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**Blue Swimming Crab Stock and Fisheries in Kien Giang Province  
in 2024: Insights from the Fishery Improvement Project Indicators**

**By**

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## List of Abbreviations

BSC: Blue Swimming Crab

FIP: Fisheries Improvement Project

M: Natural Mortality Rate

F: Fishing Mortality Rate

Z: Instantaneous rate of mortality

$CW_{\infty}$ : Asymptotic carapace width of crab

$CW_t$ : Carapace width of crab at the time  $t$

K: Growth rate

E: Exploitation rate

LCC: Length Converted Catch Curve

SPR: Spawning Potential Ratio

LBSPR: Length Based Spawning Potential Ratio

CW: Carapace Width

BG: Bottom Gillnet

CT: Collapsible Trap

ChT: Chinese Trap

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## 1. Introduction

The Blue Swimming Crab (BSC), *Portunus pelagicus* (Linnaeus 1758) (Family: Portunidae), is widely distributed in the coastal zones of tropical waters. They are found from the intertidal zone to a depth of 50m throughout the Indo–West Pacific. BSC inhabits various environments, including mangroves, seagrass beds, coral reefs, and estuaries, on both sandy and muddy bottoms, with a concentration in the depth range of 5-25m (Williams 1982, Edgar 1990, Clarke and Ryan 2004). In Vietnam, BSC is distributed along the coastal waters from North to South and is densely aggregated in the waters of Kien Giang.

The BSC fishery has been a long-lasting sector in the Kien Giang province, localized to the districts of Ha Tien, Kien Luong, Hon Dat, and Phu Quoc Island. Fishers reside in numerous small fishing communities along the coast, relying heavily on this fishery for their livelihoods. They utilize small fishing boats equipped with engines ranging from 20-33HP. Bottom gillnets and traps (Chinese traps and collapsible traps) are the primary fishing gears targeting the BSC. Ha Tien and Phu Quoc are the two main landing sites where the majority of the catches are landed. Additionally, along the coasts of Kien Luong and Hon Dat districts, catches are landed locally.

The BSC fishery in Kien Giang is open access, and fishing activities occur throughout the year, with the main season from April to August. The BSC stock has been heavily exploited since 2009.

To promote effective fisheries management for the sustainable use of Blue Swimming Crab (BSC) resources, WWF Vietnam, VASEP Crab Council and RIMF have collaborated to support the Kien Giang Department of Agriculture and Rural Development (Kien Giang DARD) in implementing the Fisheries Improvement Project (FIP). The Fishery Action Plan, adopted in 2012 with 26 indicators were monitored covering three core principles of the FIP as Principle 1: Sustainable target fish stocks; Principle 2: Environmental impact of fishing and Principle 3: Effective management. Stock assessments of BSC indicated over-

exploitation during the period 2012-2016; however, there was a gradual recovery observed in the period 2017-2019 (Ha and Cuong 2020).

Since 2020, the Kien Giang BSC FIP has been inactive after seven years implementation. A key challenge has been the significant gap in updated information related to stock assessments, fisheries data, and the management of BSC fisheries. To address this issue, the Vietnam Association of Seafood Exporters and Producers (VASEP), with support from the National Fisheries Institute (NFI), Ocean Outcomes (O2), and the Research Institute for Marine Fisheries (RIMF), is working to reactivate the Kien Giang BSC FIP.

The aim of this report is to provide information that enhances understanding of the current status of the BSC stock and the BSC fisheries in Kien Giang province.

## 2. Overview of MSC Performace Indicators

The MSC Fisheries Standard applies to wild-capture fisheries and is comprised of the following core Principles:

### *Principle 1: Sustainable target fish stocks*

A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery.

### *Principle 2: Environmental impact of fishing*

Fishing operations should allow for the maintenance of the structure, productivity, function, and diversity of the ecosystem on which the fishery depends. The ecosystem includes habitat and associated dependent and ecologically related species.

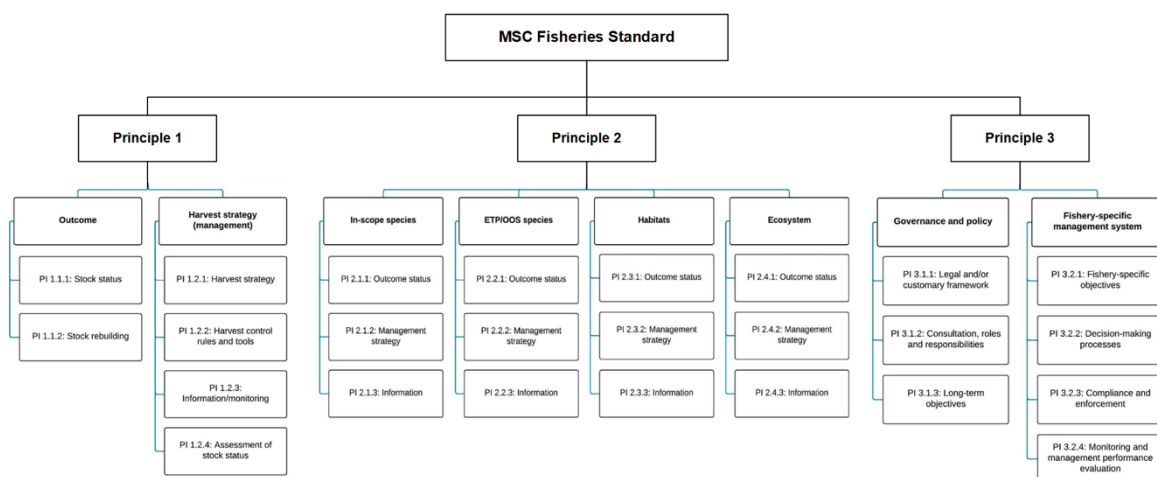


Figure 1. MSC Fisheries Standard default assessment tree by Principles

### *Principle 3: Effective management*

The fishery is subject to an effective management system that respects local, national, and international laws and standards, and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

There are 28 performance indicators covered by three principles reflecting all aspects of the fisheries management. The list of performance indicators is indicated in Figure 1.

### 3. Status of Kien Giang BSC fisheries performance indicators

The 2009 pre-assessment of the BSC fishery in Kien Giang indicated that the fishery is open access, and fishing activities occur year-round, with the main season lasting from April to August. The BSC stock has been heavily exploited.

The Fishery Action Plan adopted in 2012 by implementing the Pre-assessment in 2009 with 24 performance indicators (PI) were covered three core principles of the FIP as Principle 1: Sustainable target fish stocks; Principle 2: Environmental impact of fishing and Principle 3: Effective management.

At the beginning state, only three PIs scored above 80, nine PIs was between 60-79 and 12 PIs ranked below 60 in a total of 24 PIs. It means that the BSC fisheries in Kien Giang was unsustainable

Stock assessments of BSC indicated over-exploitation during the period 2012-2016; however, there was a gradual recovery observed in the period 2017-2019 (Ha and Cuong 2020).

Component	Performance Indicator	Actual Year 1	Actual Year 2	Status	Actual Year 3	Status	Actual Year 4	Status	Actual Year 5	Status	Actual Year 6	Status
Outcome	1.1.1 Stock status	<60	<60	On Target	<60	On Target	<60	Behind	60-79	Behind	<60	Behind
	1.1.2 Stock rebuilding	---	---	---	<60	Behind	60-79	Behind	≥80	Behind	<60	Behind
	1.2.1 Harvest Strategy	<60	<60	On Target	<60	Behind	60-79	Behind	60-79	Behind	<60	Behind
Management	1.2.2 Harvest control rules and tools	<60	<60	On Target	<60	Behind	60-79	Behind	60-79	Behind	<60	Behind
	1.2.3 Information and monitoring	60-79	60-79	On Target	≥80	Ahead	≥80	On Target	≥80	On Target	≥80	On Target
	1.2.4 Assessment of stock status	<60	≥80	Ahead	≥80	On Target	60-79	Behind	≥80	On Target	≥80	On Target
	2.1.1 Outcome	---	---	---	---	---	---	---	---	---	---	---
Primary species	2.1.2 Management	---	---	---	---	---	---	---	---	---	---	---
	2.1.3 Information	---	---	---	---	---	---	---	---	---	---	---
	2.2.1 Outcome	60-79	60-79	On Target	<60	Behind	60-79	Behind	60-79	Behind	<60	Behind
Secondary species	2.2.2 Management	<60	<60	On Target	<60	On Target	60-79	On Target	60-79	Behind	<60	Behind
	2.2.3 Information	<60	<60	On Target	<60	Behind	≥80	On Target	≥80	On Target	≥80	On Target
	2.3.1 Outcome	<60	<60	On Target	<60	Behind	≥80	On Target	≥80	On Target	≥80	On Target
ETP species	2.3.2 Management	<60	<60	On Target	<60	Behind	≥80	On Target	≥80	On Target	≥80	On Target
	2.3.3 Information	60-79	<60	Behind	<60	Behind	≥80	On Target	≥80	On Target	≥80	On Target
	2.4.1 Outcome	≥80	≥80	On Target	≥80	On Target	60-79	Behind	≥80	On Target	≥80	On Target
Habitats	2.4.2 Management	≥80	≥80	On Target	≥80	On Target	60-79	Behind	≥80	On Target	≥80	On Target
	2.4.3 Information	<60	<60	On Target	<60	Behind	60-79	Behind	≥80	On Target	≥80	On Target
	2.5.1 Outcome	≥80	60-79	Behind	60-79	On Target	≥80	On Target	≥80	On Target	≥80	On Target
Ecosystem	2.5.2 Management	60-79	60-79	On Target	60-79	On Target	≥80	On Target	≥80	On Target	≥80	On Target
	2.5.3 Information	60-79	60-79	On Target	60-79	On Target	≥80	On Target	≥80	On Target	≥80	On Target
	3.1.1 Legal and customary framework	60-79	60-79	On Target	60-79	On Target	60-79	On Target	60-79	Behind	≥80	On Target
Governance and Policy	3.1.2 Consultation, roles and responsibilities	60-79	60-79	On Target	≥80	On Target	≥80	On Target	≥80	On Target	60-79	Behind
	3.1.3 Long term objectives	60-79	60-79	On Target	≥80	On Target	60-79	Behind	60-79	Behind	≥80	On Target
	3.2.1 Fishery specific objectives	<60	60-79	Ahead	≥80	On Target	≥80	On Target	≥80	On Target	<60	Behind
Fishery specific management system	3.2.2 Decision making processes	<60	60-79	Ahead	60-79	On Target	≥80	On Target	≥80	On Target	<60	Behind
	3.2.3 Compliance and enforcement	<60	<60	On Target	<60	On Target	<60	Behind	<60	Behind	<60	Behind
	3.2.4 Management performance evaluation	60-79	60-79	On Target	60-79	On Target	≥80	On Target	≥80	On Target	60-79	Behind
	25s equal to or greater than 80	3	3		7		12		17		13	
25s 60-79	9	11		6		11		7		2		
25s less than 60	12	10		12		2		1		9		
<b>Overall BMT Index</b>		<b>0.31</b>	<b>0.35</b>		<b>0.40</b>		<b>0.70</b>		<b>0.82</b>		<b>0.53</b>	

*Figure 2. Tracking the improvement of the BSC fishery by PIs from Year 1 (2012) to Year 6 (2017).*

Since 2020, the Kien Giang BSC FIP has been inactive after seven years implementation. A key challenge has been the significant gap in updated information related to stock assessments, fisheries data, and the management of BSC fisheries.

There have been no score changes since the FIP was re-activated in February 2024. That said, we note the following challenges:

Management of the BSC fishing fleets is complex: In Vietnam, the provincial office manages fishing boats with a length of 12 meters and longer, while those of smaller size are managed at the district level.

We need to re-build connections with stakeholders, especially the provincial government office, which will take time.

There is a limited budget to cover all the Kien Giang BSC comprehensive FIP activities.

#### **4. Actions, activities conducted in 2024**

In 2024, we have prioritized implementation of the following tasks to demonstrate progress.

Review and update information on the Kien Giang BSC stock (e.g. biomass, abundance, size structure, gear selectivity, mortality rate, exploitation rate) and fisheries (total catches, BSC size in catches, fishing grounds, and bycatch of BSC fisheries).

Inspection of minimum landing sizes of BSC and checking on mesh sizes of fishing gears, interviewing the frequency of fishing operations in closed areas. These activities are expected to determine not only the size of BSC in landings, the mesh size of fishing gears, fishing grounds, as related to enforcement and compliance, but also to provide data for stock assessment using LBSPR.

These tasks contribute to Action 1, Action 2, Action 3, and Action 11 in the FIP Work Plan, which relate to PIs 1.1.1, 1.1.2, 1.2.1, 1.2.2, and 3.2.3.

Expected Indicators for 2024 including:

- 1) Data of BSC are available for stock assessment
- 2) Size of BSC in catches of the fishing gears (Collapsible trap, Chinese trap and Bottom gillnet) across the landing sites
- 3) Compliance with regulations on the restricted mesh size of the fishing net/trap
- 4) Compliance with regulations on closure fishing area
- 5) Compliance with regulations on ETP species
- 6) Knowledge of the fisherman with fisheries regulations

## **5. Materials and Methods**

### **5.1. Data sampling**

*Biological information collection of BSC:* Data were collected from the catches of fishing boats at landing sites along the coast of Kien Luong, Ha Tien, and Phu Quoc districts in Kien Giang Province, where the majority of catches of this species are landed using bottom gillnets (BG), collapsible trap (CT), Chinese trap (ChT). The locations of the sampling sites are indicated in Figure 3.

In June and November 2024, ten-day field visits were conducted each month to collect BSC samples from catches of fishing boats. Crab samples, each weighting approximately 2.5 kg, were randomly collected from unloaded boats for size measurement and biological analysis.

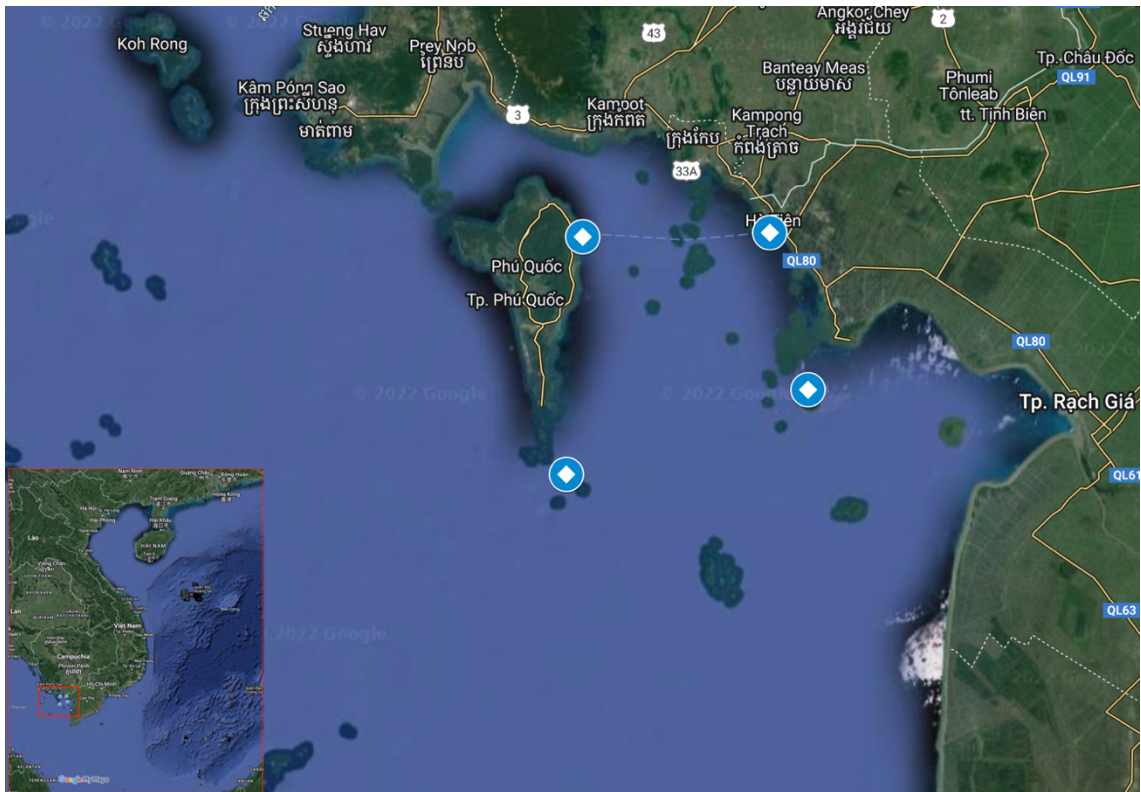


Figure 3. Sampling sites for BSC biological data in Kien Giang Province

Each crab was individually examined for abdominal morphology to determine sex. Carapace width (CW) was measured to the nearest 0.1 mm using a Palme ruler. Body weight (BW) and gonad weight (Wg) were measured to 0.01 grams using an electric weight scale. The gonad maturity stage was determined using a 5-level scale as described by Sumpton et al. (1994).



*Figure 4. Photos of Blue Swimming Crab: upper: male and lower: female. Taken by Vu Viet Ha in Ham Ninh landing site, Phu Quoc District, Kien Giang Province during the survey in March 2013*

*Interview of BSC fishing activities and related information:* A field trip interview with fishermen was conducted in June 2024 using a designed questionnaire to collect information related to fishing activities. The focus was on the fishing grounds and the fishermen's understanding of government regulations regarding the legal minimum size for crabs, the legal mesh size for fishing gears, and temporary closures of areas to protect small-sized crabs. The designed questionnaire covers six groups of information including:

*Vessel Information:* Vessel owner, registration number, engine horsepower, and length of the vessel.

*Fishing Trip Information:* Number of crew, fishing time, landing date, number of fishing hauls per day, trip duration, active days of the fishing trip, weather conditions, fishing ground, depth of the fishing ground, cost of the fishing trip and total catches.

*Fishing Gear Information:* Fishing gear type, number of nets/traps deployed, and technical information of the fishing gear.

*Catch Composition:* Catch of BSC and catches breakdown by commercial groups.

*ETP Species:* Endangered, Threatened, or Protected (ETP) species—whether kept or released if caught.

*Knowledge of Fishermen on Fisheries Regulations:* Minimum legal size of species, minimum mesh-size of the net, and fishing closure areas.

In parallel with interview with fisherman on the technical information of the fishing gear, we also do check of the stretched mesh (2a) of the fishing net on boat fishing vessel by using the palme ruler.

A total of 115 fishermen were interviewed during the field survey in June 2024. Of these, 40 interviewees used Chinese trap, 19 used collapsible trap, and 56 used bottom gillnet (Table 1).

*Table 1. Number of fishermen was interviewed during the field survey in June 2024 categorized by fishing gears and fleets*

Fishing Gear	Fleet				Total
	<6m	6–12m	12–15m	>15m	
ChT	–	32	8	–	40
CT	2	10	7	–	19
BG	–	40	14	2	56
Total	2	82	29	2	115

## 5.2. Data analysis

BSC biological data and fisheries data were encoded into the Fisheries Biology Database at the Research Institute for Marine Fisheries. Quantitative biological indicators, such as mean size, size frequency, sex ratio, and maturity stage composition, were analyzed descriptively. The R packages 'dplyr' (Wickham H, François R et al. 2023) and "ggplot2" (Wickham H 2016) were utilized for statistical analysis and visualization of the indicators. Additionally, data from in-depth interviews with fishermen were qualitatively analyzed to assess their knowledge of fisheries regulations and to gather insights into how fishing communities comply with fisheries laws and regulations.

## 6. Results

### 6.1. Brief information on BSC stock and fisheries in Kien Giang to 2023

The Blue Swimming Crab (BSC) fisheries in Kien Giang predominantly utilize bottom gillnets and traps, with the majority of fishers originating from Ha Tien, Kien Luong and Phu Quoc. The number of vessels engaged the BSC fisheries was 1,844 in 2018 1,706 BG; 99ChT and 39 CT.

The latest vessel statistics conducted in 2023 by the Department of Fisheries of Kien Giang reported a total of 5,229 fishing vessels under 15m in overall length, including 4,072 vessels <12m and 1,157 vessels 12-15m. These vessels employ various fishing gear types, such as handlines, trawlnets, gillnets, and purse seines (Table 2).

Problem issue with the 2023 fishing vessel statistics is the fishing gears have not been reported at the most specific identification level; instead, it has been grouped by the gear families. As a result, it is not possible to determine the exact number of fishing vessels under 15 meters that engaged in BSC fisheries.

The fleets >15m are all installed a vessel monitoring system (VMS). This fleets are managed at the province level. All technical information of these vessel is encoded and stored in the central database at the Department of Fisheries under the Ministry of Agricultural and Rural Development.

*Table 2. Number of fishing vessels of the fleets <12m and 12-15m in Kien Giang province based on the census in 2023 by the Department of Fisheries of Kien Giang*

Fishing gear	Fleet		Total
	<12m	12-15m	
Handline	1,996	197	2,193
Trawl	8	252	260
Others	553	269	822
Gillnet	1,507	415	1,922
Purse seine	8	24	32
<b>Total</b>	<b>4,072</b>	<b>1,157</b>	<b>5,229</b>

The fleets >15m in Kien Giang include 236 fishing vessels engaged the bottom gillnet but only 115 vessels registered for the crab fishery. The remaining are 115 bottom gillnets in general and six trammelnets that targeted on the demersal resources (Table 3).

Table 3. The bottom gillnet fleets in Kien Giang province

Fishing gear	Fleet		Total
	15-24m	>24m	
Crab Bottom Gillnet	113	2	115
Bottom Gillnet	103	12	115
Trammel net	3	3	6
Total	219	17	236

The fishing grounds of the BG and traps for BSC based on the data collected in 2023 by the Research Institute for Marine Fisheries under the project "Survey of the fisheries resources and related environment in the coastal and inshore waters of Kien Giang Province" are presented in Figure 5. The areas of high fishing intensity for BG are located southeast of the Nam Du to Hon Son islands, while the traps are primarily concentrated between the Ba Lua Archipelago, the Hai Tac Archipelago, and the coastal region of Ha Tien District.

Spatial analysis indicates significant changes in the fishing grounds of BG fisheries in 2023 compared to those observed during the 2013–2015 period. These shifts may reflect the fishing practices where the large BG fleet increasing in number and the small fleets decreased recently. In contrast, the spatial distribution of traps has remained stable, suggesting unchanged fishing practices in these areas.

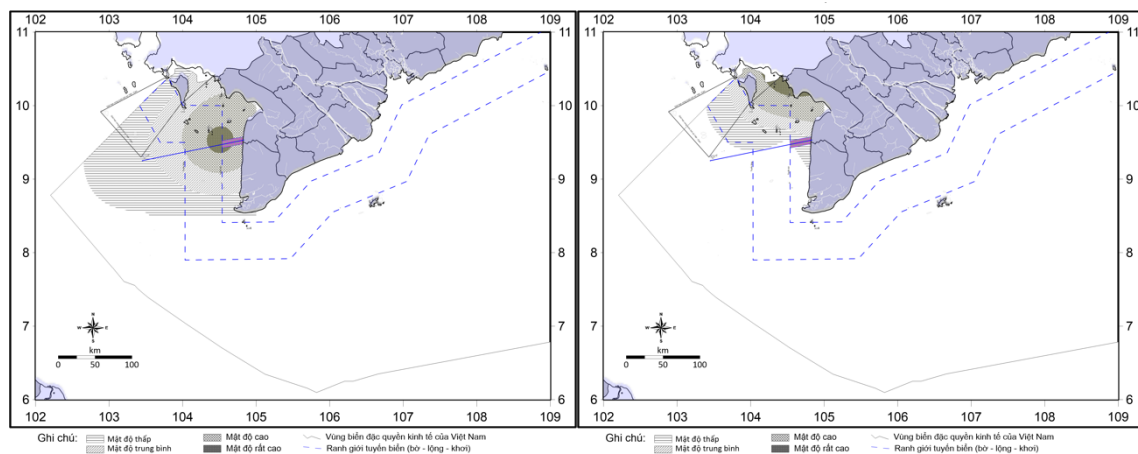


Figure 5. The fishing grounds of the bottom gillnet (on the left) and the traps (on the right).

Total catches of BSC in Kien Giang province exhibit a distinct pattern of fluctuation between 2013 and 2023 (Table 4), reflecting underlying ecological or economic factors. In 2013, the catch volume was at its highest, with 7,854 tons, followed by a gradual decline in subsequent years. By 2016, catches had recovered slightly to 7,232 tons before experiencing a significant downturn, with total catches dropping to 3,632 tons in 2017 and further to a low of 2,072 tons in 2018. This marked reduction, particularly between 2016 and 2018, may suggest overfishing, shifts in environmental conditions. It is noted that a catastrophic event happened in 2017 in the coastal area, affecting the depletion of BSC stock biomass and total catches (Ha and Cuong 2020). However, starting in 2019, a reversal of this downward trend became evident, as catches increased to 3,899 tons, continuing the upward trajectory to 6,712 tons by 2023. The recovery in catch volumes in the latter period might indicate changes in fishing intensity from the lower fishing effort in 2017 and 2018 (Ha and Cuong 2020) and relative high fishing effort in 2023. These variations highlight the dynamic nature of BSC fisheries, underscoring the need for adaptive management strategies to ensure sustainable exploitation of this resource.

*Table 4. Total catches (tons) of BSC in Kien Giang in periods 2013-2019 and 2023 and the change of total catches in compared to the previous year*

<b>Year</b>	<b>Total catches (tons)</b>	<b>Compared to the previous year (%)</b>
2013	7,854	-
2014	6,196	-21
2015	6,111	-1.4
2016	7,232	+18
2017	3,632	-50
2018	2,072	-43
2019	3,899	+88

...	...	
2023	6,712	+72

The fluctuations in BSC catches in Kien Giang province between 2013 and 2023 underscore the complex interaction of ecological and economic factors influencing the fisheries. The sharp decline in catches from 2016 to 2018, likely exacerbated by overfishing and environmental disturbances, highlights the vulnerability of BSC stocks. However, the recovery in catch volumes starting in 2019, potentially due to adjustments in fishing effort, signals the resilience of the fisheries. These trends emphasize the importance of implementing adaptive management strategies to ensure the long-term sustainability of BSC resources in Kien Giang.

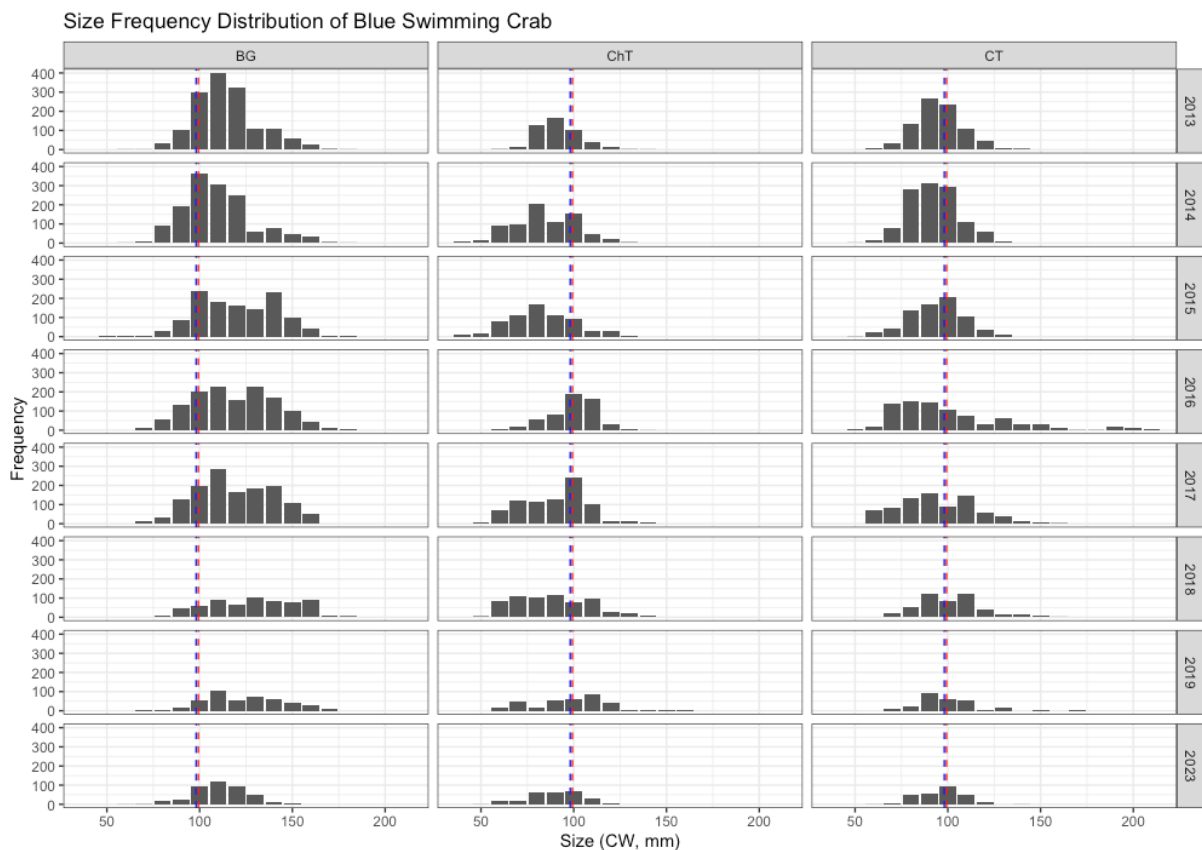


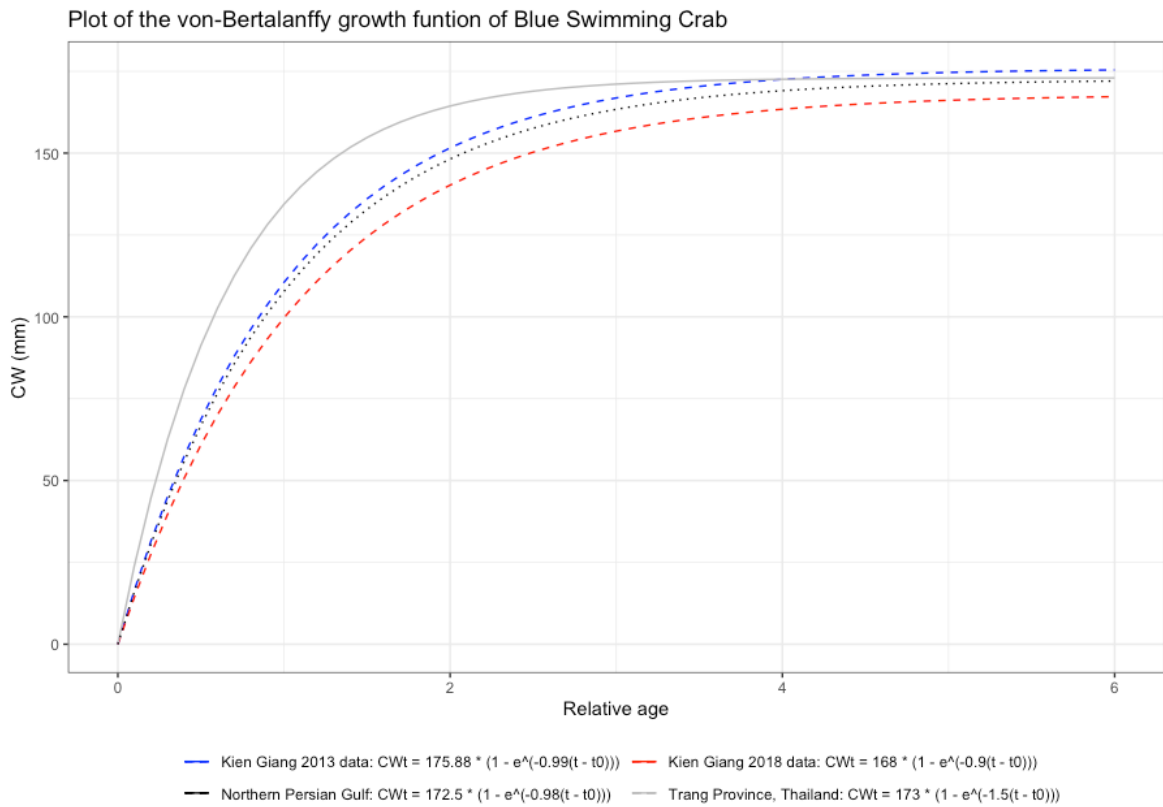
Figure 6. Length frequency (CW) distribution of the BSC in catches of different fishing gears in the Kien Giang province. The vertical red and blue dash lines denote the size at first maturity ( $CW_{m50} = 99.28\text{mm}$ ) estimated by Cuong & Ha (2014) and re-estimated in 2023 ( $CW_{m50} = 98.1\text{mm}$ ).

The catch size of BSC in Kien Giang from 2013 to 2023 reveals distinct bimodal patterns, indicating the presence of multiple cohorts within the stock. While crabs caught using BG are generally larger than those captured with CT and ChT, there has been a notable reduction in the overall size of BSC in 2023 compared to previous years, particularly 2017–2019. The prevalence of undersized crabs in the catch, especially in period after the spawning season, highlights the need for management interventions, such as increasing mesh size, to promote sustainable harvesting and improve stock reproductive potential.

The growth pattern of BSC in Kien Giang province was first studied by Cuong & Ha (2014) using data collected in 2013. The von Bertalanffy growth equation for all sexes combinations ( $n=4,370$ ) was identified as  $CW_t = 175.8*(1-e^{-0.99(t-t_0)})$ .

There are differences in growth between the male and female. The parameters of the von Bertalanffy growth function for the females were  $CW_\infty = 175.4$ ;  $K = 0.94*\text{year}^{-1}$  and for the males were  $CW_\infty = 177.9$  and  $K = 1.2*\text{year}^{-1}$ . The analysis also showed that the growth rate of males was higher than that of females (male:  $\phi' = 4.570$ ; female:  $\phi' = 4.464$ ).

The re-estimated von-Bertalanffy growth function for BSC in 2018 indicated that the  $CW_{\text{infinity}}$  was smaller than the estimates from 2013 ( $CW_{\text{infinity}} = 168\text{mm}$ ,  $K = 0.9*\text{year}^{-1}$  for both sexes combined). The plots of the von Bertalanffy growth function for BSC in Kien Giang from estimated in 2013, 2018 and other studies are presented in Figure 7.



*Figure 7. Plots of the von Bertalanffy growth function of BSC in Kien Giang together with other studies*

The size at maturity ( $CW_{m50}$ ) for female BSC in Kien Giang was estimated to be 99.28 mm using the biological data collected in 2013 (Ha, Nhan et al. 2014). A subsequent re-estimation in 2023 revealed a  $CW_{m50}$  of 98.1 mm, with a 95% confidence interval of 97.1 to 99.2 mm, indicating a slightly decrease in comparison to the earlier estimate. The  $CW_{m50}$  curve for BSC is illustrated in Figure 8.

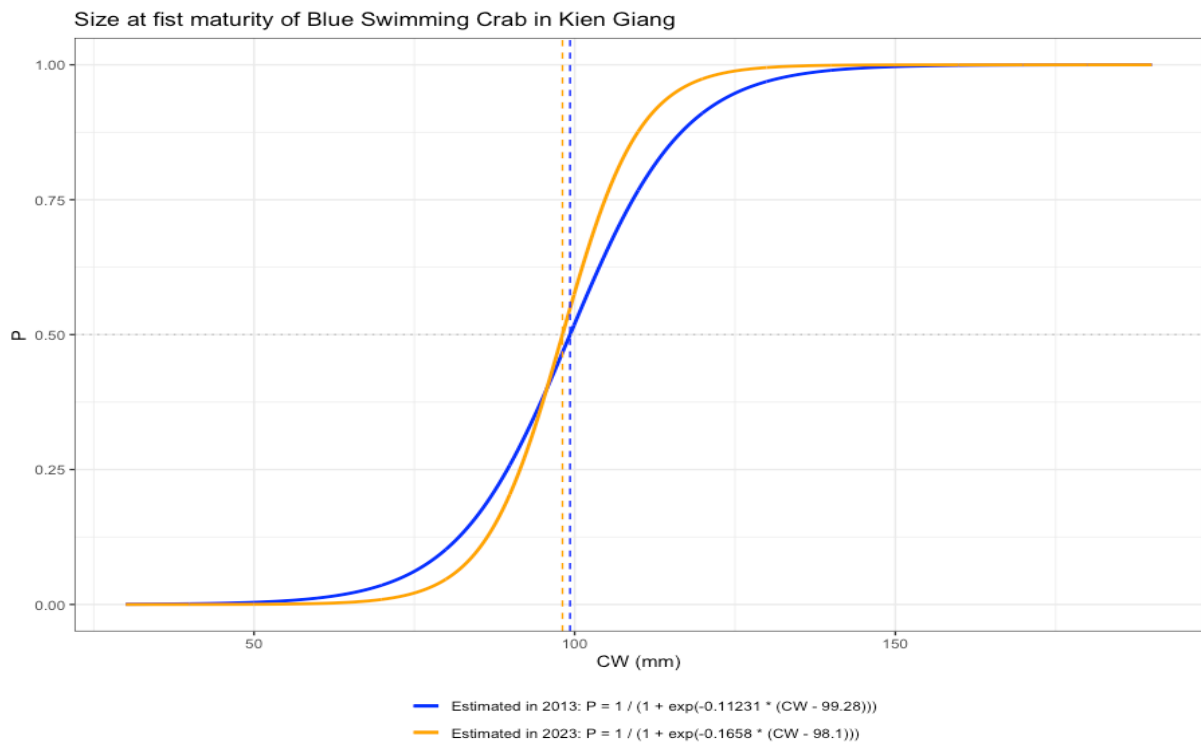


Figure 8. Size at first maturity ( $CW_{m50}$ ) of Blue Swimming Crab in Kien Giang province (re-plotted from Cuong & Ha, 2013 and estimated from data collected in 2023)

The LCC method was applied in stock assessment of BSC in Kien Giang for the period from 2013 and the exploitation rate (E) was used as an indicator reflecting the health of the stock.

The data provided in the stock assessment underscores a growing concern regarding the sustainability of BSC fisheries in Kien Giang. While natural mortality (M) has remained relatively stable, the consistent rise in fishing mortality (F) and total mortality (Z) suggests increased fishing effort over the past decade. Between 2017 and 2023, fishing mortality nearly doubled, reaching a critical point in 2023 with a value of 2.86 (Table 5). This escalation in fishing mortality has led to a corresponding increase in the exploitation rate (E), which has steadily risen from 0.45 in 2019 to 0.73 in 2023. Such a high E value, especially in 2023, signifies that a substantial proportion of the BSC population is being removed by fishing activities.

*Table 5. The mortality rate (natural mortality – M; fishing mortality – F; instantaneous rate of mortality - Z) and exploitation rate (E) of BSC in Kien Giang province*

Năm	M	F	Z	E
2013	1,10	1,91	3,01	0,64
2014	1,10	2,03	3,13	0,65
2015	1,09	1,65	2,74	0,60
2016	1,08	1,75	2,83	0,62
2017	1,40	1,70	3,10	0,55
2018	1,05	0,97	2,02	0,48
2019	1,05	0,86	1,91	0,45
...	...	...	...	...
2023	1,05	2,86	3,91	0,73

The observed trends suggest that current fishing practices may not be sustainable, as they exceed the rate at which the stock can replenish itself naturally. Given the overexploitation status in 2023, immediate management measures, such as reducing fishing effort or implementing seasonal closures, are necessary to prevent further depletion of the stock and to ensure long-term sustainability of the BSC fishery in Kien Giang.

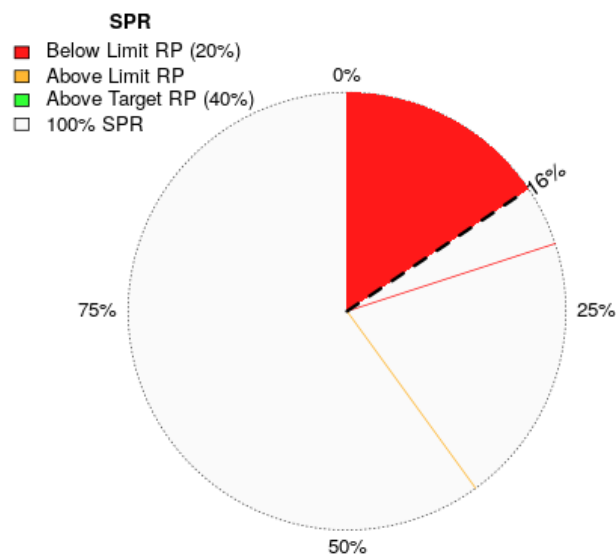
The LBSPR method was first applied to stock assessment of BSC in 2023 using the catch size data collected periodically in February, May, August and November.

Based on the available parameters ( $CW^\infty$ , K and M) estimated in 2018, M/K is 1.2. L50 and L95 values were estimated from 2023 data are 98.1mm and 116mm.

The SPR estimated for BSC stock is shown in Figure 9. The mean SPR for all data combined was 0.16, with a 95% confidence interval of 0.14-0.17 (SL50~98.01mm; SL95~123.23mm). It is noted that the combined

SPR of BSC is below the limit referent point, suggesting that the stock is experiencing unsustainable rates of exploitation.

The SPR is related to the size composition of individuals caught by the fishing gears. The size of BSC caught ChT is smaller compared to those caught by CT and BG. When analyzing data by fishing gears, we found that all of which predictably produced low SPR estimates with only the SPR value of the BG exceeding the below-limit referent point (SPR = 0,23; 95% confident interval: 0.2-0.25).



*Figure 9. The LBSPR estimates for BSC stock in Kien Giang waters based on the data collected in 2023*

The SPR values of the ChT and CT were relatively low due to the high ratio of small size crab in catches. The mean SPR value estimated for the CT was 0.08 (95% confident interval: 0.04-0.12) and SL50 ~ 87.91mm; SL95~113.41mm and for the ChT, SPR was 0.05 (95% confident interval: 0.03-0.08) with SL50~95.08mm and SL90~118.68mm. It is necessary to increase the mesh of the net in ChT and CT to improve the escapement of smaller crabs.

## 6.2. BSC data for stock assessment 2024

Table 6 provides a summary on the number of BSC sampled for size measurement and biological analysis during June and November 2024, broken down by female and male. The total number of samples collected was 1,370, with 447 females and 923 males.

In June 2024, a total of 601 BSCs were sampled, with 165 females and 436 males. The samples were distributed across different fishing gears: BG (241 specimens), ChT (210 specimens), and CT (150 specimens). For the BG, 60 females and 181 males were sampled. In contrast, samples from the ChT were 77 females and 133 males, while the CT had the fewest samples, with 28 females and 122 males.

In November 2024, the total number of sampled BSCs was 769 with 282 females and 487. Samples collected from catches of the BG was 184 females and 305 males and from the ChT was 98 females and 182 males, resulting in 280 specimens.

The data indicate an overall increase in sampling between June and November 2024, with a more balanced sex distribution in November (approximately 37% females and 63% males) compared to June, where males represented a higher proportion of the sample. The higher total number of males in both months suggests a possible skew in the population warranting further investigation into the species' size distribution and sex ratios

*Table 6. Number of BSC sampled for size measurement and biological analysis in June and November 2024*

Sampling time/Fishing gear	Female	Male	Total
June 2024	165	436	601
Bottom Gillnet	60	181	241
Chinese Trap	77	133	210
Collapsible Trap	28	122	150

November 2024	282	487	769
Bottom Gillnet	184	305	489
Chinese Trap	98	182	280
Total	447	923	1370

### 6.3. Compliance with fisheries regulation

#### 6.3.1. The mesh-size of the fishing gears

The mesh sizes of the nets used in BSC fisheries are small compared to those regulated in Decision 23/2015/QD-UBND, dated June 25, 2015, by the People's Committee of Kien Giang Province. Decision 23/2015/QD-UBND specifies that the minimum stretched mesh size (2a) for BG is 120mm, 50mm for CT, and 43mm for ChT.

Data from interviews with fishermen in June 2024 indicated that the stretched mesh size of the BG is about 80-100mm, while the mesh sizes for the ChT and CT are 18mm and 20-26mm, respectively (Table 7). This indicates that the nets used in BSC fisheries are in violation of the regulations on the minimum legal mesh size as regulated in Decision 23/2015/QD-UBND.

*Table 7. The stretched mesh size (2a) of fishing gears*

<b>Fishing Gear</b>	<b>Mesh Size (2a=...mm)</b>	<b>n</b>	<b>Ratio</b>
BG	80	17	30.4
BG	90	28	50.0
BG	100	11	19.6
ChT	18	40	100.0
CT	20	16	88.9
CT	26	2	11.2

#### 6.3.2. Knowledge of fishermen on the Law of Fishery and related regulations

A total of 115 individuals participated in the survey, providing a comprehensive sample for analysis.

The survey results regarding the fisherman's knowledge of fishery law regulations are presented in Table 8. It notes that 62.6% of the respondents (n = 72) reported being familiar with the fishery regulations.

In contrast, 37.4% (n = 43) of the respondents indicated that they were not aware of the relevant regulations.

*Table 8. Fisherman's Knowledge on the Law of Fishery Law and regulations*

No	Know the regulations of the fishery law	Number of Interviewees	Percentage
1	Yes	72	62.6
2	No	43	37.4
Total		115	100.0

### 6.3.3. Compliance with minimum legal mesh size of the nets

The survey results on fishermen's awareness of the minimum legal mesh size for fishing nets are presented in Table 9. A total of 115 fishermen participated in the survey. It shows that 61.7% of the respondents (n = 71) reported being aware of the minimum legal mesh size. In contrast, 38.3% (n = 44) of the respondents indicated that they were not familiar with the minimum legal mesh size requirements.

*Table 9. Fishermen's knowledge of the minimum legal mesh size (MLS) of nets used in fisheries*

No	Know the MLS of nets	Number of Interviewees	Percentage
1	Yes	71	61.7
2	No	44	38.3
Total		115	100.0

#### 6.3.4. Compliance with the closed fishing areas for fisheries resources protection

The data presented in Table 10 reveals the prevalence of illegal fishing activities within closed fishing areas intended for fisheries resources protection. Out of 115 interviewees, a substantial 72.2% (83 individuals) reported not engaging in fishing within these restricted zones, indicating a general adherence to the regulations. However, 27.8% (32 individuals) acknowledged fishing in these closed areas, highlighting a significant minority that may be involved in illegal or unauthorized fishing practices. This disparity suggests that while the majority of the respondents comply with the fishing restrictions, a notable portion of the population continues to engage in activities that could undermine the conservation efforts and sustainability of local fisheries. Addressing the underlying reasons for these illegal fishing practices, such as enforcement challenges or economic pressures, would be essential for improving the effectiveness of fisheries protection policies.

*Table 10. Fishing illegal in the closed fishing areas for fisheries resources protection*

No	Fishing in closing area	Number of Interviewees	Percentage
1	Yes	32	27.8
2	No	83	72.2
Total		115	100.0

#### 6.3.5. Behaviour of fishermen on egg-bearing crabs

Table 11 presents the behavior of fishermen when egg-bearing crabs are caught. The overwhelming majority of respondents, 99.1% (114 interviewees), reported that they keep the egg-bearing crabs, while only 0.9% (01 interviewee) stated that they release them back into the water.

This suggests a strong inclination among fishermen to retain egg-bearing crabs. The low percentage of respondents who release the crabs indicates a potential lack of awareness or disregard for the importance of preserving reproductive individuals, which could affect the regeneration of local crab stocks. Given the critical role of egg-bearing crabs in maintaining population levels, these findings highlight the need for more effective education and regulation enforcement to ensure that fishermen adhere to sustainable fishing practices

*Table 11. Behaviour of fishermen when the egg-bearing crabs get caught*

No	When the egg-bearing crab get caught	Number of Interviewees	Percentage
1	Keep	114	99.1
2	Release	1	0.9
Total		115	100.0

#### 6.4. The BSC size in catches based on data collected in 2024

Table 12 presents the descriptive statistics of crab size across different fishing gears and by female, male, and both sexes combined. For BG, the mean carapace width for females is 102.2 mm, for males 103.9 mm, and for both sexes combined 103.4 mm. The minimum carapace width is 61 mm for both sexes, and the maximum is 148 mm for both sexes, indicating a broad range of sizes within the sampled population.

For ChT, the average CW for females is slightly smaller at 88.1 mm, while for males, it is 92.2 mm, and for both sexes combined, it is 90.7 mm. The size range for crabs caught by ChT is narrower compared to BG, with a minimum of 62 mm and a maximum of 119 mm.

In case of BSC caught by CT, the mean CW is 105.1 mm for females and 106.6 mm for males, with an overall mean of 106.3 mm for both sexes combined. The size range is narrow with a minimum of 81 mm

and a maximum of 125 mm. The sample size is much smaller, with 28 female crabs, 122 male crabs.

It suggested that the BG generally caught the largest crabs, with a wide size range, followed by CT, which also shows a broader size distribution than ChT, which tends to capture smaller crabs. The data reveal gender differences in CW, with males generally being slightly larger than females across all fishing gears. The relatively smaller sample size for CT limits the ability to generalize, but the results indicate that BG targets larger crab. The findings underscore the variability in crab size across different fishing gears, which could have implications for fishing practices and management strategies.

*Table 12. Descriptive statistic analysis of crab size among the fishing gears*

Fishing Gear/Indicators	Female	Male	Both sex combined
BG			
Mean of CW (mm)	102.2	103.9	103.4
Min. of CW (mm)	62	61	61
Max. of CW (mm)	148	143	148
N	244	486	730
ChT			
Mean of CW (mm)	88.1	92.2	90.7
Min. of CW (mm)	65	62	62
Max. of CW (mm)	119	117	119
N	175	315	490
CT			
Mean of CW (mm)	105.1	106.6	106.3
Min. of CW (mm)	81	87	81
Max. of CW (mm)	123	125	125
N	28	122	150

Comparing to the MLS for BSC, it is noted that the average size of crabs caught by ChT is smaller than the MLS, while the crabs caught by both BG and CT are larger than the MLS.

## 6.5. The fisheries indicators based on data collected in 2024

### 6.5.1. Number of crew fishing on board

The number of crew members on fishing vessels varies across different fleets. Except for fleets >15 meters, which typically have seven crew members (n=2), most fleets consist of only 1-3 fishermen (Table 13). Typically, on smaller fishing boats, a husband-and-wife work together in crab fishing.

*Table 13. Number of crew onboard fishing vessel of the BSC fisheries*

Gear	Fleet	Number of Crew			
		Mean	Min	Max	n
ChT	6-12m	1	1	2	32
ChT	12-15m	3	2	4	7
BG	6-12m	1	1	5	40
BG	12-15m	3	1	6	14
BG	>15m	7	7	7	2
CT	<6m	1	1	1	2
CT	6-12m	2	1	3	10
CT	12-15m	3	1	4	7

### 6.5.2. Number of net settings

The number of net settings depends on the fleet's capacity. The larger the fishing boat, the higher the number of net settings. The descriptive statistics of net settings across the fishing gears are provided in Table 14.

*Table 14. The average of the net setting by fishing gears based on data collected in June 2024*

Gear	Fleet	Fishing net setting				
		Mean	sd	min	max	n

ChT	6-12m	101	73	10	350	32
ChT	12-15m	631	246	150	900	8
BG	6-12m	36	37	6	150	40
BG	12-15m	121	125	20	500	14
BG	>15m	150	0	150	150	2
CT	<6m	120	0	120	120	2
CT	6-12m	231	159	100	500	10
CT	12-15m	814	811	300	2000	7

### 6.5.3. Catch per Unit of Effort (CPUE)

Table 15 presents the CPUE, measured in kg/day, across different fishing gears and fleet sizes. The data shows significant variation in CPUE based on both the type of fishing gear used and the size of the fishing vessel.

#### + *Chinese Trap (ChT)*

- Fleet 6-12m: The mean CPUE is 11.2 kg/day (sd = 7.6 kg/day), indicating considerable variability in the catch. The CPUE ranges from a minimum of 3.0 kg/day to a maximum of 24.0 kg/day, with a sample size of 32 vessels.

- Fleet 12-15m: The mean CPUE is 9.7 kg/day (sd = 3.3 kg/day). The CPUE ranges from 5.0 kg/day to 12.0 kg/day, based on a smaller sample of 7 vessels.

#### + *Bottom Gillnet (BG)*

- Fleet 6-12m: The mean CPUE is 12.4 kg/day (sd = 17.1 kg/day), indicating high variability in the catch. CPUE ranges from a minimum of 3.0 kg/day to a maximum of 92.6 kg/day, based on 40 vessels.

- Fleet 12-15m: There is a notable increase in CPUE to a mean of 41.6 kg/day (sd = 26.1 kg/day). The catch ranges from 12.0 kg/day to 100.0

kg/day, based on a sample of 14 vessels. This fleet size shows a significantly higher average CPUE compared to the 6-12m fleet.

- Fleet >15m: The mean CPUE is about 25.4 kg/day (sd = 34.8 kg/day), indicating considerable variation in catch across this fleet. CPUE ranges from 0.8 kg/day to 50.0 kg/day, based on just 2 vessels.

+ *Collapsible Trap (CT)*

- Fleet <6m: The mean CPUE is 7.5 kg/day (sd = 0.7 kg/day). The CPUE is quite consistent, ranging from 7.0 kg/day to 8.0 kg/day, with a very small sample size of only 2 vessels.

- Fleet 6-12m: The mean CPUE increases to 17.7 kg/day (sd = 13.4 kg/day). The CPUE ranges from 7.0 kg/day to 40.0 kg/day, based on 10 vessels, indicating greater variability.

- Fleet 12-15m fleet: The mean CPUE is 25.1 kg/day (sd = 6.9 kg/day). The CPUE ranges from 20.0 kg/day to 40.0 kg/day, based on a sample of 7 vessels, showing moderate variability.

*Table 15. Average catch per unit of effort (CPUE, kg/day) by the fishing gears based on data collected in June 2024*

Gear	Fleet	CPUE (kg/day)				
		Mean	sd	min	max	n
ChT	6-12m	11.2	7.6	3.0	24.0	32
ChT	12-15m	9.7	3.3	5.0	12.0	7
BG	6-12m	12.4	17.1	3.0	92.6	40
BG	12-15m	41.6	26.1	12.0	100.0	14
BG	>15m	25.4	34.8	0.8	50.0	2
CT	<6m	7.5	0.7	7.0	8.0	2
CT	6-12m	17.7	13.4	7.0	40.0	10
CT	12-15m	25.1	6.9	20.0	40.0	7

#### 6.5.4. Price of BSC caught by different fishing gears

Table 16 provides the average prices of BSC by different grade categories for three fishing gears. The prices are presented with mean values, standard deviations (sd), and the minimum and maximum prices for each category.

##### + *BSC caught by the Chinese Trap (ChT):*

The broken crab group: The mean price is 50,000 VND per kg, indicating uniform pricing across the 2 samples.

Mixed crab: The mean price is 116,000 VND, with a relatively high standard deviation (74,000 VND), indicating substantial variation in prices, ranging from a minimum of 20,000 VND to a maximum of 220 VND (n = 39).

##### + *BSC caught by the Bottom Gillnet (BG):*

BSC grade I: The mean price is 218,000 VND per kg, with a small standard deviation (18,000 VND), suggesting stable pricing within the range of 200,000-250,000 VND (n = 6).

BSC grade II: The mean price is 155,000 VND per kg, with a low standard deviation (12,000 VND), indicating consistent prices within the range of 150,000-180,000 VND (n = 6).

Broken crab: The mean price is 50,000 VND per kg based on only 1 sample.

Mixed crab: The mean price is 147,000 VND per kg, with a moderate standard deviation (45,000 VND), indicating some price variation ranging from 92,000 VND to 250,000 VND (n = 50).

##### + *BSC caught by Collapsible Trap (CT):*

BSC grade I: The mean price is 235,000 VND per kg, with a small standard deviation (17,000 VND), indicating relatively consistent pricing within the range of 220,000-250,000 VND (n = 4).

BSC grade II: The mean price is 165,000 VND per kg, with a standard deviation of 17,000 VND, suggesting moderate variability in prices ranging from 150,000 VND to 180,000 VND (n = 4).

Mixed crab: The mean price is 157,000 VND per kg, with a relatively high standard deviation (57,000 VND), indicating a wide variation in prices, ranging from 80,000 VND to 220,000 VND (n = 15).

*Table 16. Average price of the BSC by grade categories among fishing gears*

<b>Gear</b>	<b>BSC</b>	<b>Mean Price</b>	<b>sd</b>	<b>min price</b>	<b>max price</b>	<b>n</b>
ChT	Broken crab	50	0	50	50	2
ChT	Mixed crab	116	74	20	220	39
BG	Grade I	218	18	200	250	6
BG	Grade II	155	12	150	180	6
BG	Broken crab	50	-	50	50	1
BG	Mixed crab	147	45	92	250	50
CT	Grade I	235	17	220	250	4
CT	Grade II	165	17	150	180	4
CT	Mixed crab	157	57	80	220	15

### **Conclusion remarks**

1) *Data of BSC are available for stock assessment:* Two surveys in June and November 2024 were sampled and analysed a total of 1,370 crabs with 447 females and 923 males supporting for stock assessment as planned to conduct in 2025

2) *Size of BSC in catches:* Size data of BSC sampled in 2024 reveals that the BG and CT is low risk to the BSC population in comparison to that of ChT since the the average size of crabs caught by ChT smaller

than the MLS, while both BG and CT are caught the larger crabs with the average size is bigger than the MLS.

3) *Mesh size violations*: Fishing gears used in BSC fisheries, including BG, CT, and ChT, frequently fails to meet the minimum legal mesh size stipulated by Decision 23/2015/QD-UBND of Kien Giang Province

4) *Regulatory awareness*: Among 115 fishermen surveyed, 62.6% reported being aware of fishery regulations, whereas 37.4% indicated a lack of knowledge. This gap in awareness highlights the need for enhanced dissemination of legal information.

5) *Knowledge of fishermen on mesh size requirements*: Awareness of minimum legal mesh size was reported by 61.7% of respondents, while 38.3% were unfamiliar with these regulations, underscoring a potential barrier to achieving compliance.

6) *Illegal Fishing in Restricted Areas*: Survey data revealed that 27.8% of respondents admitted to fishing in closed areas, while 72.2% complied with the restrictions. The presence of a substantial minority engaging in illegal activities suggests the need for addressing underlying factors, such as enforcement deficiencies or economic pressures.

7) The findings regarding fishermen's behavior toward egg-bearing crabs indicate critical challenges in sustainable fishing practices since 99,1% fishermen reported keeping the egg-bearing crabs and only 0.9% releasing them. This behavior highlights a widespread lack of adherence to sustainable practices aimed at protecting reproductive crab populations.

8) Some indicators on BSC fisheries include the average number of crew members on board, the average number of net settings, CPUE

(Catch Per Unit Effort), and the price of crabs categorized by fishing gear and grade were reported.

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