Guidelines for Blue Swimming Crab (*Portunus pelagicus* Linnaeus, 1758) Stock Enhancement of a Fishery Community in Trang Province, Andaman Sea Coast of Thailand

Rattanaporn Anantasuk* and Thongchai Nitiratsuwan

ABSTRACT

This study was conducted to find a suitable program and procedure for blue swimming crab (BSC) stock enhancement which is guided by the fishery community and to identify the level of agreement and cooperation of the fishermen in assessing BSC management options. This study also explored the primary information on socioeconomic status of BSC fishers and BSC fishing characteristics in the study areas. The sample respondents of this study included three groups: 265 BSC fishers, 27 BSC dealers, and 8 local authorities. The first group was selected by accidental sampling technique whereas the second and the third groups were selected by purposive sampling techniques. Survey results revealed that most of the fishers agreed (WAI=4.11±0.85) to set up the stock enhancement project in their communities by using the following procedures; 1) select a suitable site; 2) explain the rationale and objectives of the project; 3) establish fisher groups; 4) arrange workshop and training about berried female BSC hatching; 5) set up a meeting for working procedure and assign working groups; 6) practice on hatching the BSC; 7) release of the larvae; and 8) management of female BSC after hatching. In practice, the process should be thoroughly investigated and experimented in pilot communities to confirm the methodology and acceptance from the fishers before starting the project. There also should be specialists consulting and assessing the working group regularly. Proper guidelines should be established for the communities in order for them to continue the stock enhancement of BSC, using their own funds as a long term activity.

Keywords: Guideline, blue swimming crab, *Portunus pelagicus*, stock enhancement

INTRODUCTION

Thailand has 24 coastal provinces surrounded by more than 3,000 kilometers of coastline (DMRC, 2013). This advantageous characteristic supported marine fishery activities in the country. The Thai Department of Fisheries (DOF) reported that in 2012, the total catch of marine fisheries in Thailand was 1,500,200 tons which generated 54,911.06 million THB, in which 40,557 tons were crabs valued at approximately 4,792.04

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million THB (DOF, 2014). Blue swimming crab (*Portunus pelagicus* Linnaeus, 1758) is one of the most distinctive species with large quantities caught around coastal provinces along the coast of Thailand. The total catch and value of blue swimming crab (BSC) are higher than other crab species, with catch and value of 33,464 tons and 4,184.7 million THB, respectively (DOF, 2014). Therefore BSC is the most valuable and commercial crab species that many of the people in coastal communities including Trang province engaged in for fishing and as an important income source. However, BSC fishery yield has declined with the size of caught crab smaller than in previous years, while the percentage of caught pre-reproductive female crab increased (Songrak and Choopunth, 2006; Sawusdee and Songrak, 2009). These have led to the degradation of BSC resource which affected the livelihoods and socioeconomic conditions of the fishers including Thailand's economy for both domestic consumption and export.

The efficient program of BSC stock enhancement could improve BSC resources and yield, especially if the program provided by the people involved in BSC fishery will lead to more participation and give more opportunity to achieve program objectives. This study was conducted to find the suitable program and clear procedure of BSC stock enhancement which is guided by the fishery community, and to identify the level of agreement and cooperation of the fishers in assessing BSC management options. Moreover, the study provides an overall picture related to the social and economic status of BSC fishers, BSC fishing methods, gears and catch from each type of gear as primary information to support the establishment of efficient BSC fishery management programmes in the study areas.

MATERIALS AND METHODS

Study sites

The study was conducted in Trang Province, which is located along the Andaman coast in southern Thailand. BSC fishing is conducted in many areas of the province. Four districts, namely Hadsamran, Kantang, Palian and Sikao, which are along the coast, were selected as study sites because the operation of BSC fishery is conducted mainly by the people who live in these districts (Fig. 1).

Sampling technique and sample size

Accidental sampling technique was used for selecting BSC fishers as representatives of the BSC fishing households. Based on the minimum number of samples required from the total population, a total of 265 fishers were interviewed.

Purposive sampling technique was used for selecting the BSC middlemen and local authorities involved in BSC resource and its production. The respondents were comprised of 27 BSC dealers and 8 local authorities. They were interviewed and the topics discussed were related to the status of BSC fishery and stock enhancement as well as their management guidelines.

Data collection

The data were collected during October 2011 to January 2012 through household

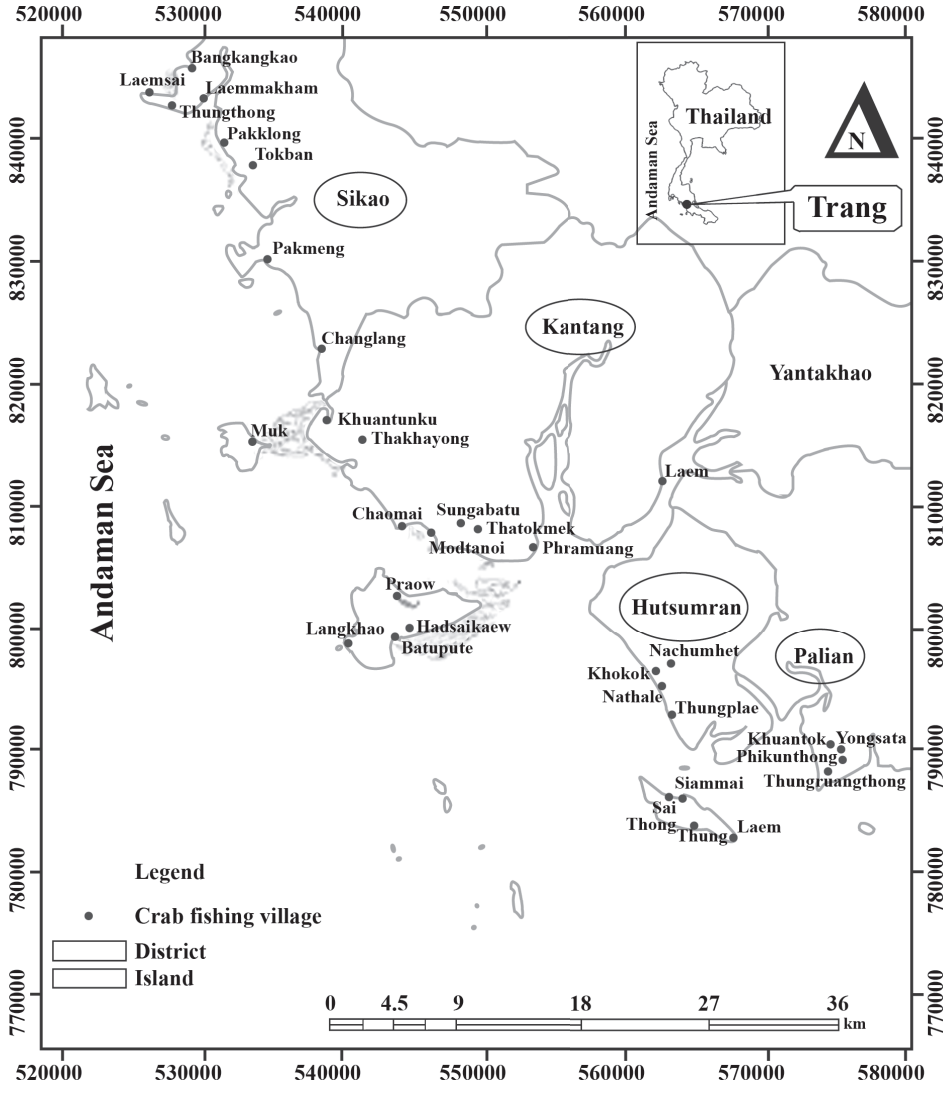


Figure 1. The study sites (encircled) (Songrak and Nitiratsuwan, 2009)

interviews using a highly structured questionnaire. These interviews were conducted to collect information directly from BSC fishers. In addition, data from dealers and local authorities were collected through focus group interviews and discussions in order to provide information on the views of particular stakeholder groups and generate in-depth qualitative information on specific issues (Bunce *et al*., 2000).

Data Analysis

Descriptive statistics were used to analyze both quantitative and qualitative data in order to explore the features of sampled and measured data. The results of the analyses include percentage, means, and standard deviations (SD), which are summarized in the tables.

Weight Average Index (WAI) was used to explore the mean score of agreement and cooperation in BSC stock enhancement measures. An index was calculated by the following equation:

$$I = \sum s_i f_i / N$$

Where,

I = priority index

s_i = scale value at i^{th} priority

f_i = frequency of i^{th} priority

N = total number of observations

The means of WAI were scaled from 0 to 5, explained below:

0.00-1.25	=	disagree/ uncooperative
1.26-2.50	=	agree/cooperate in low level
2.51-3.75	=	agree/cooperate in medium level
3.76-5.00	=	agree/cooperate in high level

One Way Analysis of Variance was used to compare the similarities and differences of mean score of agreement and cooperation in BSC stock enhancement measure between four groups of fishers from different districts.

RESULTS AND DISCUSSION

Socio-economic status of BSC fishers in Trang province, Thailand

Figure 2A shows the gender ratio of fisher respondents measured by the percentages of the population. The results of gender analysis showed that 95.5% were male and 4.5% were female. These results implied that male fishers are predominantly involved in the management and development programs introduced in the study areas. However, the difference in the gender structure may be due to the involvement of the fishers in any program. The classification of the age is measured by the percent of fishermen and fisherwomen in different age categories. The results showed that 34.7% of fishers were between 20 and 35 years old (young adults); 42.3% were between 36 and 50 years old (middle adults); and 23.0% were older than 50 years old (mature adults). No fisherman was less than 20 years old (Fig. 2B). As a result, fishers considered to be of working-age (young and middle adults) accounted for 77% of all respondents and this indicates the proportion of potential workers who can greatly effect change in BSC productivity in the study areas.

In terms of education, most of the fishers finished primary school (78.1%), while a few finished middle school, high school and diploma (Fig. 2C). Bunce and Pomeroy (2003) indicated that education is important to understanding impacts of management on livelihood and well being. Increase in education levels associated with a particular management strategy indicates a positive impact. According to the high percentage of low education level among the respondents, an educational development program should be implemented in order to improve their livelihood, social and economic conditions.

The study also revealed that 86.4 % of BSC respondents were Muslims (Fig. 2D). This is similar to the proportion of fishers who engaged in the other coastal fisheries in Trang province, as reported by Anantasuk *et al*. (2010). Religion is important to gaining stakeholder participation. This relatively

homogenous community of BSC fishers will be more capable of working together.

Household size varies among the respondents. The average number of household members was 4 persons, with a standard deviation of 1.5. The biggest household size was 10 persons. Household size was classified by the number of family members; small size containing 1-4 persons, medium size containing 5-8 persons, and large size containing 9 persons and above (Omakup, 2005). The results indicated that the majority of the respondents were from small and medium households (60.4% and 38.5% respectively) while a few came from a large household (Fig. 2E).

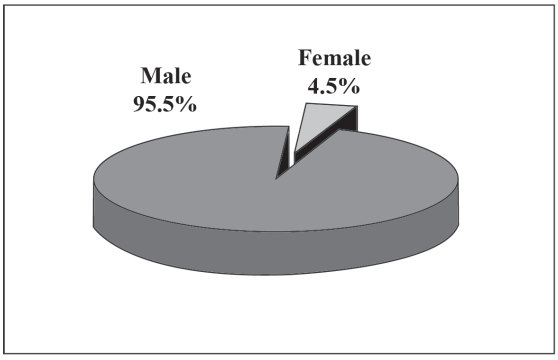
Regarding occupations and incomes of fisher respondents in the study areas, all of them were engaged in BSC fishery. Some of them also worked in other economic activities, mostly in other coastal fisheries followed by rubber plantation, general labour, and employee. BSC fishery generated average monthly incomes of 6,800.0±4,199.5 THB (Figure 2F) while the minimum daily wage in Trang province is 240 THB or 7,200-7,440 THB per month. These results indicated that BSC fishers have low income levels which consequently result in difficulties in social and economic improvement. Additionally, all of them depend on coastal fisheries therefore their community will be severely impacted by a collapse in fishing activity, with coastal resources considered to be changeable resources that can change over the years (Bunce and Pomeroy, 2003).

BSC fishing in the study areas

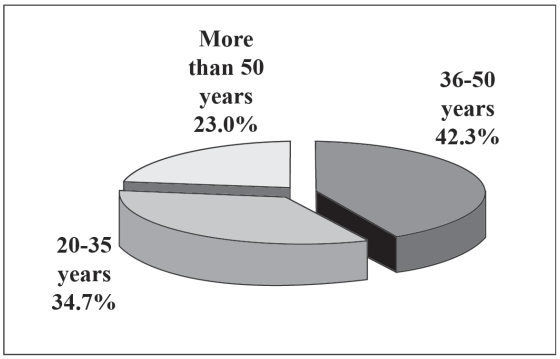
Four types of BSC fishing gear are used in the study areas. The fishers have been operating BSC fishery by using collapsible trap, collapsible box trap, fixed box trap and bottom gill net. The study revealed that traps were the major types of gear used, coinciding with this study's result on selectivity of traps for blue swimming crab in Trang province. It was reported that traps were a major type of gear for catching blue swimming crab, aside from bottom gill net (Songrak *et al*., 2013).

The characteristics of BSC fishery classified by type of gear are described as follow:

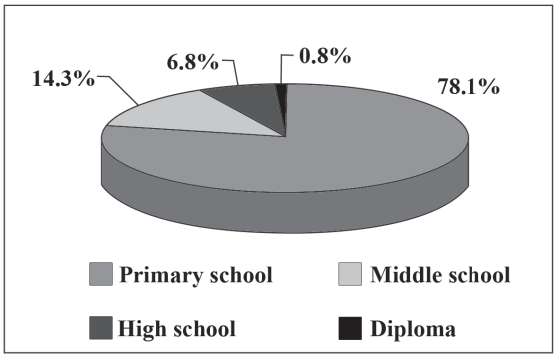
Type 1: The first type of fishing gear is the collapsible vertical trap (Fig. 3A). The two main components of the trap are its two rings and net. The rings are built using steel rod with a diameter of 0.5-0.7 cm. The diameters of the top and bottom rings are 40 and 45 cm, responsively. The second component is the net which is made from green polyethylene net with a mesh size of 2 inches and fixed with the rings on both upper and lower parts of the trap. Nylon ropes are used to tie the upper part of the trap with a buoy. The bottom of the trap is weighed down by a flat concrete. The shape of the trap is cylindrical with a height of 20-30 cm during operation. Around 100-300 traps are used for fishing in areas where the water depth is approximately 9.1±5.1 meters. Fishing period is around 2-5 hours•trip^{-1} and the catch is 13.5±6.2 kg•trip^{-1}.



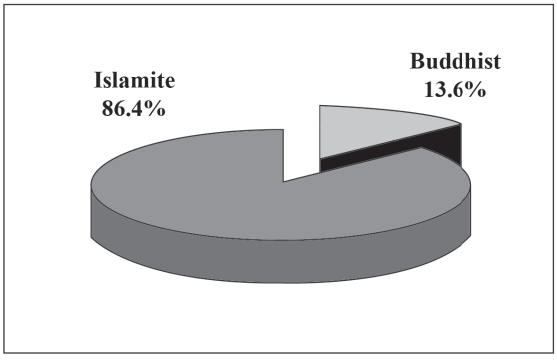
A) Gender



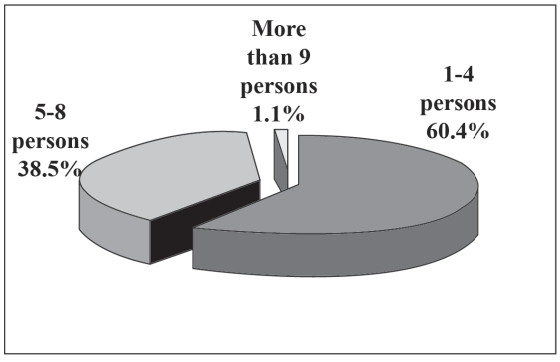
B) Age structure



C) Education level



D) Religion



E) Household size

Occupations	No. of fishers	Income per month		
		Min	Max	$\bar{X}$ ± SD
BSC fishery	265	1,500	25,000	6,800.0±4,199.5
Other coastal fisheries	91	1,000	11,000	4,027.5±2,210.2
Rubber plantation	76	1,000	20,000	8,085.5±4,837.6
General labour	13	1,500	6,000	3,884.6±1,757.7
Employee	10	2,000	10,000	5,200.0±2,573.3

F) Occupations and income per month (THB)

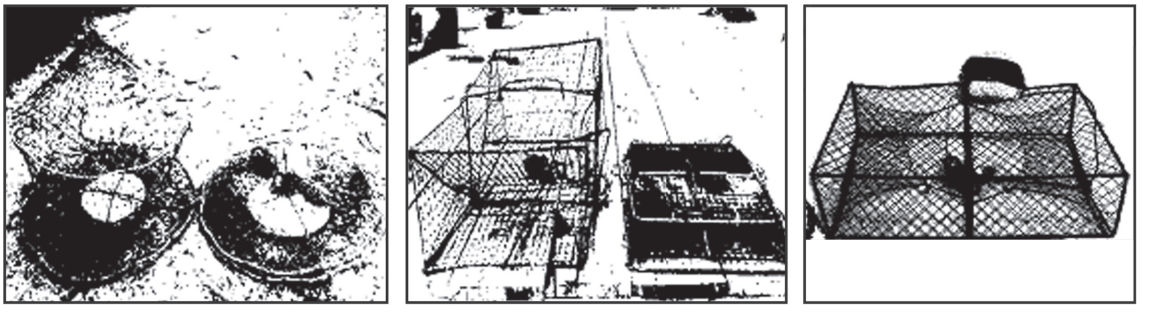
Figure 2. Demographic data of BSC fishers in the study areas

Type 2: The second type of fishing gear is the collapsible box trap (Fig. 3B) and the two main components of the trap are the body and net. The trap body is built using steel rods with a diameter of 0.5 cm. The body looks like a rectangular basket box, with width, length, and height of 35, 50, and 20 cm, respectively. The second component is the net, which is made from green polyethylene net. The mesh sizes

found in the study areas were from 1 to 1.5 inches. Nylon ropes are used to tie the net and body together. The upper part of the body could be opened when the fishers want to collect the caught crabs, and it could be collapsed when they want to keep the traps. The fishers use 100-300 traps for fishing in areas where the water depth is approximately 7.1±6.3 meters. The fishing period is around 2-4 hours•trip^{-1} and the catch is 9.2±6.5 kg•trip^{-1}.

Type 3: The third type of fishing gear is the fixed box trap (Fig. 3C). The characteristics of this gear are similar to those of the collapsible box trap, but the colour of the polyethylene net is red and the trap body is built using harder and heavier steel rods. They are not collapsible. The fishers use 100-150 traps for fishing in areas where the water depth is approximately 1-4 meters. The fishing period is around 2-4 hours•trip^{-1} and the catch is 5.7±3.0 kg•trip^{-1}.

Type 4: The fourth type of fishing gear is the crab bottom gill net which is made of nylon monofilament with a mesh size of 4-5 inches. The shape of the net is rectangular with width and length of 1-1.5 and 200-500 m. The fishers increase the length of their nets by connecting many nets together until it reaches 1,000-1,500 meters. They use 2 sets of nets (2,000-3,000 meters in length) for fishing in areas that is far from the shore at 10.8±8.5 km or around islands where the water depth is approximately 10.1±5.6 meters deep. They spent 3-5 hours•trip^{-1} and the catch is 10.7±5.9 kg•trip^{-1}.



A) Collapsible vertical trap **B) Collapsible box trap** **C) Fixed box trap**

Figure 3. Blue swimming crab fishing gear types

Assessment of the procedure of blue swimming crab stock enhancement which is guided by the fishery community

The BSC fishers in Trang province agreed (WAI=4.11±0.85) to implement the stock enhancement project, modelled from crab bank projects operated in many areas in Thailand. They are willing to cooperate in hatching the berried female BSC (WAI= 3.85±0.94) and releasing the larvae to the natural habitat in order to improve the BSC stock.

Below are their suggestions on how to implement the project:

1. Select a suitable site for project implementation. The fishers suggested that the project should be operated at the village (Ban) level. Suitable villages located in different districts were recommended:

1.1 Sikao district: Ban Laem-sai and Ban Laem-ma-kham

1.2 Kantang district: Ban Mod-ta-noi and Ban Nam-rab

1.3 Hatsamran district: Ban Ta-se and Ban Thung-plaew

1.4 Palian district: Ban Yong-star and Ban Thung-ruang-thong

2. Explain the rationale and objectives of the project. The fishers recommended that DOF should be the main organization to assess the BSC stock enhancement project and transfer necessary information to the fishers.

3. Establish fisher groups for the implementation of all activities of the project. The head of the established groups should be the head of the village or any of the fishers elected by the members of groups. The consultant or adviser of the group should be from the DOF and the Department of Marine and Coastal Resources Management (DMCR).

4. Arrange workshop and training about berried female BSC hatching, nursing of larvae, collection and release of larvae and clarify the methods to the members of the group. Information and financial support should be provided by DOF and DMCR.

5. Set up a meeting for working procedure and assign working groups.

6. Operation of BSC stock enhancement. The equipment or financial support of the project should come from DOF, DMCR and BSC dealers in the community. The fishers expressed their opinion that DOF and DMRC are the main responsible organizations which should directly deliver manageable and sustainable strategies for fishery and coastal resources. The requirement on any support related to the enhancement of these resources may be easily procured and managed if the two organizations are working closely.

6.1 Set up hatching equipment such as plastic containers, aerators and tubes. It was suggested that the equipment should be placed near fish landing station or in a dealer's shop because the fishers usually go to these places immediately after finishing their fishing trip.

6.2 Collection of berried female BSC by willing fishers.

6.3 Hatching the BSC.

6.4 Nursing of larvae and female BSC after hatching.

7. Release the larvae to a suitable habitat. Most of the respondents agreed that the fishers should bring and release the larvae during their fishing trip.

8. Management of the female BSC after hatching. Most of the fishers recommended that the working groups should return the BSC females to the fishers.

Form and procedures of BSC stock enhancement guided by the fishers in the study areas were modeled from a crab bank

program initiated in Thailand since 2002 with a purpose to conserve crab resources. Arkronrat *et al*. (2013) studied the change in BSC yield after crab bank implementation in Prachuap Khiri Khan province and reported that there was an increase in crab production after 4-8 months of implementation. This concurred with the results of crab bank implementation in Chumphon, Chon Buri and Phetchaburi provinces, Thailand (Suppanirun, 2007; Phoonsawat *et al*., 2008; Suanratanachai *et al*., 2010 cited in Arkronrat *et al*., 2013).

The fishers arranged the procedures of BSC stock enhancement and also recommended who are the supporters for the suitability of their community. The summarized procedures of BSC stock enhancement are presented in Figure 4. This figure shows the main procedures in solid line boxes and the supporters for in each procedure in dashed line boxes as below.

However, the process should be thoroughly investigated and trialed in pilot communities to confirm the methodology and acceptance of the fishers before starting the project. Table 1 shows the mean score of agreement and cooperation of the fishers in the study areas. These are classified by groups of the fishers who live in different districts. The results show that the mean score of agreement generated by fishers who came from Sikao and Hadsamran districts were 4.39±0.64 and 4.22±0.95, respectively, which is significantly higher than the mean score generated by fishers from Kantang and Palian districts ($P<0.01$). Regarding cooperation, the fishers who came from Sikao, Hadsamran and Kantang districts generated mean scores of 4.18±0.73, 4.08 ±0.83, and 3.94±0.88, respectively, which were higher than the mean score generated by the fishers from Palian district ($P<0.01$). These results indicated that the fishery communities located in Sikao and Hadsamran districts should be selected as pilot communities to implement the project and validate the methods and practices used by the fishers.

Table 1. Mean score of agreement and cooperation in BSC stock enhancement project at community level of the fishers separated by their native district

District	Mean score of agreement±SD	Mean score of cooperation±SD
Sikao	4.39±0.64^{a}	4.18±0.73^{a}
Hadsamran	4.22±0.95^{ab}	4.08±0.83^{a}
Kantang	3.95±0.86^{b}	3.94±0.88^{a}
Palian	3.95±0.90^{b}	3.24±1.04^{b}
Total	4.11±0.85	3.85±0.94

* *Different superscripts in the same column indicate significant differences ($P<0.01$)*

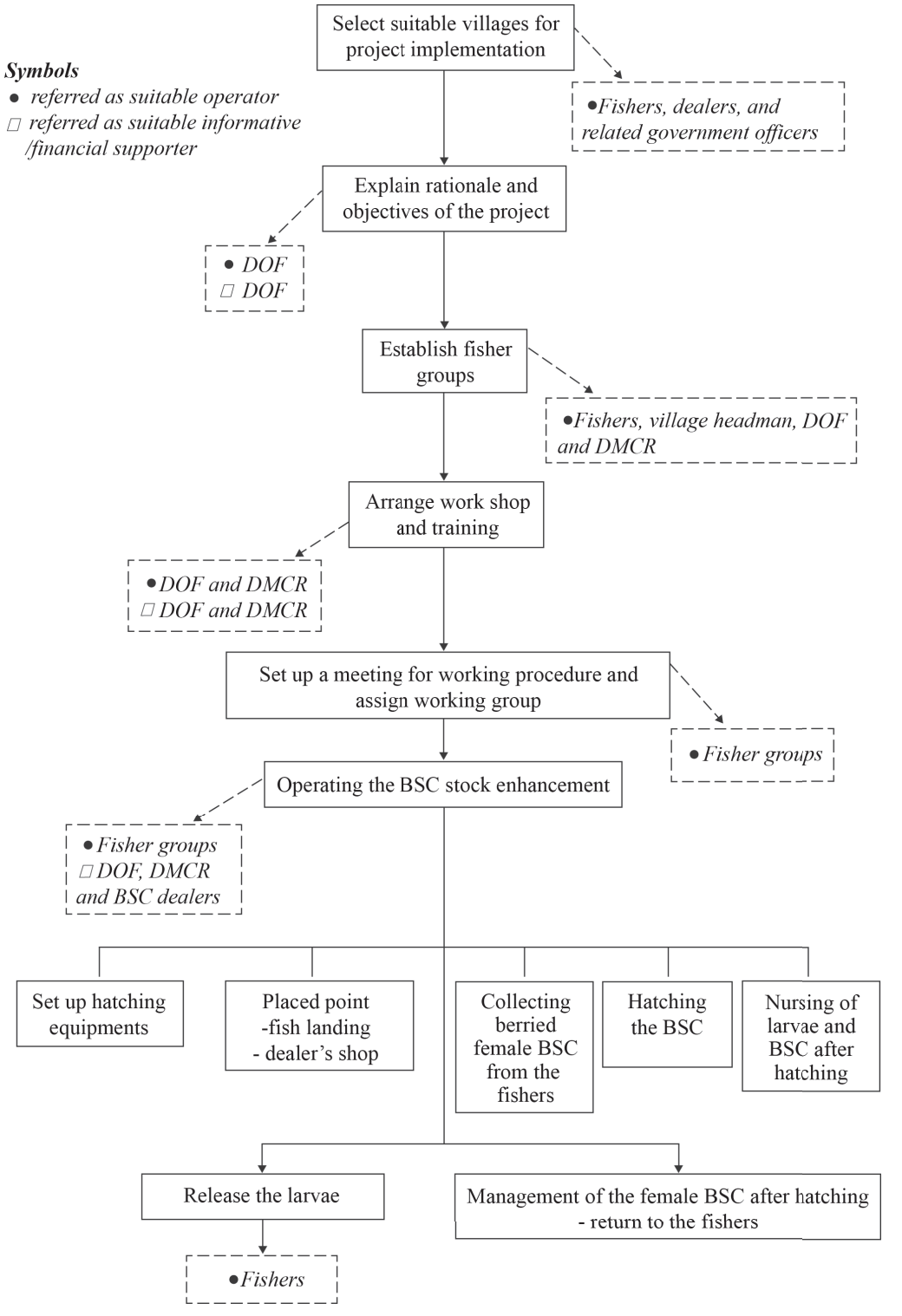


Figure 4. Procedures for fishery community-managed blue swimming crab stock enhancement

CONCLUSION

The fishers strongly agreed to implement the BSC stock enhancement project by hatching the BSC at the community level. The procedures for project implementation to be managed by the BSC fishers are as follows: 1) select a suitable site; 2) explain rationale and objectives of the project; 3) establish fisher groups; 4) arrange work shop and training about berried female BSC hatching; 5) set up a meeting for working procedure and assign working groups; 6) hatching the BSC; 7) release the larvae; and 8) management of the BSC females after hatching. The process should be investigated in fishery communities in Sikao or Hadsamran districts as pilot communities to confirm the methodology and acceptance of the fishers before starting the project. They should be supported by specialists whom the fishers can consult, and assess the working group regularly. The fishers recommended that the DOF and DMRC are the two main organizations which should play an important role in project implementation. With the close association between DOF and DMRC, it will be possible to provide all necessary support in order to achieve project objectives. However, the respondents from the local authority recommended that the involvement of the fishers will play a larger role in the future because their participation is a very important factor for project implementation. More importantly, proper guidelines should be established for the communities in order for the fishers to continue the stock enhancement of BSC and to use their own funds as a long term activity and source of income.

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