Surat Thani Blue Swimming Crab
Fishery Improvement Project

Milestone 6 & 11: Crab Bank evaluation & young BSC released evaluation

Background: Thailand's fisheries management to restore blue swimming crab resources has been carried out done step by step from the past. Starting from the implementation of various measures and restoring the BSC stock in the wild from the BSC bank operation. But the scientific data showing the impact of such actions has not been reported much. Therefore, this report is conducted to show information on the impact of such measures / activities to demonstrate the achievements of BSC resource management in Thailand.

Sources of data & Data analyses

1) Before-After/Control-Impact analysis (BACI)

Total catch data from crab traps in the experimental area of Before-After/Control-Impact (BACI) (Figure 1) from the research project "Development and Improvement Plan for Marine Fisheries Systems to Increase Competitiveness of the Sustainable Fishing Industry under the Principles of International Standards Year 2 (Year 1 and 2)" Supported by the Agricultural Research Development Agency (Public Organization) (ARDA) was analyzed by the Randomized Intervention Analysis (RIA) method to determine the difference of BSC total catch in the BACI area.

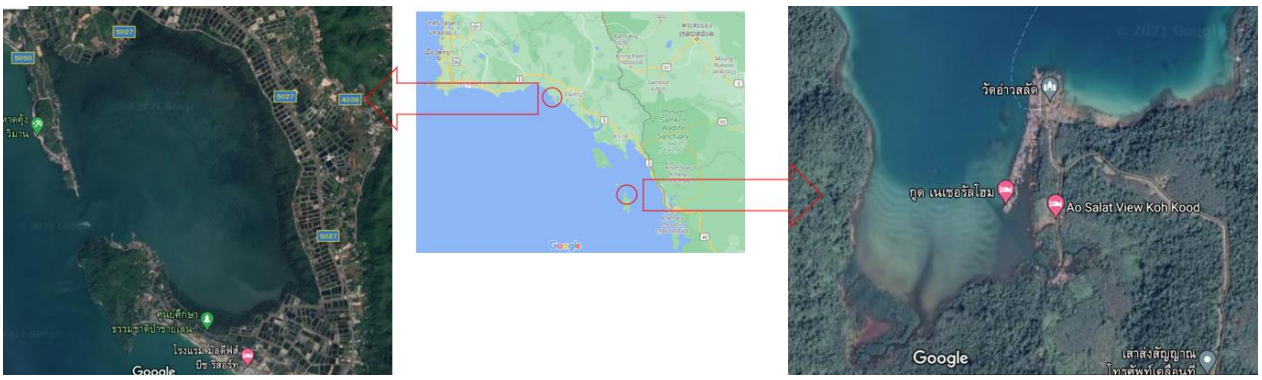

Figure 1 Study area of Before-After/Control-Impact (BACI)

2) Marking and Recapturing BSC from the research project "Study of fishery biology, socio-economic and ecosystems related to the restoration of BSC resources according to fishery development guidelines. (Fishery improvement program: FIP) in Bandon Bay area Surat Thani Province (1st and 2nd year)" Supported by the Agricultural Research Development Agency (Public Organization) (ARDA)

Marking and release of blue swimming crabs in Ban Don Bay area conducted 2 times, 1st time: 249 BSC were released into the study area during the operation of various BSC

banks in the area (September 2021). Then proceed to follow up and take back the marked crabs from September 30-November 30, 2021 (this is the time when young crabs were released from various BSC banks), for a total of 2 months. The 2nd time: conducting the release of BSC marked during the period when young crabs are not released from the BSC bank (May 2022), a total of 192 crabs. Carry out a follow-up to return the marked crabs from 21 May - 30 June 2022, for a period of 1 month and 9 days. (This is the time when young crabs are not released from various BSC banks.) After that, data on BSC recaptured in each period were used to calculate the population size for each time period using the information from marking and recapturing. (with the method of the Lincoln-Peterson Index) and calculate the difference in blue swimming crab stocks between the two periods according to Equation 1.

$$\frac{stock\ size\ (phase\ I)}{stock\ size\ (phase\ II)} \times 100 \quad \text{.....(1)}$$

3) Analysis of BSC Catches in the Gulf of Thailand from Fisheries Statistics Division, Department of Fisheries.

Yearly BSC catch data in the Gulf of Thailand from every fishing gear from the Fisheries Statistics website, Department of Fisheries (https://www4.fisheries.go.th/local/index.php/main/site/strategy-stat) were used to analyze the status of catches from fisheries according to the concept of Froese & Kesner-Reyes (2002); Tsikliras et al. (2013); Kleisner et al. (2013); Kesteven (1973) which classifies the characteristics in catch according to the fishing situation as in Table 1 to examine the influence of various blue swimming crab resource management measures on blue swimming crab catch in the Gulf of Thailand.

Table 1 The concept of Froese & Kesner-Reyes (2002); Tsikliras et al. (2013); Kleisner et al. (2013); Kesteven (1973) which classifies the characteristics in catch.

Exploitation status	Characteristic in catch	Criteria decision
Undeveloped	Low, stability, low variation	$Y_C < Y_{Cmax}$ and $C_Y < 0.1_{Cmax}$
Developing	Growth, increasing with rapid ration	$Y_C < Y_{Cmax}$ and $0.1_{Cmax} < C_Y < 0.5_{Cmax}$
Fully exploited	High, stability, low variation	$C_Y > 0.5_{Cmax}$
Overexploited	Fluctuation, high variation	$Y_C > Y_{Cmax}$ and $0.1_{Cmax} < C_Y < 0.5_{Cmax}$
Collapsed	Decline with rapid ration	$Y_C > Y_{Cmax}$ and $C_Y < 0.1_{Cmax}$

Results:

1. Before-After/Control-Impact (BACI) analysis.

1) At Before, release zoea BSCs into the impact site. It was found that there was a statistically significant difference in sub-adult and adult BSC catches between the control sites and impact site (Figure 1)

2) At After, release zoea BSC into the impact site. There was no statistically significant difference of the catch of sub-adult and adult BSC between the control sites and Impact site (Figure 1).

3) At After, release zoea BSC into the impact site. It was found that the difference of sub-adult and adult BSC catches between the control sites and impact site were statistically significantly reduced. (Figure 1), demonstrating the influence of BSC release on catch.

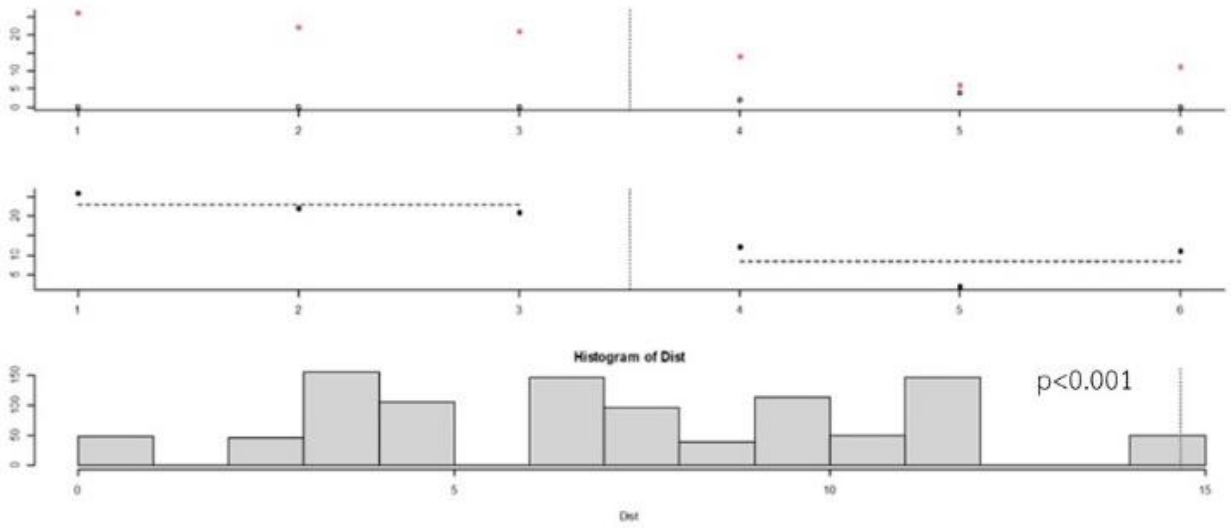

Figure 1 Analysis of catches of blue swimming crabs entering fishing gear by comparing the changes after hatching crabs were released by Randomized intervention analysis (RIA) method.

2. Population size analysis using data from marking and recapturing.

The results of the calculation of the blue swimming crab population in Ban Don Bay area from the marking and recapturing data showed that the population size at the time when operated the BSC bank was 31.80% higher than the population size at the time when the BSC bank was not in operation. The details of the study are shown in Table 1.

Table 1 Results of the stock size study from the marking and recapturing in the study area.

Details	1st time	2nd time
1. Study period	30 Sep. - 30 Nov. '21	21 May - 30 June 2022
2. Season	rainy season	Hot and dry season
3. Crab Bank Operations/Not Operations (before 4 months in advance)	Operated	Not operated
4. Number of BSC Marked and Released into the Study Area (crabs)	249	192
5. The source of the blue crab is marked.	from the culture system	from nature
6. The external carapace width (ECW) of the BSC is marked.	< 5 centimeter 85 crabs > 5 centimeter 164 crabs	> 9 centimeter 192 crabs

7. Number of times for field re-sampling (times)	7	10
8. Number of blue swimming crabs recaptured (crabs)	4	13
9. Number of BSCs caught with marked BSCs (crabs)	298	953
10. Stock size calculation result (crabs)	18,551	14,075

3. Catch data analysis

An analysis of the development of blue swimming crabs catches in the Gulf of Thailand in the past found that there were 4 phases: Developing->Fully exploited->Overexploited and Recovering. At the present, the catch of blue swimming crabs in the Gulf of Thailand is in Recovering phase (Table 2, Figure 2). The important measures that resulted in the recovering phase of the BSC population are 1) Announcement of the Royal Ordinance on Fisheries B.E. 2558, 2) Announcement of the Ministry of Agriculture and Cooperatives on the determination of fishing gear, Method of fishing and fishing areas that are prohibited for fishing in the coastal area B.E. 2561 and 3) BSC Bank operation since 2019.

Table 2 Development of Blue Swimming Crab catches in the Gulf of Thailand

phase	During the year	Duration (year)	Average catch + SD (tons)
Developing	2524-2527	4	7,386±1,060
Fully exploited	2528-2548	21	29,780±6,072
Overexploited	2549-2558	10	18,421±3,471
Recovering	2559-2564	6	26,471±3,782

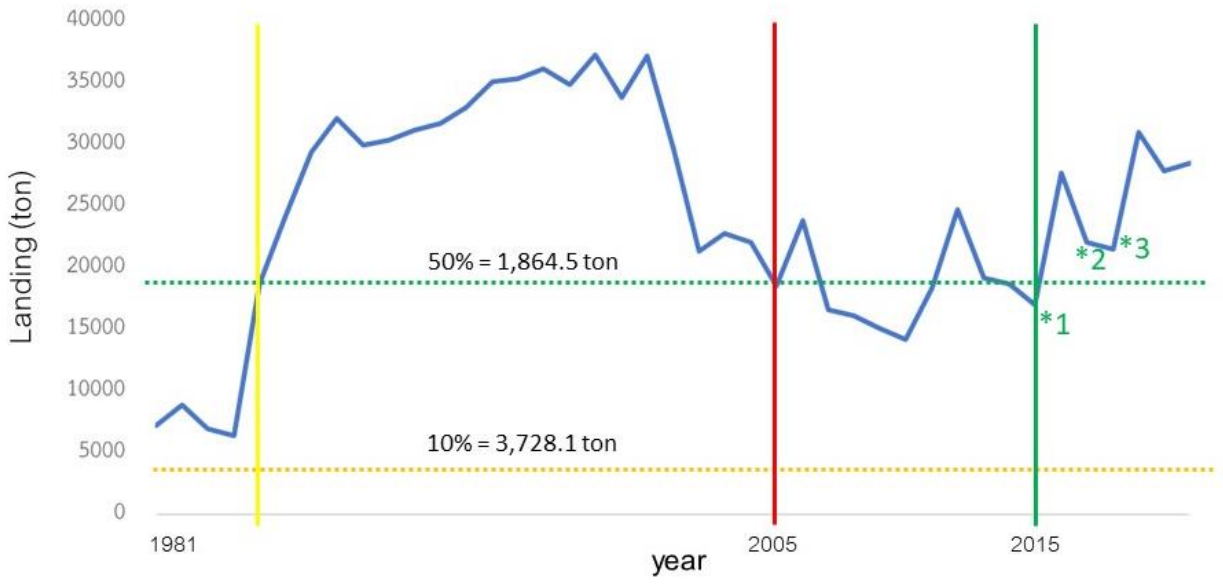

Figure 2 The development of blue swimming crabs catches in the Gulf of Thailand.

Remarks: *1) Announcement of the Royal Ordinance on Fisheries B.E. 2558.
*2) Announcement of the Ministry of Agriculture and Cooperatives Subject: Determination of fishing gear, Method of fishing and fishing areas that are prohibited for fishing in the coastal area, B.E. 2561.
*3) BSC Bank operation since 2019 onwards.

Conclusion and discussion.

All results confirmed the effect of blue swimming crab fishery management measures and blue swimming crab banks on increasing blue swimming crab stocks both in the study area and in the Gulf of Thailand. The operation of the community's crab bank not only has the effect of increasing BSC catches, but also has the effect of reducing variability of BSC catches. Therefore, the recommendation for an ideal crab bank operation period is to continue operated until the variability of BSC catches is reduced to a low level and stabilized. The best practice guideline for the operation of Blue Swimming Crab Bank in Thailand, supported by the National Research Council of Thailand (NRCT), can be found in Attachment 1. (But in Thai version)

References:

Froese, R., & Kesner-Reyes, K. (2002). Impact of fishing on the abundance of marine species. ICES Document CM 2002/L:12, 1-15.

Kesteven, G.L. (1973). Manual of fisheries, science. Part 1. An introduction to fisheries science. FAO Fisheries Technical Paper No.118. Rome: FAO.

Kleisner, K., Zeller, D., Froese, R. & Pauly, D. (2013). Using global catch data for inferences on the world's marine fisheries. Fish and Fisheries, 14(3),293-311.

Tsikliras, A.C., Tsiros, V.Z. & Stergiou, K.I. (2013). Assessing the state of Greek marine fisheries resources. Fisheries Management and Ecology, 20,34-41.

Annex 1

BSC Banks in the Gulf of Thailand (data from Dof)

Year	Period	Number of crab banks	Number of berried female (crabs)	Note
2018	-	-	-	Activity to promote and support the research of Blue Swimming Crab Bank Outreach Project for "Returning BSCs to the Thai sea" for 2018 to expand BSC banks in 159 communities in the old areas of the Department of Fisheries and in new areas in 31 communities.
2019	Jan-Dec	7	40,747	
2020	Jan-Sep	128	138,607	
2521	-	-	-	
2522	-	-	-	

Remarks: The follow-up period for the report is from January 2019 to September 2020.

Annex 2
Young BSC releasing in the Gulf of Thailand.

Year	Phase	Plan (Body)	Result (Body)
2018	Zoea	-	-
	Megalopa	-	-
	Young Crab	-	1,828,380
	Total	**1,413,200**	**1,828,380**
2019	Zoea	-	180,000
	Megalopa	-	-
	Young Crab	-	3,846,000
	Total	**3,324,000**	**4,026,000**
2020	Zoea	-	500,000
	Megalopa	-	20,000
	Young Crab	-	3,382,799
	Total	**1,971,000**	**3,902,799**
2021	Zoea	-	-
	Megalopa	-	300,000
	Young Crab	-	2,295,020
	Total	**2,150,000**	**2,595,020**
2022	Zoea	-	-
	Megalopa	-	80,000
	Young Crab	-	1,098,000
	Total	**875,000**	**1,178,000**

In addition, reporting the results of the activity “Returning Life by releasing the berried female crabs back to the sea" by the fishermen from October 2019 to October 2022, the fishermen reported the release of a total of 43,550 berried female crabs.

Annex 3
BSC catch data in the Gulf of Thailand. (Data from the Department of Fisheries)

no.	year	BSC catch (ton)	no.	year	BSC catch (ton)
1	1981	7,252	22	2002	21,407
2	1982	8,879	23	2003	22,825
3	1983	7,022	24	2004	22,113
4	1984	6,389	25	2005	18,567
5	1985	18,705	26	2006	23,860
6	1986	24,120	27	2007	16,638
7	1987	29,400	28	2008	16,156
8	1988	32,132	29	2009	15,132
9	1989	29,969	30	2010	14,262
10	1990	30,402	31	2011	18,411
11	1991	31,190	32	2012	24,741
12	1992	31,784	33	2013	19,216
13	1993	33,059	34	2014	18,721
14	1994	35,157	35	2015	17,076
15	1995	35,414	36	2016	27,733
16	1996	36,219	37	2017	22,123
17	1997	34,916	38	2018	21,554
18	1998	37,281	39	2019	31,012
19	1999	33,864	40	2020	27,862
20	2000	37,219	41	2021	28,544
21	2001	29,634			

Annex 4

Indirect benefits of crab banks.

The BSC Bank operates in coastal areas throughout Thailand. Especially in areas where blue swimming crabs are the main fisheries. Since most fishermen want to set up blue swimming crab banks to directly increase the number of blue swimming crabs to fishermen in the area, the efficiency of the blue swimming crab bank can be assessed obtained from the catches that occur along the coast.

For socio-economic, from a survey of fishermen's satisfaction and opinions in the area where the BSC bank was established, it was found that Most of the fishermen want the government to support the activities of the Blue Swimming Crab Bank and want to establish a blue swimming crab bank continuously. Because it is part of helping to increase the number of young BSCs in the sea, resulting in fishermen having more catches and earning more income. It is also a study visits on the conservation of aquatic animals. The BSC Bank has been expanded to become a learning center and an eco-tourism destination by exchange the knowledge that has been passed on to tourists, students, and interested people who have visited the crab bank activities and it is a source of income for the community which contributes to the cultivation of awareness and initiative in helping to conserve BSC resources and other aquatic resources in their own area. It is also another way to strengthen the fishing community.