

Guidelines for Management of Blue Swimming Crab Resources by Small Fishing-Boat Fishery Communities Based on Local Wisdom: Case Study of Phe Bay of Rayong Province

Khemapat Yenpiam
*Faculty of Humanities and Social,
Suan Dusitt University*
dr.khim_4@hotmail.com
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Abstract

This study was the qualitative research based on the participatory action research (PAR), which has been conducted by cooperation of small fishing-boat fishery communities earning for living by crab gill net fishery at the Phe Bay of Rayong Province, and other officials and technical specialists from related agencies in the area. The result showed some local fishery wisdom such as observation of Blue Swimming Crab habitat, tideway, wind, fishing operation, removal of crabs from crab gill net, crab catch seasons, season and environmental changes, etc. It was found that there have been some changes in Blue Swimming Crabs regarding the reduction of crab amount and size. Causes of changes in Blue Swimming Crabs at the Phe Bay included: 1) changing natural environment, e.g. delayed monsoon season; 2) impact resulted by leak of crude oil at Phrao Bay, Samed Island of Rayong at the end of July 2003; 3) use of smaller mesh-size net, catch of small-sized crabs, and selling of berried females; 4) destruction of marine and coastal resources resulted by the government policy in the coastal area development at Rayong; and 5) commercial fishing vessel operators' employment of alien labors and use of high-tech tools to catch Blue Swimming Crabs regardless of crab types and sizes. The guidelines for management of Blue Swimming Crabs at the Phe Bay of Rayong Province to be implemented includes setting of core area as the fishery free zone, and establishment of Blue Swimming Crab bank to feed berried females.

Keywords: Management of blue swimming crab, Small fishing-boat fishery communities, Local wisdom

Introduction

Changes of economic status at Rayong from the agricultural to industrial community, expansion of tourism and seafood industry, and urbanity have definitely given the impact to the marine and coastal environment, especially coastal pollution caused by coastal communities, industrial plants, piers where are full of oil slick. The pollution in the sea is also caused by oil rigs, ocean mining, dredging, and leakage of crude oil, etc. (Pollution Control Department, n.d.). On August 2013, the leakage of crude oil close to Map Ta Phut coast of Rayong caused the huge impact Phrao Bay, Samed Island and other areas at Rayong Bay from oil slick to the marine and coastal resources as well as fishery resources.

Phe Bay is a bay affected by the leak of crude oil. This bay is an important economic source of Rayong Bay as it is the tourist attraction with a harbor to Koh Samed, the residence of small fishing-boat fishery communities, the site for an industry of seafood processed products and the market for dried and fresh food, and the major stop spot for tourists to buy seafood products of Rayong Province.

Fishery resources of Ban Phe communities are economic resources generating a huge amount of revenues for these communities. According to the Eastern Marine Fisheries Research and Development Center, Rayong Province (2011), there were 192 fishing boats at Tambon Ban Phe and 104 out of them were local fishing boats (small fishing boats). Most of fisheries there were crab gill net, fish trap and squid trolling line. According to a survey at the aquatic animal pier at Tambon Phe, Amphoe Muang from February – December 2011, the catch of aquatic animals was approximately 11.4 kilos/time, and most of aquatic animals caught were Blue Swimming Crabs. This data indicates the utilization of aquatic animals for fisheries, especially Blue Swimming Crabs that have been most abundant at the Phe Bay, which has generated huge income and economic growth for Ban Phe communities. Earlier, the small fishing-boat fishery communities at the Phe Bay has got such impact directly, especially fishery life greatly relying on the marine and coastal resources, but these fishermen have slightly been involved in the rehabilitation and preservation of marine and coastal resources although the Constitution grants rights to each community in management of natural resources and environment as well as biodiversity as stated in Article 66-67 of the Constitution of the Kingdom of Thailand, B.E. 2550 (1997).

Therefore, promoting and encouraging the small fishing-boat fishery communities at Phe Bay of Rayong Province to have more forums for knowledge and opinion sharing would allow these communities to recognize the problems, and to find out solutions together. This would make all related people to recognize their participation, and to be responsible for the utilization and preservation of aquatic animals, especially Blue Swimming Crabs, which are important resources generating huge income for small fishing-boat fishermen at the Phe Bay of Rayong Province, in the future.

Subject to the circumstances and problems in relation to the management of Blue Swimming Crab resources at the Phe Bay of Rayong Province, the Author felt interested in studying this matter to find out the guidelines for the management of Blue Swimming Crab resources by small fishing-boat fishery communities based on local wisdom at the Phe Bay of Rayong Province because this area was the location of small fishing-boat fishery communities where most fishermen earned for living by crab gill net, and they were directly affected by the falling quantity of Blue Swimming Crabs. In addition, the small fishing-boat fishermen for crab gill net would have some local wisdom to be used for the management of Blue Swimming Crab resources. This is why the Author intended to conduct this study by allowing the small fishing-boat fishermen for crab gill net to be involved in it.

Objectives of the Research

1) To study community contexts and local wisdom of the small fishing-boat fishery communities earning for living by crab gill net at the Phe Bay of Rayong Province.

2) To study changes of Blue Swimming Crab resources, as well as causes and impact of such changes at the Phe Bay of Rayong Province.

3) To study the guidelines for the management of Blue Swimming Crab resources by small fishing-boat fishery communities based on local wisdom at the Phe Bay of Rayong Province.

Literature Review

For the study on Guidelines for Management of Blue Swimming Crab (*Portunus Pelagicus*) Resources by Small Fishing-Boat Fishery Communities Based on Local Wisdom: Case Study of Phe Bay of Rayong Province, all related concepts, theories and research studies were reviewed as described below.

Common-pool Resources and Principles of Common-pool Resources Management

Common-pool resources are characterized as resources for which the exclusion of users is difficult due to the huge scope of resources and these resources are rivalrous. The more these resources are consumed or harvested, the fewer these resources will be. Ostrom mentioned

“Subtractability” or the resources decrease when they are used. Some examples of common-pool resources are forest and forest resources, marine and marine animals, etc. Therefore, the problems caused by too many users of resources and exaggerate use of resources are the problem of utilizing common-pool resources; meanwhile, the users have been no inspired to maintain them because they are unable to exclude other users to share costs of maintaining and using such resources.

Blue Swimming Crab resources deem a type of common-pool resources, that is, the exclusion of users for utilization is difficult and the use of such a resource by one user decreases resource benefits for other users. In the meantime, the cooperation for the management of resources, which are like public goods, encounters the problems of exploitation or individual survival and free rider because a user does not help maintain resources, but he/she continues receiving benefits (Bunnag, 2011).

Elinor Ostrom (1990) conducted a study on Use of Common-pool Resources by Communities. The result showed that the communities capable of managing common-pool resources sustainably were those powerful for self-governing. Ostrom offers 8 design principles for how common-pool resources can be governed:

- 1) Define clear group boundaries, both the boundary of resource users and the boundary of resources.
- 2) Match rules regarding the appropriation and provision of common resources that are adapted to local conditions.
- 3) Ensure that those affected by rules can participate in the decision-making process and the modification of rules.
- 4) Effective monitoring by monitors who are part of accountable to the appropriators.
- 5) A scale of sanctions for resource appropriators who violate community rules.
- 6) Mechanisms of conflict resolution that are cheap and of easy access.
- 7) Self-determination of the community recognized by higher-level authorities.
- 8) Rules and resource management are linked and relevant to larger common-pool resources because the resource system and management exist and are linked to the social ecological system.

Setting rules for maintenance of common-pool resources for the sustainable utilization is different from unlimited and unconditioned use of common-pool resources (Witthayakorn Chiangkul, 2014).

Community Rights in the Management of Natural Resources

Udomsak Sinthipong (2015) stated that the natural resources in a community exist for living of local people or local community. People or local community shall be entitled in those resources. They must be conserved and managed for sustainable utilization. Therefore, a local community becomes lawful and has right in the natural resources and environment in the area more than other external people who do not rely on those natural resources and environment in living. This is an important reason that the government must permit each local community to be involved in such management to enhance public benefits in the utilization, maintenance and conservation of resources. This also prevents some conflicts caused by battle of resources, and destruction of natural resources and environment by local people. On the contrary, these local people would be able to get benefits from those natural resources.

The Author considered that this concept was consistent with community rights in the management of natural resources. Community rights have been differently defined by academics, e.g. Pairoj Polpetch (2004), Chontira Sattayawatana (2003), Anan Kanchanapand (2001), Yos Santasombat (1998). However, it may be concluded that “community rights” mean a tribe or a group of people who have the same objectives, and live together as a society in a community or communities or races. A group of people not only involves rural people, but also urban ones. These people have the social relationship, culture, allocation and use of resources, and benefits together. This group of people has the lawful power according to rules, tradition or agreements agreed together.

Community rights contain some important principles. They are the complexity of rights, which mean the existence of rights for several social units, and the existence of several rights on the same area. For example, forest or land is in the “right of possession” by the government, but a community holds the “right of management” while general people hold the “right of access and utilization”. The consideration of the complexity of rights would offer more alternatives and flexibility in arranging the relationship of power (Kanchanapand, 2001). Community rights are also characterized as the participatory management, which do not exclude any participation of people outside, but demand such external support. This could be seen in community forest management or rehabilitation of local identity; they were activities demanding external supports. A community is able to define some conditions and criteria to control the utilization by external people, and to prevent the violation of community rights. However, the exclusion of external people may occur in events of conflict or grasp of resources or in inequitable resource management structure (Boonchai, 1999). In addition, for community rights in the jurisprudence process, community rights deem the community-based law, which is the customary law, and takes an important role to be conformed to in general community life. In several cases, community rights are more influential than the written law (Jamarik, 1999).

Community Roles in the Management of Fishery Resources

Korten (1986) stated that the community-based fisheries management is the management of resources based on community abilities in mobilizing the existing community resources to benefit community members' production, and to enhance fairness and sustainability in responding to community members' demands. Therefore, the community-based management is the community's duty and responsibility in controlling and managing the utilization of resources. The community members must be involved in the utilization plan and implementation according to their community-based resource management plan.

Participation in the fisheries management allows the fishery resources users to be involved in setting measures, which lead to their acceptance and compliance (Nilsson et al., 2001). Akin Rapeepat (1988), Cohen & Upholf (1980), WHO (1978) said similarly that the participation process included 5 stages: 1) people jointly seek for, consider and prioritize problems; 2) people jointly seek for causes of such problems; 3) people jointly plan for problem-solving; 4) people jointly carry out the planned activities to solve problems; and 5) people jointly perform the assessment.

Apart from participation, network can provoke the power of changes and solutions. Parichart Valaisathien and others (2000) stated that network is derived from the group formation. Either group formation or network building, it is derived from mutual awareness, interest and objectives to solve problems, protect benefits, and build the power of changes or negotiation for a matter. Discussion on any interesting issue and brainstorming from many people would improve human ties, create the information network, and share resources together (Waroonpitikul & Rerngjit, 1999).

Local Wisdom in the Management of Fishery Resources

Chaladchai Ramitanon (1993), Ekavidya Na Talang (1993), Department of Environmental Quality Promotion (2005), Patcharin Sirasoonthorn (2007) identically defined the local wisdom as wisdom of local people or Thai wisdom, which is referred to everything initiated and created by local people under their potential and existing environment in order to solve their life problems appropriately at each era, and this wisdom could be succeeded and accumulated from the ancestors to the present generation.

Local wisdom may be categorized into: 1) food or nutrition; 2) dressing; 3) dwelling or architecture; 4) philosophy, religion, belief and tradition; 5) language and literature; 6) Thai traditional medicine; 7) career, which may be divided into agriculture, industry and handicraft; 8) management of natural resources and environment; and 9) fine arts (Department of Marine and

Coastal Resources et al., 2012). Some examples of artisanal fisheries using local wisdom for the management of marine and coastal resources are mentioned below.

Wisdom for the management of coastal resources by Trang Lay at Ban Thung Laem Sai, Laem Makam under the strategy of utilization forest rehabilitation – Local people requested the existing utilization forests seized by the mangrove forest concessionaire, and rehabilitated them to be the community mangrove forests under the principle of 5-party participation, comprising local people, NGOs, government officials, academics and mass media. The preservation of seagrass and sea turtles under Trang Lay wisdom are to bury turtle eggs in the sand around local people's houses so that the turtle eggs hatch out naturally. By this natural hatching, every hatchling turtle would be strong and creep to the sea by not losing its way (Sriwarathanaboon, n.d.).

Wisdom for the management of community-based mangrove forest and the landscape-based management of marine and coastal resources by Ban Nam Rab, Moo 4, Tambon Bang Sak, Amphohe Kantang, Trang Province. The leaders of local people who were local fishermen joined hands with the Local Fishermen Club of Trang Province, and Private Developers to make campaigns and educate local people about the impact of using unlawful fishery tools and destroying aquatic animal breeds. These local people formed the group to officially establish the Artisanal Fishery Saving Group and Ban Nam Rab Community-based Mangrove Forest Group. The Community-based Mangrove Forest Committee was also appointed. The rules and regulations on the use of woods from the mangrove forest were defined clearly, which were complied with by internal and external people. In addition, this community has arranged the marine and coastal resource preservation and rehabilitation activities twice a year. These activities included the mangrove planting, seagrass planting, release of aquatic animals until this area was announced as young aquatic animal preservation zone of 4 villages (Khet Lay-Say Ban). The marine inspection and surveillance were also undertaken by the Marine Volunteer Specific Force in collaboration with the Marine & Coastal Resource Conservation Center, No. 6, Trang Provincial Police Specific Force, Coastal Fisheries & Aquaculture Management in Andaman Sea of Thailand, Krabi Province (Green Leaf). The consequences were the reduced fishery tools destroying aquatic animals and more abundance of aquatic animals.

Apart from the rehabilitation and preservation of berried females, the Blue Swimming Crab Bank was also established so that its members operating the Blue Swimming Crab fishery and other piers buying the Blue Swimming Crabs there could feed the berried females until Blue Swimming Crab larvae were born and they would be released to the sea. As a result, the quantity of Blue Swimming Crabs has been increasing, and the local people have earned more revenues. At present, the Ban Nam Rab Artisanal Fishery Saving Group sets up a learning center for the management of marine and coastal resources, and a learning center for the berried females bank (Department of Marine and Coastal Resources et al., 2012:17-19).

The Crab Bank project at Ban Koh Tueb, Tambon Pak Khlong, Amphoe Pathio, Chumphon Province was chaired by "Uncle Jang" (Mr. Jang Fungfueng), 65 years. He narrated that most local people there performed the artisanal fisheries for crabs and fishes. These fishermen have gradually got fewer crabs or 5-6 kilos a day. Thus, these fishermen have quarreled about crab catch tools, that is, crab gill net and crab trap. Uncle Jang also thought that if no preservation measure was set, these crabs in the local sea would become extinct.

By this reason, the local people turned to discuss and hold the local forum to find out the solutions together. They tried to experiment the crab trap (Crab Larvae Nursing Center), and Uncle Jang was assigned to do this experiment. Under this experiment, there was a rule among the project members that berried females had to be given to Uncle Jang, which would be put in cages of "Crab Bank".

After laying eggs in common cages, those eggs would be released to the nature while the mother crabs would be sold to be the fund for these local people. Any local people having participated in this project and depositing berried females would retain the right to borrow some money from the selling of crabs. The amount of loan granted depended on the quantity of berried females deposited in the Bank. By this project, the local people there could catch 50-60 kilos of crabs instead of 5-6 kilos earlier (Rattakul, 2005).

Research Methodology

This study was the qualitative research based on the participatory action research (PAR), which has been conducted by cooperation of small fishing-boat fishermen earning for living by crab gill net fishery at the Phe Bay of Rayong Province and living in 5 villages, including Moo 1, 2, 3, 5 and 7 and most fishermen have made fisheries by crab gill net. This study was also involved by other officials and technical specialists from related agencies; namely, Marine and Coastal Resources Conservation Center, No. 1 at Rayong Province, The Eastern Marine Fisheries Research and Development Center, one official for each. The sample of this study involved 23 persons in total.

An in-depth structured interview was the research tool of this study used to survey community contexts, local wisdom used for catch of Blue Swimming Crabs, changes of Blue Swimming Crab resources, and causes and impact from changes in Blue Swimming Crab resources. Then, the research team assigned the representatives of each fishery group to survey the Blue Swimming Crab resources at the Phe Bay of Rayong Province. The survey was based on the survey form constructed by the Author to survey fishery sources, length of daily fishery, dates of fishery per month, amount and size of Blue Swimming Crabs caught, and utilization, etc.

The data collection was divided into 2 periods: April – May 2014 (normally, low season of crab catch); and July-August 2014 (normally, high season of crab catch).

Then, all data was compiled, analyzed and summarized to get some important issues to be used in the focus group discussion. The representatives of small fishing boats groups, technical specialists and workers of all related agencies were invited to mutually discuss the problems about changes of Blue Swimming Crab resources, causes of these changes, and effect, and to find out solutions for the management of Blue Swimming Crab resources based on local wisdom.

Results

The Author presented the results, and discussed them according to the research objectives as follows:

1) Community contexts and local wisdom of small fishing-boat fishery communities earning for living by crab gill net at the Phe Bay of Rayong Province.

The result showed that the economy of Tambon Phe involved commerce, fisheries, and processed seafood industries. There were 5 processed squid industries and 2 fresh markets. Ban Phe Market was a distribution place for fresh and dried food, and was a major stop spot for tourists to buy some seafood products at Rayong Province.

At Tambon Phe, there were 192 fishing boats; 104 out of them were the local fishing boats. Most of fishermen there earned for living by operating the crab gill net, fish trap and squid trolling line. There were 54 fishing boats for crab gill net (The Eastern Marine Fisheries Research and Development Center (Rayong), 2011: 18).

At the Phe Bay (from Ban Phe to Suan Son Beach), there were 4 groups of small fishing boats; namely, Kok Laem Thien Fishery Group, Sala Kaew Fishery Group, Nuan Thip Fishery Group, and Suan Son Fishery Group. From interviews of all 4 fishery groups, they have earned for living by crab gill net over 20 years, and this career has been succeeded from their grandparents. At the areas they have now lived and fished, they have been used for anchoring, removing crabs from crab gill net, and selling crabs, which would be sold to regular clients and tourists.

Regarding group relationship, from interviewing the leaders of those 4 small fishing-boat groups, the group relationship remained slight because each group spent most time for fisheries. For Blue Swimming Crab preservation projects or activities held by local authorities, they were participated by some groups because these groups considered that such projects and activities have not been held consistently and not given tangible outcome.

From the above information, it could be analyzed that the small fishing-boat fishermen had no confidence in the Blue Swimming Crab resources preservation held by government authorities. In addition, those small fishing-boat fishermen spent most time for fisheries, which caused the slight group relationship and discussion about problems and impact to the crab gill net fishery. As a result, the attitude towards the Blue Swimming Crab resources preservation has not been successful yet.

Therefore, to arouse each small fishing-boat group to pay attention and give cooperation, participation and network setting must be built up. According to Nilsson et al. (2001), participation in the fishery resources management would arouse the fishery resources users to take part in setting measures they accepted and complied with. In this study, the Author et al. used the participatory action research (PAR) in which the representatives of all 4 local fishery groups were invited to find out causes and results of such problem, and to obtain solutions together. This method made the small fishing-boat fishermen have good knowledge, understanding and awareness of the Blue Swimming Crab resources preservation, which were the common-pool resources of Ban Phe fishermen.

In my opinion, this method was relevant to Yutthana Waroonpitikul and Supit Rengjit (1999) that discussion on interesting issues and brainstorming from various people could improve human ties, build the information network, and share resources with each other. Network setting is derived from the mutual awareness, interest and objectives to solve problems, protect benefits, and build the power of changes or negotiation for a matter (Valaisathien et al., 2000).

For local wisdom of small fishing-boat fishery communities operating the crab gill net at the Phe Bay of Rayong Province, it was found that the fishermen bought some tools to make their gill net. For crab catch sources, they were up to fishermen's observation. For example, many crabs would stay in any gutters or holes or water courses. For catching techniques, the fishermen usually guessed or speculated. At any places they could catch the crabs; the gill nets would be set there. The fishermen also observed the wind current and tideway. During the monsoon season, the crabs would be caught easily. During the turbulent stream or violent sea, the crabs would not stay silent but moved and be trapped. During the silent stream, the crabs would not move. In April – May, the silent stream caused the little crab catch. When the monsoon season started in July-October, the crabs would be trapped regularly. For the gill net setting, the gill net will be tied with the rock, which would be thrown into the sea together with the bamboo flag pole. The pontoon tied with the bamboo flag pole makes the flag pole float on the water surface. This bamboo flag pole will drag the gill net to the sea ground, but the gill net must be also tied by rope as it must stay on the sand surface. The long line of rope is used to tie between the flag pole and the gill net, and the crabs will walk into the gill net. The flag pole of each fisherman was made in different colors for easy distinguishing.

Wisdom of crab gill net fishery by small fishing-boat fishermen at the Phe Bay of Rayong Province mentioned above was relevant to Chalad Ramitanon (1993), Ekavidya Na Talang (1993), Department of Environment Quality Promotion (2005), and Patcharin Sirasoonthorn (2007) who defined the local wisdom as wisdom of local people or Thai wisdom, which is referred to everything initiated and created by local people under their potential and existing environment in order to solve their life problems appropriately at each era, and this wisdom could be succeeded and accumulated from the ancestors to the present generation.

Moreover, the local wisdom of small fishing-boat fishermen at the Phe Bay of Rayong Province was relevant to the local wisdom of local fishermen at Ban Thung Na Dum, Tambon Kura, Amphoe Kuraburi, Phang Nga Province (Research and Development Center for Marine, Coastal and Mangrove Forest Resources and other agencies, 2009) regarding the invention of fishing implement, wisdom relating to nature, season, tidal currents, wind, cycle of aquatic animals, etc. In general, the fishery wisdom was identical, except some details.

2) Changes of Blue Swimming Crab resources, as well as causes and impact by changes of Blue Swimming Crab resources at the Phe Bay of Rayong Province.

From interviewing representatives of all 4 small fishing-boat groups, the quantity of Blue Swimming Crabs has been decreasing. If comparing the same period of Year 2013 and 2014 (April – May), a fisherman could, in 2013, catch the Blue Swimming Crabs approximately 7-8 kilos a day while, in 2014, only 3-4 kilos of Blue Swimming Crabs could be caught per day. During the monsoon season (July – October), a fisherman could get 20-30 kilos of Blue Swimming Crabs per day. But, in 2013, the oil leak occurred in August; the fishermen got a low quantity of Blue Swimming Crabs. The quantity of Blue Swimming Crabs they got during July – August 2014 was around 3-4 kilos a day.

In addition, the Author used the fishery mathematic program to computerize the surplus fishery production¹ by using data obtained from the questionnaire distributed to the representatives of 4 small fishing-boat fishery groups. The data collection was done in 2 periods, April – May 2014 and July – August 2014. This questionnaire was to survey the replacement of Blue Swimming Crabs and the fisheries at the Phe Bay to find out the quantity tendency. The result showed that, in April – May 2014, the replacement value was 0.653, and 0.656 in August 2014. The replacement value of both periods was higher than 5.00 of the maximum sustainable yield (MSY). This meant that the replacement of Blue Swimming Crabs and the fisheries at the Phe Bay tended to be falling because higher quantity of Blue Swimming Crabs has been caught

¹ Computerized by the Fishery Mathematic Program to analyze changes of Blue Swimming Crab resources at the Phe Bay of Rayong Province by simulating the Relative yield-per-recruit (Y'/R and B/R analysis using knife-edge selection of Beverton & Holt, 1996, which was the data supporting the qualitative data analysis, and reflected the problems of crab gill net at the Phe Bay of Rayong Province. Under the limited period of this study, the study has been conducted for 4 months only in 2 periods or in April – May 2014 (low amount of crabs caught) and in July – August 2014 (in the monsoon season when the high amount of crabs could be caught)

until MSY has been gradually small. This indicates the future crab gill net fishery that the Blue Swimming Crab resources at the Phe Bay would be decreasing, which certainly takes effect to the crab gill net fishery there in the future. This result was relevant to Sitthipan Siriratanachai and others (n.d.) that the outcome of fisheries beyond the aquatic animal production capacity was the reducing quantity of aquatic animals, either targeted or bycatch. Consequently, most aquatic animals caught were smaller due to the negative selection by which big aquatic animals would be chosen first. This seems the selection of aquatic animals until only small-size parents survive, which causes the genetic change in aquatic animals. The exploitation of fishery resources exceeding the production capacity also reduces the quantity of breeders. This leads to genetic changes and reduction of biodiversity due to inbreeding. As a result, the aquatic animals may be extinct because they have less adaptation to changes in aquatic animal compositions and ecosystem. The collapse of fishing several aquatic animals comes from the surplus fisheries like the case of codfish fishery and whale hunting, etc. Some types of aquatic animals may not be extinct, but the amount is so few that they take no longer role in the ecosystem they have lived.

From interviewing representatives of all 4 small fishing-boat groups at the Phe Bay of Rayong Province, the causes of changes in Blue Swimming Crab resources were summarized below.

1) Changing natural environment; for example, the delayed monsoon season caused no wind. Whenever the wind was still, the crabs would not come out because the Blue Swimming Crabs preferred staying on the ground surface. The strong wind and water current would sweep the Blue Swimming Crabs and more Blue Swimming Crabs would be trapped. Thus, most small fishing-boat fishermen for crab gill net preferred catching the Blue Swimming Crabs in the monsoon season.

2) Since the oil leak at Ao Prao, Koh Samed, Rayong at the end of July 2013, although the government and private sectors were successful in wiping out the oil slick, it was observed by the fishermen there that the crab gill net setting has been more difficult because the small fishing-boat fishermen have regularly set the crab gill nets around Koh Samed. When the catch of Blue Swimming Crabs there was impossible, the fishermen had to set the crab gill nets in longer distance, and they took longer time in their fisheries. Fewer amounts of crabs caught may be affected by oil leak to the marine and coastal ecosystem of Rayong province, especially aquatic animals living there. This was consistent with Theera Worathanarat (2015) who mentioned about the impact of oil leak to aquatic animals that the oil slick on the water surface would react with oxygen. The results were less oxygen and blockage of photosynthesis by plankton, seaweed, and other aquatic plants. The decomposition of bacteria in the water would be changed as well. These changes all gave negative impacts to all aquatic animals there (fish, marine benthos, coral, etc.). In addition, the oil slick would stick on aquatic animals and those burying in the sand could not exchange some oxygen, so they could not breathe and die finally.

Regarding the impact to environment and ecosystem, the oil particle accumulating or suspending in the environment (especially on beaches) took the great effect to animals' life. Moreover, spreading chemicals or absorbents to wipe out the oil slick is another composition affecting the overall environment and ecosystem. The next ecosystem affected by this event is the coral reef and rock beaches around there. For example, the animals that stay on the rock and cannot flee will get such toxin, or the animals living in the tidal current zone will get the impact as well.

Some technical specialists and officials of related local agencies gave some information about the causes of changes in Blue Swimming Crab resources as summarized below.

3) Use of smaller mesh-size net, catch of small-sized crabs, and selling of berried females, which were consistent with Thongchai Nitiratsuwan and others (2004); Thanasomwong and others (2004); Petchkamnerd & Suanrattanachai (2003).

4) Marine and coastal resources have been destroyed by the government policy on the coastal land development at Rayong Province, e.g. industries, deep seaport and tourism. The oil leak in 2013 also devastated the shelters and food sources. These were consistent with the report of the Department of Pollution Control (n.d.) that the economic changes of Rayong Province from an agricultural to industrial area, growth of tourism industry, seafood and urbanization have greatly taken effect to the marine and coastal environment. The coastal pollution came from coastal communities, industrial plants, tourist attractions and aquatic animal breeding along the coast, which emitted polluted water into the sea, as well as piers and jetties where there was much oil slick, oil rigs, ocean mining, watercourse dredging, and crude oil leak, etc.

5) Operators of commercial fishing boats, employment of alien labors, and use of efficient tools for the catch of Blue Swimming Crabs regardless of crab types and sizes. These were consistent with Sangob Songmuang (2003) that the commercial fishery investors have used the trawl-push nets, lighted Anchovy purse seines, short-necked clam fishing boat, etc. under the government policy on production promotion for exports, which deemed successful for the creation of economic value, but, on the contrary, it caused many problems of no control and monitoring of impact to local fishermen.

The representatives of small fishing-boat groups also talked about the impact from the falling quantity of Blue Swimming Crabs that: 1) sailing for longer distance with higher costs for oil and crab catch tools as well as longer catching duration; 2) smaller size of crabs, that is, most crabs caught were small and medium-sized; 3) less income and fishermen had to operate other gillnetting, e.g. fish net, squid net, etc.

3) Guidelines for the management of Blue Swimming Crab resources based on local wisdom at the Phe Bay of Rayong Province

From the focus group meetings between representatives of small fishing-boat communities operating crab gill nets at the Phe Bay of Rayong Province and other representatives from related local agencies, the following were the guidelines for the management of Blue Swimming Crab resources at the Phe Bay of Rayong Province. The Marine and Coastal Resources Conservation Center, No. 1 of Rayong Province supported those communities for fishery tools and devices, and made floating cages to nurse berried females. Three core areas were fixed at the coast in front of the Conservation Center, the coast at Suan Son Fishery Community, and the coast at Kok Laem Thien Fishery Community, where all were in the area of the Eastern Marine Fisheries Research and Development Center. Any further actions must be first approved by the General-Director of the Center.

The guidelines for the management of Blue Swimming Crab resources at the Phe Bay of Rayong Province came from the participatory research approach in which the small fishing-boat communities were involved to recognize the problems after the joint operation, starting from data collection, data analysis, and problem solutions based on local wisdom of Ban Phe fishery communities, and on ideal support by responsible authorities there. This is the participatory fishery management according to Korten (1986) that the community-based fisheries management is the management of resources based on community abilities in mobilizing the existing community resources to benefit community members' production, and to enhance fairness and sustainability in responding to community members' demands. Therefore, the community-based management is the community's duty and responsibility in controlling and managing the utilization of resources. The community members must be involved in the utilization plan and implementation according to their community-based resource management plan.

Participation in the fisheries management allows the fishery resources users to be involved in setting measures, which lead to their acceptance and compliance (Nilsson et al., 2001).

In addition, the sustainable management of Blue Swimming Crab resources, which deem a type of common-pool resources, needed the cooperation of those small fishing-boat communities according to the 8 design principles for the management of common-pool resources offered by Ostrom. (1990). This is deemed the community rights subject to the principle of community rights that they are the complexity of rights, which mean the existence of rights for several social units, and the existence of several rights on the same area. For example, forest or land is in the "right of possession" by the government, but a community holds the "right of management" while general people hold the "right of access and utilization". The consideration of the complexity of rights would offer more alternatives and flexibility in arranging the relationship of power (Kanchanapand, 2001). Community rights are also characterized as the participatory management, which do not exclude any participation of people outside, but demand such

external support. This could be seen in community forest management or rehabilitation of local identity; they were activities demanding external supports. A community is able to define some conditions and criteria to control the utilization by external people, and to prevent the violation of community rights. However, the exclusion of external people may occur in events of conflict or grasp of resources or in inequitable resource management structure (Boonchai, 1999).

For the guidelines for the management of Blue Swimming Crab resources at the Phe Bay of Rayong Province by setting the core area as fishery free zone and crab bank for the nursing of berried females, the Author et al. considered that several local fishery communities using these methods and having success included the local wisdom for the management of community mangrove forest, and the landscape management of marine and coastal resources at Ban Nam Rab, Moo 4, Tambon Bang Sak, Amphohe Kantang, Trang Province, and the Crab Bank project at Ban Koh Tueb, Tambon Pak Khlong, Amphoe Pathio, Chumphon Province was chaired by "Uncle Jang" (Mr. Jang Fungfueng), 65 years as mentioned in Supaporn Anuchirachiva (2012) who mentioned about the success of the community-based crab bank based on local fishery wisdom, etc.

Conclusion

Economy of Tambon Phe involved commerce, fisheries, and processed seafood industries. At Tambon Phe, there were 192 fishing boats at Tambon Ban Phe and 104 out of them were local fishing boats (small fishing boats). Most of fishermen there earned for living by operating the crab gill net, fish trap and squid trolling line. There were 54 fishing boats for crab gill net.

At the Phe Bay (from Ban Phe to Suan Son Beach), there were 4 groups of small fishing boats; namely, Kok Laem Thien Fishery Group, Sala Kaew Fishery Group, Nuan Thip Fishery Group, and Suan Son Fishery Group. From interviews of all 4 fishery groups, they have earned for living by crab gill net over 20 years, and this career has been succeeded from their grandparents. At the areas they have now lived and fished, they have been used for anchoring, removing crabs from crab gill net, and selling crabs.

Some local fishery wisdom such as observation of Blue Swimming Crab habitat, tideway, wind, fishing operation, removal of crabs from crab gill net, crab catch seasons, season and environmental changes, etc.

For changes of Blue Swimming Crab resources, as well as causes and impact by changes of Blue Swimming Crab resources at the Phe Bay of Rayong Province, it was found that the quantity of Blue Swimming Crabs has been decreasing. If comparing the same period of Year 2013 and 2014 (April – May), a fisherman could, in 2013, catch the Blue Swimming Crabs

approximately 7-8 kilos a day while, in 2014, only 3-4 kilos of Blue Swimming Crabs could be caught per day. During the monsoon season (July – October), a fisherman could get 20-30 kilos of Blue Swimming Crabs per day. But, in 2013, the oil leak occurred in August; the fishermen got a low quantity of Blue Swimming Crabs. The quantity of Blue Swimming Crabs they got during July – August 2014 was around 3-4 kilos a day.

Additionally, it was found that the replacement of Blue Swimming Crabs and the fisheries at the Phe Bay tended to be falling because higher quantity of Blue Swimming Crabs has been caught. This data came from the fishery mathematic program computerizing the surplus fishery production and the maximum sustainable yield (MSY) higher than 5.00.

The guidelines for the management of Blue Swimming Crab resources at the Phe Bay of Rayong Province to be implemented are the setting of core area as the fishery free zone, and the crab bank for the nursing of berried females.

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