for the electric power source supply. The setting of the hatchery house was done through the participatory approaches from the project working committee and local fishers at the Angkaol village. The further step for the hatchery system is the collection of gravid female crabs which need to be identified for the sustainable approach.



Figure 11. *Previous crab bank location (crab bank cage system)*



Figure 12. Present crab bank location at Angkaol CFi (Combination crab hatching tanks and cage system) (November 2018)



Figure 13. Solar cell supporting for the crab bank hatchery system (for crab hatching tanks) (November 2018)

In February 2019, SEAFDEC would like to restart the crab bank activity through the participatory and voluntary basis to sustain activities at Angkaol village. Hence, the discussion among Project Working Committee (PWC) and the former crab bank group was conducted to reform the crab bank group. There are 20 participants from the local people at Angkaol village, besides the former members of the crab bank group also there are some of the new interesting persons participated in this meeting.

The results of the meeting came up with all of the people who participated the meeting are willing to provide gravid crab one (1) or two (2) crabs per month to Mr. Meas Va who is the former leader of the crab bank group and he was a volunteer to take care of the crab bank during the initial stage. Moreover, the meeting has gained the idea to show transparency system in crab bank management with the recording on who donated the crabs and how many of the crabs should be conducted for the purpose to let everyone check all the time. After the crabs released its eggs, the money from the selling crabs should be a clear transaction to show how much money the group earned and how much money was spent for the crab bank management. Moreover, before the crab bank activities restarted, the group suggested engaging the trader to participate in the crab bank activities via the gravid female crabs' donation too.

The crab bank group have their previous regulation form, therefore, the discussion to revise the regulation for more suitable have been conducted. In the previous regulation, there have none of the regulations on how to manage the money from the selling crabs, to show the transparency transaction system of crab bank management; this issue has been raised to be discussed.

Then, the crab bank activity in Angkaol CFi now is under the Enhancement of Sustainable Management of the Blue Swimming Crab Fisheries in Kep Province, Cambodia which have fishers who are willing and voluntarily to provide gravid female crabs at least one (1) or two (2) crabs per month to the crab bank. Besides, the crab bank as hatchery system could not be initiated after setting all equipment since November 2018, because of the battery backup system malfunctioned.



Figure14. Meeting for encouraging participation and voluntary to engage in the crab bank activities at Angkaol village (February 2019)



Figure 15. Meeting agreed on the participation and voluntary to engage in the crab bank activities at Angkaol village (February 2019)

The battery for the crab bank hatchery was not well-performing; therefore, the crab bank activity by the hatchery system could not be started. By the way, a crab cage system is still active and function which could be used instead, but from the observation by fishers found that some of the gravid crabs in the cage were dead.

In February 2019, PWC has checked for the solar cell system which used to support the electric power driven to the crab bank hatchery activities, such as air pump, water pump and light source. We found some problems with the battery capacity not enough to supply for a long time running through, only half-day duration supported for aeration supplying via air pump only. With these phenomena led the hatching crab larvae could not survive for the first trial. Then the working team tried to contact the solar cell system set-up shop for requesting the technician staff to check it. The result found and concluded that the battery was in bad and poor working conditions; it needed to bring back to the company for checking or replacing with the new one.



Figure 16. *Checking for solar cell and battery system (Left) and battery transfer (Right) (February 2019)*



Figure 17. *Running test for the crab bank hatchery system (1) (February 2019)*



Figure 18. *Running test for the crab bank hatchery system (2) (February 2019)*

In June 2019, the meeting among the Project Working Committee (PWC) and the local fishers were conducted to follow-up on the constraints and opportunities to continue the crab bank activities. At the Angkaol village, the combination methods were conducted for the crab bank activities regarding the color stage of gravid crab eggs; hatchery system for grey and black egg gravid crabs while the cage system for yellow-orange and brown gravid crabs stocking.



Figure 19. *New location CFi crab bank (Hatchery house system) (June 2019)*



Figure 20. Crab Bank (Cage system) (June 2019)

From the observation of the crab bank cage system by the crab bank fishers, they found that the gravid crabs in the cage were fed and eaten from the outside cage predator (Old Woman Octopus *Cistopus indicus* Férussac & d'Orbigny, 1835)(**Figure 21**), therefore in the meeting, fishers expressed their good idea to put the gravid female crabs in the bamboo cage or plastic basket and then floating them inside the crab bank net cage to protect and prevent the mortality of the gravid female crabs from the octopus feeding. The meeting decided, three (3) small or medium size bamboo cages with a maximum of five (5) gravid crabs will be initiated.

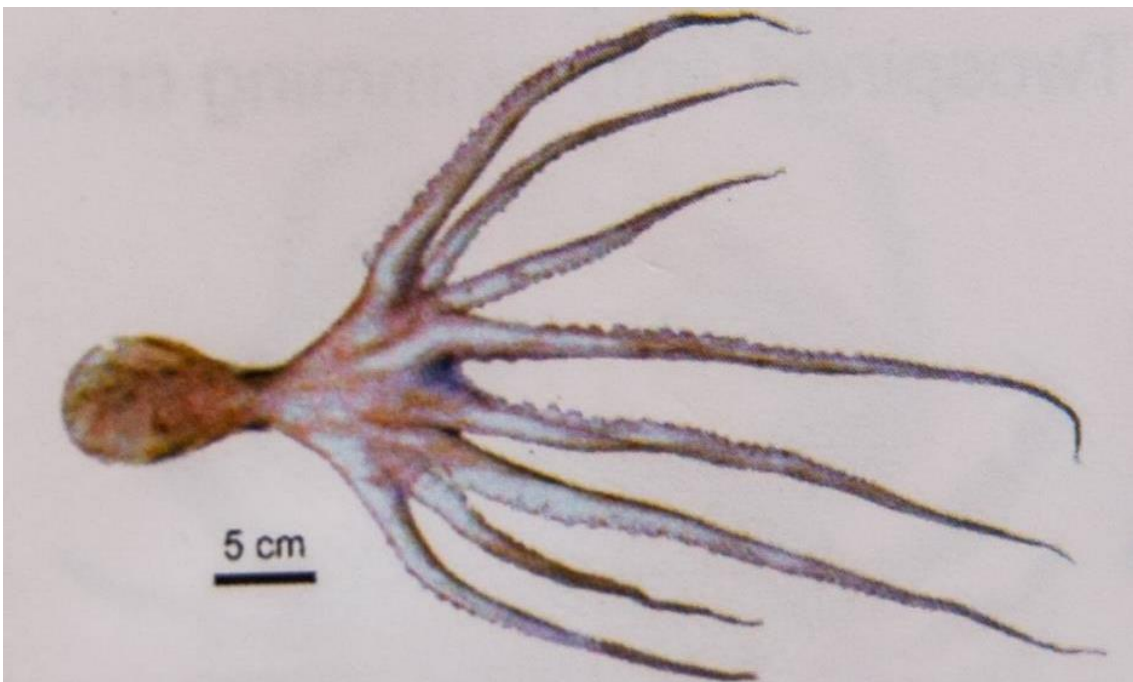


Figure 21. Old woman octopus *Cistopus indicus* (Férussac & d'Orbigny, 1835)



Figure 22. *Preparing for the plastic floating cages (Left) and completed (Right) (June 2019)*



Figure 23. *Preparing for the plastic floating cages (June 2019)*



Figure 24. *Completing for the plastic floating cages (June 2019)*

The previous follow-up in February 2019, found that the battery for the hatchery system could not be simultaneous functioning run throughout for 24 hours, it caused the hatching eggs for zoea stage dead, therefore the technician from the solar cell company came and fixed for the battery, since then until June 2019, the working condition still unable to support for the air pumping. Hence, during this trip, the PWC team requested to technical staff from the company to recheck and solve the problem again. Then, the new battery system for the solar cell has been used to testing and checking how it works for the hatchery system.



Figure 25. *Old battery (left) Replacing with the new battery (Right) (June 2019)*



Figure 26. Old solar charge controller (June 2019)



Figure 27. New solar charge controller (June 2019)

Moreover, Mr.Meas Va, the leader of crab bank group proposed to relocate the hatchery house from the current position which is located quite far from his house to the new hatchery house building which belongs to the Fisheries Administrative Cantonment (FiAC)'s property and located nearby/close to his own house, that makes it more easily for him to taking care of the gravid crabs in the hatchery house both for the day and night times.



Figure 28. Relocating all facilities from the old hatchery house to resetting at the new hatchery house (June 2019)



Figure 29. Solar panel system relocating (June 2019)



Figure 30. *Solar panel transferring (June 2019)*



Figure 31. *DC/AC power inverter transferring (June 2019)*



Figure 32. Solar panel transferring to the new hatchery house (June 2019)



Figure 33. Battery transferring to the new hatchery house (June 2019)



Figure 34. Solar cell and hatchery system resetting at the new hatchery house (June 2019)



Figure 35. New battery system for solar cell system setting (June 2019)



Figure 36. Setting up the new battery and DC/AC power inverter (June 2019)



Figure 37. Solar cell working condition after resetting (June 2019)



Figure 38. Re-arranging and preparing the hatching tank containers (June 2019)



Figure 39. Preparing for the aeration system for each hatching tank containers (June 2019)



Figure 40. *Preparing for the system running test (June 2019)*



Figure 41. *Complete setting the new hatchery house with the solar cell system support (June 2019)*



Figure 42. *Previous hatchery house located at the coordinate N10°27.387, E104°23.041 (June 2019)*



Figure 43. *Present hatchery house located at the coordinate N10°27.446, E104°23.065 (June 2019)*

In addition, while hatchery cannot be conducted, there is a showcase of the hatchery to express all fisherfolk about the hatchery process and progress at the leader's house. This activity quite useful and successful to make the fisherfolk and local villagers clearly understand the crab bank activities.



Figure 44. A showcase on hatching the blue swimming crab in the aquarium (June 2019)



Figure 45. A showcase on hatching the blue swimming crab in the aquarium (June 2019)

Fishers donated gravid crabs with the voluntary based by initiated by five (5) persons donated in February 2019 to thirteen (13) persons at present (May 2019). It showed increasing numbers of fisherfolk participated in crab bank activities. The leader has recorded fisher's name and the number of gravid crabs in each day of the month on the announcement whiteboard then transfer to record in the crab donation logbook.

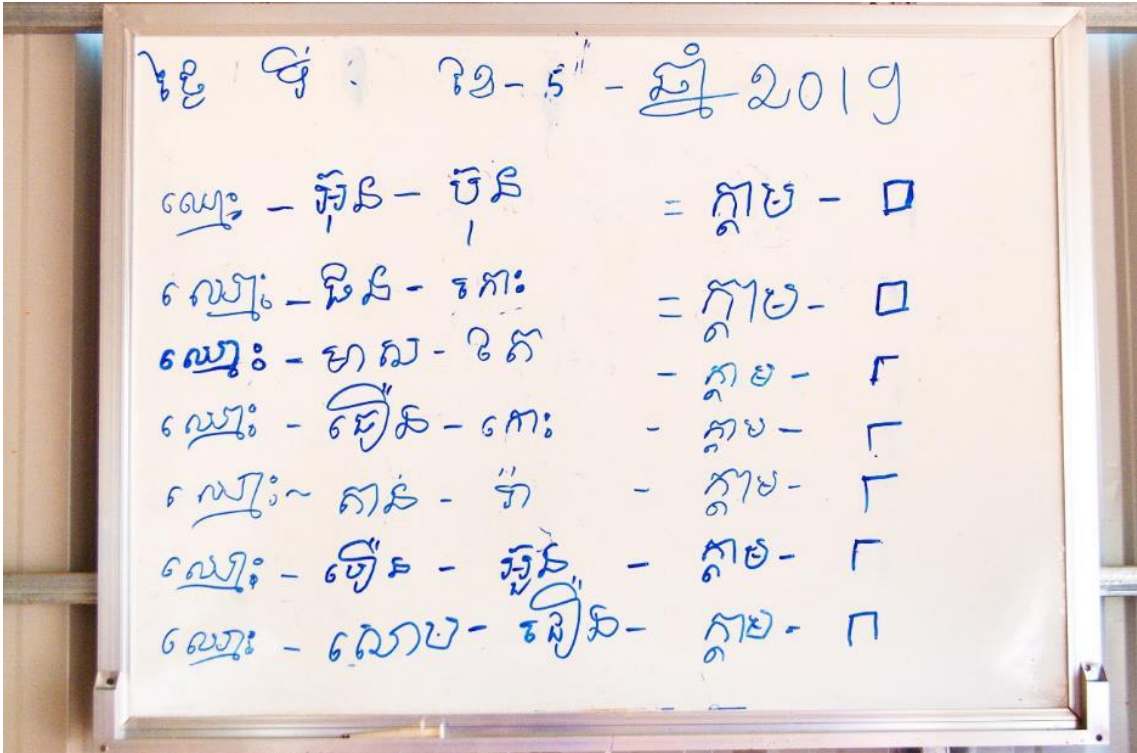


Figure 46. Recording of the fisher's name and the number of gravid crabs on a whiteboard (June 2019)

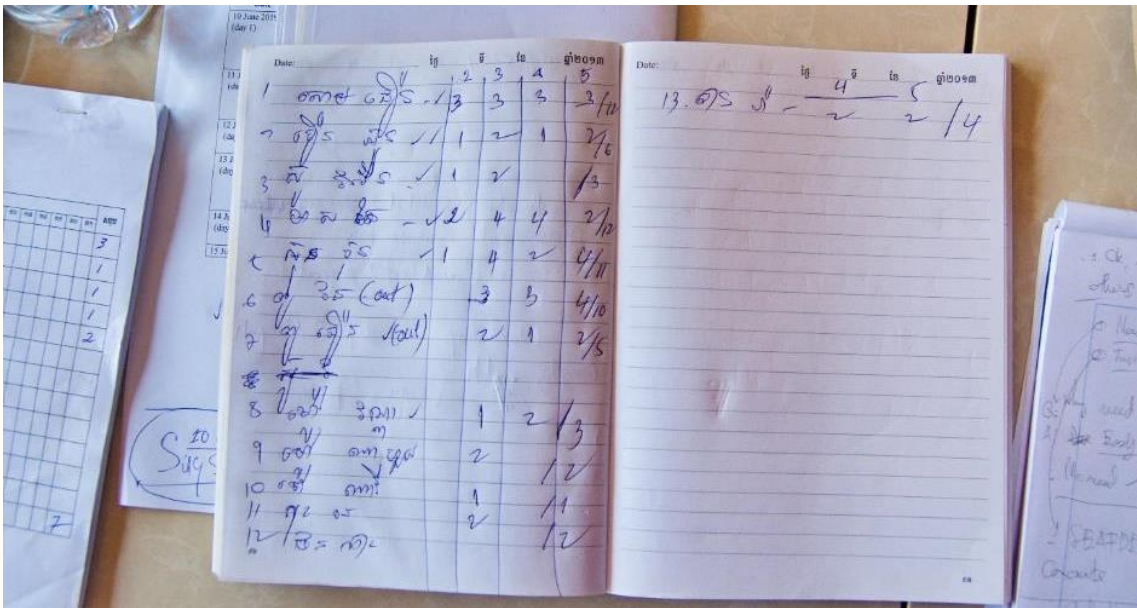


Figure 47. Recording of the fisher's name and the number of gravid crabs on the logbook (June 2019)



Figure 48. Guiding and explaining to the fishers how to record the fisherfolk's names and the number of gravid crabs donated (June 2019)

From the name list of fishers showed that there is two (2) fisherfolk from other villages. This is proved that fisherfolk willing to donate the gravid crabs without any benefit requested in return. At present a total of seventy-one (71) gravid crabs were donated. Regarding the voluntary based on gravid crab donation, SEAFDEC provided crab bank activities shirt to the leader to award those fisherfolk who donated gravid crab through the crab bank project.



Figure 49. Crab bank activity leader awarding the crab bank activities shirt to fishers who voluntary donated the gravid crabs to the project (June 2019)



Figure 50. Crab bank activity leader awarding the crab bank activities shirt to fishers who voluntary donated the gravid crabs to the project (June 2019)



Figure 51. Crab bank activity leader awarding the crab bank activities shirt to fishers who voluntary donated the gravid crabs to the project (June 2019)



Figure 52. Crab bank activity leader awarding the crab bank activities shirt to fishers who voluntary donated the gravid crabs to the project (June 2019)



Figure 53. Feeling happy to be the one who voluntary donates the gravid crabs to the crab bank project (June 2019)



Figure 54. Crab bank activities signboard (June 2019)



Figure 55. The crab bank signboard installation (June 2019)

According to the solar cell system to generate the electric power sources that could not continuously function last long for 24 hours, the project tried to fix it since the previous trips in June 2019, but it is still could not completely solve the problem. Mr. Meas Va, the fisher who takes care of the crab hatchery suggested using the electricity from his house to support the project. Therefore, the trip in August 2019, the project staff set-up the electricity power system for use while the solar cell power system is running out or during a cloudy or rainy day.



Figure 56. *Set-up the electric power system to support crab bank hatchery (August 2019)*



Figure 57. *Set-up the electric power system to support crab bank hatchery (August 2019)*

To sustain the crab bank activities after project termination, the management system on crab selling should be well managed and turned into a budget for the group circumstances. The meeting started by FiAC staff, Mr. Pheun Phalla had reviewed about crab bank activities in Angkaol village, he mentioned how important of the blue swimming crab in Kep Province. The blue swimming crab is an important species as the main production from fishing in Kep as it shows in the big statue of the blue swimming crab in this area. SEAFDEC supports many crab bank activities in Kep including in Angkaol too. Then the rule of blue swimming crab was showed and discussed which focused on the highlighted that was added for transparence on the group management. Some are revising the rule in the concern Article as the following:

Article 3: Members of the crab bank have the following obligations and duties on to voluntarily provide the gravid blue swimming crab by donating at least five (5) gravid crabs to make this rule a more voluntary base.

Article 17: Management and usage of budget:

- Budget management must have an accounting list
- Revenues received from other sources must be kept in a crab bank account
- Each expenditure must have invoices and listed properly
- Spent money is only for the management, conservation, and development of the crab banks
- Crab bank committee shall receive 20% of the money from selling crabs
- Saving money of 10% from selling crabs
- Operation cost for crab bank is 70% of selling crab (this sentence added from this meeting for revolving money of the crab bank group)



Figure 58. *Presentation on the crab bank activities in Kep by FiAC (August 2019)*



Figure 59. *Presentation on the rule of crab bank (August 2019)*

At the end of the meeting, Mr. Meas Va expressed his commitment to continue running the project after the project termination because they have a rule on running and system (solar power at day time and electricity may support in the night time) to support their group.



Figure 60. *Mr. Meas Va expressed his idea during the meeting (August 2019)*

Regarding the project that was terminated by the end of December 2019, then the project planned to bring the PWC to Thailand for a study trip on crab bank activities management. The project has supported four (4) fishers, one (1) FiA, and one (1) FiAC. The discussion came up with the result that there were two (2) fishers who are willing and able to participate, due to they can have their passport and they have available time within this year. Therefore, the project will be

allocated the budget to support one (1) more person from FiAC. The condition of FiA and FiAC staff is the project staff who never visited the crab bank activities management in Thailand. The study trip was done from 6 to 12 October 2019.

The last activity of the year 2019 for the project closing seminar was held in the first or second week of December 2019. The seminar has planned to have one (1) day in the meeting room to present the result of all project activities and one (1) day study trip to showcase the activities under the crab bank project. The FiAC staff and fishers from the four (4) coastal provinces in Cambodia including FiA from Phnom Penh were invited as participants for this end project closing seminar.

4.4 Conclusion and recommendations

The different studies suggested that there are advantages and failures in each crab bank model and that the success of a crab bank project is primarily dependent on its setup and implementation and the failures also can be a good lesson learned for development in the future. The crab bank system has inspired the local people to ensure that the crab resources are protected and conserved sustainably. The following are the conclusion and some recommendations for the crab bank implementation in Angkaol Village and other areas in the future.

- The crab bank cages suggested being site away from the area where freshwater runoff in the rainy season will reduce the water salinity as this stress the crabs result in stop feeding and die.
- The crab bank cages suggested to be site away from the very strong current and wind effected where easy access to the cages which close to the village or to the landing site to shorten the transportation time of gravid females and reduce the mortality rate and convenient in terms of the routine daily crab management.
- Active involvement of fishers, the active participation of fishers and positive interaction among fisheries stakeholders need to be encouraged due to the success of a crab bank project that is primarily dependent on the participation of the local communities. The additional incentives such as small gifts for participation may be needed.
- Strong leadership, the commitment of committee members, strong commitment of fishers and group leaders are the keys to sustainable crab bank scheme activities, leadership is required.
- The crab bank system has motivated fishers and their communities to protect and conserve crab resources and conservation areas for sustainable livelihood.
- Through the implementation of crab banks, a sense of ownership has been developed among the groups given that local communities have managed the activity themselves.
- The development of transparent governance mechanisms with clear roles and responsibilities will also contribute to the successful implementation of a crab bank project.
- A comprehensive approach of sustainable fisheries resource management may need, for a higher and better impact, crab banks need to be linked with measures to regulate crab fishing itself, as is successfully done in Pathew District, Chumphon Province, Thailand, with a change in collapsible crab traps and a minimum mesh size at 2.5 inches.
- The success of crab banks is closely related to the effectiveness of CFi and the enforcement of laws related to illegal fishing gear practices.
- To assess the impacts of crab banks, and particularly the survival rates of crab larvae, more scientific research is required to access the long-term impact of crab bank schemes on the blue swimming crab stock abundance, crab catch record are suggested to be monitored in the early steps of crab bank development and continuing after its implementation.

- To sustain the crab bank system, the Fisheries Administration Cantonment (FiAC) should assist CFi and crab bank groups by organizing awareness campaigns about the importance of the crab banks, organize a regular monthly meeting with the crab bank group committee members with the participation of commune council members and fisheries officers, to ensure that stocking and transaction logbooks are recorded properly.
- Voluntary releasing of small size and gravid female blue swimming crab should be encouraged to be released at the sea.
- Organization of a field visit to the successful crab bank operations model should be conducted to exchange lessons learned and experiences
- The development of transparent governance mechanisms, good governance and transparent mechanisms with clear roles and responsibilities will contribute to the successful implementation of crab bank schemes.
- Awareness campaigns and information on future benefits to create sufficient interest among the CFi members and to ensure that they share the same understanding.
- Learning Center establishment is recommended for awareness building.
- Eco-tourism and homestay approach might be challenged for the crab bank group's additional income in the future.

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5. Strengthening of blue swimming crab resource management

5.1 Status of stock management on blue swimming crab in Kep Province

5.1.1 Background

Blue swimming crab *Portunus pelagicus* (BSC) is the main fishery product in Kep, the smallest province in southeastern Cambodia. A large amount of this product is sold to various cities such as Phnom Penh, Sihanoukville, and neighboring countries. It is an important income source for people who are engaging in the fishery in this area. However, the crab population itself is vulnerable to the impacts of climate and salinity level change (Jöhl, 2013) and Kep is data-poor for fisheries management. These problems are common for small-scale fisheries and Kep which Kep can be a typical example as the smallest unit of fisheries management in small-scale fisheries. Therefore, the further sustainable use of crab stock in Kep required appropriate fisheries management.

To carry out fisheries management effectively, it is important to be clarified and understood for real fisheries situation. For these purposes, fisheries management can be assessed in several ways such as Fishery Performance Indicators (Anderson *et al.*, 2015) and the MSC Fisheries Standard of (Marine Stewardship Council, 2018) and so on.

Fishery Management Assessment Tool (FishMAT) for Developing Country (Terashima *et al.*, 2016) is one of the assessment tools for fisheries management. It was designed to assess fisheries situation comprehensively in developing countries and can be enabled to conduct a qualitative interview survey systematically in a data-poor situation. Therefore, assessing fisheries management using FishMAT will enable us to clarify the actual fishing activities of BSC in Kep, comprehensively.

In this study, for establishing sustainable use of BSC stock and livelihood for local people in Kep Province, FishMAT was used for analyzing the result of the interview survey. This survey was conducted to assess the current situations and determine the appropriate management measures in the future.

5.1.2 Structure of FishMAT

FishMAT is a set of criteria to understand issues of fisheries management for the enhancement of fisheries support to developing countries. It is based on Resource Management Toolbox (Fisheries Research Agency, 2009; Makino *et al.*, 2011; Makino, 2013) and MCS (Monitoring, Control, and Surveillance) code from FAO (1994). Besides these three (3) activities, Terashima *et al.* (2016) suggested that “the information regarding management activities in a participatory approach and jointly undertaken by local fishers and administrative institutions is also important” (p.28), especially for developing countries. Thus, management Activities (A) were added to the MCS code and applied as MCSA (Management, Control, Surveillance and management Activity) code. FishMAT categorize activities (from the reproduction of fishery products to consumption) into eight (8) categories, as the following **(1) Basic information of the current situation, 2) Maintenance/Rehabilitation of the Ecosystem, 3) Management of efforts, 4) Management of harvest, 5) Business improvement 6) Post-harvest treatment/processing, 7) Human and organizational capacity, and 8) Assessment and analysis capacity**). Besides, each category contains 10 to 15 factors, a total of 87 factors (**Table 1**). Eighty-seven factors will be classified as Monitoring, Control, Surveillance, or Activities and weighted from lowest (1) to highest important (3) according to the importance of factors for fishery activities. This weight is used as

a score and total scores of each category are calculated. In FishMAT, the score is given when target countries have at least one (1) case that matched the factors.

5.1.3 Method

Data was collected by face to face interviews from 27 November-2 December 2019, 12-13 February 2019, 10-15 June 2019, and 26-29 August 2019 using semi-structured interview techniques. Questionnaires were designed based on the contents of FishMAT to assess the fishery situation of BSC in Kep. Interviewees were five (5) kinds of occupations: 1) Small-scale owner fishers 2) Small-scale labor fishers (not a family member) 3) Middle traders 4) Officers of Fisheries Administration in Cambodia (FiA) and 5) Officers of Kep Fisheries administration cantonment (Kep FiAC). Interviews were conducted in three (3) major landing places of BSC, namely: Ou Krasar (Ou Krasar village), Angkaol (Angkaol village) and Kep crab market (Thmei village) (**Figure 61**). Regarding FishMAT factors, FiA were asked questions on all factors, but other stakeholders were asked only several factors related to them.

Collected data were organized and applied as scores for FishMAT. All interviews were translated from English and conducted in Khmer by local translators. A total of 42 interviewees including ten (10) boat owner fishers, six (6) labor fishers, 16 middle traders, and four (4) enumerators in three (3) landing places, two (2) officers from Kep FiAC and four (4) officers from FiA joined the survey (**Table 25**).

Table 25. Interviewees of interview survey

Occupation	No. of Interviewee	Time of interview
Boat owner fisher	10	20 min/person
Labor fisher	6	15 min/person
Middle trader	16	20 min/person
Enumerator	4	15 min/person
Kep FiAC	2	3 hours
FiA	4	3 hours
Total	42	16 hours

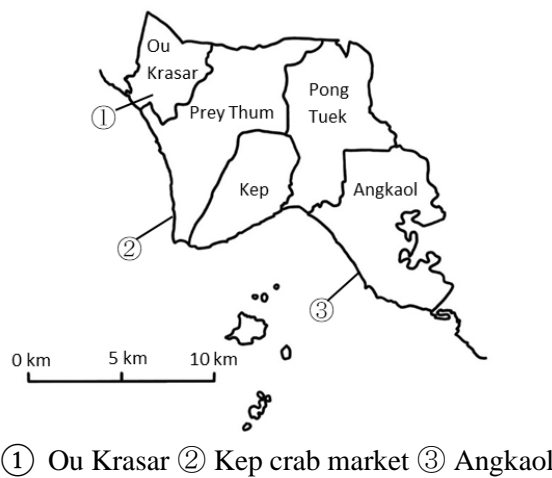


Figure 61. Map of landing place

5.1.4 Results

Based on the survey, several situations of fisheries management of BSC were identified (**Table 3**). Both categories 5, **Business improvement** and category 6, **Post-harvest treatment and processing** have the lowest scores (13%) and category 4, **Output-control** is the second-lowest score (17%) of all categories. Regarding surveillance systems (S) for fisheries management provide 4% which is the lowest score of MCSA code. On the other hand, category 7, **Human and organizational capacity** showed 73% which is the highest score of all categories and category 8, **Assessment and analysis capacity** is the next highest score (71%). Management (M) also gets the highest score (64%) of the MCSA code. Details of each category will be described as follows:

1) Basic information to understand the current situation

The percentage of the total score in this category was 53% (**Table 26**). All factors regarding category 1 were classified for management (M) of the MCSA code. Lack of statistical data such as the number of fishers and catch amount was conspicuous in this category.

Table 27 shows the answers from stakeholders about category 1 for comparison. About Factor 1, Kep FiAC had information on the number of fishing vessels which was 728. However, the total vessel number of each landing place was 641. If this difference is converted into the catch, it will be about 80 tons per year even if it was the smallest estimate. Besides this, they did not collect information on the number of local fishers.

For Factor 2, Kep FiAC provided information for the day of operations of BSC fishery ranged between 15 to 20 days per month. Information on the catch amount of BSC of Factor 3 was not collected.

For information on the distribution amount of Factor 4, Kep FiAC provided all BSC will be consumed domestically. However, according to the value chain of BSC which was revealed in this survey, BSC in Kep is consumed not only domestically but also in other countries (**Figure 62**). Each landing place had different value chains of BSC. In the case of the Kep crab market, the biggest crab market in the province, a huge amount of crabs was landed almost every day including the catch from nearby areas. Most of the crabs were sold by middle traders in this market and most of BSC caught in Kep will be consumed domestically. Whereas some middle traders processed crab and sold it to Phnom Penh, or Thailand via Sihanoukville. At Ou Krasar village, a total of three (3) middle traders were working. One middle trader sold alive crabs to the local market in Ou Krasar and sometimes to Kampot Province. Another trader brought crabs to the factory in Thmei for processing while another trader collected crabs and sold at the Kep crab market. In Angkaol village, middle traders sold both alive and processed crabs to Vietnam and Phnom Penh, especially for alive crabs will be brought to Kep by middle traders.

For Factor 5, price data of BSC in the landing place was around 5\$ (USD) to 8\$ per kilogram depends on the size (**Table 28**). The market price was around 10\$ to 15\$ per kilogram.

Information on the facilities of the landing site of Factor 6, no special facilities were there. Instead of ice-making machines and storage, fishers or middle traders kept alive crab under the water. For Factor 7, no one had information about the domestic consumption of BSC.

Information on the middle traders of Factor 8 is shown in **Table 5**. A total of 50 middle traders were operating in Kep. 30 middle traders were in Thmei. Ou Krasar had three middle traders which were the smallest of each landing place.

For the information of fishery cooperative and resource management activities in local fishers of Factors 9 and 10 are that Kep Province has five (5) Community Fisheries (CFis) (Ou Krasar,

Kampong Tralach, Thmei Kep, Angkaol). CFis had activities for resource management such as crab bank and patrolling for IUU fishing and Marine Protected Areas (MPA).

Table 26. Result of FishMAT as a whole -Relationship between factors and MCSA code of each category

Categories/MCSA code	M	C	S	A	Total
1) Basic information of current situation	*8/15				8/15 (53%)
2) Maintenance Rehabilitation of the Ecosystem		3/5	1/5	5/5	9/15 (60%)
3) Management of efforts (Input-Control)		9/15	0/10		9/25 (36%)
4) Management of harvests (Output-Control)	0/4	2/6	0/6	1/2	3/18 (17%)
5) Business improvement				2/15	2/15 (13%)
6) Post-harvest treatment / processing		0/2	0/2	2/11	2/15 (13%)
7) Human and organizational capacity	8/8			3/7	11/15 (73%)
8) Assessment and analysis capacity	9/12			1/2	10/14 (71%)
Total	25/39 (64%)	14/28 (50%)	1/23 (4%)	14/42 (33%)	54/132 (41%)

Note: *8/15= 8 is scores of Kep got from each factor of category 1. 15 shows total score of all factors in category 1.

Table 27. Answers from stakeholders of category 1) **Basic information of current situation**

Factors	Weight	MC SA	Kep FiAC	MT	BO	LF	FiA	Total
1) Information on the number of fishing vessel and local fishers	2	M	2	-	-	-		
2) Information on the number of days of fishing operation	1	M	1	-	1	1		1
3) Information on the catch amount of principal species	2	M		2	2	2		
4) Information on the distribution amount of principal species	1	M	1	1	1	1		
5) Price data on landing and retail site for principal species	1	M	1	1	1	1		1
6) Information on the facilities of landing site such as number of ice-making machines and storage	1	M			-	-	1	
7) Information on the domestic consumption of principal species	1	M			-	-		
8) Information of the number of middle-persons in active	1	M	1	-	-	-		1
9) Information of fisheries cooperatives in active	2	M	2	-	-	-	2	2
10) Information of resource management activities in local fishers	3	M	3	-	3		3	3
Score	15		11	4/6	7/8	5/8	6	8

Note: MT=Middle trader; BO=Boat owner; LF=Labor fisher

- =Some metrics are not relating to the middle trader, boat owner, and labor fisher. In this case, the scoreboard is showed as “- “. The total score of these stakeholders is calculated without “- “.

Total shows that result from an assessment of each factor from the answer of stakeholders, document, and observation.

Table 28. Market price of BSC by each size and number of middle traders in Kep

Crab size	Price (\$)/kg	No. of crab/kg
Small	3	20
Middle	8-10	10
Big	12-15	5

Landing place	No. of middle trader	No. of interviewed middle trader
Thmei (Kep crab market)	30	11
Angkaol	10	3
Ou Krasar	3	2
Others	7	0
Total	50	16

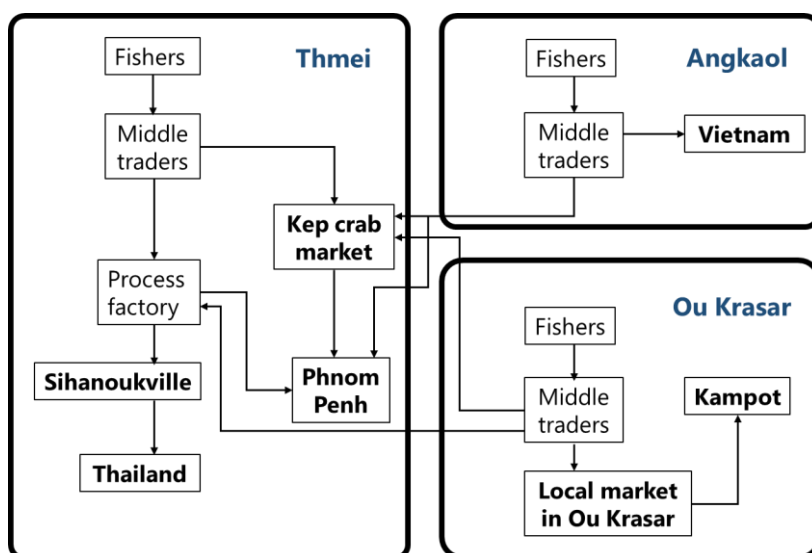


Figure 62. Value chain of BSC at each landing place. (Bold is places of consumption)

2) Maintenance Rehabilitation of the Ecosystem

The percentage of the total score in this category was 60%. Kep Province had several activities for ecosystem enhancement collaborating with NGOs or governmental sectors. Regulations on the ecosystem are stipulated by the law in Cambodia. From observation, Cambodia had regulations but measurement for waste disposal and control did not work. Besides this, no surveillance system was found.

Table 29 shows answers from stakeholders of category 2 for comparison. For Factor 1, regulations of the inflow/outflow sediment including sands or soil mining in this province had not been established yet. Meanwhile, for Factors 2 to 5, the Ministry of Environment confirms that the regulations about sewage and industrial effluent water, deforestation including mangrove, and waste disposal and control were implemented but not for surveillance systems such as for preventing IUU fishing. However, protective activities such as nursery ground for stock

enhancement and conservation activities have been conducted. In 2018 Marine Fishery Management Area (MFMA) was nationally proclaimed to protect the marine environment in Kep. MFMA consisted of four different sections namely 1) Conservation areas, 2) Fisheries refugia, 3) Fisheries protected Area and 4) Recreational and Research Areas. Conservation areas are prohibiting any activity that harms fishery resources. Any fishing activities were banned from recreational and research areas. In the observation, people who live in a fishing village throw away for waste everywhere and any activities for waste disposal and control system were not functioning.

Information on the activities for rehabilitation of the environment of Factor 6, the boat owner fishers showed a higher score than the labor fishers due to differences of knowledge about ecosystem enhancement and regulation of fishery activities. Besides, the knowledge gap between CFis member fishers and non-member fishers was also found.

For Factors 9 and 10, Kep Province had activities of protecting and enhancing endanger species such as seahorse, dolphin, and dugong and they had posters to promote these activities.

Table 29. Answers from stakeholders of category 2) **Maintenance Rehabilitation of the Ecosystem**

	Factors	Weight	MC SA	Kep FiAC	MT	BO	LF	FiA	Total
On land	1) Regulations on inflow/outflow sediment including sands/soil mining	2	C		-		-	2	
	2) Regulations on sewage and industrial effluent water	1	C	1	-	-	-	1	1
	3) Regulations on deforestation including mangrove	1	C	1	-	-	-	1	1
	4) Regulation on waste disposal and control	1	C	1	-	-	-	1	1
	5) Surveillance system on the practice of the above factors	2	S		-		-	2	
On water	6) Activities for rehabilitation of environment (Coral reef, mangrove, tidal flat and seaweed bed)	2	A	2	-	2		2	2
	7) Surveillance system for preventing IUU fishing	2	S		-			2	
	8) Seed production and release and installation of nursery ground for stock enhancement	2	A	2	-	2	2	2	2
	9) Conservation activities for rare and endangered species	1	S	1	-			1	1
	10) Public awareness on the practice of the above factors	1	A	1	-			1	1
	Score	15		9	-	4/12	2/8	15	9

3) Management of efforts (Input-control)

The percentage of the total score in this category was 36%. Especially, the surveillance system is not working for this category. Registration systems for fishery and restrictions for input-control were not found. If members of CFIs use illegal fishing gear, there will be punishment based on the fishery law. However, examples of actual restrictions were few due to the lack of surveillance activity.

Table 30 shows answers from stakeholders of category 3 for comparison. For Factor 1, the registration system for vessel and fishers were still in process. A license or permission system for fishery of Factor 2 was not necessary for small-scale fisheries in Cambodia. The definition of small-scale fisheries in Cambodia is “coastal fisheries, small-scale fisheries with or without engine (from 5-50 Hp) and they are operating from shoreline to 20 m depth” (SEAFDEC, 2015). This regulation will be applied only from medium-scale fisheries. Almost all fishers in Kep are engaging for small-scale fisheries. Therefore, this situation might be one reason that Kep FiAC did not collect exactly the number of each information.

For Factor 4, Kep had regulations about the zoning of the fishing ground by the fishing method. The bottom trawling fishing within 20m from the shoreline and elongated collapsible trap were prohibited. Some labor fishers did not know which fishing gear was prohibited, but most owner fishers knew. Even though many fishers said that they see illegal fishing every day, they did not take any action against it.

Restrictions on the fishing method of Factor 7 were found. The destructive fishery such as dynamite fishing, cyanide fishing, and electric fishing were prohibited. According to the declaration of the Ministry of Agriculture, Forestry, and Fishery, CFIs members can use only crab trap or crab gill net with five to six centimeters mesh size and length is 100 to 200 m individually. In case of any community member of CFIs uses illegal fishing gear, they will be punished by fishery law.

For Factors 9 to 12, the input-control such as the operation days, time and period of BSC fishery did not observe.

About the surveillance system for input-control of Factor 3,5,12, Cambodian fishery had patrolling sections for surveillance of these factors conducted by CFIs. However, in Kep the surveillance system did not work due to lack of manpower.

Table 30. Answers from stakeholders of category 3) **Management of efforts (Input-Control)**

Factors	Weight	MC SA	Kep FiAC	MT	BO	LF	FiA	Total
1) Fishers/ vessel registration system for each fishing type	2	C	2	-				
2) License/ permission system for each fishery	1	C	1	-				
3) Surveillance system on the practice of the above factors	2	S					2	
4) Zoning of fishing ground by fishing method	2	C	2	-	2		2	2
5) Surveillance system on the practice of the above factor	2	S		-			2	
6) Regulation on fishing vessel capabilities such as HP, Tonnage, length	1	C	1	-			1	1
7) Restrictions on the fishing method including destructive fishing	2	C	2	-	2	2	2	2
8) Surveillance system for destructive fishing	2	S		-			2	
9) Restrictions on the fishing gear or equipment of the fishing vessel	1	C		-	1		1	1
10) Restrictions on the fishing period (months in year)	1	C		-	-	-	1	
11) Restrictions on the operational time of fishing (time in a day)	1	C		-	-	-		
12) Restrictions on allowable operational days (day a year)	1	C		-	-	-		
13) Surveillance system on the practice of the above factors	1	S		-				
14) Regulation on fishing ground such as no-fishing zones, marine preserves, MPAs	3	C	3	-	3		3	3
15) Surveillance system on the practice of the above factor	3	S		-			3	
Score	25		11	0/2	8/22	2/22	19	9

4) Management effort (Output-control)

The percentage of the total score in this category was 17%. The restriction of crab sizes was found with the poor surveillance system. Regulation for crab catch size and public awareness of these were observed but other activities including surveillance and periodical communication of these topics between fishers and government were not found.

Table 31 shows answers from stakeholders of category 4 for comparison. For Factor 1, systematic mechanisms to understand fish-catch information had not been established not only for Kep Province but also in Cambodia.

For Factor 2, regulation on catch size was observed. FiA provide notification to the fishers in the coastal area that ‘any commercial activities such as fishing, trading, stocking or transporting of BSC seed with carapace size is less than 9 cm or the crab number is higher than 20 crab per kilogram are prohibited including any commercial activities for gravid crab were not be allowed’.

In case of fishers do not follow this notification, they will be punished by fishery law with the transaction fine. However, they had little attention to the notification.

Restriction about by-catch and upper-limit for fishery products of Factor 4 was not stipulated in the country. About the fish catch recording system of Factor 10, Kep FiAC provided logbook to CFis but it was not used.

For Factor 11, public awareness of resource protection was found in the fishing village in Kep as a notice board about the protection of crab resources (**Figure 63**). However, any surveillance system for out-put control was not working.

Table 31. Compared answers from stakeholders of category **4) Management of harvests (Output-Control)**

Factors	Weight	MC SA	Kep FiAC	MT	BO	LF	FiA	Total
1) Systematic mechanisms to understand fish-catch information such as catch amount, size of caught fish	2	M		-				
2) Regulation on catch size of principal fishery species or restrictions on the catch by maturation stage or sex of crustaceans	2	C	2	2	2	2		2
3) Surveillance system on the practice of the above factors	2	S		-				
4) Restrictions on by-catch in industrial fishing	1	C						
5) Surveillance system on the practice of the above factor	1	S						
6) Restrictions on upper-limit of catch amount per each fisher	2	C						
7) Surveillance system on the practice of the above factor	2	S		-		-		
8) Restrictions on upper-limit of catch amount per region or in the nation	1	C		-		-		
9) Surveillance system on the practice of the above factors	1	S		-		-		
10) Regulation or support system on local fishers or fishery cooperative for fish catch recordings	2	M	2	-		-		
11) Public awareness or fishers' training program regarding the above factors	1	A	1	-	-	-	1	1
12) Periodical communications between fishers and government regarding the above factors	1	A	1	-	1	-		
Score	18		6	2/6	3/17	2/10	1	3



Figure 63. Notification board about crab resource preservation

5) Business improvement

The percentage of the total score in this category was 13%. This was the lowest score of all categories. In this category, all factors were categorized as “Activity” (A) of MCSA code. Few activities or guidelines from the government to improve the management for small-scale fishers were found. The only things Kep had about business improvement were micro-finance schemes for local fishers from the private bank, NGOs, or crab bank.

Table 32 shows answers from stakeholders of category 5 for comparison. From the results of interviews provided answers for Factor 1 to 4. For the guidelines and activities for cost saving of fishing operation, fish preservation, value-adding to fish products and alternative income sources were not found in Kep. Answers of these factors showed some gaps between FiA and fishers. Similarly, technical training such as packaging and maintaining freshness during transportation has begun as a country but not for Kep. Since the governmental activities had not yet spread to the local area as Kep, most fishers still did not know how to improve their business and had no opportunity to get information. Same as these factors, for Factors 5 to 7, activities for diversion of fishing type, cooperative shipping, and financial support for assisting resource management schemes were not found.

For Factor 8, Kep Province had several micro-finance schemes for local fishers. When fishers are members of CFIs, they can borrow money from crab bank loan without interest by donating gravid crabs. Some boat owner fishers borrowed money from the middle trader, private bank or NGOs.

Table 32. Answers from stakeholders of category 5) **Business improvement**

Factors	Weight	MC SA	Kep FiAC	MT	BO	LT	FiA	Total
1) Activities or guidelines for cost saving of fishing operation	1	A					1	
2) Activities or guidelines for fish preservation	2	A	2	-			2	
3) Activities or guidelines for value-adding to fish products	1	A					1	
4) Activities or guidelines for alternative income sources	3	A					3	
5) Activities for diversion or change of fishing type	1	A						
6) Activities for cooperative shipping or marketing by local fishers groups or fishery cooperatives	2	A						
7) Finance support systems such as tax reduction or financial compensation for local fishers or fishery cooperatives which assist any resource management scheme	1	A						
8) Micro-finance scheme for local fishers	2	A	2	2	2			2
9) Activities for the business development service (BDS) for fishery cooperatives and related small and medium-sized enterprises (SMEs)	1	A		-				
10) Public awareness activities by administrative institutions regarding above factors	1	A	1	-				
Score	15		5	2/11	2	0	7	2

6) Post-harvest treatment and processing

The percentage of the total score in this category was 13%. This was another lowest number as category 5. FiA provided training to processors to improve processing techniques. However, for the fishers, few people had been trained. In the case of BSC, fishers, middle traders, and processors keep the freshness to sell higher prices, but they did not care much about sanitation. Besides that, no standard and surveillance for sanitary were found in Kep.

Table 33 shows answers from stakeholders of category 6 for comparison. The situation of this category was like category 5. For Factors 1 and 2, FiA had a section of post-harvest and processing. This section trained fishers for technically, but it was not common for fishers in Kep province. About equipment for fish preservation of fishing vessels of Factor 3, many fishing vessels had storage areas for keeping alive crabs. For Factor 4, the standard for on-boat and landing sanitary was not established in Cambodia. This category also did not have any surveillance system of Factors 5 and 7.

For the post-harvest treatment of fish after landing in Factors 6, 8, and 9, FiA provided technical support for processors. They had trained for fishers and processors such as the way of how to improve their processing technology, storage fish for freshness and clean standard equipment. However, local fishers did not have enough knowledge about these things. These activities were working in the country and the provincial level, but not for the local level.

Any activities for improvement of fishery product distribution, fish landing factor, and fish market of Factors 9 to 11 were not observed. Most of the fish market in Cambodia is operating by private sectors made by FiA and it was difficult to distribute the standard approach or training activities. For Factor 12, the training on awareness to the traders and fishers was not common at the local and national level.

Table 33. Answers from stakeholders of category 6) **Post-harvest treatment / processing**

Factors		Weight	MC SA	Kep FiAC	MT	BO	LT	FiA	Total
On boat	1) Activities for improvement of fish preservation techniques	2	A	2				2	1
	2) Technical guidance by administrative institutions	1	A	1	-			1	
	3) Fishing vessels equipped with cold storage facilities for fish preservation	1	A	1	-	1	1	1	
	4) On-board sanitary standard	1	C		-	-	-		
	5) Surveillance system on practice of the above factors	1	S		-	-	-		
After landing	6) Sanitary and quality standard for fishery products	1	C			-	-	1	1
	7) Surveillance system on the practice of the above factor	1	S		-	-	-		
	8) Activities for improvement of processing techniques	1	A	1	-			1	
	9) Activities for improvement of fishery products distribution	2	A	2	-			2	
	10) Activities for improvement of fish landing factors	1	A	1	-				
	11) Activities for improvement of fish markets	2	A						
	12) Public awareness activities by administrative institutions regarding above factors	1	A	1				1	
Score		15		9	0/6	1/11	1/11	9	2

7) Human and organizational capacity

The percentage of total score in this category was 73%, which is the highest number of all categories. Especially, the management section got full scores. NGOs collaborated with CFIs to educate local fishers and support fishery management activities. However, the education system by the government was still ongoing. These activities including education for local officers and researchers depend on external organizations.

Table 34 shows answers from stakeholders of Category 7 for comparison. For Factor 1, the officers for dissemination and protection for fishery have been appointed in each area. In the case of Factor 2, several NGOs including World Wildlife Fund, Marine Conservation Cambodia, and so on, were supporting fisheries management activities in Kep.

Periodical communications among several stakeholders such as FiA, Kep FiAC, CFIs, and other related authorities were confirmed. For Factor 3, Kep FiAC was requested to submit a report to

FiA monthly including the annual meeting. For Factor 4, FiA had periodical communications with other related authorities. For Factor 5, in case of fishery authority and fisheries cooperative, CFis was required to submit a report to Kep FiAC while FiA will consult with Kep FiAC for any problem that happened. For Factor 6, sometimes CFis and NGOs have meeting when they have projects.

The Education system for local people who engaged in the fishery was working only for local officers. For Factor 7, local officers of Kep FiAC have opportunities to take several educations such as training for making a plan of the fishery. European Union (EU) has supported education for the staff of research institutes. Fisheries affair had trained for fishers about fisheries law, but local fishers were not familiar with this. For Factor 10, FiA was still under processing for the education system of the middle traders and processing persons.

Table 34. Answers from stakeholders of category 7) **Human and organizational capacity**

Factors	Weight	MC SA	Kep FiAC	MT	BO	LF	FiA	Total
1) Officers for dissemination and protection in each local area	2	M	2	-	-	-	2	2
2) NGOs and other organization supporting fishery management activity	2	A	2	-	-	-	2	2
3) Periodical communications between central and local fishery authorities	1	M	1	-	-	-	1	1
4) Periodical communications between fishery authority and related other authorities such as ministry of environment and coast guard	1	M	1	-	-	-	1	1
5) Periodical communications between fishery authority and fisheries cooperatives	2	M	2	-	2	-	2	2
6) Periodical communications between private organizations such as fisheries cooperatives and NGOs	2	M	2	-	-	-	2	2
7) Education system for the local officers	1	A	1	-	-	-	1	1
8) Education system for the staff of research institutes	1	A	-	-	-	-	1	-
9) Education system for the local fishers	2	A	2	-	-	-	2	-
10) Education system for the middle persons and processing persons	1	A	1	-	-	-	-	-
Score	15		14	0/1	2/4	0/4	14	11

8) Assessment and analysis capacity

The percentage of the total score in this category was 71%. Research institute for inland fishery and aquaculture were more developed compared to the marine fishery in Cambodia. The stock assessment and biological studies were still in process.

Table 35 shows answers from stakeholders of category 8 for comparison. For Factor 1, Cambodia has two (2) research institutes for fishery science. One is the Inland Fisheries Research and

Development Institute (IFReDI) that aimed to develop and upgrade the national capacity for the rational management of inland fisheries and maximize the income of fishers and farmers. Another institute is the Marine Fisheries Research and Development Institute (MFRDI), aimed to develop marine resources management. For the aquaculture section, there are Marine Aquaculture Research and Development Centre (MARDeC) in Sihanoukville, which was established to develop and disseminate marine fish seed production and aquaculture techniques.

For Factors 2 and 3, the institutes for stock assessment, ecological or biological research were not established yet. For Factor 4, FiA sent staff to the activities which were held by external organizations to support studying for oceanography. The biological chemistry of Factor 5 was researched by the above institute. For Factor 6, they had studied for the socio-economic of the inland fishery. About studies for processing techniques and fishing equipment of Factors 7 and 8 were found. For instance, improving rice field fisheries was conducted with Michigan State University. Administrative organizations and researchers had an annual meeting of Factor 9. For Factor 10, they also held a meeting for dissemination activities for the research results. Same as the situation of category 7, many supporting activities depend on an external organization.

Table 35. Compared answers from stakeholders of category **8) Assessment and analysis capacity**

Factors	Weight	MC SA	Kep FiAC	MT	BO	LF	FiA	Total
1) Research institutes for fishery science	2	M	-	-	-	-	2	2
2) Stock assessment to principal species by local researchers or institutes	2	M	-	-	-	-		
3) Studies for ecological and biological characteristics such as spawning ground, period on principal species by local researchers or institutes	2	M	-	-	-	-		
4) Studies for oceanography such as current variation, salinity change and ocean temperature anomaly by local researchers or institutes.	1	M	-	-	-	-	1	1
5) Studies for biological chemistry on coastal, estuarine and swampy waters by local researchers or institutes	1	M	-	-	-	-	1	1
6) Studies for socioeconomics on fishery by local researchers or institutes	2	M	-	-	-	-	2	2
7) Studies for processing techniques by local researchers or institutes	1	M	-	-	-	-	1	1
8) Studies for fishing equipment and techniques, by local researchers or institutes	1	M	-	-	-	-	1	1
9) Periodical communications between the administrative organizations and researchers regarding above factors	1	A	-	-	-	-	1	1
10) Dissemination activities for the research results regarding above factors	1	A	-	-	-	-	1	1
Score	14		-	-	-	-	10	10

5.1.5 Conclusions

The overall outcomes of FishMAT, among all the categories, only the category 1, **Basic information of current situation (53%)**, category 2, **Maintenance rehabilitation of the ecosystem (60%)**, category 7, **Human and organizational capacity (73%)** and category 8, **Assessment and analysis capacity (71%)** had scores more than half. The common thing for these categories is that several external supports concentrated on these categories.

Whereas category 3, **Management of efforts (Input-control) (36%)**, category 4, **Management of efforts (Output-control) (17%)**, category 5, **Business improvement (13%)**, and category 6, **Post-harvest treatment/processing (13%)** had scored less than half. For the MCSA code, Surveillance (S) was 4 % and Management Activity (A) was 33 %. To conduct the management of harvests effectively, collecting information such as the catch amount and number of vessels for each fishing type is necessary. Moreover, several activities of business improvement and post-harvest were conducted only at the country or provincial level, not for local people. Although regulations for managing fisheries were found, cases in which the regulations were not effective because the surveillance system was not functioning were conspicuous in several categories.

In the future, by focusing on supporting these categories, educating CFis, and making opportunities for communications between CFis, Kep FiAC, and FiA will have possibilities to contribute to management issues and sustainable use of BSC.

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5.2 Strengthening the protection of the blue swimming crab fishery resources

The conservation area of Angkaol CFi is the protected area for fishery habitat restoration of fisheries resources including the blue swimming crabs, seagrass beds and others. The Angkaol CFi conservation area is covering the area approximately about 100 hectares (1 square kilometer) which were declared to the community as the conservation area by the local government authorities. To identify and notice this conservation area, SEAFDEC under the Japanese Trust Fund (JTF) supported to provide the materials for 12 conservation buoys which were made of the plastic drum with 100 liters capacity input with the mixed cement inside and cover the painting with the white color (easy for observing in the sea). The buoy was fixed in the sea by using the cement block size 35×40×30 cm and approximate weight around 100 kgs. as the sinker. The buoy setting location has been investigated and recorded by Garmin handy GPS Model Montana 680 (**Figure 64**). Hondex High-Frequency Digital Depth Sounder Model PS-7 (**Figure 65**) has been used to investigate the depth of water in each buoy setting point for the process of the rope length calculation for each buoy.



Figure 64. GPS Model Montana 680 using for location checking and plotting



Figure 65. *Hondex High Frequency Digital Depth Sounder PS-7 using for sea depth checking*

The location of each buoy as shown in the **Table 36**.

Table 36. Angkaol CFi Conservation Buoys Location

Buoy No.	Latitude (N)	Longitude (E)
01	10°27'09.09"N	104°23'14.19"E
02	10°26'59.57"N	104°23'06.32"E
03	10°26'43.42"N	104°23'25.30"E
04	10°26'13.92"N	104°24'15.05"E
05	10°26'25.04"N	104°24'20.89"E
06	10°26'46.85"N	104°23' 45.02"E
07	10°26'55.00"N	104°23'12.50"E
08	10°26'49.80"N	104°23'18.80"E
09	10°26'38.80"N	104°23'35.20"E
10	10°26'32.90"N	104°23'44.90"E
11	10°26'27.10"N	104°23'54.70"E
12	10°26'21.20"N	104°24'04.60"E

The conservation area was indicated by 12 buoys at the Angkaol CFi to identify the conservation area of Angkaol CFi. (**Figure 66**)



Figure 66. Map of 12 buoys installing at the Angkaol CFi conservation area

The local fishers gave full cooperation and engaged along with all the process of buoys construction and completed the installation at sea. The rope work practiced and knowledge on to know-how have been transferred to the local fishers and FiAC officers via the PowerPoint presentation and the actual practice. (Figure 67)

Rope Work for Conservation Buoy

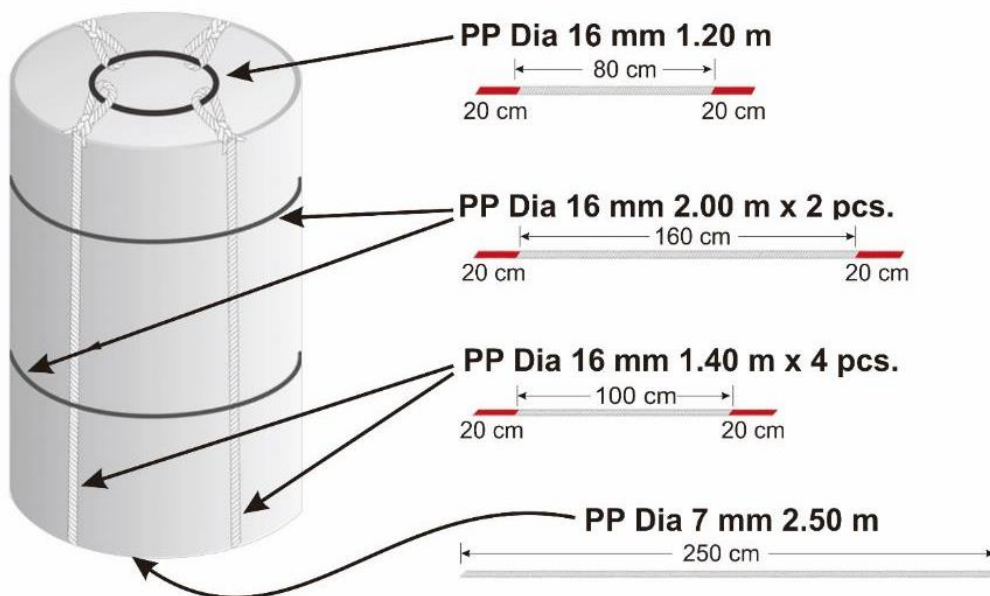


Figure 67. Cutting pattern on the rope work for conservation buoy construction

The first step, SEAFDEC technical staff provided the knowledge and explained how to make the conservation buoy to the local fishers, FiAC and FiA staff, and then followed by the learning by doing techniques. On the first day, the fishers, FiAC, and FiA gained the knowledge and understood how to do the rope work and one buoy could be finished as an example model.

The second day plans to finish for the remaining buoys. Then, the mixed cement was put inside as its weight for supporting and making buoy's self-standing in the sea condition to be ready for the next day installation. Two (2) fishing boats were engaged in the installation process. Twelve (12) sets of the conservation buoys were completed and finished as planned by the technical support from SEAFDEC. All photos to illustrate the process of the conservation buoy construction and installation provided as **Figure 68 - 81**.



Figure 68. Buoy making (Rope measuring)



Figure 69. Buoy making (Rope working 1)



Figure 70. Buoy making (Rope working 2)



Figure 71. Buoy making (Rope working 3)



Figure 72. *Buoys transferring.*



Figure 73. *Buoy Making (Buoy balancing weight by mixed cement input 1)*



Figure 74. *Buoy making (Buoy balancing weight by mixed cement input 2)*



Figure 75. *Complete of 12 sets of conservation buoys*



Figure 76. *Buoys installation at Angkaol CFi conservation area, Kep Province, Cambodia*



Figure 77. *Buoys installation by local fishers at Angkaol CFi conservation area, Kep Province, Cambodia*



Figure 78. *Buoy installation (Buoy setting)*



Figure 79. *Buoy installation (Buoy condition)*

The conservation signboard was installed at the position which agreed by the local community members (**Figure 80 and 81**)

គម្រោងលើកកម្ពស់ការគ្រប់គ្រងការនេសាទក្លាយសេះ ប្រកបដោយនិរន្តរភាពនៅសហគមន៍នេសាទអន្តោល ភូមិអន្តោល ឃុំអន្តោល ស្រុកដំណាក់ចន្ទីរ ខេត្តកែប

សហគមន៍នេសាទអន្តោល

១. ហាមចូលនេសាទក្នុងកន្លែងអភិរក្សសហគមន៍នេសាទ
 ២. ហាមនេសាទដោយឧបករណ៍អ្ននអូស ឧបករណ៍នេសាទទំនើប ឬឧបករណ៍នេសាទ ដែលបង្កើតថ្មី ឬរៀបរយនេសាទបែបថ្មី ឬឧបករណ៍នេសាទដែលមិនបានកំណត់ក្នុង ប្រកាសរបស់ក្រសួងកសិកម្ម រុក្ខាប្រមាញ់ និងនេសាទ ដែលនាំមកនូវការបំផ្លិច បំផ្លាញមធ្យមភាព ធនធានជលផល ឬប្រព័ន្ធអេកូឡូស៊ី
 ៣. ហាមចាប់ ទិញ លក់ ធ្វើសន្និធិ និងដឹកជញ្ជូនកូន ពងក្រី ឬកូន និងពងរ៉ាវីសតូ
 ៤. ហាមចាប់ ទិញ លក់ ក្លាយសេះមេដែលមានពងក្រៅ
 ៥. ហាមធ្វើនេសាទ ឬធ្វើអាជីវកម្មផ្សេងៗដែលប៉ះពាល់ ឬរំខានដល់ការលូតលាស់ ស្មៅសមុទ្រ ឬផ្កាថ្ម

រួមគ្នាអភិរក្សធនធានជលផលសមុទ្រអនាគតរុងរឿង

Figure 80. Conservation area signboard



Figure 81. The conservation area signboard installation

5.3 Conduct study tours to learn resource management measure

A study trip was conducted to transfer technical assistance and enhance the capacity and awareness of researchers in Cambodia on crab fishery resources rehabilitation in seagrass fishing grounds. On 6-12 October 2019, a study visit was conducted for the FiA, FiAC, and fishers from Cambodia to visit four (5) fishing villages in Thailand, namely: 1) Tong Tom Yai Village in Chumphon Province, 2) Phru Jood Village in Trang Province, 3) Lampho Community in Chai Ya District, Surat Thani Province, 4) Pak Nam Pran, 5) Lam Phak Bia Crab Bank Group in Phetchaburi Province Village in Prachuap Khiri Khan Province, to learn on the blue swimming crab fishery resource management measures undertaken in different areas. They also exchanged views with Thai fishers on local crab bank systems and related fisheries resources management initiatives. Through this study trip, fishers from Angkaol village could directly obtain information on measures for blue swimming crab conservation and management system in Thailand; and it is expected that management measures would be taken-up and applied in Kep Province toward sustainable utilization of the blue swimming crab resources in the future. The lessons learned from their visiting, as following:

1) Tong Tom Yai Village, Dan Sawi sub-district, Sawi District, Chumphon Province
Participants from Cambodia visited the first Community, which located in Tong Tom Yai village, Dan Sawi Sub-District, Sawi District, Chumphon Province. According to Mr. Watcharin Sawangkarn (Kai), the head of the community described the history of the establishment of the commune since 1999. He mentioned that this community was established by the local people's idea after he volunteered in diving of the Royal project. There are 4 main activities which are conducted in the community such as Fish Enhancing Devices (FEDs), Crab bank, Squid bank, and Seahorse habitat conservation. Among the four main activities, Fish Aggregating Device and Squid bank were interested in the participants from Cambodia, because it can be applying for their CFi at Angkaul, Kep province. Besides that, all participants also interested in the contribution of the local people in the conservation activities. The model of crab bank in Tong Tom Yai is different from Angkaul CFi, in which the fishermen just put the gravid female crabs in the baskets at their own house and let the mother crabs release the eggs.



Figure 82. Tong Tom Yai homestay at Chumphon Province to learn about the fisheries habitat and fisheries resources enhancement, FADs and FEDs (local wisdom), and eco-tourism



Figure 83. Tong Tom Yai homestay at Chumphon Province to learn about the fisheries habitat and fisheries resources enhancement on squid bank activities



Figure 84. Special thanks for Tong Tom Yai homestay owner and leader for knowledge and information sharing

2) The Small and Micro-Community Enterprise Fish Farming, Baan Phru Jood, Bo Hin Sub-District, Sikao District, Trang Province

Next visiting is the Small and Micro-Community Enterprise Fish Farming, Baan Phru Jood, Bo Hin Sub-District, Sikao District, Trang Province as to be the center of planting seagrass seedlings. As Mr. Banjong Na-rue matee, the head of community mentioned, there are main occupiers in the community, such as Rubber tree plantation, Fishermen and Aquaculture. Besides that, he also briefed the reason for the establishment of the Eco-community. Starting in 1987, there were plenty of fisheries resources at the community but since 1992, the resource started to be declined because of the high demands of the local consumptions. To meet the high demands, fishermen start to modify their fishing gear to increase the production of the blue swimming crabs. Due to the depletion of the blue swimming crabs, the community was established in 2000 which supported by the Coastal Habitats and Resources Management (CHARM) project. The main activities in the commune were tourist boat services, crab bank, recover seagrass beds by planting seagrass seedlings and Batik painting by the women group. During this trip, all participants got the chance to visit two crab banks at Khuan Tung Ku and Baan Nam Rap crab bank. The process of both crab banks is the same, which the fishermen willing to donate the gravid female crabs to the middleman, after releasing the eggs, the female crabs were sold. Then the money from selling crabs was used for electricity, water, and other management expenses. For this community, the interesting activity which was interested in all participants was the recovery seagrass beds by replanting the seagrass seeds which can provide a good habitat for the blue swimming crabs from the crab bank activities and another fisheries resources. Besides, participants from Cambodia also appreciated the high commitment of the committee of the commune which put the effort, kept moving forward and try to find the technical support from the stakeholders. Asst. Prof. Dr. Apirak Songrak and Dr. Wikit Phinrub, from Rajamangala University of Technology Srivijaya, Trang campus have shared their experiences, lesson learned and the best practices showcase for the crab bank activities and management in all coastal provinces of Thailand which fully supported by Thai's government including Private sectors, Institutes, Universities, Banks, etc.



Figure 85. *Small and Micro-Community Enterprise Fish Farming, Bo Hin Farm stay at Trang Province to learn about the seagrass habitat and resources enhancement, alternative livelihood (housewife) and communities' base tourism.*



Figure 86. *Bo Hin Farm Stay at Trang Province to learn about the crab bank activities and management in Thailand from the Professor of Rajamangala University of Technology Srivijaya, Trang Campus*



Figure 87. *Small and Micro-Community Enterprise Fish Farming, Bo Hin Farm Stay at Trang Province to learn about the planting seagrass seedlings*



Figure 88. *Special thanks to Bo Hin Farm Stay owner and the Professor from the Rajamangala University of Technology Srivijaya, Trang Campus*



Figure 89. *Learning on the Batik painting at the OTOP (One Tambon One Product) village from the women group*



Figure 90. *Khuan Tung Ku crab bank group in Trang Province to observe the crab bank activities management by the middle person*



Figure 91. *Baan Nam Rap Ecotourism Group in Trang Province*



Figure 92. Special thanks to the crab bank and Eco-tourism Group at Baan Nam Rap, Trang Province

3) Lampho Community, Phumriang Sub-District, Chai Ya District, Surat Thani Province

The third visiting place is Lampho Community, which located in Phumriang Sub-District, Chai Ya District, Surat Thani Province. According to Mr. Narong Changaksorn (Ruoy) vice leader of this group and Mr. Jarin Cheiycheiychom (Nen), implementation committee of crab bank, before starting the crab bank, they had project which name as sea for life which providing them as the idea for crab bank by visiting the crab bank Chumphon model at Chumphon province. Because of the depletion of the blue swimming crabs, then the crab bank was established in 2004 at the island and moved to the village in 2007 by putting the gravid female crabs to release the egg in the cage. Because of the low hatching rate, the community adapted from stock crab in the cage to hatch in the tank (hatchery system). At the same time, Mr. Jarin also mentioned the development of crab fishing gear and some experiment on different mesh sizes of crab fishing gear to prove that, small mesh size of the crab trap caught many small crabs, which lead to depleting blue swimming crab stock in the wild. The process of crab bank was briefed by the committee of the commune that, each fisherman has each hatching tank for hatching the blue swimming crab larvae, after releasing the egg, fishermen can get back the crab for selling. There were two activities to support crab banks such as tourist service and food service for the visitors. Activity for the boat trip to the island, fishing and women will service on foods that contributed by 5% of charged to the community to run activities in crab bank. The interesting point from this community was strategic of motivation fishermen to contribute to crab bank and alternative income generation to a member of the community.



Figure 93. Lampho crab bank group in Suratthani Province to learn about crab bank and ecotourism management



Figure 94. Specials thanks to the Lampho crab bank group in Suratthani Province for crab bank and ecotourism management information sharing

4) Pak Nam Pran Commune, Pranburi District, Prachuab Kiri Khan Province

Crab bank which located in Prachuap Khiri Khan Province, Pranburi District, Pak Nam Pran commune, number 2 village. In the beginning, Mr. Kae Yai, team leader, briefed the story of crab bank in this village that, in 1987, there were a lot of fisheries resources, because of a smaller number of fishermen and lack of market, after the resources decreased, a greater number of fishermen and modern fishing gear. 2003, because of the depletion of the blue swimming crabs in the wild, the fishermen changed fish gear from crab to mackerel fishing gear. 2006, there were many commercial fishing boats operated in the shallow water (300 m from the coastline) without intervention from DOF. To prevent those illegal fishing practices the fishermen used their boat to close the stream to prevent the commercial fishing boat to go out for fishing. After 2006, because of concerns in depletion of resources and illegals fishing, a group of fishermen established the group named Pak Klong Pran small scale fishing in 2008. After group established, DOF and provincial authority introduced the crab bank which followed the Chumphon model (released the gravid crabs in the cage) and at the same time, PTT Public Company Limited provided the cages and nets for the crab bank activities. Because of Chumphon model was not suitable for this area, the group changed from cage to on land hatchery system model. At the beginning of establishment, any color of stages of the egg from female gravid blue swimming crabs was collected from fishermen and hatched in tanks, after 24 hours and directly released into the sea. After establishment the crab bank for 3 months, many juvenile crabs were found in the shallow water coastal area. 2009 idea from queen about the Fish Enhancing Devices by the TV program, fishermen group talked and discussed how to provide habitat for released the crabs by using the coconut leaves, rope and applied in 2010 by requesting the money and coconut leaves from the local people. Eight (8) areas (20 sets in each area) were deployed with 500 m distance from each other. After putting the fish trap are allow, while gill net and light fishing were prohibited, only hook was allowed. After one month, fishermen found more fish and new species which have never found in this area. In the year of 2011, a new election for the group's leader was done, Mr. Jeur Kae Yai became the leader of the group. After becoming the leader, about 20 times/month of the meet was regularly conducted. He also led the group to clean up the beach twice per month. For sustainable management, he rent the land for setting up the crab bank, which costs about 17,000 to 20,000 Baht per 4 Rai. For supporting the operational on the crab bank, he set up the new regulation as follows; new member needs to pay 50 Bath for the registration and pay 200 Bath/year in both news and old members. The interested point of this community was the initial idea of stocking enhancement and conservation by fishermen and at leadership of Mr. Jeur Kae Yai which can motivated fishermen to contribute and pay for running cost to cover the crab bank activities, clean up the beach twice per month and stop fishing for 2 days per month as the same time.



Figure 95. *Pramong Realek Group in Prachuap Khiri Khan Province to learn about the crab bank activities and fisheries resources enhancement activities*



Figure 96. *Special thanks to the Pramong Realek Group in Prachuap Khiri Khan Province for sharing the experiences on the crab bank activities and fisheries resources enhancement activities*

5) Lam Phak Bia Crab Bank Group in Phetchaburi Province

The last visiting is Lam Phak Bia Crab Bank Group in Phetchaburi Province which is close to Bangkok about 2 hours driving. This group started by decreasing the Blue Swimming Crab in the year 2007. The group has a chance to visit the Crab Bank activities in Chumphon province then

come back and start their crab bank which put the floating cage in the sea during initiated. After knowing that the cage in the sea is not easy working because, during the monsoon season, it cannot continue the activities and spent much more money on fuel oil and time of fishers to release the crabs in the cage then the group change to put the gravid crab in the tank as the hatchery system on the land with supporting by the private sector and government. Group members further thinking on how to continue the project after no funding then the group start the tourism activities as an alternative livelihood for fishers and input the juvenile crab releasing and crab bank visiting as activities of the group.



Figure 97. Lam Phak Bia crab bank group in Phetchaburi Province: Learn about crab bank and ecotourism management



Figure 98. Special thanks to the Lam Phak Bia crab bank group in Phetchaburi Province for sharing the lesson learns about crab bank and ecotourism management

6) Conclusion from the study trip

- Crab bank in Thailand started for 10 years and was put in the National Plan of Action of the Thai government from local to the national level, right now the crab bank is the good cooperation program among local person, academe, government, private sectors, etc.
- The main organization are the National Research Council of Thailand (NRTC) and Department of Fisheries (DOF), Thailand. The goal of this plan is 500 crab banks have to establish along the Thai coastlines, until now total of 329 were established.
- The crab bank that we have been visited is use the same model by putting the gravid blue swimming crab in the hatching tanks or boxes with aeration support and waiting until hatching and then will be released the juvenile directly into the sea or canal.
- All groups that we visited can continue crab bank activities with supported themselves by the use of tourism activities to obtain the income for their group and spent some money on crab bank activities
- All groups, now fishers cooperated crab bank activities by voluntary donate gravid crabs
- There an interesting system on the engagement of the middlemen to participate in the crab bank activities which could be challenged in Kep Province, Cambodia.
- Women and men who participated in the crab bank activities depend on their expertise, for example, women support cooking for visitors or tourists, while men can support the technical about the crab bank activities and resources enhancement or area protection.
- Therefore, the crab bank in Thailand now not just the resources enhancement program and also can support alternative jobs for fishing communities and it can be initiated activities to enhance awareness and knowledge to fishers.

6. Conclusion and recommendations

1) Project objective and activities

The overall goal of this Project was to conserve and manage the blue swimming crab (BSC) resources in Kep Province as not to reduce the resources but to increase for sustainable utilization. To achieve that goal, the Project carried out the following activities;

Activity 1: Understand the current situation of BSC fisheries in Kep Province

This is meant to clarify the direction of the measures to conserve and manage the BSC resources by understanding the current situation of BSC fisheries in Kep Province.

Activity 2: Collect catch data and evaluate the stock of BSC resources

This would provide understanding of the catch status of the BSC resources in Kep Province and of the need to evaluate the stock, and based on such information, measures could be developed for fisheries resource management of BSC resources, in particular, catch management.

Activity 3: Enhance the conservation of BSC resources by complying with fishing regulations

3.1 Compliance with catch restrictions on crab size

Signboards to be installed indicating the restrictions for catching certain crab sizes

3.2 Strengthening the regulations on fishing operations in the conservation area

Buoys to be set up in no-fishing area (conservation area) so that fishers can see the location of the conservation area from the sea

Activity 4: Implement measures to increase BSC resources

Introduction of hatching and stocking system

This is intended to increase the BSC resources by protecting hatching larvae (from instars to crablets) through the promotion of hatching and larval rearing technology

2) Results

Activity 1: Understand the current situation of BSC fisheries in Kep Province

➤ Conduct socio-economic and market surveys

Socio-economic and market survey were conducted to understand the fishery situation in Kep Province. The items in the questionnaire included information on the income of fishers, asset (properties), fishing operations, the status of cooperation networks, awareness of resource management, sales and prices, sales destinations, etc.

It is expected that local governments (Kep FiAC) and Community Fisheries (CFi) will use the detailed data/information obtained from these surveys to formulating and implementing the effective management measures.

➤ Assessment of fishery management and future measures

The current situation of fishery management in Kep Province was assessed using the “FishMAT” method. Results of the assessment clarified the shortcomings of fishery management activities in Kep Province.

The management areas with the highest assessment were “Human and organizational competence”/ “Evaluation and analytical skills.” which could be due to presence of an education system for fishers in the area, and also the existence of the Marine Research and Development Center (MARDeC) in Sihanoukville, where research and technology dissemination activities are being carried out.

The management areas with the lowest assessment were “Management effort (input control)”/ “Management harvest (output control)” / “Business improvement and post-harvest processing.”

The reason for such low score are as follows:

- There is no fishery registration system or licensing system,
- The fishing surveillance system is not functioning,
- Illegal fishing gear continue to be in operation,
- Although there are restrictions on size of crab allowed to be caught, but fishers seem not compliant with such regulations,
- Regulations on mesh size of fishing gear not enforced and operational restrictions in conservation areas not controlled,
- The output control monitoring system is not functioning,
- Fishers do not know how to improve their livelihoods and do not have the information to do so,
- There are no standards for fish post-harvest hygiene management and no monitoring system,

Given these facts, the fishery management in Kep Province should be strengthened through the following approaches:

- Introduction of the fishery registration system and licensing system
- Conduct of activities to control illegal fishing operations,
- Enforcement of regulations should be strengthened and find ways for fishers to comply with catch regulations, and fishery surveillance systems should be introduced and enforced
- Introduction of post-harvest hygiene standards, technology to maintain the freshness of fish, and technology to add value to fish products.

Activity 2: Collect catch data and evaluate the stock of BSC resources

The utilization status of BSC resources in Kep Province was not known because catch data had not been collected so far. This Project therefore collected the catch data of BSC resources and analyzed catch trends and stock status of BSC resources.

Data on BSC catch and fishing vessels were gathered from crab traders at three of the landing sites in Kep Province. The data for stock assessment was collected by sampling crabs caught and measuring the size of carapace and weight by an individually.

Although the data collection period was only two (2) years, it was possible to analyze crab catching trends and stock status in Kep Province. Result of analysis indicated that the crab stock in Kep Province is not currently overfished. However, if fishers would continue to catch small-sized crabs as they are currently doing, the BSC resources in Kep Province could be reduced. In order to ensure the sustainable utilization of BSC resources in Kep Province, fishing pressure must not be increased, in which case it would be effective if fishers were to release under-sized crabs caught and catch only large-size crabs.

Activity 3: Enhance the conservation of BSC resources by complying with fishing regulations

3.1 Compliance with catch restrictions on crab size

➤ Install signboards indicating restrictions for catching certain crab size

There are fishery regulations that prohibit the catching of individual crabs with carapace length of 9 cm or less, but many fishers do not comply with such regulation. Neither crab traders nor tourists consuming the crabs know such regulations. Therefore, as part of the Project's activities, the signboards were made and posted in strategic areas to indicate that catching of under-size crabs is prohibited. It is important to make this known not only to fishers but also to the crab traders and tourists. Informing the local crab traders and consuming parties through the sideboards that fishing under-size crab fishing is prohibited will help the fishers comply with the regulations.

3.2 Strengthening the regulations on fishing operations in the conservation area

➤ Install buoys in the conservation area (no-fishing operation area)

The conservation area (no-fishing operation area) is located inshore near the Angkaol village. Considering the claims that fishers could not confirm the exact location of the conservation area from the sea and as result continue their illegal fishing operations, the Project facilitated the installation of buoys to mark the estimated location of the said area. These buoys should be able to guide the fisher, and thereby eliminate illegal fishing.

These buoys were created and installed by fishers themselves, so that by doing so, the fishers also increased their awareness of the need to conserve and manage BSC resources.

Activity 4: Implement measures to increase BSC resources

Introduction of hatching and stocking system

Hatching and stocking of BSC have already been carried out in other fishing villages in Cambodia as well as in villages of Thailand. Therefore, the technology is already in practice and does not require to be developed further, therefore is not technically difficult to introduce.

For hatching and stocking system to be established in fishing villages, the key to their success is how to source for gravid female crabs, and construction of overall system for managing the hatching facilities. This led to the introduction of a crab bank system in the village.

The first feature of the crab bank system under this Project is that gravid female BSC crabs had been provided free of charge by the fishers who caught them. The second feature is that a system has been established wherein the fishers themselves manage the hatching facilities free of charge.

In other areas in the region, the crab bank system is mainly operated with government funding or financial support from other sources of funds provided to fishers. However, the operation of hatching and stocking activity at Angkaol Village were made possible through a system of cooperation among the fishers themselves. The commitment of fishers to be activity involved in the hatching and stocking activities is a major factor that enabled the introduction and establishment of BSC hatching and stocking systems in the villages.

In the future, the case of the hatching and stocking system practiced in Kep Province based on the contribution and support of fishers, would be considered a successful case study in promoting such system for conserving the BSC resources in other areas of the country and the region.

Also, if the stocking of crab larvae through the crab bank system which is maintained by the fishers themselves, would lead to increased BSC resources then it is expected that the fishers will become more aware of the need to enhance the crab resources. For such purpose, it is necessary to develop a method of evaluating the effect of larval crab stocking in a crab bank scheme, to the BSC resources.

3) Recommendation

This Project had implemented measures to conserve and manage the BSC resources so as not to allow the depletion of this economically important resource in Kep Province, by carrying out Activities (a)-(d). The approach of this Project has had very positive effects on the management of BSC resources in Kep Province, so this approach could be promoted as a small-scale fisheries resource management method in other parts of the country and in the region.

The approaches developed through the Project were:

- (a) Understanding the current situation of the fisheries in Kep Province
 - Conduct of socio-economic and fisheries management assessment surveys
- (b) Collection of catch data and evaluation of the resources stock of target species
 - Collect catch data and evaluate the BSC resources
- (c) Enhancement of the conservation of target resources by complying with fishing regulations
 - Dissemination and enlightenment of fishery regulations to fishers and traders, as well as to consumers
- (d) Implementation of measures to enhance the target resources
 - Implementation of measures to enhance the stocks of target resources by introducing hatching and stocking technology

In this Project, the successful implementation of the activities (a)-(d) would show the procedure on how to manage small-scale fisheries. Moreover, the voluntary efforts by fishers themselves to manage the fishery resources are very crucial in the conservation and sustainable utilization of the resources.

Fisheries resource management would not be as successful if the activities are led solely by the government or international organizations. In this Project, the fishers were encouraged to actively participate in the Project activities, and true enough the fishers themselves cooperated and participated actively in the activities. This is, above all, the main factor that has led to achieving significant results in the activities of this Project.

The approach implemented in this Project is effective for strengthening the fisheries resource management measures in small-scale coastal fisheries and can be applied to other areas.

Questionnaire for basic information

For Situation Analysis (Information of the wider socio-economic and environmental trends and patterns and the value and context of coastal resources in the area)

Name of respondent

.....

Address:

.....

Interviewer.....Date

.....Venue.....

Part I: General Information

1. Sex [1] male [2] female
2. Age years
3. Religion [1] Buddhist [2] Muslim [3] Christian [4] Other (specify).....
4. Marital status [1] Single [2] Married [3] Widow [4] Divorce
5. Education [1] None [2] Primary school [3] Junior high school
[4] Senior high school [5] Bachelor's degree [6] other
(specify).....

6. Total member in family.....person
 - 6.1 Adult Person. No. of men..... No. of women.....

 - 6.2 Children (under 15 years old).....person. No. of men..... No. of women.....

7. Major Source of total monthly income KHR
 - [1] Fisheries (.....KHR) [6] Aquaculture (.....KHR)
 - [2] Agriculture (.....KHR) [7] Trading (.....KHR)
 - [3] Laboring (.....KHR) [8] Live stock (.....KHR)
 - [4] Processing (.....KHR) [9] Tourism (.....KHR)
 - [5] Other (specify) (.....KHR)

8. Monthly expenditure KHR
- [1]Electricity (.....KHR) [6]Water (.....KHR)
- [2]Food/beverage (.....KHR) [7]Clothing (.....KHR)
- [3]Education (.....KHR) [8]Social affair (.....KHR)
- [4]Entertainment (.....KHR) [9]Transportation (.....KHR)
- [5]Other(..... KHR) [10] Other.....(..... KHR)

9. Asset ownership
- [1] Fishing boatunit [2] Landhectare
- [3] Livestock (cow....., buffalo....., pig....., chicken.....)
- [4] Carunit [5] Other (specify).....,unit
- [6] Houseunit [7] Farmland/paddy field hectare
- [8] Motorbike.....unit

10. About household goods, what kind good does your household have?
- [1] TV [2] Washing machine [3] Refrigerator [4] Microwave [5] Air-conditioner [6] Electric fan
- [7] Mobile phone [8] Motorbike [9] Car [10] Home theater [11] DVD player [12] Computer

Part II: Fisheries Sector

1. Fishing experience..... years
2. Fishing boat

2.1 fishing boat	2.2 In/Out board motor	2.3 Length (meters)	2.4 Engine power (horse power)	2.5 Construction material (wood/FRP)	2.6 Price of boat when purchased (KHR)	2.7 Licensed/ Unlicensed boat	2.8 No. of crew (person)
No.1	<input type="checkbox"/> Yes <input type="checkbox"/> No
No.2	<input type="checkbox"/> Yes <input type="checkbox"/> No
No.3	<input type="checkbox"/> Yes <input type="checkbox"/> No

3. Type of fishing gear

3.1 Type of fishing gear	3.2 No. of fishing gear	3.3 Fishing Season (month)	3.4 No. of fishing day per month	3.5 Fishing hours a day	3.6 No. of haul per fishing trip	3.7 Fishing ground (see map) (mile)
(1).....
(2).....
(3).....

4. Catch utilization and distribution (per trip)

4.1 Type of fish species	Utilization (%/trip)		4.4 Total Quantity (kg/trip)	4.5 Price (KHR/kg)	4.6 Total income (KHR/trip)
	4.2 Family consumption	4.3 sale			
.....
.....
.....
.....

5. Whom do you sell your catch? (MA) [1] Men [2] Women [3] Both

5.1 [1] Middleman [2] Fish retailer [3] Restaurant [4] End customer (Home use, Local market)

[5] Others.....

5.2 How do you carry them? (MA)

[1] By motorcycle [2] By Car [3] By boat [4] Human power [5] Middleman comes to pick up

6. Operating cost (KHR/trip) *(Refer to 3.1)*

6.1 Type of fishing gear	Operational costs (KHR)						6.8 Total cost (KHR)	6.9 Maintenance costs
	6.2 Fuel	6.3 ice	6.4 food	6.5 labor	6.6 Bait	6.7 other		
(1).....	
(2).....	
(3).....	

7. Boat Maintenance costs.....KHR/year

8. About labor

8.1 Number of labor in a operation [1] Men.....pr [2] Women.....pr

8.2 Relationship between you and your employer (MA); [1] family [2] relative [3] fisherman's fellow [4] neighborhood of your house [5] foreign employee [6] others.....

9. Do you have any problems with fisheries? State the problems and level the seriousness to continue fishery. [1] YES [2] NO

What problem?

No. 1.....

No. 2.....

No. 3.....

10. Fisheries Management

These sentences should be addressed before the questions. At present in Thailand, fishery resources are considered as a common property and fishing is open access activity. So, anyone have right to catch the fish, shrimp, crab and mollusk in Thai water according to Thai Fisheries Act.

10.1 Does fishing under this principle may lead over-fishing and fishery resource reduction?

[1] Yes [2] No [3] Do not know

10.2 Explain Fisheries Management to respondents as follows.

“Fisheries Management (FM) is a marine policy to control fishing gear and methods to protect aquatic resources. For example, controlling mesh size, setting seasonal closure, prohibit particular fishing gear in some areas. (Artificial reefs and crab banks are stock enhancement not F.M.)

Have you ever heard of fisheries management in and around your fishing ground?

[1] Yes, what kind of FM? [2] No

10.3. What is the purpose of fisheries management in your fishing ground? (MA)

[1] Releasing seeds/fingerling [2] Conserve fishery resources

[3] Increase fishery resources [4] Maintain fishery resources

[5] Don't know [6] Other

10.4 What kind of fisheries management do you have in this area?

10.4.1 Name of the target species;

10.4.2 Name of the target fishing gear;

10.4.3 Outline of penalty;

10.4.4 Name of main organization;

10.4.5 Others

10.5 Do you think a fisheries management is necessary in and around your fishing ground?
(SA)

No need 1 2 3 4 5 Very necessary

10.6 What is your suggestion or comment for fisheries management in your area?

.....
...
.....
...

Part III: Aquaculture

3.1 Do you operate aquaculture? [1] YES (go to 3.2) [2] NO (if no skip this part)

3.2 Production schedule

3.2.1 Species	3.2.1 Type of facility 1 – pond 2 – cage 3– fence 4- others, specify	3.2.3 What year did you start?	3.2.4 How many production cycles do you have in a year? (stock to harvest)	Based on last production cycle			
				3.2.5 What % of the total harvest was sold and equivalent in kg? % in kg	3.2.6 Price/kg received	3.2.7 Operation Cost	

3.3 About labor

3.3.1 Number of labor in a operation[1] Men.....pr [2] Women.....pr

3.3.2 Relationship between you and your employer (MA); [1]family [2] relative [3] fisherman’s fellow [4]neighborhood of your house [5] foreign employee [6] others.....

3.4 Whom do you sell your catch? (MA) [1]Men [2] Women [3] Both

3.4.1 [1] Middleman [2]Fish retailer [3] Restaurant [4]End customer (Home use, Local market)

[5]others.....

3.4.2 How do you carry them? (MA)

[1]By motorcycle [2] By Car [3]By boat [4]Human power [5]Middleman comes to pick up

3. 5. Problem on aquaculture

1. Do you have any problem on aquaculture operation? [1] YES [2] NO

- What problem?

No. 1.....

No. 2.....

No. 3.....

Part IV. Agriculture

4.1 Do you have agriculture farm? [1] YES [2] NO

4.2 Main Agriculture

Crop name	How many production cycle do you have in a year? (stock to harvest)	Based on last production cycle				
		Volume of product per one cycle (kg)	What % of the total harvest was sold and equivalent in kg?		Average price/kg received (KHR/kg)	Total Cost (Bath per cycle)
			%	in kg		

4.3 Do you sell agriculture products?

[1] YES [2] NO

4.4 Whom do you sell your agriculture products to? (MA) [1] Men [2] Women [3]

Both

[1] Middleman [2] Retailer [3] End customer (Home use, Local market) [4] Processing factory

[5] Others.....

4.5 How do you carry them? (MA)

[1] By motorcycle [2] By Car [3] By boat [4] Human power [5] Middleman comes to pick up

[6] Factory come to pick up

4.6 Do you have a fixed selling space? How much is the rent of the selling space?

[1] YES, How much?.....KHR/month [2] NO

Part V. Main livestock

5.1 Do you have livestock? [1] YES [2]NO

Livestock name	How many months do you raise livestock? (stock to harvest)	Based on last production cycle				
		Volume of product per one cycle (kg)	What % of the total harvest was sold and equivalent in kg?		Average price/kg received (KHR/kg)	Total Cost (Bath per cycle)
			%	in kg		

5.2 Do you sell livestock?

[1] YES [2] NO

5.3 Whom do you sell your livestock products to? (MA) [1]Men [2] Women [3]

Both

[1] Middleman [2] Retailer [3] End customer (Home use, Local market) [4]

Processing factory

[5] Others.....

5.4. How do you carry them? (MA)

[1] By motorcycle [2] By Car [3] By boat [4] Human power [5] Middleman comes to pick up

[6] Factory come to pick up

5.4. Do you have a fixed selling space? How much is the rent of the selling space?

[1] YES, How much?..... KHR/month [2] NO

Part VI. Social Capital

4.1 Reproductive Roles (*the Roles/Activities that cannot get income*)

Reproductive roles	Men	Women	Both (50/50)	Comments
Child care				
Care for elderly and sick family members				
Cooking				
Cleaning				
Water collection				
Fuel collection or energy production				
Food security & nutrition (<i>e.g.</i> home gardening, livestock, gleaning)				
Grazing for animals/livestock				
Community activities				
Building/repairing a house				
Traditional rice milling				
Other.....				
Other.....				
Other.....				

4.2 Productive Roles *(the Roles/Activities that can get income)*

Livelihood activities	Men	Women	Both	Boys	Girls	Both	Comments
Farming (subsistence)							
Farming (commercial crops/crop production)							
Fishing (subsistence/HH level) - Capture fisheries (caught fish, prawns, crabs, or shellfish)							
Fishing (commercial/local or external market) - Capture fisheries (caught fish, prawns, crabs, or shellfish)							
Gleaning/hand-collection from wetland areas (e.g. snails, frogs, crabs, etc)							
Water collection (consumption, water management, irrigation management etc.)							
Aquaculture							
Preparing fishing gear							
Fish processing / post harvest production							
Marketing/Selling (fish, vegetables, rice, forest products, other)							
Livestock rearing (goat, cow, buffalo, chicken, other) or Animal husbandry/livestock production							
Timber Collection							
Collecting Non Timber Forest Products (this can also include aquatic plants) or Forest user (e.g. gathering non-timber forest products)							
Salaried / waged employment							
Eco-tourism; e.g. tour guide, boat operator, cooking, homestay working in a guesthouse, etc.							
Informal employment (unpaid work e.g. shopkeeper, food preparation, handicraft production, casual work)							
Business (SME, shop, trading)							
No job/unemployment							
Remittance from relatives							
Illegal activities (hunting, smuggling, poaching)							
Other.....							
....							
Other.....							
....							

4.3 Access and control

Resources	Access (can use)			Ownership (can own formally or legally)			Control (can independently make decisions over (e.g., have rights to share/sell/alienate, sell, consume, improve)			Notes /comments
	Men	Women	Equal	Men	Women	Equal	Men	Women	Equal	
Land										
Water supply										
Forest products										
Borrow money from Bank										
Borrow money from Community Group										
Borrow money from private loan										
Labor (e.g. family relations), informal labor, hired labor)										
Fisheries inputs: - fishing gear - boats - boat engines										

- storage facilities										
Fishing license										
Agricultural production materials: - seed - machinery - poultry - water buffalo - storage										
Livestock production requirements										
Raw materials for artisan and craft production										
Transportation (boats, trucks, other vehicles)										
Education/training Skill development, etc.										

4.5 Human network

4.5.1 Are you a member of any organization in the community?

[1] YES [2] NO ⇒ go to (4.5.3)

4.5.2 Which type of organization is this? And how many times did you attend the organization's meetings over the past year?

[1] Name of groupyour position..... andtimes/yr

[3] Insufficiency of children's education.

[4] Health condition of the family.

[5] Others.....

4.6.4 Do you think a good human relationship is very important within the village and neighborhood?(SA)

[1] YES [2] NO [3] Don't know

4.6.5 What kind of person has a respect in your village (SA)

[1] Much-earning and rich person

[2] The person who has much life capital such as the field, fishing boat and net

[3] The person who has wide social network

[4] Others

4.6.6 Do you have any hope in the future? (SA)

[1] Much [2] Some [3] Little [4] None [5] I don't know

What kind of hope?.....

4.6.7 Are you happy in the present life?

[1] Very happy [2] Happy [3] Neither happy nor unhappy

[4] Unhappy [5] Very unhappy [6] Don't know.

4.6.8 Do you think rich natural resources (exclude fishery resources) are very important for maintaining your job?
(SA)

[1] YES [2] NO [3] Don't know

4.6.9 Here are two (2) statements people sometimes make when discussing the environment and economic growth. Which of them comes closer to your own point of view? (Read out and code one answer):

- [1] Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs.
- [2] Economic growth and creating jobs should be the top priority, even if the environment suffers to some extent.
- [3] Other answers.....

Interview form for middlemen

Time of interview	Start: _____ End: _____	Place of interview	_____
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Date (date/month/year) _____

My name is :_(Ms./Mr.) _____ **Age:** _____

I live in: _____

1 About the business

- 1.1 Year of establishment (_____)
- 1.2 Previous job (_____)
- 1.3 Number of employees (_____) persons
- 1.4 Selling value/day (_____) KHR
- 1.5 No. of Working Days (_____) days / year
- 1.6 Purchasing area (_____)

1.7 Besides buying fish, do you sell anything (for example; fishing gear, fuel, engine, engine oil, boat) or provide any service to fisher?

1.8 Do you have another business, excluding the middleman?

1- (1)Yes (Proceed to next) (0)No

2- If yes, What kind of the business is it? _____

3- Which is main business for you the middleman and others? (1) Middleman (0) Others

1.9 Do you buy the aquatic animal by yourself?

1- (1)Yes (0) No (Proceed to next)

2- If no, Who buy the aquatic animal for you?

(1) Male (2) Female The relationship is _____

1.10 Do you sell the aquatic animal by yourself?

1- (1)Yes (0) No (Proceed to next)

2- If no, Who buy the aquatic animal for you?

(1) Male (2) Female The relationship is _____

2 Buying fish from the seller (fisher/middleman/other)

High season

(1) Species	(2) Quantity (kg/day)	(2.1) Buying Price (KHR/kg)	(3) Buyin g place	(4) Business category of seller	(5) Transportation for gathering aquatic products	(6) No. of regular seller	(8) How to transport live fish?	(9) Trends of easiness to buy			
								At the time of establish -ment	10 yrs. ago	5 yrs. ago	Last year

Low season

(1) Species	(2) Quantity (kg/day)	(2.1) Buying Price (KHR/kg)	(3) Buyin g place	(4) Business category of seller	(5) Transportation for gathering aquatic products	(6) No. of regular seller	(8) Live, Fresh, or Chilled?	(9) Trends of easiness to buy			
								At the time of establish -ment	10 yrs. ago	5 yrs. ago	Last year

Remark:

<p>(3)</p> <p>1. Interviewee's house</p> <p>2. Local Market</p>	<p>(4)</p> <p>1. Fishers</p> <p>2. Middleman</p>	<p>(5)</p> <p>1. Walking 4. Pickup truck</p> <p>2. Motorcycle 5. Refrigerator truck</p> <p>3. Motorcycle with side car 6. Others (Write down)</p>	<p>(8)</p> <p>1. Live</p> <p>2. Fresh</p>
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2.1 Why do you buy it from the (4) ↑ (Multi answer allowed)

- 1- He/she is old acquaintance / friend
- 2- He/she is relative
- 3- He/she brings large amount of fish
- 4- His/Her fish is good quality
- 5- His/Her sorting is good
- 6- Others _____

3 Selling fish

(1) Species	(3) Transportation	Customer			(8) Trends of easiness to sell			
		(4) Business category	(5) Quantity percentage of each customer	(6) Location	At the time of establishment	10 yrs. ago	5 yrs. ago	Last year

Remark:

(2) Grade, quantity (kg/day) and price (Riels/kg) of goods

(3)

- 1. Walking 4. Pickup truck
- 2. Motorcycle 5. Refrigerator truck

(4)

- 1. Wholesale market 4. Supermarket
- 2. Processing company 5. Importer

Appendix 3

Criteria listed in FishMAT (Terashima et al., 2016)

Categories	Factors	Weight	MCSA
1) Basic information of current situation	1) Information on the number of fishing vessel and local fishers	2	M
	2) Information on the number of days of fishing operation	1	M
	3) Information on the catch amount of principal species	2	M
	4) Information on the distribution amount of principal species	1	M
	5) Price data on landing and retail site for principal species	1	M
	6) Information on the facilities of landing site such as number of ice-making machines and storage	1	M
	7) Information on the domestic consumption of principal species	1	M
	8) Information of the number of middle-persons in active	1	M
	9) Information of fisheries cooperatives in active	2	M
	10) Information of resource management activities in local fishers	3	M
	Score	15	
2) Maintenance Rehabilitation of the Ecosystem	1) Regulations on inflow/outflow sediment including sands/soil mining	2	C
	2) Regulations on sewage and industrial effluent water	1	C
	3) Regulations on deforestation including mangrove	1	C
	4) Regulation on waste disposal and control	1	C
	5) Surveillance system on the practice of the above factors	2	S
	6) Activities for rehabilitation of environment (Coral reef, mangrove, tidal flat and seaweed bed)	2	A
	7) Surveillance system for preventing IUU fishing	2	S
	8) Seed production and release and installation of nursery ground for stock enhancement	2	A
	9) Conservation activities for rare and endangered species	1	S
	10) Public awareness on the practice of the above factors	1	A
	Score	15	
3) Management of efforts (Input-Control)	1) Fishers/ vessel registration system for each fishing type	2	C
	2) License/ permission system for each fishery	1	C
	3) Surveillance system on the practice of the above factors	2	S
	4) Zoning of fishing ground by fishing method	2	C
	5) Surveillance system on the practice of the above factor	2	S
	6) Regulation on fishing vessel capabilities such as HP, Tonnage, length	1	C
	7) Restrictions on the fishing method including destructive fishing	2	C
	8) Surveillance system for destructive fishing	2	S
	9) Restrictions on the fishing gear or equipment of fishing vessel	1	C
	10) Restrictions on the fishing period (months in year)	1	C
	11) Restrictions on the operational time of fishing (time in a day)	1	C
	12) Restrictions on allowable operational days (day a year)	1	C
	13) Surveillance system on the practice of the above factor	1	S
	14) Regulation on fishing ground such as no-fishing zones, marine preserves, MPAs	3	C
	15) Surveillance system on the practice of the above factors	3	S
	Score	25	

Categories	Factors	Weight	MCSA	
4) Management of harvests (Output- Control)	1) Systematic mechanisms to understand fish-catch information such as catch amount, size of caught fish	2	M	
	2) Regulation on catch size of principal fishery species or restrictions on catch by maturation stage or sex of crustaceans	2	C	
	3) Surveillance system on the practice of the above factors	2	S	
	4) Restrictions on by-catch in industrial fishing	1	C	
	5) Surveillance system on the practice of the above factor	1	S	
	6) Restrictions on upper-limit of Catch amount per each fisher	2	C	
	7) Surveillance system on the practice of the above factor	2	S	
	8) Restrictions on upper-limit of catch amount per region or in the nation	1	C	
	9) Surveillance system on the practice of the above factors	1	S	
	10) Regulation or support system on local fishers or fishery cooperative for fish catch recordings	2	M	
	11) Public awareness or fishers' training program regarding above factors	1	A	
	12) Periodical communications between fishers and government regarding above factors	1	A	
Score		18		
5) Business improvement	1) Activities or guidelines for cost saving of fishing operation	1	A	
	2) Activities or guidelines for fish preservation	2	A	
	3) Activities or guidelines for value-adding to fish products	1	A	
	4) Activities or guidelines for alternative income sources	3	A	
	5) Activities for diversion or change of fishing type	1	A	
	6) Activities for cooperative shipping or marketing by local fishers groups or fishery cooperatives	2	A	
	7) Finance support system such as tax reduction or financial compensation for local fishers or fishery cooperatives which assist any resource management scheme	1	A	
	8) Micro-finance scheme for local fishers	2	A	
	9) Activities for the business development service (BDS) for fishery cooperatives and related small and medium-sized enterprises (SMEs)	1	A	
	10) Public awareness activities by administrative institutions regarding above factors	1	A	
Score		15		
6) Post- harvest treatment / processing	On boat	1) Activities for improvement of fish preservation techniques	2	A
		2) Technical guidance by administrative institutions	1	A
		3) Fishing vessels equipped with cold storage facilities for fish preservation	1	A
		4) On-board sanitary standard	1	C
	After landing	5) Surveillance system on practice of the above factor	1	S
		6) Sanitary and quality standard for fishery products	1	C
		7) Surveillance system on the practice of the above factor	1	S
		8) Activities for improvement of processing techniques	1	A

9) Activities for improvement of fishery products distribution	2	A
10) Activities for improvement of fish landing factors	1	A
11) Activities for improvement of fish markets	2	A
12) Public awareness activities by administrative institutions regarding above factors	1	A

Score 15

Categories	Factors	Weight	MCSA
7) Human and organizational capacity	1) Officers for dissemination and protection in each local area	2	M
	2) NGOs and other organization supporting fishery management activity	2	A
	3) Periodical communications between central and local fishery authorities	1	M
	4) Periodical communications between fishery authority and related other authorities such as ministry of environment and coast guard	1	M
	5) Periodical communications between fishery authority and fisheries cooperatives	2	M
	6) Periodical communications between private organizations such as fisheries cooperatives and NGOs	2	M
	7) Education system for the local officers	1	A
	8) Education system for the staff of research institutes	1	A
	9) Education system for the local fishers	2	A
	10) Education system for the middle persons and processing persons	1	A
Score		15	
8) Assessment and analysis capacity	1) Research institutes for fishery science	2	M
	2) Stock assessment to principal species by local researchers or institutes	2	M
	3) Studies for ecological and biological characteristics such as spawning ground, period on principal species by local researchers or institutes	2	M
	4) Studies for oceanography such as current variation, salinity change and ocean temperature anomaly by local researchers or institutes.	1	M
	5) Studies for biological chemistry on coastal, estuarine and swampy waters by local researchers or institutes	1	M
	6) Studies for socioeconomics on fishery by local researchers or institutes	2	M
	7) Studies for processing techniques by local researchers or institutes	1	M
	8) Studies for fishing equipment and techniques, by local researchers or institutes	1	M
	9) Periodical communications between the administrative organizations and researchers regarding above factors	1	A
	10) Dissemination activities for the research results regarding above factors	1	A
Score		14	

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