

CRAB FISHERIES IN CAMBODIA AND THE DEVELOPMENT OF CRAB BANKS



2012



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EXECUTIVE SUMMARY

The crab (swimming crab; *Portunus pelagicus*) fishery in coastal Cambodia appears to have declined in recent years due to over-fishing and a growth in the number of fishermen, but remains an important source of income for households along the coast. Several initiatives have started since 2007, with support from NGOs, international organizations and the Fisheries Administration (FiA), to test stock enhancement techniques through the release of crab larvae. The so-called “crab bank” initiative involves keeping harvested gravid crabs alive in cages for a few days until they spawn, instead of immediately selling them for consumption or processing. In Cambodia, this initiative has developed within the framework of Community Fisheries (CFis) and thus implies a community-based approach. The FiA has promoted the continuation of such initiatives; however, the nature of crab fisheries and the results from crab bank initiatives have not been documented in detail. The scope of this study was to understand the diversity of approaches to crab bank development in Cambodia, as well as their operational status and the challenges faced at different sites.

Detailed case studies were conducted for four crab bank initiatives in Kep (one), Kampot (one) and Preah Sihanouk provinces (two). At each survey site, focus group discussion (FGD) was used to investigate livelihood options and the range in wealth status among the community members. Participants in these discussions included crab fishers, non-crab fishers, and Crab Bank Committees. The process of crab bank development and the role of CFis were investigated during the FGDs with the Crab Bank Committee and Community Fishery Committee members. At least 50% of the crab bank members were interviewed about crab bank implementation, challenges and incentives to join the initiative. In addition, technical and quantitative data on crab fisheries and income diversification was collected. The role of the FiA and Commune Councils was also investigated during semi-structured interviews with representatives of each institution.

The nature of the crab fishery itself was diverse across the four survey sites. Practices ranged from those associated with small-scale inshore fisheries to medium-scale offshore fisheries, with a wide difference in fishing intensity and access to the resource. In Kampong Samaki, CFi fishers used hand push-nets and crab traps (average of 100 traps per fisher) for fishing near the shore, while in Phum Thmey, CFi fishers used on average more than 1,000 crab traps and fished offshore. The average volume of crab catch varied from 4.5 kg/day/fisher in Kampong Samaki to more than 39 kg/day/fisher in Phum Thmey. Crab fishers were highly specialized in targeting crabs, with more than 50% of their income generated from the crab fishery. Fishing for other resources such as fish, squid and octopus was not as popular among fishers. Only in Tomnop Rolok did it represent 18% of the household income, which was similar to the share of rice farming and other crops in the three other survey sites.

Crab fishing is highly seasonal activity, and fishers at various sites use different gears and have different target fishing grounds. Tomnop Rolok and Phum Thmey have a peak season during the rainy season (June-August), while the two other sites experience the peak time of year mainly during the dry season (November-March). Direct marketing channels for fishers are limited as most crab fishers sign contracts with middlemen living in the same village. These middlemen then provide informal loans to allow fishers to purchase fishing gear and in return the middlemen gain exclusive rights to the fishermen’s harvest. Fishermen have to sell their catch at a fixed price to the middlemen.

Results show that crab bank models used in Cambodia are diverse, ranging from systems based on the purchase of gravid crabs (Kampong Samaki, Tomnop Rolok), to donation of the crabs (Prey Nop II) and donation with access to loans (Phum Thmey). The number of participants (Table 1) as well as the duration of crab bank operation varies from only two months in Kampong Samaki to 6-9 months in Prey Nop II.

Table 1. Crab bank characteristics at the survey sites

Crab bank	Kampong Samaki	Phum Thmey	Prey Nop II	Tomnop Rolok
Year and duration of operation	2009-2 months	2009-6 months	2008-9 months 2009-6 months	2008-4 months 2009-5 months
Operational status as of Jan. 2010	Inactive	Active	Active	Inactive
Members	CF Committee	27 fishermen	38 fishermen	CF Committee
Systems (loan, donations)	Purchased – fattening – marketing - lump sum from NGO	Loan (125 USD for each) with the total of 2,750 USD from NGOs	Donations	Purchase-fattening- marketing- lump sum from Fisheries Administration Cantonment

The membership also varies among the study sites. Only selected crab fishers from the village participated in crab bank activities in Phum Thmey, while volunteers could freely join in Prey Nop II. In Tomnop Rolok and Kampong Samaki, only Community Fishery Committee members were involved. At the latter two sites the crab bank became inactive after a few months because the high mortality rate of the gravid female crabs in the cages resulted in insufficient gross economic return. Other models based on the donation of gravid crabs were found to be more economically viable. The model using the provision of loans as an incentive was the most successful in terms of establishing a sustainable crab bank operation, as the number of participants increased and the operation was economically more viable. However, this model requires the highest start-up investment to provide the revolving funds for the loans to crab bank participants. In addition, this system requires a more transparent processes and external support and oversight (FiA, NGOs, Commune Councils) to monitor activities and financial records.

Some crab bank operations were found to be severely constrained by natural environmental conditions. According to fishermen, decreased water salinity and a higher frequency of storms in the rainy season led to lower crab fishing yields. Only the Prey Nop II site has been able to operate cages for more than 6 months to keep gravid crabs. In addition the peak spawning season for at least one of the sites was during the rainy season, when the crab bank could not be implemented for the reasons mentioned above. Other technical factors impeding the crab banks were the accessibility of the cages from the village. Easy access to the cages is necessary to encourage greater participation and donation of gravid females. Technical support is needed to organize the crab banks and to develop transparent management mechanisms, such as clear recording of financial transactions and the crab "flow". This is particularly important for building trust within the group and encouraging more fishers to join projects using models based on crab donations or loans. The lack of involvement of crab fishers in planning and the poor awareness of crab bank activities restricted the adoption of the model.

We conclude that crab banks can be successfully developed along the Cambodian coastline. However, they are unlikely to be viable in all geographic areas and careful consideration needs to be given to the design, location and natural environment. The case studies suggest that villages with a medium-scale crab

fishery can more easily develop such activities in part due to a more stable supply of gravid female crabs. The location of the crab bank should allow easy access and be suitable for keeping crabs alive in the cage while they spawn, especially considering biological conditions and water salinity. In addition, institutions should identify whether the peak catch season and the peak spawning season coincide before developing crab banks.

An awareness campaign, clear roles and a transparent organizational structure can help to assure greater participation from fishers. In the absence of direct and visible short-term benefits to fishers, participation in crab bank activities is low. Additional financial incentives, such as access to loans or gifts from the project, would help increase the initial participation of local fishers, even if financial incentives can later limit their voluntary effort to participate in the crab bank when these incentives cease or are no longer attractive. Active participation of middlemen in crab bank development has shown to be beneficial to the overall approach.

The presence of illegal fishing within the CFI area, and poor law enforcement in combating it, discourages fishers from participating in stock enhancement activities such as crab banks. From a broader perspective, crab banks need to be part of a wider coastal resource conservation strategy and are most likely to be effective in combination with other fisheries management measures that ensure the sustainability of crab populations and the crab fishery in general.

In Cambodia, crab bank development is relatively new. More research is needed to gain a better understanding of basic issues such as crab spawning rates, the survival of crabs after spawning, and even the behavior of crabs when stocked in cages. Crab banks are generally considered a promising stock enhancement method as fishers in two survey sites felt (data collected during semi-structured interviews) that the crab catch had improved since the implementation of the crab bank. However, this could be caused by an increase in fishing effort related to loans for additional nets, traps, and other equipment, or by natural year-to-year fluctuations in the crab stock. Monitoring of the crab catch by fishers, based on sound scientific principles, is probably the most efficient method of assessing the impact of crab banks. In order to ensure the effectiveness of efforts to implement crab banks, this approach needs to be coupled with the enhanced capacity of the CFI organizations to manage crab fishing activities, including combating illegal fishing and avoiding overexploitation.

I. INTRODUCTION



Marine fisheries in Cambodia play an important role in coastal livelihoods. Most Cambodian households in coastal provinces are dependent on small to medium-scale fisheries. Despite the importance of marine fisheries, few studies document the diversity of the sector and the coastal livelihoods derived from it. According to the Fisheries Administration (FiA), more than 17,000 households are directly involved in small and medium-scale fisheries (cited in An 2006). Although not well documented, the importance of crab fisheries to coastal livelihoods in Cambodia is evident; they not only support the livelihoods of fishers, but also contribute to diversification of household income through employment in processing sector jobs such as crab peeling (Sam Ath & Roitana 2006).

Fisheries along the Cambodian coastline are characterized by low fishing capacity, with motorized vessels above 30 HP representing only 9% of the entire fleet of 6,531 boats according to official statistics (DoF annual report 2002, cited in An 2006). One of the important species targeted in marine fisheries is the swimming crab (*Portunus pelagicus*). With high demand from international markets, crab meat is processed and exported to Thailand and Vietnam. Crab catches vary depending on the province, with variation between the dry and the rainy season. In 2006, Koh Kong reported the highest catch (2,000 tonnes), followed by Preah Sihanouk (1,500 tonnes) and Kampot and Kep (627 tonnes) (FiA Kampot Cantonment; FiA 2007 cited in Puthy & Kristofersson 2007).

Crab fisheries are regulated by the new Fishery Law enacted in 2007. Regulations indicate the minimum size of crab that can legally be harvested, as well as the smallest allowable mesh size (3.5 cm) for nets. However, in practice, law enforcement is difficult and the use of unlawful fishing gears and catch practices is widespread. According to FiA statistics, the overall crab catch along the Cambodian coast has slightly increased (Figure 1) from 3,500 to more than 4,000 tonnes between 2000 and 2006 (FiA 2007 cited in Puthy & Kristofersson 2007).

However, according to FiA cantonment officers, crab catch monitoring is notoriously difficult and the statistics should be treated with caution¹. In addition to several issues concerning the monitoring of catch itself, fresh crabs may be transported to other provinces. While official crab catch statistics from Kampot show a declining trend, the reported quantity of processed crab meat increased, from 24 tonnes in 2000 to almost 80 tonnes in 2009. This can be explained by the fact that more raw crabs were brought from Preah Sihanouk and Koh Kong provinces to Kampot, in addition to local supply.

⁽¹⁾ For example, catch monitoring in Kampot cantonment shows a decrease of 50% between 2000 and 2009. According to FiA cantonment officers this apparent trend resulted from logistical constraints on the collection of statistical data: lack of resources at the FiA statistics department, shifting landing sites, direct export to neighboring countries or direct marketing to middlemen to supply cities. The reported crab landing in Kampot cantonment does not necessarily reflect the actual catch by fishers from Kampot, according to local cantonment officers. Crab fishers in Kampot do not always bring their catch to a port in Kampot and not all the catch landed in Kampot is systematically recorded.

While the crab catch seems to be stable at the national average, concerns around overharvesting and depletion of crab stocks are growing among experts and fishers alike. Inspired by similar initiatives in Japan, Thailand, and Malaysia, some international NGOs, research institutes and the government of Cambodia have implemented a variety of methods for natural crab stock enhancement. The method developed in Cambodia, called a “crab bank”, aims at stock enhancement through keeping gravid female crabs alive in cages for a few days until they release the larvae into the water. This differs from regular practices whereby crabs are immediately sold at market for processing or consumption. This crab bank approach is promoted through the framework of Community Fisheries (CFIs) and thus implies a community-based approach.

At least 19 crab bank projects have sprouted up along the Cambodian coastline since late 2007 and crab bank systems are now strongly promoted by the FiA (Hap *et al.* 2009). While diverse approaches to crab banks have been implemented through CFIs, very few have properly document the model developed, the process of implementation, the challenges faced and the impact on the natural environment and livelihoods of fishers. The strengths and weaknesses of a community-based approach are also unclear. Therefore, the scope of this study was to understand the diversity of approaches for crab bank development in Cambodia and the operational status and challenges faced at different sites.

This study aims to document the crab bank experience through four case studies, highlighting key issues and challenges impeding this model of natural resource management. The report is divided into five main parts. After the definition of the research objectives and the approach used, we characterize fishers’ livelihood portfolio, and technical aspects of crab fisheries with a special emphasis on seasonality. In the third part, we review the different models of crab banks and their background in Cambodia. In the fourth part, we discuss the incentives used to promote crab banks and the challenges faced by the crab banks. Finally, we draw lessons learned and present recommendations in the fifth and final part.

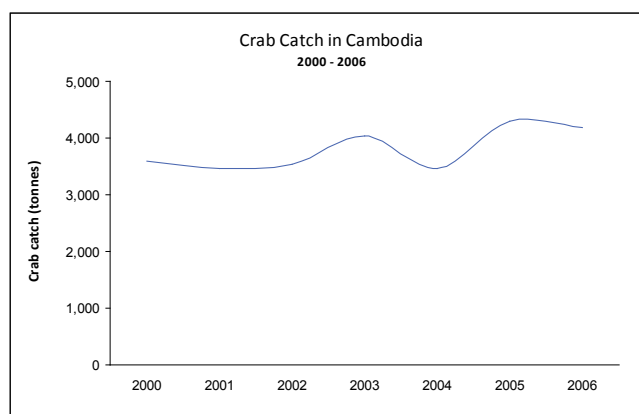


Figure 1: Crab catch trend in Cambodia (2000-2006).
Source: Fisheries Administration 2007, cited in Puthy & Kristofersson 2007



Fishing vessel on their way out on Kampot river

Photo by: The WorldFish Center

II. OBJECTIVES, RESEARCH QUESTIONS AND METHODOLOGY



Crab banks have been promoted and supported by the Fisheries Administration, Ministry of Agriculture, Forestry and Fisheries of the Royal Government of Cambodia, as a promising way of encouraging sustainable harvesting of wild crabs. The approach aims to create incentives for local fishers to participate in CFi organizations and their activities. However, the process of implementing crab banks has rarely been documented and there is no blueprint for this approach in Cambodia that has proven effective in achieving its stated goals and objectives. Coastal fisheries and especially crab fisheries are not well monitored in Cambodia. Scientific information on these natural resources is scarce and designing resource management activities based on limited knowledge is a challenge.

We decided to conduct this review as it has been more than one year since the crab bank approach was first introduced to Cambodia and there are sufficient experiences for us to document. Moreover, our approach attempts to understand key factors underlying the sustainability of crab bank operations at an institutional level in diverse environmental and socio-economic contexts.

The main research questions can be summarized as follows:

- What are the factors that influence the success or the inactivity of crab banks?
- Which approach and model is suitable for the socio-economic and environmental context in Cambodia?

The analytical framework used to answer these questions was developed in order to integrate thematic data on governance, economic, social, technical, and environmental issues. Each issue was analyzed at the community level. This analytical framework aimed to dissect the key variables that help clarify how and why governance, technical or economic factors either contribute to or detract from the achievement of desirable outcomes.

Crab banks and stock enhancement are closely linked to biological factors and especially the interactions between the lifecycle of the species and environmental conditions at crab bank sites. Biological characteristics of swimming crabs and technical aspects of the crab fisheries were investigated in a literature review and information about coastal livelihoods in Cambodia were gathered before the field survey to assess knowledge gaps on this specific topic.

II.1. Site selection and sample size

Five different crab banks were visited during a preliminary field visit in Kampot, Kep and Preah Sihanouk provinces². The purpose of this visit was to identify key research questions and select the final sites for more detailed survey. During this visit, the CFi Committee, Crab Bank Committee, FiA and NGO representatives were interviewed to gain

⁽²⁾ Crab banks in Koh Kong province were not visited due to the logistical and financial limitations of this study.

a better understanding of the different crab bank models and discuss the following topics:

- History of crab bank implementation in the provinces;
- Process of crab bank implementation and operation;
- Role of the different stakeholders;
- Perception of the local people of crab bank effectiveness;

- Crab value chain.

After this first step, four crab banks were selected for their variety in terms of operational status, level of success, crab bank model, and crab fishery (Table 2, Figure 2 & 3). The selected sites were not meant to be representative of all other crab banks, but to highlight and compare differences and commonalities among them.

Table 2. Crab banks selected for case studies

CFi	Province	Origin of Gravid Crabs	Support	Status
Kampong Samaki	Kampot	Purchased	CWDC	Inactive
Phum Thmey	Kep	Interest on loans	CORIN-Asia	Active
Prey Nop II	Preah Sihanouk	Donated	SEAFDEC	Active
Tomnop Rolok	Preah Sihanouk	Purchased	FiA	Inactive

CWDC: Children and Women Development Center in Cambodia
 CORIN-Asia: Coastal Resources Institute of Prince Songkla University
 SEAFDEC: Southeast Asian Fisheries Development Center

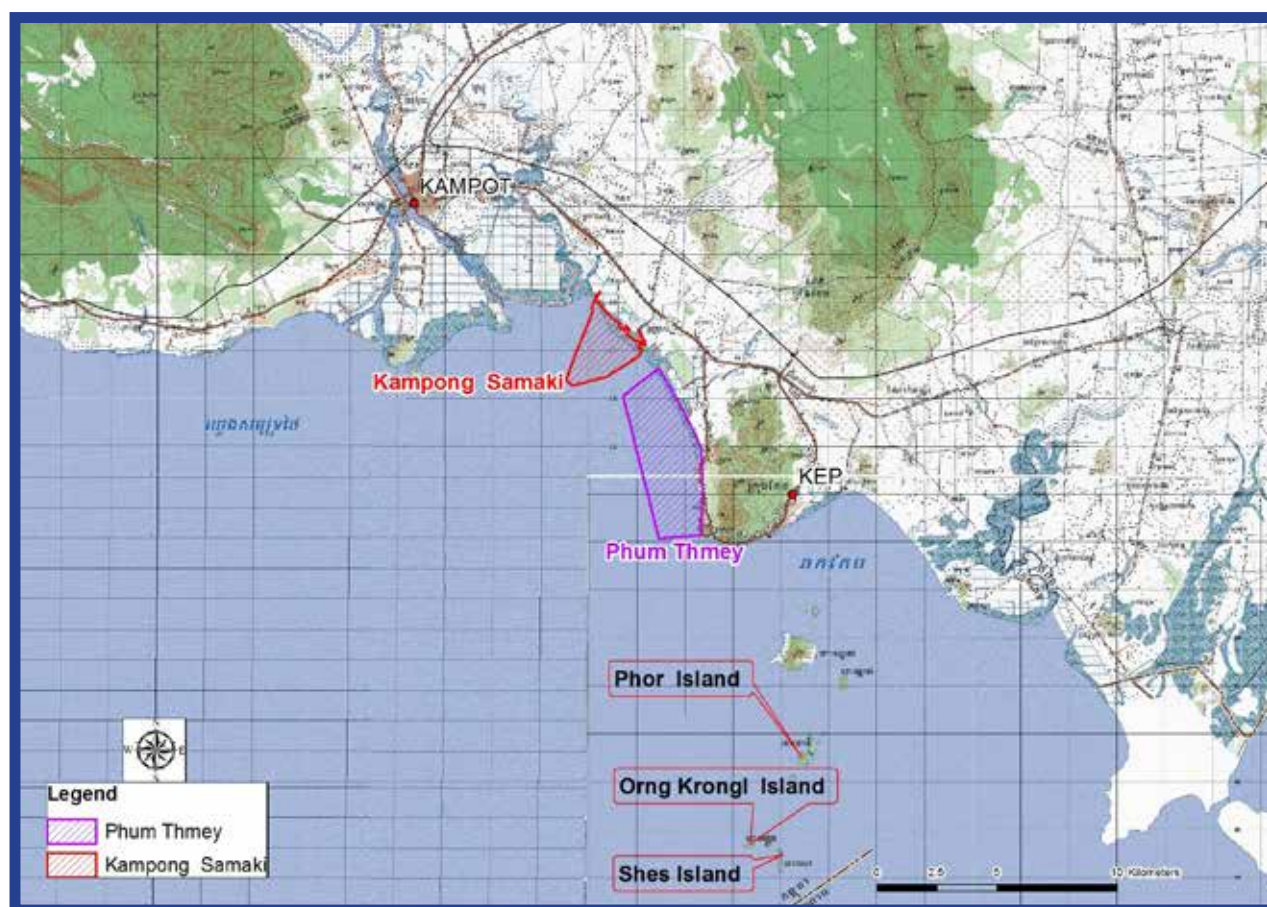


Figure 2. Location of the 2 survey sites: Phum Thmey in Kep province and Kampong Samaki in Kampot province indicated by colored cross-hatched areas, including name and area of the Community Fisheries

Source: The Learning Institute



Source: The Learning Institute

Figure 3: Location of the 2 survey sites: Prey Nop II and Tomnop Rolok in Preah Sihanouk province indicated by colored cross-hatched areas, including name and area of the Community Fisheries

II.2. Data collection

The sampling framework attempted to include all the different stakeholders involved in each crab bank.

II.2.1 Beneficiaries and other community members

In each survey site, both qualitative and quantitative data were collected using several tools, including the following:

- Focus group discussion (FGD) sessions with members of CFis and Crab Bank Committees were used to understand operational, governance, and management issues, constraints and anomalies related to crab banks;
- Seasonal calendaring and wealth ranking were performed with both crab bank members and non-members to understand the different wealth categories³ in the community, how each category can be defined in the local context, and the category to which crab fishers belong. These participatory exercises also provided

information on the diversity of livelihood activities throughout the year;

- Semi-structured interviews (SSIs) with at least 50% of crab bank members were undertaken to gain a better understanding of the incentives, challenges, impacts and benefits related to crab banks. To understand reasons for non-participation, crab fishers who were not members of the crab bank initiatives (if any were present in the CFI) were also interviewed. We also investigated fishers' suggestions and recommendations to improve crab bank implementation. The interviews also covered the diversity of fishing techniques, the seasonality of crab fishing, the value chain and the local crab market.

II.2.2 Local authorities and other institutional stakeholders

Interviews with key informants such as Commune Council members and FiA staff were conducted in order to understand crab bank management from a third-party

⁽³⁾ Wealth categories were divided into the better off, the average, and the poor, using a local definition of wealth, including assets, land ownership, house type, family size and livelihood activities.

point of view, and also to assess the role of these stakeholders in crab bank implementation. The crab value chain and the role of middlemen in crab bank implementation were investigated through interviews with a local middleman.

II.3. Data processing and analysis

Focus group discussions at the community level provided the opportunity to understand the diversity of livelihoods in each CFI and the relative wealth of crab fishers in terms of the entire community. Data collected at the household level about livelihoods were analyzed to understand the relative importance of crab fisheries in household incomes. Household interviews also provided quantitative data on crab fisheries, including fishing capacity, catch seasonality and the diversity of fishing grounds.

Household interviews produced qualitative answers on incentives and enabling or constraining factors for crab

bank development. The different answers were then regrouped into similar topics by survey site, providing a quantitative representation of the relative importance of different factors affecting the adoption of the project for each site. Information was classified according to broad categories related to crab bank development, including governance, economic, environmental and technical issues.

II.4. Validation workshop

Once the main conclusions and recommendations were drafted and reviewed by external experts, a consultation workshop with FiA Central and Cantonment officials, Crab Bank Committee members from the crab bank surveyed, as well as a representative of CORIN (an NGO supporting crab banks in Kampot and Kep), was held in Phnom Penh (23rd February 2011). During the workshop, this panel of local stakeholders discussed and validated the conclusions and recommendations.



Photo by: The Learning Institute

Middlemen are sorting crab size at their landing site in Tomnop Rolok CFI, Preah Sihanouk province

III. CRAB FISHERS AND FISHERIES

III.1. Biological overview of crab fishery

In Cambodia, the crab fishery is mainly based on *Portunus pelagicus*, the blue swimming crab. Other crab species of economic importance found in Cambodia are the blood spotted swimming crab (*Portunus sanguinolentus*), cruxifix crab (*Charybdis feriatus*), sentinel crab (*Podophthalmus vigil*), two-spine arm swimming crab (*Charybdis anisodon*) and the spotted belly rock crab (*Ozius guttatus*) (Sam Ath & Roitana 2006). All these species are processed for their meat and exported to Thailand or Vietnam. Mud crabs (*Scylla* sp.) are also found but are not processed for their meat and are instead sold directly to domestic or international markets. Juvenile mud crabs are also of economic importance, with a high demand from Vietnamese farmers, using juveniles as seed for mud crabs in fattening or extensive pond production systems.

The blue swimming crab's lifecycle is divided into 3 main stages: the larval, juvenile and adult stages. The larval stage includes the zoea and megalopa stages. The development from zoea to megalopa takes 12 days in a controlled environment with a 99% mortality rate (Ingles & Braum 1989). During the megalopa stage, the limbs form and can be used for movement. The larvae reach an average size of 2.4 mm. During the juvenile phase, crabs can reach a size of 4 to 6 mm and cannot be sexually distinguished. Adults can reach a maximum size of 14 to 15 cm after 3 to 4 years of growth in a controlled environment (i.e. laboratory).

According to Etoh (2007), crabs can spawn 3 to 4 times a year, mainly from May to September. The value of zoea hatch per spawning varies according to studies. Etoh (2007) estimated that a gravid female can hatch between 1 and 3 million zoea per spawning, while Ingles and Braun (1989) estimated the number of eggs of *Portunus pelagicus* per spawning between 0.14 and 1.1 million eggs. A study conducted in the Philippines shows that *Portunus pelagicus* are sexually mature when they reach a carapace size of 10.5 cm for females and 9.6 cm for males. In a controlled environment, females spawned 13 days after copulation and fecundity was below 1.2 million eggs. Eggs carried by gravid females can represent up to 18.8% of the total body weight of the female (Ingles & Braum 1989). The monitoring of megalopae catch found that the abundance of larvae is higher near reefs compared to low salinity areas near the shore. Research suggests that even if the salinity tolerance of the zoea is between 16.2 to 35 ppt, the daily fluctuation due to tidal patterns and irregular amounts of rainfall can affect the presence and survival rate of larvae. Catch monitoring demonstrates that gravid crabs can be found all year round, but two main seasons were highlighted: February to April and July to October (Ingles & Braum 1989).

Studies on other swimming crabs (*Ovalipes punctatus*) in Japan show that the spawning grounds of crabs are offshore (40-60 m depth). The main spawners were adult crabs with a carapace of 7.5 to 8 cm in width (2 years old), while smaller crabs spawned less often. Immature crabs are normally found near the shore, while adult crabs are found more offshore (Sasaki & Kawasaki 1980).



Photo by: The Learning Institute

The biological characteristics of the crabs show that larvae are sensitive to salinity level and the local environment will affect the survival rate. Also, sexual maturity of the crabs is reached after substantial growth. From a crab bank perspective, the benefits of stocking crabs will likely be observed on a long- or medium-term (more than 2 years) timescale.

III.2. Livelihoods of Cambodia's Community Fisheries members

Only limited information is available on coastal livelihoods in Cambodia. Crab and shrimp peeling are one significant employment sector in the area, even if the scale of factory operations remains small. According to a recent study on livelihood diversification in coastal Cambodia, coastal people are highly dependent on marine resources. Opportunities are bound to environmental and seasonal conditions, with a wide range of opportunities offered by the diversity of ecosystems (IMM *et al.* 2005). Diversification was also found to be linked to geographical location and proximity to markets. Approximately 90 to 95% of poor households in coastal areas consumed low-value marine fisheries products such as fish, snails and oysters every day (An 2006).

The wealth ranking exercise, conducted in the four different CFIs showed that livelihood options differ according to the economic status of households. For the better-off households, rice farming, livestock and small and medium-scale business were common livelihood activities. Fisheries played a more significant role in the medium or poor wealth categories. Fisheries activities also varied from low intensity fishing along the coast using a push net, to semi-industrial crab fishing using larger boats and more than 1,000 crab traps per vessel.

III.2.1. Income diversification

Relative income diversification in the crab fishers' households is presented in Figure 4.

a. Crab fisheries

Crab fishers were highly specialized, with more than 70% of household income provided by crab fisheries in three of the survey sites. The only site where crab fisheries were less important lacked access to offshore fishing grounds, causing fishing intensity to be low. Crab fishers in most cases specialized in only one type

of fishing (traps or gill nets) and did not own gears for other types of fishing. Only in Tomnop Rolok was the share of other marine species such as squid, octopus and fish more important to fishers' incomes. Income from crab fisheries also included wage labor as crab peelers in factories or at landing sites.

b. Rice farming

The importance of farming in local livelihoods was relative to the access to land. On average, crab fishers owned 0.62 ha to 0.76 ha in three of the sites. The exception was Tomnop Rolok, where fishers did not have access to farmland in most cases. Rice farming could provide for family needs for a few months only, with low yields (below one tonne/ha) through cultivation of small plots. Other types of income diversification such as small businesses were an opportunistic exception. Wage labor opportunities were area-specific, as in the cases of wage labor in a salt pan in Kampong Samaki and crab peeling factories in Tomnop Rolok. An (2006) found that rice culture also plays an important role in livelihoods where fishers have access to land, such as in Kampot and Preah Sihanouk provinces. In none of the study sites was aquaculture found or reported. This could be due to lack of knowledge, land or investment capacity.



Photo by: The Learning Institute

Hired labour in salt pans, example of coastal livelihood, Kampot

c. Fishing related activities and other wage labor opportunities

In Kampot province, fishers have the option of working as hired labor in a salt pan. Additional income outside of fisheries can be generated due to the development of the salt cooperative and the mangrove resources (Sam Ath & Roitana 2006). Wage labor in the fishing sector was more common in Preah Sihanouk than in Kampot province, with the presence of medium and large-scale fishing trawlers. According to An (2006) 85% of fishery employees are engaged in fisheries throughout the year, including wage labor in fishing, and only 15% are involved in other activities.

from June to August in Preah Sihanouk. The peak season was occurred earlier in Kampot province (Figure 5). In the rainy season, access to some fishing grounds was limited by the more frequent storms and higher waves. Therefore, only larger boats could go fishing during this period. According to fishers, the catch is related to water salinity and temperature, with crabs migrating away from the shore when the water salinity decreases at the onset of the rainy season. However, no data on water salinity changes over the seasons is available to examine the correlation. In addition, both fishers and FiA cantonment officers acknowledge that the crab population “migrates” from east to west during the rainy season, resulting in larger catches near the Vietnamese

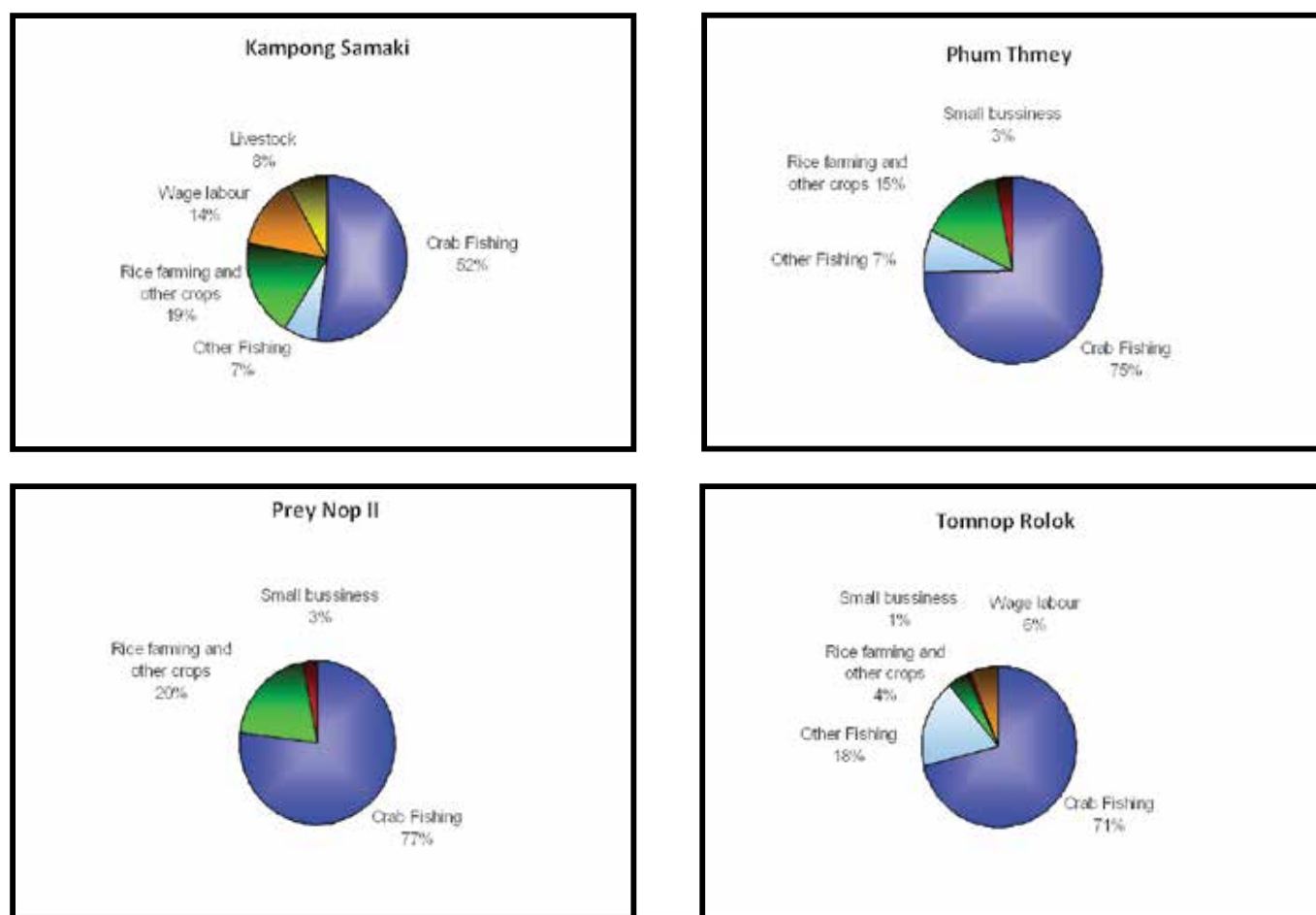


Figure 4: Income diversification of crab fishers in the different crab banks (n=20 in K. Samaki; n=24 in Phum Thmey; n=21 in Prey Nop II and n=21 in Tomnop Rolok)

III.2.2. Seasonality of livelihood activities

Livelihood options were also linked to seasons. Differences in fishing season could be found along the Cambodian coastline according to the fishing ground and fishing technique. Fishing near the shore using fish/crab traps and hand push-nets occurred during the dry season from November to March. Fishers with boats to take them offshore around the different islands, sometimes settling for short period on those islands, had their peak fishing season during the rainy months,

border earlier in the season and gradually farther west toward Preah Sihanouk and Koh Kong.

Rice farming occurred during the rainy season, as it is based on rain-fed systems. In the rainy season some fishers continued fishing by diversifying their fishing techniques, targeting shrimp. Mulletts and needlefish were targeted by fishers in Phum Thmey CFi, early in the dry season and octopus later in the dry season. Collection of natural resources in the mangroves occurred from February to October, and in Prey Nop II adult clams were collected mainly at the end of the

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dry season												
Rainy season												
Crab fishing-Crab trap Kampot			***	***	***	***						
Crab fishing Preah Sihanouk					***	***	***	***	***			
Crab fishing – hand push-net for shrimp and small crabs	***	***	***								***	***
Octopus		***	***									
Mullet, needlefish	***									***	***	***
Shrimp					***	***	***	***				

Figure 5 : General seasonal calendar for crab fishers along the Cambodian coast

Note: *** peak season

dry season (April to May). Collection of mangrove and mudflat products were considered livelihood options when no other economically valuable options were possible.

Crab fishing was seasonal and the peak season varied depending on the fishing ground (offshore or inshore), the fishing area (from Kampot to Preah Sihanouk) and the fishing capacity. For offshore fishing, species targeted in the dry season were mixed between octopus, mullets or needlefish.

III.3. Fishing techniques, fishing assets and catch trends

The fishing techniques used differed significantly depending on the skills and experiences of the fishers. Choosing the right fishing zone partially depended on available assets. For example, some fishers used large engine boats (more than 10 HP) that could go farther

into the open sea with many crab traps, while others used small engine boats in shallower waters with fewer crab traps.

Tomnop Rolok crab fishers used more diverse fishing techniques including using engine boats to obtain higher fishing yields. Target species were more diversified, including shrimp, fish and squid as secondary target species depending on the season. In this CFi, with their diversified fishing techniques and investment capacity, the crab fishers could switch their fishing grounds and target species according to the season. This strategy for securing sufficient income from fisheries throughout the year is not possible for poor and very poor households, and thus they have to find other alternatives (An 2006). In Phum Thmey, fisheries were also diversified, with some fishers involved in shrimp, octopus, or needle fish catches.

Table 3: Fishing assets in the different crab banks (percentage of the crab fishers using specific fishing gears and average number of crab traps and net length per household)

	K. Samaki	Phum Thmey	Prey Nop II	Tomnop Rolok
n	16	24	21	21
Engine boats	13% - 5 HP	100% - 13 Cc	86%-3.5 to 6.5 Cc	95% - 5 to 24 Cc
Row boats	53%	0%	14%	5%
No boats	34%	0%	5%	0%
Crab traps	56%-131 traps/HH	92%-1,250 traps/HH	100%-246 traps/HH	81% - 451traps/HH
Net (Crabs)	-	8% ^a	-	21% (5,500m)
Gill net (fish)	-	-	-	28% (620m)
Shrimp net	-	-	-	10%
Hand push net	75%	0%	9%	-
Squid traps	-	-	-	14%

^{a)} Also includes seine nets, long line hooks and octopus traps



Photo by : The Learning Institute

Crab fisherman at the landing site in Kampot Province

The fishing capacity and the level of diversification can give us an idea of wealth differences between crab bank members. However, access to informal loans and contracts with middlemen strongly influence the fishing capacity of the fishers. Therefore, we did not draw any conclusion regarding wealth differences of crab fishers between CFIs on the basis of fishing assets.

In Phum Thmey and Tomnop Rolok, 8% and 21% respectively of interviewed crab fishers were still using nets to catch crabs. At other CFI sites (Prey Nop II and Kampong Samaki) this technique had almost disappeared due to technical challenges (destruction by trawlers for example) and lower catches compared to crab trapping. In both CFI sites, some fishing vessels employed 1 to 3 crew members for fishing, while in Prey Nop II and Kampong Samaki, individuals fishing with smaller engine boats or row boats was the dominant method.

Fishing intensity was lower at the two CFI sites. There was also a higher proportion of fishers using row boats or no fishing vessel and less equipment. In Kampong Samaki, the predominant fishing technique was hand push-nets used along the coastline. In Prey Nop II, most fishers had access to engine boats of limited power, thus restricting their fishing grounds to the coastline and surrounding areas.

With a limited fishing capacity, fishers using traps or hand push-nets diversified their catch. Hand push-nets were normally used to catch shrimp, but fishers also used them for low-intensity fishing for juvenile mud crabs and immature or small swimming crabs. Some of the offshore fishers also diversified their techniques by using seine nets to catch fish, shrimp, octopus, mantis shrimp and squid during the low season for crabs.

The new market in Vietnam for juvenile mud crabs provides Cambodian fishers with new opportunities, particularly from October to February when demand for juvenile mud crabs is high in Vietnam.

The small and mostly immature swimming crabs are collected, sold and processed for their meat or as fertilizers in rice fields in Cambodia. Overfishing juvenile crabs may cancel out any positive effect from crab banks, as the high demand means that crabs are sold before they get the chance to spawn even once.

In Tomnop Rolok CFI, intensification and changes of fishing techniques are recent phenomena. From the 1980s to 2005, the catch was stable with large sized swimming crabs caught using both gill nets and traps. Average catches reached upwards of 100 kg per boat and per outing. During this period, fishing vessels were equipped with 5 HP engines and fishing capacity was around 100-150 crab traps per boat. According to fishers, since 2005 the catches have been decreasing, with 20 kg/outing/boat on average during the peak season and 3-5 kg in the low season. In response to decreasing catches, fishers have had to reach other fishing grounds and increase their fishing capacity to 500-1,000 traps.

A similar trend was described in Prek Pros village in Prey Nop II CFI. The catches in 2000 averaged 30-40 kg/outing with 10 individuals/kg and in 2010 averages reached only 10-15 kg/outing with 30 individuals/kg. Some fishers reported changing crab fishing techniques from using gill nets to trap fishing in 2000. The change was motivated by the destruction of gill nets by trawlers and traps being less damaged by trawlers.

III.4. Seasonality of fishing and markets

We have already noted that crab fishing varies according to the season, with peak and low seasons during the year. The peak season for crab fishing differs according to fishing ground and fishing technique. For offshore fishing, the peak season is from May to September, while the peak season is later, in October-November, when fishing is limited to coastal areas (Table 4).

Crab fisheries can be divided into two types: low intensity inshore practices using traps or hand push-nets, and high intensity offshore practices using boats, more efficient equipment and diversified fishing grounds.

The intensification of the latter type of practice is more recent and probably due to the decrease of the resource.

A clear distinction in yields can be made between offshore and inshore crab fisheries. Inshore fishers have a peak fishing season limited to early in the dry season and a lower average catch compared to offshore fishing. Offshore fisheries tend to utilize larger boats, enabling fishers to change their fishing grounds according to the season and thereby maximize their potential catch. For example, Figure 6 indicates the different fishing grounds of crab fishers in Phum Thmey, which are more diversified and further away from their port compared to Kampong Samaki, which has fishing grounds located only along the shore.

Table 4: Diversity of fisheries, fishing techniques in the crab banks

Type of fishing gear	Species targeted	Peak season	Average daily catch (size) in peak season
Inshore/coastal fishing – Low intensity			
Crab traps (<500 traps)	Swimming crabs (and mud crabs)	Oct-Nov	3 – 12 kg of swimming crab (5-12 cm)
Hand push-net	Shrimp, swimming crabs, mud crab juveniles and other small fishes	Nov-Dec	1.2- 7 kg of swimming crab (5-12 cm)
Seine nets	Mullet, needlefish	Oct-Jan	-
Seine nets	Shrimp	May-Aug	-
Offshore fishing – High Intensity			
Crab traps (>1,000 traps)	Swimming crabs	June-September Kep - Kampot	39-52 kg (>10 cm)
Cab traps (>700 traps)	Swimming crabs	May-June Preah Sihanouk	23 kg (>10 cm)
Long Line hooks	Squid	Oct-Jan	-
Traps (Conch)	Octopus	March - April	-



Source: The Learning Institute

Figure 6: Some of the crab fishing grounds (circles) in the different survey sites. Not all the fishing ground is represented in the figures.

III.5. Processing, marketing channels and access to loans

The marketing channels for crab fishers remained simple and were not diversified. Crabs were sold directly to middlemen at the landing site or were processed (peeled) by the household. Small sized crabs were peeled and the meat was sorted, packaged and sold to other middleman or directly exported to Vietnam or Thailand. Larger sized crabs were sold directly for higher prices to restaurants and tourists in some specific areas (Kep, Preah Sihanouk) or were processed for the meat.

Market price depended on the class or the size of the crab. Average crab prices according to the size recorded in the different CFIs are given in Table 5. The difference between the low and peak season was not important. According to Sam Ath and Roitana (2006) the price at the landing site varied from 4.5 to 6.25 USD/kg in 2008 in Preah Sihanouk.

Table 5: Crab price according to size

Class	Number of crab/kg	Price (USD/kg)
1st Class	10 to 15	2.5 -5
2nd Class	20 to 25	1.13 – 1.88
3rd Class	> 30	0.5 – 0.88

The crab peelers are generally women and children, as young as 9 years old (Sam Ath & Roitana 2006). Only the Khmer ethnic group is found to participate in this type of activity. Crab peeling can be home-based, with fishers purchasing small sized crabs (raw material) and later selling the meat to middlemen at the landing site. According to Sam Ath and Roitana (2006), home-based crab peeling mainly occurs in Preah Sihanouk province and is less popular in Kampot or Kep provinces.

Home-based crab peeling appeared around 2000 in response to the emergence of a new market for small crabs (50 -140 crabs/kg). Previously small sized crabs were considered trash fish. Now, the peeled crab meat is sold to local middlemen and exported to Thailand (Sam Ath & Roitana 2006). A household can produce up to 4.5 kg of crab meat per day, giving an income of around 2.80 USD/day/HH, with the daily income ranging from 1.75 to 3.75 USD/day/HH.

At the landing site, crab peeling workers were paid at 0.63 USD/kg of crab meat,

with some variation depending on the size of the raw material. A higher fee was paid for peeling smaller crabs, which require more work to extract the same quantity of meat. The fee ranges from around 0.75 USD per kg to around 0.5 USD per kg for larger crabs. Crab peeling and the extraction of meat was an opportunity to sell undersized crabs.

Crab peeling is linked to crab supply and differs according to province and location. An (2006) shows that in Kampot province, peeling activities are higher in the dry season than in the rainy season, which is the opposite of Preah Sihanouk province.

Crab peeling did not appear as a hired labor activity during the crab bank survey with only a limited percentage of household income coming from wage labor. During interviews, respondents usually integrated income from crab peeling into income from crab fishing activity in general. Crab peeling seems to be a source of employment for women along the Cambodian coast and 24 small- to middle-scale crab meat processors are operational along the Cambodian coast. For example, 150 peelers were employed⁴ in Tomnop Rolok Chas according to Sam Ath and Roitana (2006).

Marketing channels were closely tied to middlemen from whom fishermen borrowed money for fishing gears. Accessing formal loans was not the common practice, even when fishers were aware of the availability of loans via ACLEDA or AMRET (with an interest rate of 4-5% per month for small loans below 10,000 USD and 2 to 3% for loans above 10,000 USD). The preference typically went to informal loans from middlemen who did not require land title or other guarantees.



Women involved in crab peeling in processing plant in Preah Sihanouk province

⁽⁴⁾ Part-time workers receive a wage based on the number of kilograms of crab meat they process, whereas full-time workers receive a fixed monthly salary.

Informal loans from middlemen were used to invest in or replace fishing gears, engines or boats, but the amount varied greatly depending on local conditions and individual middlemen.

Table 6: Access to loans in the different crab banks

	K. Samaki	Phum Thmey	Prey Nop II	Tomnop Rolok
Number	27	24	21	21
Formal credit	m.d.	28%	0%	4%
Average amount	-	m.d.	-	m.d.
Informal credit	m.d.	80%	90%	21%
Amount (USD/HH)	-	1,000 – 4,000	188	250-1,000

m.d : Missing data

The informal contract between fishers and middlemen stipulated that fishers had to sell their catch to the middlemen at a fixed price. The fixed price was usually lower than the actual market price of 0.25 to 0.5 USD/kg. In Kampong Samaki where the crab fishery was limited, there was no such arrangement, as middlemen were not able to provide larger loans for investment in boats and crab traps (Table 6). On the other hand, in Phum Thmey CFI, 80% of the crab fishers had access to loans ranging from 1,000 to 4,000 USD to invest in boats, engines and traps. In this case, fishers did not own the equipment and had to give it back to the middlemen when they stopped fishing. In this CFI, fishers had a more diversified value chain, with the landing site included in a tourist area. Direct marketing to tourists was possible, with a higher selling price of up to 5 to 7 USD/kg for larger crabs.

In Tomnop Rolok and Prey Nop II, fishers were more tied to middlemen, with limited access to markets. In Phum Thmey, the distance to Preah Sihanouk market did not allow fishers to have access to direct marketing and even if they were not in contract with local middlemen, their choices for marketing crabs were limited. In Tomnop Rolok, the link between fishers and middlemen was

stronger. Middlemen owned their own pier, usually where their fleet was located. Fishers had access to loans of 250 to 1,000 USD, but had to sell their catch to a middleman, sometimes 30% below the market price.

Surveys conducted in four selected CFI sites showed the diversity of crab fisheries, in terms of fishing intensity and type of fishing grounds, access to loans, dependence on crab resources, and the nature of the CFI. Within each context, crab bank development followed different approaches and showed different

results. In the next section, we present the different crab bank models piloted in Cambodia so far, as well as the challenges faced during their implementation.

Crab fishers and crab fisheries

- Crab fishers are still highly dependent on crab resources for their incomes
- Crab fishing is seasonal and provides income for only a few months per year
- Diversification of target species depends on the ability to invest in fishing equipment
- Fishing capacity varies greatly among the sites, from almost subsistence fishing to medium-scale fisheries
- Fishing effort has been increasing since early 2000s, with a higher number of traps per boat and fishing grounds farther away, while the crab catches have been decreasing
- Diversification of income sources varies according to commune, with more opportunities in some sites compared to others
- Middlemen play an important role in crab fisheries, providing loans and contracting crab fishers



Rice fields in the coastal area in Kampot Province

Photo by: The Learning Institute

IV. CRAB BANKS

IV.1. Origin and diversity of crab bank systems

The 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 NGOs and the FiA in Cambodia. Originally, “crab bank” referred to stock enhancement and not to micro-finance aspects. The primary aim of this approach is to manage crab resources in a sustainable manner, and to increase stocks by allowing gravid females caught by fishers to release their zoea⁵ before being marketed.

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 (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 the mid-eighties.

In the Japanese model, gravid female crabs are purchased by the cooperative and the carapace is marked before being released back into the ocean. Later, if a fisherman 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 own funds and trust among the crab fishermen. 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.

Diversity of crab bank models in Thailand (Suanrattanachai et al. 2009)

The *Chumphon model* (from the Chumphon Marine Fisheries Research and Development Center) is based on the donation of 30 gravid crabs per month, which are stocked in a cage and sold after spawning. The income from selling the crabs is then used to cover operational costs of the crab bank. The crab bank also includes new regulations concerning mesh size of the crab trap and not all fishers can participate, with some restrictions according to the fishing capacity.

A similar approach was developed in Chonburi province, where gravid crab stocks are submerged in resting cages and released into the sea or sold after spawning. Here the main difference compared to the *Chumphon model* is through the use of a different cage type.

In *Bang Saphan Bay* in Thailand, the system is slightly different with gravid crabs stocked in plastic tanks instead of cages in the open sea. This difference was due to technical and operational constraints. In addition, crabs are sold by the fishermen who caught the crabs after spawning.

⁽⁵⁾ Zoea is the first larval stage of the crab, before entering the megalopa stage.



Photo by: The Learning Institute

Since 2002 and 2007 in Thailand and Malaysia respectively, different approaches have been developed by the Integrated Coastal Resources Management (ICRM) projects and implemented by SEAFDEC. In Malaysia, (Pulau Langkawi) the Japanese model was introduced, but gravid crabs were voluntarily donated by fishers instead of being purchased. In Thailand, the “Chumphon” model (see box above) has been successfully applied and other slightly different models were tested in other crab fishing communities.

The crab bank system has been adapted from its model in Thailand to suit the different socio-economic and natural conditions in Cambodia. Since 2008, crab banks have been developed within CFIs in partnership with SEAFDEC, CORIN-Asia, the FiA and other NGOs.

IV.2. Crab banks in Cambodia

In Cambodia, crab bank development has been strongly promoted by the central government and the Minister of Agriculture, Forestry and Fisheries. Since 2008, there have been 19 crab⁶ banks developed in the three coastal provinces, namely Kampot, Preah Sihanouk, and Koh Kong provinces (Hap *et al.* 2009). Among those crab banks, some are directly supported and coordinated by the FiA, while others are supported and coordinated by local and international organizations (Table 7).

CORIN-Asia initially used the Chumphon model of donating gravid crabs (CORIN-Asia 2009). However, after a low participation rate from local fishers, CORIN modified its approach by providing loans to members of the crab banks as incentives. SEAFDEC, FiA-NCDD and three other FiA initiatives also used the Chumphon model but were more successful in generating voluntary

participation and the donation of gravid crabs (FiA Cantonment in Preah Sihanouk province 2009).

CWDCC, AFSC and FiA models in Tomnop Rolok used a modified Chumphon approach. Gravid crabs were stocked in cages during the spawning period and sold to cover the operational costs, but CFIs were financially supported (by the FiA or NGOs) to purchase the gravid crabs from the fishermen. Table 8 presents the diversity of models and approaches in the four crab banks visited during the survey.



Crab peeling in Prey Nop II CFI, Preah Sihanouk province

Photo by: The WorldFish Center

Table 7: Number of crab bank initiatives developed in each coastal province in Cambodia, supporting partners and model applied

Province	Number of crab banks	Model
Kep-Kampot	4 (CORIN) 1 (CWDCC ^a)	Chumphom model (loans) Modified Chumphon model (purchased)
Preah Sihanouk	2 (SEAFDEC) 4 (FiA) 1 (FiA-NCDD ^b) 1 (AFSC ^c)	Chumphon model (no loans) Chumphon model (no loans) and purchased (in Tomnop Rolok) Chumphon model (no loans) Modified Chumphon model (purchased)
Koh Kong	1 (CORIN) 5 (FiA)	Chumphom model (loans) Chumphon model

^a) Children and Women Development Center in Cambodia

^b) The National Committee for Sub-National Democratic Development

^c) American Family Service Cambodia

⁽⁶⁾ At the end of 2010, there were 7 active crab banks (2 others were inactive) in Kampot Cantonment. In February 2011, another crab bank was reportedly being established and another was to be created subject to additional funding support. Together with NCDD and private initiatives by crab middlemen, FiA was supporting 11 crab banks in Preah Sihanouk Cantonment.

Table 8: Differences between approaches in the 4 crab banks

Province and Community Fishery/Village	Number of members/ Crab banks	Number of CF members	Membership	Loan	External support	Crab Bank System
Kep/Kampot						
Kampong Samaki	CF Committee	396	CF Committee	No	Funds for purchasing crabs + Fishing equipment + cages	Purchased
Phum Thmey	27	196	Voluntary	Yes	Revolving fund for loans, and equipment	Interest on loans
Preah Sihanouk						
Prey Nop II Prek Pros	38	1,659	Voluntary	No	Operational costs, equipment and incentives were given as gifts	Voluntary donation
Tomnop Rolok	CF Committee	50	CF Committee	No	280 USD from FiA cantonment to purchase crabs + cages	Purchased

IV.2.1 Loan Repayment – Phum Thmey

CORIN applied a model based on access to loans as an incentive to get fishers involved in the development of crab banks. Through this approach, crab bank participants were selected based on the fishers' fishing capacity, specialization in crab fishing, capacity to repay the loan and willingness to provide gravid crabs. Loan interest was paid in nature, with 1 gravid crab per day. This approach integrating crab banks with micro-finance functions is unique to Cambodia.

Phum Thmey was the only crab bank among the case study sites that provided loans. Members were selected based on their ability to catch gravid crabs which led to 22 and 27 fishers being involved in the first and second month respectively. To be eligible for a loan, fishers needed to specialize in crab fishing, thus having the capacity to pay back the interest. In January 2009, 22 loans were provided (125 USD/member) for a period of 10 months. During this period, members repaid 12.5 USD/ month to the crab bank and interest of 30 gravid crabs per month. With the first reimbursements to the crab bank, 5 additional loans were given to new members. By January 2010, all the loans had been repaid and a new cycle of loans was launched.

Based on a signed agreement with the Crab Bank Committee, members possessing a loan had to pay back the loan by a fixed date. In case of delay, there was a penalty of 2 gravid females for 1 to 3 days delay and 4 gravid crabs for 4 to 6 days delay. Cash flow, operational costs and reimbursement of the loan were recorded by the cashier. The committee received technical and managerial support from CORIN, village authorities and the FiA. Most of the loans were used to invest in or repair fishing gears, resulting in increased crab fishing capacity and fishing effort.

IV.2.2 Voluntary Donation – Prey Nop II

For the crab bank supported by SEAFDEC, the model was based on voluntary participation achieved through awareness campaigns and small gifts for the members. Like CWDC or the FiA, SEAFDEC provided funds to cover operational costs (fuel and food mainly) and cage structures. While in Phum Thmey (supported by CORIN), operational costs were covered by the marketing of the crabs.

IV.2.3 Purchased – Kampong Samaki and Tomnop Rolok

In Kampong Samaki, the selection of members was based on CFI Committee members, who were not crab fishers. In Tomnop Rolok, where crab resources were more important, the crab bank was also developed with the CFI Committee but did not involve the crab fishers directly. The crab bank was operated by the CFI Committee members (buying crabs, feeding them, and patrolling). In these two models, the support of the FiA and CWDC was financial, providing a lump sum to purchase gravid females and the crab cages and to cover operational costs. The idea behind this model was to provide a sustainable revolving fund through marketing the crabs after they had hatched and using the funds to "re-load" the system to purchase new gravid females.

IV.3. The Role of Community Fisheries

Crab banks do not have their own legal status. The Ministry of Agriculture, Forestry and Fisheries (MAFF) strongly recommends that crab banks be developed in each CFI along the coast. In February 2008, the Minister encouraged coastal CFIs to develop crab bank activity during a meeting in Koh Kong (Hap et al. 2009).

In Cambodia, crab bank development is within local CFIs, a community-based organization (CBO) already in place in the different villages along the coast.

A statement issued by the Royal Government on the topic of national Fisheries Policy on June 15th 2005 encouraged the development of effective CFIs for sustainable management of fisheries resources by empowering local communities. CFI development is also included in the new Fishery Law (May 21st 2006), where it states that the MAFF can allocate parts of the fisheries domains for CFIs to manage. Several decrees and sub-decrees issued by the government enable the development of CFIs as a legally recognized entity.

On the ground, CFI development is promoted and supported by the FiA Cantonment. CFIs in coastal areas can be organized on a village basis or include several villages. Usually a management committee including 5 to 11 members is elected by the fishers. The committee includes an elected Chief and Vice Chief. According to several interviews, the main activity of CFIs is to regulate fishing activities within their territory, which includes patrolling and reporting illegal fishing activities to FiA staff. CFI members do not have any legal power to enforce fishing regulations, to make arrests or to confiscate illegal fishing gears.

Naturally, crab bank development relies on this CBO. The FiA and NGOs supporting crab banks introduce the concept of crab banks via CFIs and all the crab banks are based within CFI areas but with different involvement in the existing institutional structures (Table 9).

In each case, the CFI Committee was strongly involved in the crab bank. During the implementation process, two different approaches were followed when we compared the 4 cases. In Tomnop Rolok and Kampong Samaki, NGOs and the FiA provided the original idea and financial and technical support through the CFI Committee. An essential element was missed in this process through lack of consultation with primary stakeholders, the crab fishers. In addition, the awareness campaigns were limited, which led to a lack of information about the initiative on the part of fishers.



Woman is preparing bait for crab trap in Kep province

Photo by: The WorldFish Center

In Phum Thmey and Prey Nop II, CORIN and SEAFDEC introduced the concept of crab banks to crab fishers via the CFI during meetings together with the FiA. An additional incentive was provided in those cases, with access to loans (Phum Thmey) or a small gift for participation (T-shirts, cooking tools) in Prey Nop II.

Although the CFI provided a structure and some human resources for crab bank development for all four sites, only a small number of its members were involved in the crab bank. For example, only 58 members of the 1,659 members of the CFI in Prey Nop II were involved in the crab bank.

Other than NGOs and the FiA providing financial and technical support, no other institutional stakeholders were involved in crab bank development. Only in Phum Thmey did the Commune Council act as a witness during the loan provision and sign the official acts. In other crab banks, the Commune Council was not involved and there was no legal statement or document for their support.

CFIs are recent initiatives and their official registration is not always done. Fishers' involvement in crab bank development might depend on how the CFI was developed, the local status of the organization with the fisher communities and the capacity of the CFI itself to host such activities and lead their implementation.

In Phum Thmey, the CFI is part of the institutional landscape. The CFI Committee members there are actively involved in crab bank operations and decision-making processes with other local institutional stakeholders

such as the Commune Council. In contrast, the CFI in Tomnop Rolok was developed without much participation of crab fishers (as opposed to non-specialized fishers). The crab bank was developed without a concerted effort to involve local fishers who specialize in crabs.

In addition, considering the importance of middlemen in the crab fisheries, no specific role has been designed for them within crab bank development. No CFI Committees have their own resources to sustain crab bank development operations.

Table 9: Role of CFI Committees in the Crab Bank (CB) Management Committee

Province and Community Fishery/ Village	CB leader	CB Committee	CB patrolling team
Kep/Kampot			
Kampong Samaki	CFi leader	CFi Committee	CFi patrolling team
Phum Thmey	CFi leader	CFi member non-crab fisher	CFi patrolling team
Preah Sihanouk			
Prey Nop II	CFi member	CFi member	CFi patrolling team
Tomnop Rolok	CFi leader	CFi Committee	CFi patrolling team

Crab Banks in Cambodia

- Crab banks in Cambodia follow different models: crabs are purchased, donated or exchanged for loans
- Access to loans as an incentive to participate in crab banks is unique to Cambodia
- Selection of members depends on access to loans (selection based on fishing capacity) or a voluntary approach in other cases
- The CFI is the hosting organization of the crab bank, but its roles, duties, and influence vary among the sites



Crab fisher is checking crab trap before fishing in Tomnop Rolok CFI, Preah Sihanouk province

Photo by: The WorldFish Center

V. CHALLENGES AND OPPORTUNITIES FOR CAMBODIA'S CRAB BANKS

V.1. Operational sustainability at four case study sites

We selected four sites that were very different in terms of their approach to crab bank development and their environmental conditions. For a crab bank to be considered operational, it needs sustained membership and flow of gravid crabs into the crab bank over several operational cycles. Each of the four study sites had only been in operation for a short time. Results between the different crab banks varied greatly depending on how long they had been operating, which varied from 2 months in Kampong Samaki to more than a year in Phum Thmey and Prey Nop II. For this reason, it was too soon to say whether these crab banks were working, but we tried to compare the basic functioning of their crab banks while bearing in mind their relative novelty.

When crabs were purchased (Tomnop Rolok and Kampong Samaki) the duration of the crab bank was limited to 2 months in Kampong Samaki and 4 and 5 months in Tomnop Rolok in 2008 and 2009 respectively. The revolving fund was not sustainable, with 18 kg of gravid females purchased and only 3 kg sold due to a high mortality rate (83%) in Kampong Samaki. A similar constraint was observed in Tomnop Rolok, with an average mortality rate of 50% per month. The number of gravid crabs stocked in the cage decreased from 300 to 84 in 2008 and 401 to 9 in 2009.

In comparison, Phum Thmey (using a loan-based model) and to a lesser extent Prey Nop II (using a voluntary donation model) showed an interesting pattern of crab flow (Figure 7). Voluntary donation of gravid crabs or crabs provided in lieu of interest on loans provided a more consistent and sustainable number of gravid females compared to a system based on purchase.

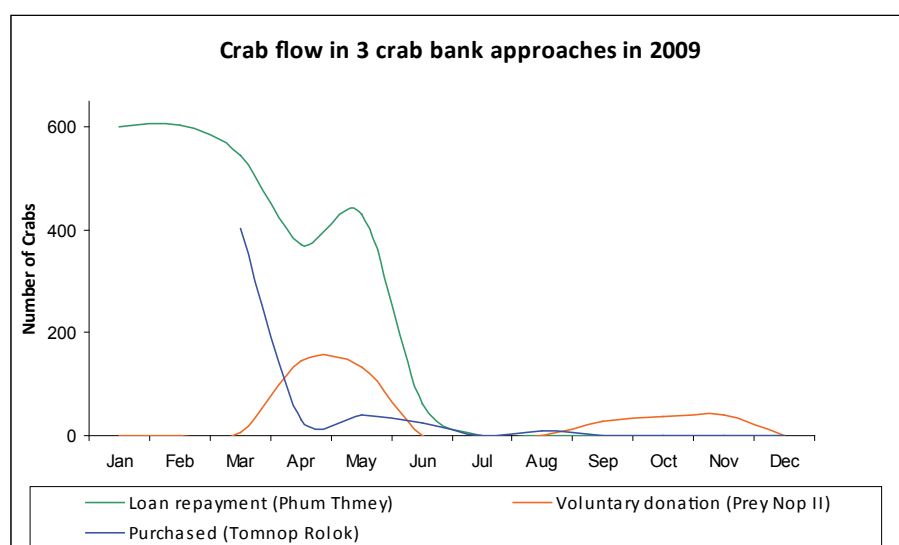


Figure 7: Evolution of gravid crabs in the different crab banks. (Kampong Samaki crab bank data are not included in the figure)

Photo by: The Learning Institute

Records of crab flows were shown to depend on the natural environment. During the rainy season, the water salinity and the higher frequency of storms impede crab culture, even if this period is the peak crab season. In addition, according to Tomnop Rolok fishers, the peak season for gravid crabs is from May to July, early in the rainy season when crab bank systems are not functioning. Only in Prey Nop II did the crab bank seem to function during the rainy season, which might be related to specific environmental conditions involving a lower local discharge of fresh water.

In Phum Thmey, access to loans encouraged fishers to join the crab bank and membership increased from 22 members in January 2009 to 27 in April. The actual number of members is now limited by the availability of revolving funds; not enough loans are available to accept more members. Similar patterns were recorded in other crab banks supported by CORIN in Cambodia, with an increase in members from 14 to 24 in Kdat, 10 to 18 in Kep Thmei, and 9 to 41 in Chroy Bros when members were given access to loans.

In Prey Nop II, the number of members also increased, but presumably because the crab bank was located in a village where fishers specialized in crab fishing using traps instead of nets. In this case, the number of members increased from 11 in the first village to 38 in the second village, mainly because of easier access to the cages. In 2011, however, as the external support and incentives ended, the crab bank reportedly became less active and required change in the Crab Bank Committee membership.

At other crab banks visited, the total number of members was not recorded. In Kampong Samaki and Tomnop Rolok the crab bank is associated only with the CFI Committee. Membership was not clearly stated and fishers did not participate in donation of gravid crabs.

Capital investment costs varied among the different systems. Crab banks with loans were the most costly, with more than 3,250 USD financed by CORIN in Phum Thmey (of which 2,750 USD was used to provide revolving funds for loans) compared to 590 USD in Kampong Samaki or 580 USD in Tomnop Rolok (and an additional 90 USD/month operational cost for feeding). In Prey Nop II the financial details of investment and return of the crab bank were not available. SEAFDEC covered the monthly operational cost of 10 USD (including feed with trash fish).

Even with a crab mortality rate higher than 20%, the crab bank in Phum Thmey has proven financially sustainable. Operational costs (fuel and food) were between 3 and 13 USD/month and the crab bank generated a net return of over 50 USD/month. Some of the benefits were re-invested in the crab bank through the purchase of equipment (a boat and bicycle) the first year. The net benefit was divided equally between the members of the committee, as a financial incentive.

On the other hand, crab banks based on the purchase of gravid crabs are not sustainable due to the generally high mortality of crabs in cages and the resulting net loss in financial returns from the original investment. The gravid crabs are purchased per kilogram and not per individual; the total weight of purchased crabs after spawning is lower than before spawning; thus, even with 0% mortality the funds generated from selling the crabs after they spawned were not sufficient to purchase the same number of new gravid crabs for the next cycle. After each spawning cycle, the number of crabs purchased and stocked in the crab bank decreased until there were none. Starting in 2011, the banks in both Tomnop Rolok and Kampong Samaki modified the approach and began to solicit voluntary donations. In Tomnop Rolok, middlemen were also invited to become more involved.

Conclusions

- Incentives (e.g. access to loans) are needed to sustain the participation of crab fishers, at least until local fishermen can feel the benefits of the crab bank (e.g. an increase in crab catch)
- Crab bank activity is dependent on the natural environment and subject to water salinity and frequency and severity of storms
- For the crab banks investigated, the high mortality rates of crabs in cages represent a significant stumbling block to the biological and economic sustainability of operations

The purchase system cannot be financially sustained unless a percentage of the crabs is donated by fishers

or middlemen, or purchased at a lower price than the normal market price.

Conclusions

- A system based on the purchase of crabs was found to be financially unsustainable, as crab bank activity ceased at both sites due to the absence of investment capacity after 4 to 5 months
- Loan and voluntary donation systems (with or without loans) are more likely to succeed, with crab banks functioning over a longer period
- The success of loan and voluntary donation systems is also linked to CFI operational strength and awareness of future benefits among members
- Loan systems are economically sustainable, showing positive economic results (over 50 USD/month)
- Loan systems require the highest start up investment (3,250 USD compared to less than 600 USD for systems based on the purchase of crabs)
- Addressing issues of crab mortality could substantially improve the economic sustainability of crab banks

Table 10: Summary of enabling factors and challenges faced in the four crab banks visited

	Enabling Factors	Challenges
Kampong Samaki	<ul style="list-style-type: none"> • Financial support from NGOs • Presence of an active CFI • Pro-active community for natural resources management 	<ul style="list-style-type: none"> • Lack of communication • Non-clear roles and responsibilities of the Crab Bank Committee, including lack of leadership and planning • Low fishing capacity, no access to gravid crabs • Technical choices not suited to natural environment (metal cages) • System based on crab purchase not economically sustainable
Phum Thmey	<ul style="list-style-type: none"> • Access to gravid crabs, with high fishing capacity • Economic incentives with access to loans from CORIN • Pro-active community for natural resources management • Involvement of crab middlemen to facilitate technical implementation and participation of fishers 	<ul style="list-style-type: none"> • Limited loans & late reimbursement from some members • More transparency in accountancy needed • Only six months implementation due to environmental constraints • More interaction with the Commune Council requested
Prey Nop II	<ul style="list-style-type: none"> • Technical support (FiA) and operational cost (SEAFDEC) • Pro-active community for natural resources management • Crab bank active all year round • Lower cost for fishers – possibility to market crabs after spawning 	<ul style="list-style-type: none"> • Illegal fishing limit incentives to participate, with benefits of the crab bank seen as going to illegal fishers (outsiders) • Lack of transparency and mistrust of leadership • Voluntary approach needs encouragement and activities to boost motivation • High mortality rate
Tomnop Rolok	<ul style="list-style-type: none"> • Support from FiA Cantonment • Access to gravid crabs, with high fishing capacity • Presence of a CFI, including crab middlemen 	<ul style="list-style-type: none"> • Lack of transparency and absence of communication • System based on crab purchase not economically sustainable • Lack of social cohesion within the CFI • Lack of strong leadership in the crab bank

V.2. Enabling factors for successful crab bank development

In this section we list a number of positive factors that have been identified to help crab banks continue. Incentives to maintain membership activities fall into 4 categories: 1) governance, 2) economic and market aspects, 3) social and technical aspects, and 4) environmental aspects. Table 10 summarizes enabling factors and challenges at each of the 4 survey sites.

Similarities can be found within the different sample

sites. For example, the presence of an active CFI is important to host the crab bank. Access to resources, with sufficient fishing capacity to provide gravid crabs, is important. In most of the sites visited, fishers are interested in developing mechanisms to manage natural resources and the crab bank concept is apparently well understood and integrated into their thinking on natural resource management. On the other hand, challenges are diverse, ranging from governance, economic and technical issues. In terms of governance, transparent management mechanisms and leadership roles appear

to be important. The system based on voluntary donation of crabs seems to be financially more sustainable.

V.2.1. Governance and institutional issues

a. Strong commitment of fishers to CFIs and resource protection

In Kampong Samaki, the main incentive to join the crab bank was related to improvement of resource management and specifically protection of the resources against private investors⁷. For 45% of the members interviewed, developing a crab bank in the area would help to protect the mangrove, improve natural resource management and enhance crab stocks. In this village, the CFI was set up to deal with a conflict related to private investors encroaching on mangrove areas several years before.

In all the crab bank study sites, the CFI structure was already in place. Crab bank initiatives could be more smoothly introduced to the community through the existing CBOs such as the CFI. The experience of the four study sites indicated that it might be easier to establish a crab bank in a small and more active CFI rather than a large CFI.

b. Development of transparent governance mechanisms

In Phum Thmey, loan access and records of cash and crab flows were transparent with several levels of control within the CFI and also external oversight by CORIN, the FiA, Commune Councils, and village authorities. According to CORIN, the Commune Council, especially the Commune chief, plays a key role in the success of the crab bank by authorizing and ensuring transparency of the micro-credit approach, and facilitating conflict resolution. Keeping clear and accessible records (especially of financial transactions) built trust within the group and may have been the reason for the increase in membership. In addition, in this crab bank the committee was composed of non-crab fishers, thereby limiting conflict of interest for loan provision between the committee members and the members of the crab bank.

V.2.2. Incentives and associated benefits

a. Support from NGOs

The financial support was the second most important incentive for members in Kampong Samaki (36%). It included distribution of fishing gears and salaries to build the cages and funds for start-up investments. In Phum Thmey, without CORIN's financial support, the crab bank model which included provision of small

loans could not have been developed. In Prey Nop II, the technical and financial support of SEAFDEC and the FiA was important and in 2011 the absence of support from SEAFDEAC limited the involvement and participation of members.

b. Side benefits and additional income

In Kampong Samaki, patrolling teams earned additional income by guarding fishing gears of other fishers during the night. Their involvement in the crab bank was rewarded by having access to crabs that died in the cage for their own consumption, since dead crabs are not marketable⁸. In Prey Nop II, 55% of the respondents acknowledge that gifts (T-shirts, cooking equipment) provided by the NGO were an important incentive for them to participate in the crab bank.

c. Access to loans

In Phum Thmey, 66% of the respondents said they joined the crab bank because of the access to loans. Even if the amount loaned was small compared to loans available from middlemen, it appeared to be one important incentive in this case.

d. Cooperation with crab middlemen

In Phum Thmey and Prey Nop II, crab middlemen were informed about the crab bank initiative and according to fishers, they supported the project by allowing fishers to donate crabs and even provided gravid crabs themselves to the crab bank. In Prey Nop II, middlemen also emphasized that purchasing gravid crabs was less profitable for them because they discarded the eggs and sold the crab meat by net weight.

For financial sustainability, a business-driven approach with stronger involvement of middlemen is a possible course for future development. In several sites (Tomnop Rolo, Phum Thmey and Prey Nop II) middlemen were interested in the concept and even supported it, in some cases with crab donations.

An option that needs further exploration is the involvement of middlemen in providing a share of their purchased gravid females for the crab bank, especially during the peak spawning season, instead of sending them directly to market. Within this system, supply of gravid females would improve and the number of gravid females in the crab bank would increase. Integration of middlemen within crab bank development seems necessary because of the contractual linkage between middlemen and fishers in most cases. The role of middlemen within the

(7) Kampong Samaki CFI was established in 2006. Before the establishment of the CF, private investors had sought access to mangrove and coastal areas for shrimp farming and salt pans. NGOs and other agencies supported the development of the CFI to protect the mangrove forest and coastal area from privatization.

(8) However, we note that this practice can create a disincentive for fishers in charge of the crab bank to keep crabs in the cage alive.

crab bank needs to be clearly defined and discussed within the CFI and among crab bank members.

In 2011, FiA cantonment officers started encouraging and facilitating the involvement of crab traders and middlemen in the crab bank activities. In Phum Thmey, the crab bank has been relocated closer to the middlemen in order to shorten the transport of gravid females and create better environmental conditions for crabs compared to the previous sites.

Other potential business approaches should be investigated. Crab banks can be more oriented toward generating profits in specific locations with access to direct marketing to consumers, restaurants and tourists. The profits generated by crab sales can be used to create a revolving fund for a micro-credit scheme or to finance community infrastructure, for example.

V.2.3. Technical and environmental issues

Enabling technical and environmental factors (Table 11) included incentives of improved crab stocks, availability of gravid crabs and the suitability of the environment for crab growth in cages.

In Prey Nop II and Phum Thmey, 100% and 83% of respondents respectively claimed that improving crab resources would be beneficial to their livelihoods. This result could be linked to the awareness campaign during the project's implementation. In Tomnop Rolok and Phum Thmey, fishers had access to different fishing grounds. Even if the catches fluctuated during the year, the catches were sufficient to allow several months of donations to the crab bank, given sufficient fishing capacity.

In Prey Nop II, the crab bank could operate all year long even during the rainy season. In other sites, the water salinity became too low during the rainy season thus restricting crab bank activities to the dry season. In addition, the location of the crab bank was important to facilitate access to the bank for the fishers.

Table 11: Enabling technical and environmental factors.

	K. Samaki	Phum Thmey	Prey Nop II	Tomnop Rolok
Stock enhancement potential	No	Yes	Yes	?
Availability of gravid crabs	No	Yes	?	Yes
Suitable environment	No	?	Yes	?

V.3. Challenges faced at four case study sites

V.3.1. Governance and institutional issues

a. Insufficient planning prior to implementation

In Kampong Samaki, 35% of the respondents reported lack of governance mechanisms as one of the main constraints. More precisely, CFI members highlighted a lack of leadership and planning in crab bank implementation processes as well as absence of clear responsibility. One of the committee members stated *"We, the committee, just know that NGOs wanted to establish a crab bank in our community fisheries and asked us to start up very soon. With this urgent time, the community itself has no time for dissemination and sharing the principles of the crab bank implementation and also has no time to engage the people in participating in this approach"*.

In Tomnop Rolok, the crab bank started with involvement only from the CFI Committee. The CFI Committee had limited resources and was not able to carry out a proper awareness campaign within the entire CFI and seek wider participation of other fishers. Thus, fishers felt they were not involved in the planning process, which resulted in limited participation of fishers in the implementation.

b. Low awareness and limited information sharing

At the Kampong Samaki site, 12% of members highlighted the lack of awareness about crab banks. Fishers and CFI members reported an unclear understanding of crab bank systems, and 4% of members reported a lack of knowledge sharing of other crab bank experiences in the region.

In Tomnop Rolok in 2008, 52% of the fishers interviewed were not aware of the crab bank initiative. Only a few of them knew that gravid females were stocked in a cage, but even these seldom had a clear understanding of the initiative and the CFI involvement. None of them

reported being asked to participate. The CFI Committee later confirmed this result by explaining that the lack of resources was a major constraint for them to share the information and implement the crab bank initiative within a Community Fishery with a large membership. In addition, the Committee was at the same time in charge of other duties of the CFI and could not allocate time to implement crab bank activities.

In Prey Nop II, 15% of the members also highlighted the lack of information sharing, absence of meetings and mistrust in leadership. The leader of the crab banks was suspected of mismanagement by several members, which later impacted negatively on the donation of gravid crabs by those members.

c. Crab poaching

In Phum Thmey, one constraint reported by crab bank members was possible poaching (5%). In Prey Nop II, a patrolling team of the CFI was charged with guarding the crab bank. However, 15% of the respondents claimed that there a specific guarding system was needed for the crab bank. Therefore, the Commune Council issued a Deka (local legislation) to forbid fishing around the crab bank cage.

d. Lack of transparency and mistrust of leadership

In Prey Nop II, there was no clear mechanism to record crab donations, and 20% of the respondents that one was needed to improve trust among the crab bank members. As a result of this lack of transparency, donations to the crab bank decreased.

In Tomnop Rolok, the implementation was carried out unilaterally by the CFI Committee, with one person taking care of everything. Transparency and community participation was not promoted in this approach.

According to a few members interviewed (5%), access to loans was not equal for all the members, with differences in the amount loaned. This anecdote highlights the shortcomings of the loan approach.

In Prey Nop II, the absence of active leadership in strengthening the group through frequent meetings and transparent records led to fewer donations to the bank.

According to CORIN staff supporting Phum Thmey's crab bank, transparency in accounting, especially in terms of expenses, required continuous monitoring and strengthening even after the administrative procedures and rules were already put in place.

e. Prevalence of illegal fishing

In Phum Thmey, 5% of respondents reported problems



Focus group discussion on crab bank with Prey Nop II CFI members, Preah Sinhanouk province

related to competition with illegal trawlers. This was a serious concern because these fishers had the ability to derive illicit benefits from the crab banks and the CFI did not have the authority to stop them.

In Prey Nop II, this issue was preponderant, with 70% of the respondents claiming that illegal fishing was the main challenge. Fishers believed that the benefits of the crab banks were lost due to illegal fishing, especially when illegal fishing was prevalent near the cage. These trawlers were using small mesh sized nets which caught all juvenile crabs as well as other fishery resources. In addition, trawlers were accused of causing damage to the fishing gears of local fishers such as crab traps and gill nets. Even if the crab bank activity was limited in Tomnop Rolok, fishers emphasized that such activity would never succeed without specific measures to combat illegal fishing on the part of CFIs and the FiA.

Even if a patrolling team was put into place, the absence of authority to enforce the law at the CFI level, the lack of cooperation with the FiA Cantonment, and the absence of equipment would limit their effectiveness in halting illegal fishing.

f. Ineffective Community Fisheries and absence of social cohesion

In Tomnop Rolok, the crab bank was developed through the CFI Committee. Fishers explained that the CFI did not involve them in meetings and decisions, and they were not consulted in the crab bank development process. Fishers in general did not attend CFI meetings, one saying that *"The CFI is only on paper but not active locally"*. The sense of community among the fishers was not strong because the CFI Committee was composed mainly of retired fishers and middlemen. This absence of social cohesion constrained the development of collective action.

V.3.2. Financial issues

a. Limited loan capital and delayed repayment

In Phum Thmey, the success of the crab bank was limited by the size of the revolving fund provided by the donor NGO. The main challenge identified by 39% of the members in this crab bank was the delay in repayment of loans, which in turn affected the availability of loans for other existing or new members of the crab bank.

This financial aspect of crab bank operation is also affected by the seasonality of crab catches; fishers may not be able to catch enough crabs to repay the interest on the crab bank loans during the low season. Moreover, 5% of the respondents complained about the size of each loan being too small, compared to other loans provided by banks or middlemen. The amount loaned within the crab bank was seen by fishers as not enough for a significant improvement in the fishing capacity, which was the main reason for them to take on a loan (even though the increase in fishing capacity is counter-productive to the objective of the crab bank, the loans made through crab banks typically are not restricted to specific purposes).

b. Limited financial support for crab bank operation

In Tomnop Rolok, the financial support from the FiA was limited according to the CFi. The absence of incentives (mainly financial) for the committee was highlighted as a constraint, as incentives could have promoted proactive behaviors to develop the crab bank. After the initial steps of crab bank implementation, the support from the FiA stopped and the model based on purchasing crabs could not continue.

V.3.3. Technical and environmental issues

a. Lack of knowledge and skills to cope with common problems

For 19% of the respondents in Kampong Samaki, technical knowledge for feeding the crabs was missing, resulting in a high mortality of crabs in the first month (83%). The mortality rate was reported to be between 35 and 75% in Prey Nop II and was identified as the main technical constraint by 30% of the respondents.

Testing and modifying the design and materials to create appropriate crab cages was a significant challenge during the first years of operation. The use of metal cages was not suitable in a sea water environment (Kampong Samaki; Prey Nop II); bamboo is more resistant to salt (no oxidation). On the other hand, small cages made of bamboo were not strong enough to withstand waves during the rainy season (Tomnop Rolok). The cages required regular maintenance and/or modification of material after 2 years of operation at these 3 sites. The crab bank members acknowledged that cages made

of poles and metal nets are not suitable. Small cages made of bamboo are easier to move and more suitable, but only in areas where wave energy is not too strong.

Deciding where to place the cage is another difficult question. The cage location was found to be too far from villagers' houses (Kampong Samaki, Phum Thmey, Tomnop Rolok) or needed to be relocated closer to the landing site to shorten the transportation time of gravid females and reduce the mortality rate (Prey Nop II, Phum Thmey). Water depth is an important factor to avoid too much freshwater; the cages need to be fixed at the middle of the water column. To ensure a less turbid environment for the crabs, the cage should avoid locations too close to boats and landing sites (Phum Thmey, Prey Nop II). To prevent fishing activity nearby from disturbing the cages, crab bank members fenced off the surroundings in Prey Nop II.

b. Low availability of gravid females

In Kampong Samaki, the crab fishery was of a very low intensity, located mainly near the shore, and lack of access to gravid crabs limited donations to the crab bank. One respondent reported *"It is difficult for my community to catch the gravid crabs for donation to the crab bank since we are small-scale fishermen using only row boats. So we cannot go offshore to fish because of storms and other dangers"*.

In Prey Nop II, 10% of respondents reported a similar issue of experiencing a period when gravid females were not available, even if the fishers had access to different fishing grounds. In Tomnop Rolok, the CFi Committee reported that the period when fishers could catch gravid females was only three months (May to July), limiting the period for crab bank implementation.

V.4. Perceived benefits of the crab bank according to members

In cases like Kampong Samaki, benefits were limited to external support from an NGO, with some members receiving additional income for cage building or access to non-marketable crabs for their own consumption.

After one year of operations in Phum Thmey, more than 60% of the members interviewed reported an increase in crab catch, mainly in juvenile and immature ones. However, these statements could not be verified by official catch records. Access to credit and higher catches were highlighted as the main reasons for livelihood improvement by 11% of the respondents and access to credit was the main benefit of this initiative for 72% of the members interviewed.

One interesting point is that loans were used mainly to intensify crab catch, to replace or invest in traps, hire

crew members, or cover fuel costs. In this context, the increased catch could be the consequence of greater fishing effort and not a greater abundance of crabs. The fact that the loans are used to increase fishing effort might have an effect on crab stocks that is the opposite of the one intended by leading to over-exploitation of the crab fishery. Within this scenario, the crab bank has to be efficient enough to counter the effect of increased fishing effort.

In Prey Nop II where the crab bank system was active for more than a year, benefits were not significant according to the majority of the members, with only 33% of the respondents claiming an increase in the crab catch. Moreover, 55% of the members interviewed did not see any direct benefits. For most of the members, the benefits will not be significant until illegal fishing is halted.

Results were based on farmers' claims and no specific studies monitored the crab catch before and after crab bank implementation. In addition, the crab banks in most places operated for only a few months. The impact of this initiative could be measurable after several years, as in the case of Chumphon province in Thailand. In this study, a significant impact on the catch and size of the crabs was found after 2 years of crab bank implementation (Suanrattanachai *et al.* 2009).

In Chumphon province, the crab bank includes 18 fishers and the total number of crabs in the bank between 2002 and 2007 was 19,475 gravid females (3,245 gravid crabs per year on average). The crab bank is operated from February to November. The impact on the crab catch (annual catch improved from 41 to 67 tons/year at the sub-district level between 2002 and 2009) was due to several catch control measures such as changes in trap mesh size (2.5 cm) and regulation of fishing grounds (minimum depth of 3 meters for fishing grounds), and not only because of the stock enhancement practice.

Similar results cannot be seen yet in Cambodia, with no additional measures related mesh size or regulation of fishing ground access. The number of gravid females passing through the crab banks is lower than in Chumphon province, with a maximum of 2,600 in Phum Thmey--the most active crab bank in our sample---and less than 600 in other sites in 2009⁹.

Crab fishing activities in Cambodia are dispersed and data on catch per unit effort is not available. Populations of short-lived species, such as swimming crabs, are not

easy to monitor and the effectiveness of stock enhancement efforts are difficult to assess. However, we can make a simple hypothesis, based on available literature, and estimate the number of successful spawnings that would be necessary to increase the crab catch by 10%. This exercise gives us some idea of the scope of crab bank activities that need to be developed for the initiative to have a significant impact on the crab fishery in coastal Cambodia.

If we assume that an average number of eggs spawned by a female crab is 940,000 (based on the average of Ingles & Braum 1989 and Yatsuzuka 1962), with a survival rate of 1% at the larval stage (Ingles & Braum 1989 in a controlled environment) and a survival rate between 10 to 30% at the adult stage (cited by Sumpton *et al.* 2003), each spawning female stocked in a crab bank can result in 1,410 more adult crabs in the wild (mature and of marketable size, more than 14 months old – based on Sumpton *et al.* 2003).

A 10% increase in the crab catch, for example, in Kampot Cantonment (47 tonnes, using the 2008 catch as a baseline) represents around 1 million individual crabs. Assuming that between 10% to 25% of the additional adult crabs in the stock (resulting from the crab banks) can be caught by fishers with the current level of fishing effort, it would be necessary to have 7,645 to 3,058 successfully spawning crabs respectively to reach the target increase in the crab catch.

The number of successfully spawning crabs through crab banks in Cambodia has increased, but to make a significant impact on crab stocks, and in turn, to increase the catch, the crab bank schemes will need to have a much larger number of female crabs.

Combined with increased survival rates of larvae and juveniles through changes in fishing practices themselves, crab banks can have a positive impact on crab stocks and sustainability, as demonstrated by the example of Chumphon province in Thailand.



Photo by: The Learning Institute

⁽⁹⁾ It was not possible to compare the Chumphon example and the Cambodian crab banks in term of the ratio between the size of the fishery and the scope of the crab banks; no crab catch data is available at each Cfi level.

VI. LESSONS LEARNED AND RECOMMENDATIONS

VI.1. Site selection

- ❖ The example of Kampong Samaki shows that an important factor in site selection is the type of crab fishery in an area. CFIs should have access to gravid females and thus should have a certain level of fishing capacity, with engine boats (or even row boats) and traps to ensure access to diverse fishing grounds.
- ❖ Areas where crab fishing occurs during the peak season and spawning season seemed to be more suitable as they had a higher gravid crab catch.
- ❖ Natural environmental conditions – such as the low influence of fresh water in the rainy season and protection from strong waves – are other factors must be taken into account when selecting crab bank sites.

VI.2. Implementing, and adapting the crab bank model for Cambodia

- ❖ Awareness campaigns, consultations and dissemination of information on the importance of crab banks as well as their purpose and processes needs to occur before implementation in order to create sufficient interest among the CFI members and to ensure that they share the same understanding of the crab bank and that they are interested in developing such an activity;
- ❖ Crab bank development has to involve crab fishers and can not be based only on Community Fishery Committee members who are directly involved with crab fishing;
- ❖ If possible, a separate Crab Bank Committee composed of non-crab fishers is desirable so as to limit conflict of interest in crab bank management, specifically where loan provision is involved;
- ❖ Development of governance mechanisms with clear roles and responsibilities within the crab bank is necessary. The contrasting experiences Kampong Samaki and Phum Thmey are representative of this requirement;
- ❖ Due to the high mortality rate of crabs kept in cages, crab banks based only on the purchase of gravid females from markets (instead of voluntary donations or as a loan repayment directly from fishers) are likely to be unsustainable because of the cost of having to purchase gravid females every cycle;
- ❖ Crab banks need to be based on the donation of gravid females and linked with incentives such as access to loans and/or other benefits;
- ❖ Even if the model is based on donation, clear operational records (financial and administrative) are needed for better transparency;

Photo by: The Learning Institute

- ❖ Poaching control mechanisms are needed even in the case of a model based on donation to create more transparency and trust within the community;
- ❖ Collective action, like crab banks, requires a cohesive social group, which can be achieved in part with information sharing and frequent meetings to address issues;
- ❖ Involving middlemen in the crab bank processes to ensure a more stable supply of gravid female crabs and improved marketing is now recommended, and is practiced by the FiA in Preah Sihanouk and Kampot cantonments;
- ❖ Potential business approaches need to be investigated, particularly in tourist areas with better marketing opportunities and higher selling prices, with successful crab banks creating a revolving fund for access to micro-credit for crab bank members;

VI.3. Technical issues

- ❖ Cage structures made of metal are not suitable in saline water and bamboo structures seems better for this environment, and cages should be placed in areas where wave energy is not too strong;
- ❖ With different landing sites for different seasons, floating bamboo cages are more easily manageable and transportable than fixed metal cages with poles. In addition, floating cages are less prone to poaching;
- ❖ Cages should be placed close enough to the landing site to minimize the time needed to transport gravid females from boats to cages, but far enough to avoid disturbance (turbidity, pollution) from the port activities;
- ❖ Cage size needs to be in accordance with the number of crabs stocked to avoid over-populated cages and higher mortality rates, as in Phum Thmey where three cage types were made for gravid females at different stages;
- ❖ Technical options for running crab banks in the rainy season when water salinity decreases need to be identified. The Japanese model can be explored and the concept should be discussed within CFis. Currently, its suitability within the Cambodian con-

text remains unknown;

- ❖ Options for placing the cage far from freshwater discharge should be explored, but such options should also take into account the time needed for transportation in order to deal with the accessibility issue;
- ❖ Options for cage design and placement also need to take into account the issue of low salinity during heavy rainfall, such as closed cages placed at lower levels in the water column;
- ❖ Crab catch should be monitored in the early steps of crab bank development and after its implementation to assess the impact of crab catches.

VI.4. Governance issues

- ❖ For a higher impact, crab banks need to be linked with measures to regulate crab fishing itself, as is done in Thailand, with a change in crab traps and a minimum mesh size¹⁰. Such changes will be implemented in Phum Thmey next year;
- ❖ The success of crab banks is closely related to the effectiveness of CFis and specifically enforcement of laws related to illegal fishing practices. Fishers will join and then follow crab bank initiatives only if other resource management measures are in place and effective;
- ❖ Local authorities such as Commune Councils should be involved in crab bank activities so that these activities receive institutional as well as financial support;
- ❖ A program to release rather than market younger spawned females should be explored. Crab bank development can have a significant impact on crab fishery management. However, the implementation and management of crab banks so far has not been simple, easy, or robust. Technical aspects are important for the success of such initiatives and more research to assess the survival rate of crab larvae released from crab banks is needed. Like many other community based initiatives, crab banks require specific institutional and geographic settings for their implementation and organization in the Cambodian context.

Examples from Thailand show that crab banks are successful when they are associated with other fishery management measures. In Cambodia, crab

⁽¹⁰⁾ For example, at the Chumphon project site in Thailand, the minimum mesh size was set at 2.5cm.

fisheries are an important resource for the coastal population, and measures for stock management are

needed to ensure the livelihood of coastal fishers. Crab banks can be one of these measures.



Photo by: The WorldFish Center

Crab fishermen coming back to the landing site in Tomnop Rolok

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