Monterey Bay Aquarium Seafood Watch

Draft Assessment for Review

April 2023

Blue swimming crab (Vietnam)

Portunus pelagicus

Vietnam and Gulf of Thailand

Bottom gillnet, Pots, Set gillnets, Traps

Report ID 27948

Seafood Watch Standard used in this assessment: Fisheries Standard v3

Table of Contents

About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard.Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report includes recommendations for blue swimming crab (*Portunus pelagicus)*, a large-bodied, benthic crustacean caught by two types of crab trap; pot and Chinese trap (discussed here as "'traps unspecified"), and bottom-set gillnet /crab tangle net. The fishery occurs in the Kien Giang Province (South of the Mekong Delta), in the Gulf of Thailand.

The most recent stock assessment for the Vietnam BSC fishery from 2018 showed that the biomass was 3.05 thousand tons, but no biological reference points were defined, and immature crabs comprised 46.39% of the catch, so a Productivity-Susceptibility Analysis was conducted, which suggested a high inherent vulnerability. In combination with an unknown stock abundance, BSC has an overall abundance score of "high" concern. Overfishing is also occurring (F_{CURR}/F_{MSY} = 1.25) and is considered a "high" concern.

Both the gillnet and the Chinese trap fisheries typically have high bycatch levels and have the potential to catch some species of concern (e.g., sharks, rays, sea turtles, dugongs). Brownbanded bamboo sharks, red stingrays, sharpnose stingrays, and sea turtles limit the Criterion 2 score for the gillnet fishery, and spineless cuttlefish limit the score for the Chinese trap fishery.

A crab management plan is in place for Vietnam BSC, which lays out the harvest control strategy and supporting tools. However, because existing management measures (in particular, the minimum landing size and the closed season) are not being applied systematically, national policy is seeking to promote a community co-management structure between government and the community fishers in order to share the responsibility and authority for BSC management. Because evidence needs to be provided that the implementation of the harvest control strategy and supporting tools will be effective to allow the rebuilding strategy to work and because MLS may not be entirely appropriate for this specific fishery, management is considered ineffective.

The Vietnam BSC fishery has an overall moderate impact on ocean habitats and ecosystems. While there are no gear-specific modifications to reduce impacts to the seafloor, there are a number of closed areas/seasons, which serve to decrease the impact of BSC fishing gear on the ecosystem.

Overall, the gillnet and pot/trap fisheries in Vietnam are rated "red" or "Avoid."

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Blue swimming crab | Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam	1.000	1.000	1.000	3.000	**Avoid (1.316)**	Unknown
Blue swimming crab | Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam	1.000	1.732	1.000	3.000	**Avoid (1.510)**	Unknown
Blue swimming crab | Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam	1.000	1.732	1.000	3.000	**Avoid (1.510)**	Unknown

Summary

The blue swimming crab (*Portunus pelagicus)* is a large-bodied, benthic crustacean common throughout the Indo-Pacific. This report covers BSC caught by two types of crab trap; normal (pot) and Chinese trap (trap unspecified), and bottom-set gillnet/crab tangle net in Kien Giang Province (south of the Mekong Delta), in the Gulf of Thailand.

The "Avoid" rank for BSC is driven by high conservation concerns over stock status, impacts on ray, sea turtle, and sharks populations, and management of the fishery's impacts on crab populations.

Eco-Certification Information

The Vietnam BSC fishery was engaged in a Fishery Improvement Project (FIP), which went inactive in January 2020. Engagement in a FIP does not affect the Seafood Watch score, since we base our assessments on the current situation. Monterey Bay Aquarium is a member organization of the Conservation Alliance for Seafood Solutions. The Alliance has outlined guidelines for credible Fishery Improvement Projects. As such, Seafood Watch will support procurement from fisheries engaged in a FIP, provided it can be verified by a third party that the FIP meets the Alliance guidelines. It is not the responsibility of Monterey Bay Aquarium to verify the credibility or progress of a FIP, or promote the fisheries engaged in improvement projects.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report includes recommendations for blue swimming crab (*Portunus pelagicus)*, a large-bodied, benthic crustacean caught by two types of crab trap; normal (pot) and Chinese trap (trap unspecified), and bottom-set gillnet/crab tangle net. The fishery occurs in the Kien Giang Province (south of the Mekong Delta), in the Gulf of Thailand.

Species Overview

Species overview

Blue swimming crabs (BSC) are brachyuran crabs that belong to the Portunidae family. Crabs from this family are usually recognized by their flat, disc-shaped hind legs, used as paddles for swimming, and by the nine spikes (aka. horns) along their carapace, on either side of their eyes (GWA DOF 2011). Males are bright blue in color with white spots and with characteristically long chelipeds; the females are a duller green/brown, with a more rounded carapace (BFAR 2012). Spawning occurs year-round, with the main spawning season in Vietnam from February to April and peak spawning season in March (Ha et al. 2014). Female blue crabs mate only during molting, with the male crabs carrying and protecting them until molting and mating occurs. BSC are common throughout the Indo-Pacific in inshore and continental shelf habitats including sand, mud, algae, and seagrass near reefs and mangrove areas; they are found in the intertidal up to depths of 70 m (Ingles 1996) (Germano et al. 2006). BSC are a focal point of fishing industries in the region, such as in Indonesia, Philippines, Vietnam, Cambodia, Malaysia, Thailand, India and Sri Lanka (Germano et al. 2006) (Creech et al. 2016) (FAO 2022); Figure 1. In Vietnam, BSC is distributed throughout the coastal waters from north to south and aggregated densely in Kien Giang waters {Ha et al. 2014}. They mature quickly (about one year), have short lifespans (about three years), and are partial brooders (Josileen and Menon 2007) (Kangas 2000). BSC in Vietnam are exploited year-round, with the main fishing season occurring from April to August (Ha et al. 2014).

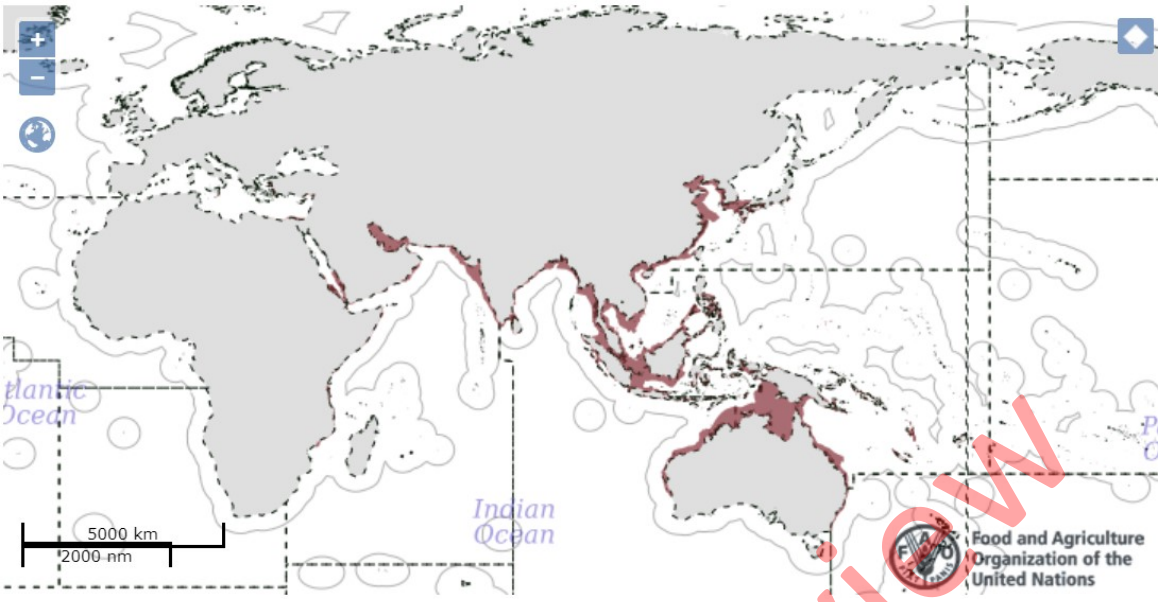

Figure 1: Global distribution of BSC. Taken from FAO 2022.

BSC fishery locations and gear

The BSC fisheries in Kien Giang waters are restricted to the districts of Ha Tien, Kien Luong, Hon Dat, and Phu Quoc Island (Ha et al. 2014). BSC fishing grounds extend from the coast out to 30 m depth, and differ among fishing fleets (ibid). The majority of BSC fishing boats are equipped with a small engine (20 to 90 HP), and crab traps (normal and Chinese); bottom-set gillnets are the main fishing gears used. Gillnet panels are set in 10 km long sets for boats with <20 HP engines, and up to 45 km long for fishing boats equipped with larger engines. Mesh sizes vary between 70 and 90 mm (ibid). Two different types of crab traps are used in the Vietnam BSC fishery; normal traps and Chinese traps (Figures 2 and 3). Normal traps are a single crab trap with a larger mesh size, whereas Chinese traps are twelve traps linked together that have a very small mesh size. Chinese traps are not covered in the FIP's scope, but their use is of great concern due to their serious impact on the BSC stock {Poseidon ARM Ltd. 2015a} (pers. comm., T. Nguyen, 4 July 2016).

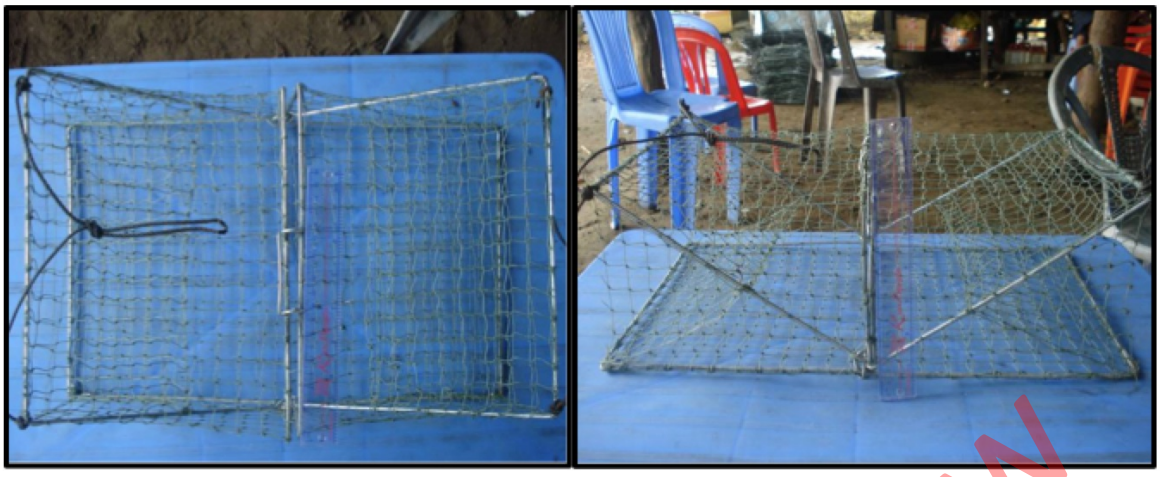

Figure 2: Normal crab trap used in BSC fishery (photo from Thuy Nyugen).

Figure 3: Chinese crab trap used in BSC fishery (photo from Thuy Nyugen).

The bottom-set gillnet fishing fleet (<20 HP) mainly occurs on the coast of the Kien Luong district, Ham Ninh–Bai Bon villages and southern region of Phu Quoc, from An Thoi to the northwest of the Nam Du archipelago (Figure 4; {Ha et al. 2015}). Fleets >20 HP have wider fishing areas, covering most of the North — Nam Du Island to Hai Tac archipelago — the historical waters Vietnam-Cambodia and western region of Phu Quoc Island (Figure 2). Crab trap fleets operate in the Ham Ninh–Bai Bon area, Kien Luong coast, and around Hon Tre Island (Figure 5; ibid).

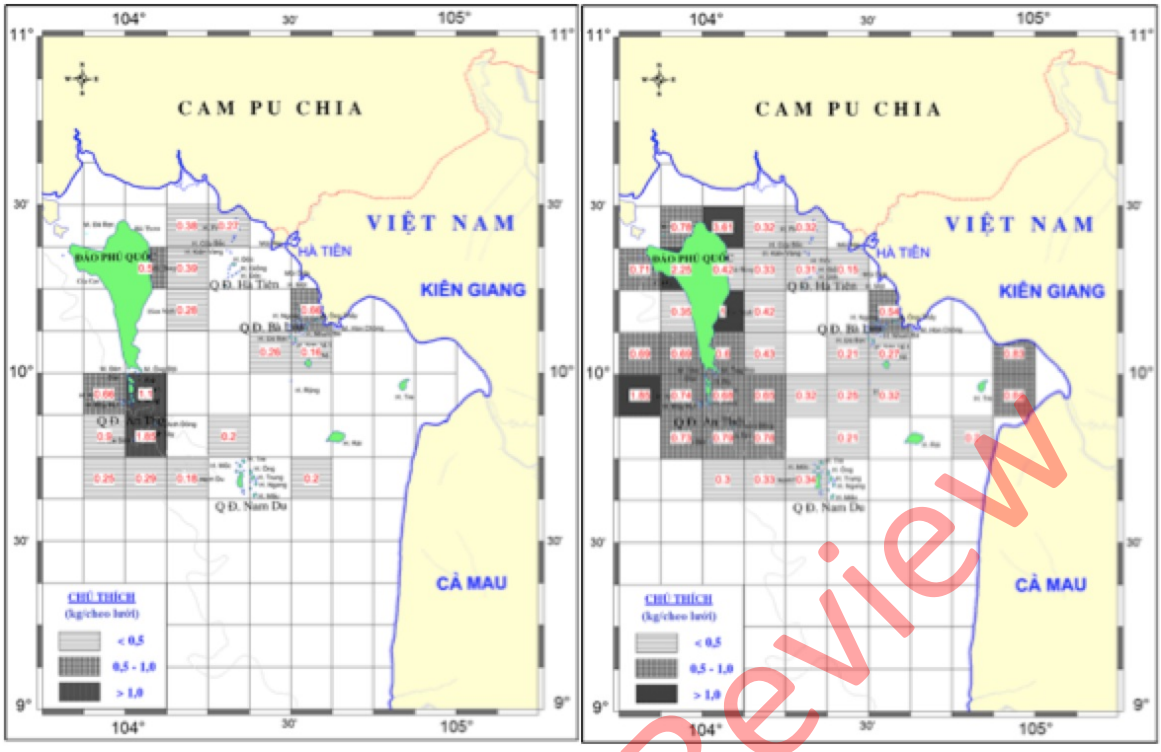

Figure 4: Bottom-set gillnet fishing grounds in Kien Giang in 2013 (Left: fleet <20CV; Right: fleet >20CV; from Ha et al. 2015).

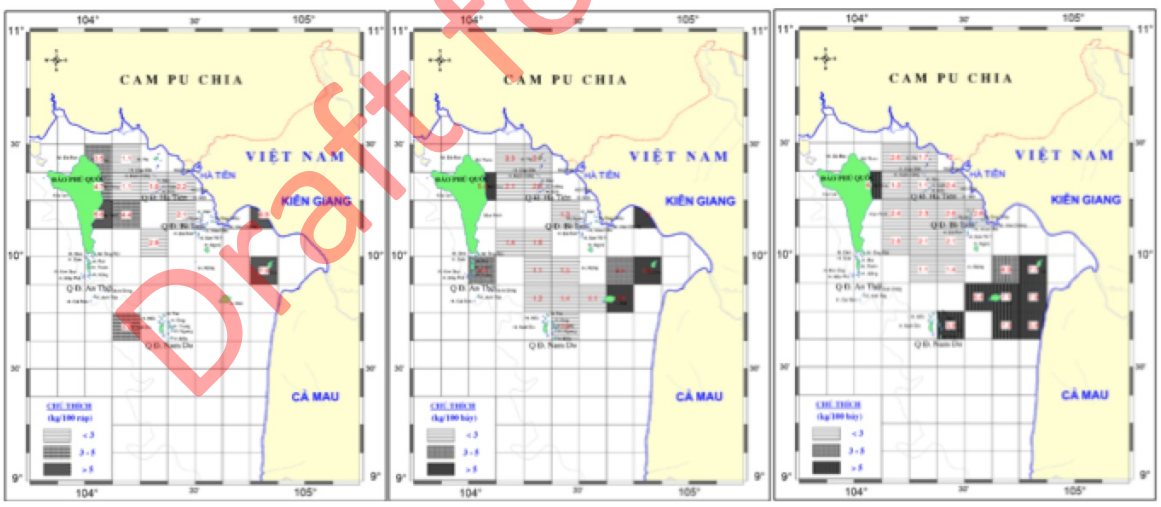

Figure 5: Normal trap and Chinese trap fishing grounds in Kien Giang in 2013 (Left: trap fleet <20CV; Middle: Chinese trap fleet <20CV; Right: Chinese trap fleet >20CV; from Ha et al. 2015).

History of BSC fishery

Up to 2014, the Vietnam BSC fishery had been heavily exploited, with a limited amount of management regulations applicable in law, as well as a limited level of control applied to the BSC fishery (Poseidon ARM

Ltd. 2015b). Management measures based on stock assessments/reference points have not been utilized in any fishery in Vietnam. Until recently, fisheries management decisions were made based on closing seasons and size limitations of target species, or nets (Ha et al. 2014). For example, fishing for BSC was banned between 1 April and 30 June every year in coastal areas, and the minimum harvesting size was 100 mm CW (ibid).

Management

There is no unified worldwide body that manages fisheries for BSC. Instead, each country has its own individual management system. In Vietnam, the Ministry of Agriculture (MARD) is responsible for preparing the underlying Fisheries Legislation, with proposed management tools set for the various fisheries (Poseidon ARM Ltd. 2015b). DARD, the Department of Agriculture and Rural Development, in Kien Giang province is responsible for the regional implementation of management measures (ibid). The Crab Advisory Council (CAC), which is comprised of all stakeholders, is responsible for coordinating research and providing advice to DARD (ibid).

FIP

In 2010, the Vietnam BSC FIP was initiated by a partnership of Vietnamese BSC processor companies (Vietnam Association of Seafood Exporters and Processors (VASEP) Crab Council), WWF-Greater Mekong, and the fishery consultancy, Poseidon, in order to address sustainability requirements by overseas customers and BSC as a depleted resource (NFICC 2016). The group initiated a Marine Stewardship Council (MSC) pre-assessment, which identified the fishery as a medium risk and prompted the creation of a FIP scoping document that includes potential strategies for addressing the deficiencies identified in the pre-assessment {Poseidon 2015a}. Implementation of FIP activities began in September 2010, after the Action Plan was finalized (NFICC 2016). The FIP covers the region of the Kien Giang Province.

Production Statistics

The increasing global demand for the BSC and their wide distribution throughout the Indo-Pacific make them an important species for a number of countries (Creech 2013) (FAO 2016a), and there has been a steady increase in global supply since the 1960s till 2018, after which there has been a slight decrease in production (FAO 2022b)(Figure 6). In 2021, the total global production of blue swimming crab was 251,915 tonnes (live weight) (FAO 2022b). The contribution of Vietnam to global production is unknown.

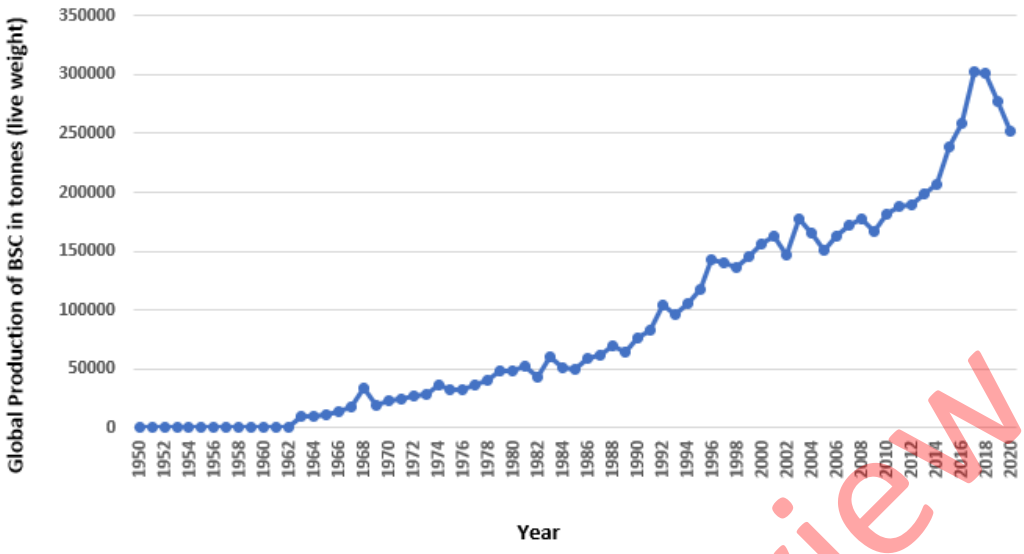

Figure 6: Global production of blue swimmer crab in tonnes (live weight). Taken from FAO 2022b.

Importance to the US/North American market.

The United States is the major export destination for pasteurized crabmeat, hence the US market drives global BSC demand (BFAR 2012). Imports of portunid crabs (species not identified) from Vietnam into the US have remained relatively steady until 2015, where there is a marked increase, after which imports have remained high (NMFS 2022b) (Figure 7). Vietnam is the fourth major supplier of portunid crab imports to the US, with Indonesia, the Philippines and China ranking in the three (Figure 8) (NMFS 2022). In 2021, 2342.57 tonnes of portunid crabs were imported into the U.S from Vietnam, with a value of about USD 49.4 million, which represents 9% of Portunid crabs by volume and 8% of Portunid crabs by value (NMFS 2022).

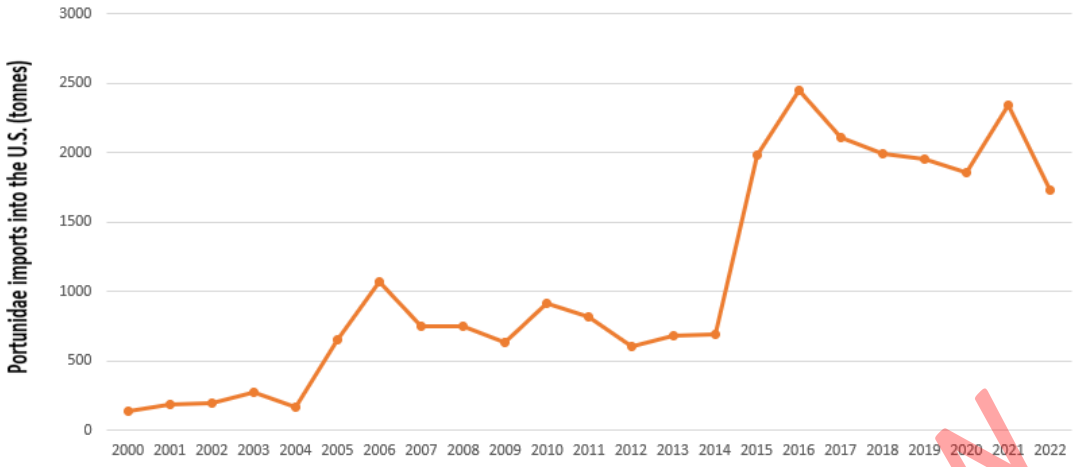

Figure 7: Portunidae (swimming crab) imports from Vietnam into the U.S. (in tonnes) from 2000-2022. Data taken from NMFS 2022b.

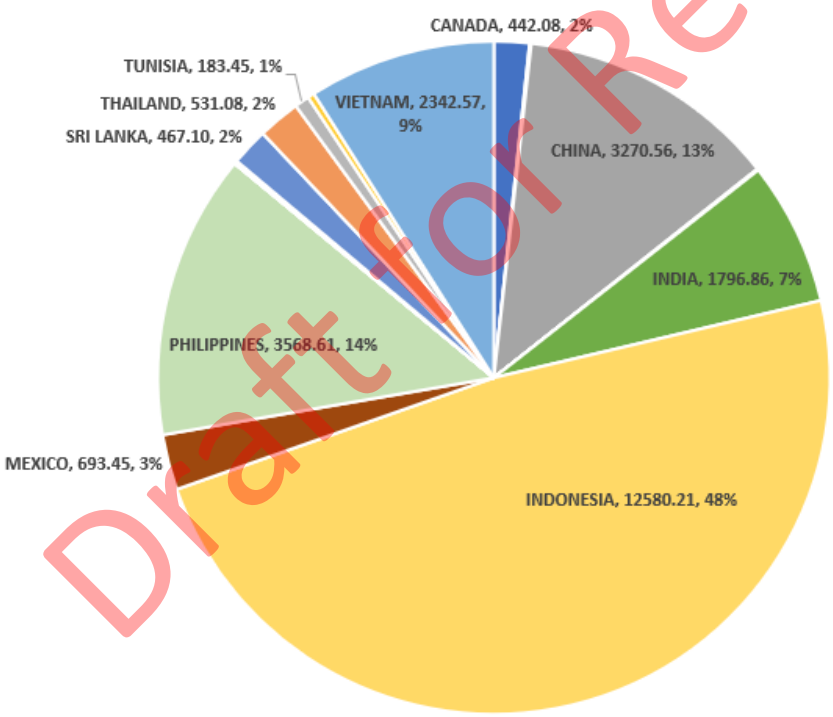

Figure 8: Portunid crab imports into the U.S. (by tonnes) in 2021 (data from NMFS 2022).

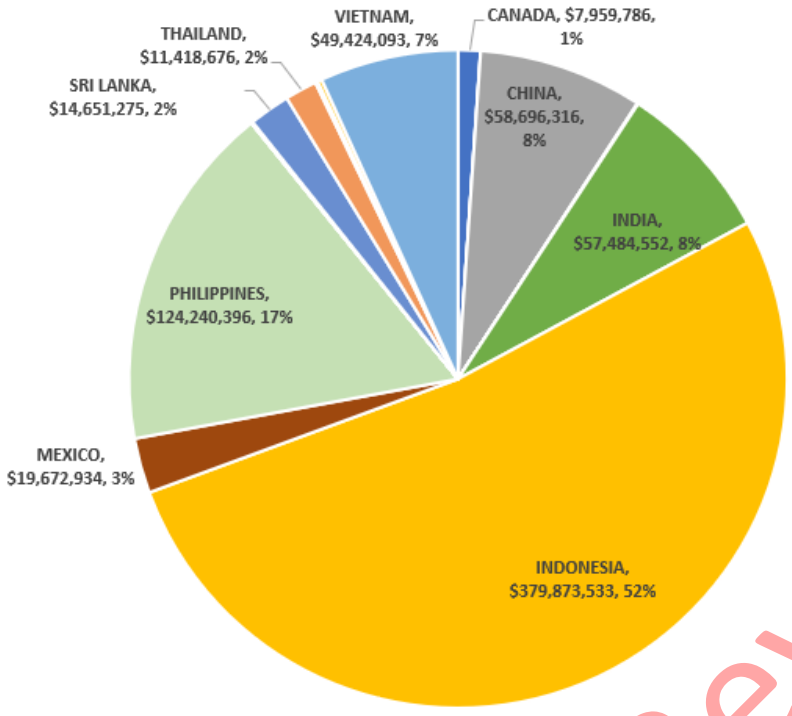

Figure 9: Portunid crab imports into the U.S. (by value) in 2021 (data from NMFS 2022).

Common and market names.

Blue swimming crab is also known as flower crab, blue crab, blue swimmer crab, blue manna crab, horse crab, sand crab, swimming crab (GWA DOF 2011) (FDA 2016) {Fishsource 2016}.

Primary product forms

Portunid crabs are sold interchangeably and these species can include RSC, BSC, and others, like *Portunis sanguinolentus* and *P. trituberculatus* (Lai et al. 2010) (Sea Fare Group 2011). BSC are exported by seafood companies as fresh, frozen and canned products. Fresh crab is either exported as "head on" or "cut crab" products. Cut crabs are processed by removing the top shell, guts and gills, and then brushed clean and cut into two sections. Canned crab is a pasteurized product that involves picking the meat from boiled crabs. Crab meat is graded according to type and size. Grades include colossal, jumbo, B jumbo, flower, lump, special, claw, B claw, and finger. Canned crab products include "fancy," "special," "jumbo lump," "back fin," "lump," "white," and "claw" (Creech 2013).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

BLUE SWIMMING CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam	1.000: High Concern	1.000: High Concern	Red (1.000)
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam	1.000: High Concern	1.000: High Concern	Red (1.000)
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam	1.000: High Concern	1.000: High Concern	Red (1.000)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*

- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Blue swimming crab

Factor 1.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

High Concern

The 2018 stock assessment from Kien Giang indicates that the biomass of BSC was 3.05 thousand tons, but no biological reference point has been specified in this document (Ha et al. 2018). Further, immature crabs comprised 46.39% of the catch (ibid), which shows that the fishery does not allow a high proportion of BSC to mature (and potentially spawn) before entering the fishery, indicating that the stock could be overfished. Because the stock is data-deficient, a Productivity-Susceptibility Analysis was calculated. The PSA score = 3.31 (detailed scoring of each PSA attribute is shown below). BSC is deemed to have high vulnerability based on the PSA scoring tool. In combination with an unknown stock abundance, BSC abundance in Vietnam is considered a "high" concern.

Justification:

RIMF, Kien Giang Provincial People Committee (PPC) issued Decision no. 23/2015/QĐ-UBND on 25 June 2015 on managing BSC fishing activities and fisheries resources protection {Ha et al. 2016}. In this Decision, the minimum mesh size of BSC gillnets was increased to 120 mm, normal traps to 50 mm, and Chinese traps to 43 mm. The stock assessment results show that the CPUE is gradually increased and the average size of crabs caught is bigger than those in 2013 and 2014 (ibid). BSC biomass in 2016 increased by 7.1% and 22.4% compared to 2015 and 2014, respectively. However, compared to 2013 the biomass in 2016 was still 9.1% lower (ibid).

Productivity-Susceptibility Analysis (if Applicable):

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)

Average age at maturity	Approx. 1 year (Josileen and Menon 2007) (Kangas 2000)	1
Average maximum age	Approx. 3 years (Josileen and Menon 2007) (Kangas 2000)	1
Fecundity	229,468 to 2,236,355 eggs/batch {Zairon et al. 2015}	1
Average maximum size (fish only)	-	-
Average size at maturity (fish only)	-	-
Reproductive strategy	Brooder	2
Trophic level	2.5 to 3.2 (first level carnivore; {de Lestang et al. 2000}	2
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.4**

* Precautionary Lowest Score given, as no information on the likelihood of depensatory or compensatory dynamics is currently available.

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	>30% overlap (Ha et al. 2015)	3
Vertical overlap (Considers all fisheries)	SFW default; high overlap w/fishing gear (target species; Ha et al. 2015)	3
Selectivity of fishery (Specific to fishery under assessment)	Species is targeted and juveniles are retained (Ha et al. 2015)	3
Post-capture mortality (Specific to fishery under assessment)	Retained species (Ha et al. 2015)	3

Total Susceptibility (multiplicative)		**3**

PSA score for BSC in Vietnamese gillnet and trap fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$?

V = $\sqrt{(1.62^2 + 3)^2}$?

V = 3.31

Factor 1.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

High Concern

Using a Beverton and Holt yield per recruitment model, $F_{current}$ = 1.0 and F_{MSY} = 0.8, therefore F/F_{MSY} > 1 (1.25), and fishing effort at the precautionary fisheries management ($F_{0.1}$) = 0.6 {Ha et al. 2015}. This indicates that the Kien Giang BSC stock was undergoing overfishing (at 20% MSY and $F_{0.1}$ 40%). A more recent update indicates that, E = 0.55 in 2017; however, no biological reference points have been specified (Ha et al. 2018). Taken together, fishing mortality is considered a "high concern".

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

BLUE SWIMMING CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam	1.000	1.000: < 100%	Red (1.000)
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam	1.732	1.000: < 100%	Red (1.732)
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam	1.732	1.000: < 100%	Red (1.732)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

GULF OF SIAM (GULF OF THAILAND) | PACIFIC, WESTERN CENTRAL | GILLNETS AND ENTANGLING NETS | VIETNAM			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Blue swimming crab	1.000: High Concern	1.000: High Concern	Red (1.000)
Brownbanded bambooshark	1.000: High Concern	1.000: High Concern	Red (1.000)
Red stingray	1.000: High Concern	1.000: High Concern	Red (1.000)
Sea turtles	1.000: High Concern	1.000: High Concern	Red (1.000)
Sharpnose stingray	1.000: High Concern	1.000: High Concern	Red (1.000)
Dugong	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Bigeye croaker	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Crucifix crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Noble volute	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Pharaoh cuttlefish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Scaly whipray	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Echinoderms	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)

GULF OF SIAM (GULF OF THAILAND) | PACIFIC, WESTERN CENTRAL | POTS | VIETNAM			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Blue swimming crab	1.000: High Concern	1.000: High Concern	Red (1.000)
Marine mammals	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Blunt-toothed crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Smoothshelled swimming crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

GULF OF SIAM (GULF OF THAILAND) | PACIFIC, WESTERN CENTRAL | TRAPS | VIETNAM			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Blue swimming crab	1.000: High Concern	1.000: High Concern	Red (1.000)
Marine mammals	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Blunt-toothed crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Goatee croaker	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Mantis shrimp	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Shortnose ponyfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Smoothshelled swimming crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Spineless cuttlefish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Tigertooth croaker	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Tropical sand goby	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

A number of species are caught as bycatch in the Vietnam BSC fisheries. In the 2014 stock assessment, Ha et al. observed a total of 102 species/species groups caught as incidental bycatch in both gillnets and traps (Ha et al. 2014). Among them, 87 species were caught by gillnet and 23 species were caught by traps. Common bycatch species in gillnets included: crab (*Charybdis feriatus**), the brownbanded bamboo shark (*Chiloscyllium punctatum*), sharpnose stingray (*Dasyatis zugei**), smooth fan lobster (*Ibacus novemdentatus*), noble volute snail (*Cymbiola nobilis**), bigeye croaker (*Pennahia anea**), largescaled terapon (*Terapon theraps*) and bartail goatfish (*Upeneus tragula;* ibid). Common bycatch species in traps included: smoothshelled swimming crab (*Charybdis affinis*), sand goby (*Acentrogobius caninus*), mantis shrimp (*Oratosquilla oratoria**) and green tiger prawn (*Penaeus semisulcatus*). From the data, it is not clear if these species (none of which are ETP species) consisted of 5% or more of the total catch, but species that were most commonly seen from the above list (with an asterisk) were included as a Criterion 2 species. The brownbanded bamboo shark (*Chiloscyllium punctatum*) is considered "Near Threatened" on the IUCN Red List (IUCN 2016), but is not listed on the Vietnamese red list. Due to its vulnerability, it has also been included as a Criterion 2 species.

BSC landings from gillnets (compared to bycatch ratios) ranged from 70.5% in February to 97.6% in December for small boats (<20 HP), and from 62.7% in May to 89.8% in January for larger boats (>20 HP); (Ha et al. 2014). BSC landings from normal traps ranged from 40.1% in May to 48.1% in October, and Chinese traps ranged from 16.8% in June to 65.7% in January for boats <20 HP. Chinese traps fished from boats >20 HP, varied from 16.9% in May to 43.7% in April (ibid).

In addition to the stock assessment program during 2014, the Research Institute for Marine Fisheries

(RIMF) implemented observer trips to assess catches of BSC and bycatch {Ha et al. 2015}. The observer data collected in 2014 identified bycatch for bottom-set gillnets, and crab traps, including normal traps and Chinese traps. All bycatch is retained, whether dead or alive (either for human consumption or for bait use) and catch rate of BSC (as the target species) varies depending on gear type, location, month/season, and weather (e.g., monsoons affect smaller boats that use traps instead of gillnets). Bycatch that consisted of 5% or more of the total catch was included as a Criterion 2 species (see table below).

Evidence from the stock assessment and the RIMF observer program suggests that there are no interactions with sea turtles and dugongs, but since these interactions need to be further observed in order to rule them out entirely, they have been included as ETP or Criterion 2 species.

For the gillnet fishery, brownbanded bamboo sharks, red stingrays, sharpness stingrays, and sea turtles limit the score for Criterion 2 due to their highly inherent vulnerability, as well as their conservation status. For the pot fishery, marine mammals limit the C2 score, and for the Chinese trap fishery, spineless cuttlefish limit the score for C2 due to their high concern for fishing mortality.

Gear	Scientific Name	Common Name	Near-threatened or ETP	Catch (%)	Month (2014)
Bottom-set gillnet	*Chilloscybium punctatum*	brownbanded bamboo shark	"Near Threatened" (IUCN 2016)	6.01	September
	Dasyatis akajei	red stingray	"Near Threatened" (IUCN 2016)	12.02	September
	Himantura imbricata	scaly whipray		34.59 6.01 23.95	June September December
	Oreasteridae	sea stars		13.03	June
	Sepia pharaonis	pharaoh cuttlefish		5.21	December
	Portunus pelagicus	BSC		31.93 71.19 57.10	June September December
Chinese trap	*Acentrogobius caninus*	tropical sand goby		7.12 11.55	June September
	Charybdis affinis	smoothshelled swimming crab		30.31 28.76	June December
	Charybdis truncata	blunt-toothed crab		6.54	June
	Dendrophysa russelii	goatee croaker		5.23 6.03	June September

	Leiognathus brevirostris	shortnose ponyfish		11.22 12.17	September December
	Ostolithes ruber	tigertooth croaker		10.23	September
	Sepia inermis	spineless cuttlefish		10.20	December
	Portunus pelagicus	BSC		26.84 14.67 7.20	June September December
Normal trap	*Charybdis affinis*	smooth-shelled swimming crab		61.51 58.72	June December
	Charybdis truncata	blunt-toothed crab		20.44 54.90	June September
	Portunus pelagicus	BSC		18.05 45.10 39.93	June September December

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Bigeye croaker

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

There is no stock assessment for the bigeye croaker (*Pennahia anea*) in Vietnam waters. Based on the SFW PSA score (2.12), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored bigeye croaker abundance as "moderate" concern.

Justification:

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	5 to 15 years (Froese and Pauly 2016)	2
Average maximum age	10 to 25 years	2
Fecundity	>20,000 eggs/year	1
Average maximum size (fish only)	<100 cm (Froese and Pauly 2016)	1
Average size at maturity (fish only)	<40 cm (Froese and Pauly 2016)	1
Reproductive strategy	Broadcast spawner (Tuuli et al. 2011)	1
Trophic level	4.0 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.57**

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	<10% overlap	1
Vertical overlap (Considers all fisheries)	Medium overlap w/fishing gear	2
Selectivity of fishery (Specific to fishery under assessment)	Can enter, but cannot easily escape from the trap, and is attracted to either the bait, or the habitat provided by the trap {Vu et al. 2015}	3
Post-capture mortality (Specific to fishery under assessment)	Retained species	3
Total Susceptibility (multiplicative)		**1.43**

PSA score for bigeye croaker in Vietnamese in gillnet fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

V = $\sqrt{(1.57^2 + 1.43)^2}$

V = 2.12

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on bigeye croaker is unknown and is therefore considered a "moderate" concern.

Blunt-toothed crab

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

There is no stock assessment for *Charybdis truncata* in Vietnam waters. Based on the SFW PSA score (2.71), the species is deemed medium vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of medium vulnerability, we have scored blunt-toothed crab abundance as "moderate" concern.

Justification:
Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<5 years {Ha et al. 2015}	1
Average maximum age	<10 years {Ha et al. 2015}	1
Fecundity	100 to 20,000 eggs/{Ha et al. 2015}	2
Average maximum size (fish only)	-	-
Average size at maturity (fish only)	-	-
Reproductive strategy	Brooder {Ha et al. 2015}	2
Trophic level	<2.75 {Ha et al. 2015}	1
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.4**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	10 to 30% overlap {Ha et al. 2015}	2
Vertical overlap (Considers all fisheries)	High overlap w/fishing gear {Ha et al. 2015}	3

Selectivity of fishery (Specific to fishery under assessment)	Traps: Can enter, but cannot easily escape (attracted either to the bait or the habitat provided by the trap; {Ha et al. 2015}	3
Post-capture mortality (Specific to fishery under assessment)	Traps: All are retained species {Ha et al. 2015}	3
Total Susceptibility (multiplicative)		**2.33**

PSA score for blunt-toothed crab in Vietnamese trap fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

V = $(1.4^2 + 2.33)^2$

V = 2.71

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern
The impact of the blue swimming crab fishery on blunt-toothed crab is unknown and is therefore considered a "moderate" concern.

Brownbanded bambooshark

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern
There is no stock assessment for the brownbanded bamboo shark (*Chiloscyllium punctatum*) in Vietnam waters, but the species is considered "Near Threatened" according to the IUCN Redlist (IUCN 2016). Sharks are also scored as "high" concern based on the SFW criteria.

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern

According to the SFW Unknown Bycatch Matrices, sharks receive a fishing mortality score of 2 out of 5, or "high" concern, for bottom-set gillnets in Southeast Asia.

Crucifix crab

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

There is no stock assessment for *Charybdis feriatus* in Vietnam waters. Based on the SFW PSA score (1.86), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored crucifix crab abundance as "moderate" concern.

Justification:

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	<5 years {Ha et al. 2015}	1
Average maximum age	<10 years {Ha et al. 2015}	1
Fecundity	>20,000 eggs/year	1
Average maximum size (fish only)	-	-
Average size at maturity (fish only)	-	-
Reproductive strategy	Brooder {Ha et al. 2015}	2
Trophic level	<2.75 {Ha et al. 2015}	1

Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.2**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	>30% overlap {Ha et al. 2015}	3
Vertical overlap (Considers all fisheries)	Medium overlap w/fishing gear {Ha et al. 2015}	2
Selectivity of fishery (Specific to fishery under assessment)	Gillnet: Length at maturity < mesh size, or 5 m in length {Ha et al. 2015}	1
Post-capture mortality (Specific to fishery under assessment)	Traps: All are retained species {Ha et al. 2015}	3
Total Susceptibility (multiplicative)		**1.43**

PSA score for crucifix crab in Vietnamese gillnet fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P2 + S)^2}$

V = $\sqrt{(1.22^2 + 1.43)^2}$

V = 1.86

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on crucifix crab is unknown and is therefore considered a "moderate" concern.

Dugong

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern
Dugongs are listed as "Vulnerable" (IUCN 2016), and are therefore scored as "high" concern using the SFW criteria.

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern
For bottom-set gillnet fisheries in Southeast Asia, marine mammals are scored 1 out of 5, or "high" concern for fishing mortality using the SFW Unknown Bycatch Matrix. The observer program suggests that there are no interactions with dugongs; however, observer coverage is limited and data is insufficient to fully discount their potential interaction. Therefore, we have scored this factor as "moderate" concern.

Echinoderms

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern
Based on the SFW Unknown Bycatch Matrices, sea stars (Oreasteridae) are scored as "moderate" concern.

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Low Concern
The impact of the gillnet fishery on benthic invertebrates as guided by the Unknown Bycatch Matrix is scored "low" concern.

Goatee croaker

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern
There is no stock assessment for the goatee croaker (*Dendrophysa russelii*) in Vietnam waters. Based on the SFW PSA score (2.02), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is

of low vulnerability, we have scored goatee croaker abundance as "moderate" concern.

Justification:
Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<5 years {Ha et al. 2015}	1
Average maximum age	10 to 25 years {Ha et al. 2015}	2
Fecundity	>20,000 eggs/year {Ha et al. 2015}	1
Average maximum size (fish only)	<100 cm {Ha et al. 2015}	1
Average size at maturity (fish only)	<40 cm (Froese and Pauly 2016)	1
Reproductive strategy	Broadcast spawner {Ha et al. 2015}	1
Trophic level	3.5 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.43**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	<10% overlap {Ha et al. 2015}	1
Vertical overlap (Considers all fisheries)	Medium overlap w/fishing gear {Ha et al. 2015}	2

Selectivity of fishery (Specific to fishery under assessment)	Can enter, but cannot easily escape from the trap, and is attracted to either the bait, or the habitat provided by the trap {Vu et al. 2015}	3
Post-capture mortality (Specific to fishery under assessment)	Retained species	3
Total Susceptibility (multiplicative)		**1.43**

PSA score for goatee croaker in Vietnamese in trap fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

V = $\sqrt{(1.43^2 + 1.43)^2}$

V = 2.02

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on the goatee croaker is unknown and is therefore considered a "moderate" concern.

Mantis shrimp

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

There is no stock assessment for mantis shrimp *(Oratosquilla oratoria*) in Vietnam waters. Based on the SFW PSA score (2.34), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored mantis shrimp abundance as "moderate" concern.

Justification:

Productivity-Susceptibility Analysis (if Applicable):

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<5 years {Ha et al. 2015}	1
Average maximum age	<10 years {Ha et al. 2015}	1
Fecundity	50,000 eggs/year (Froese and Pauly 2016)	1
Average maximum size (fish only)	-	-
Average size at maturity (fish only)	-	-
Reproductive strategy	Brooder (Froese and Pauly 2016)	2
Trophic level	2.8 to 3.45 (Froese and Pauly 2016)	2
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.4**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	10 to 30% overlap {Ha et al. 2015}	2
Vertical overlap (Considers all fisheries)	Medium overlap w/fishing gear {Ha et al. 2015}	2
Selectivity of fishery (Specific to fishery under assessment)	Traps: Can enter, but cannot easily escape, and is attracted either to the bait of the habitat provided by the trap {Ha et al. 2015}	3
Post-capture mortality (Specific to fishery under assessment)	All are retained {Ha et al. 2015}	3
Total Susceptibility (multiplicative)		**1.88**

PSA score for mantis shrimp in Vietnamese trap fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

V = $\sqrt{(1.4^2 + 1.88)^2}$

V = 2.34

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern
The impact of the blue swimming crab fishery on mantis shrimp is unknown; therefore, it is considered a "moderate" concern.

Marine mammals

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

High Concern
Marine mammals are considered highly vulnerable according to the SFW criteria; therefore an abundance score of "high" concern is given.

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern
It is unlikely that marine mammals such as dugong are retained. Marine mammal fishing mortality is scored as a "moderate" concern because there are no known interactions, but monitoring and observer coverage is limited creating uncertainty; there is insufficient evidence to support a "low" concern or to remove them from the assessment entirely.

Noble volute

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

There is no stock assessment of the noble volute (*Cymbiola nobilis*) from Vietnam waters. Based on the SFW PSA score (1.62), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored noble volute abundance as "moderate" concern.

Justification:

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<5 years {Ha et al. 2015}	1
Average maximum age	<10 years {Ha et al. 2015}	1
Fecundity	>20,000 eggs/year {Ha et al. 2015}	1
Average maximum size (fish only)	-	-
Average size at maturity (fish only)	-	-
Reproductive strategy	Broadcast spawner {Ha et al. 2015}	1
Trophic level	<2.75 {Ha et al. 2015}	1
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	<10% overlap (Dolawaththage 2015){Ha et al. 2015}	1
Vertical overlap (Considers all fisheries)	Medium overlap with fishing gear {Ha et al. 2015}	2

Selectivity of fishery (Specific to fishery under assessment)	Length at maturity is 1 to 2 times mesh size or 4 to 5 m in length {Ha et al. 2015}	2
Post-capture mortality (Specific to fishery under assessment)	Retained species or majority dead when released (Dolawaththage 2015) {Ha et al. 2015}	3
Total Susceptibility (multiplicative)		**1.28**

PSA score for noble volute in Vietnamese in gillnet fisheries is calculated as follows:

Vulnerability (V)= $\sqrt{(P^2 + S)^2}$

$V = \sqrt{(1^2 + 1.28)^2}$

V = 1.62

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on noble volute is unknown, and is therefore considered a "moderate" concern.

Pharaoh cuttlefish

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

There is no stock assessment of pharaoh cuttlefish (*Sepia pharaonis*) from Vietnam waters. Based on the SFW PSA score (1.84), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored pharaoh cuttlefish abundance as "moderate" concern.

Justification:

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish

only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P2 + S)2

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<5 years {Mehanna et al. 2014}	1
Average maximum age	<10 years {Mehanna et al. 2014}	1
Fecundity	100 to 20,000 eggs/year (Chembian and Mathew 2011)	2
Average maximum size (fish only)	-	-
Average size at maturity (fish only)	-	-
Reproductive strategy	Demersal egg layer (Chembian and Mathew 2011)	2
Trophic level	<2.75 (Dolawaththage 2015)	1
Density dependence (invertebrates only)	Depensatory dynamics at low population size (Allee effects) demonstrated or likely (Dolawaththage 2015)	3
Total Productivity (average)		**1.4**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	<10% overlap (Dolawaththage 2015)	1
Vertical overlap (Considers all fisheries)	Low overlap with fishing gear {Ha et al. 2015}	1
Selectivity of fishery (Specific to fishery under assessment)	Individuals < size at maturity are frequently caught (Dolawaththage 2015)	3
Post-capture mortality (Specific to fishery under assessment)	Retained species or majority dead when released (Dolawaththage 2015)	3
Total Susceptibility (multiplicative)		**1.2**

PSA score for pharaoh cuttlefish in Vietnamese in gillnet fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

$V = \sqrt{(1.4^2 + 1.2)^2}$

V = 1.84

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on pharoah cuttlefish is unknown, and is therefore considered a "moderate" concern.

Red stingray

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern

There is no stock assessment for the red stingray (*Dasyatis akajei*) in Vietnam waters, but the species is considered "Near Threatened" according to the IUCN Redlist (IUCN 2016). Due to the IUCN status, Red stingray abundance is scored "high" concern.

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern

Benthic vertebrates such as rays are not specifically included in the SFW Unknown Bycatch Matrices, but benthic invertebrates receive a fishing mortality score of 3 out of 5, and finfish are scored 2 for bottom-set gillnets. We have therefore scored the red stingray as 2 out of 5, or "high" concern.

Scaly whipray

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

There is no stock assessment for the scaly whipray (*Himantura imbricata*) in Vietnam waters. Based on the SFW PSA score (2.49), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored scaly whipray abundance as "moderate" concern.

Justification:
Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	5 to 15 years {Ha et al. 2015}	2
Average maximum age	10 to 25 years {Ha et al. 2015}	2
Fecundity	<100 eggs/year	3
Average maximum size (fish only)	<100 cm	1
Average size at maturity (fish only)	<40 cm	1
Reproductive strategy	Live bearer (ovoviviparous); (Froese and Pauly 2016)	3
Trophic level	3.5 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**2.14**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	<10% overlap {Ha et al. 2015}	1

Vertical overlap (Considers all fisheries)	Medium overlap w/fishing gear {Ha et al. 2015}	2
Selectivity of fishery (Specific to fishery under assessment)	Individuals < size at maturity are regularly caught {Ha et al. 2015}	2
Post-capture mortality (Specific to fishery under assessment)	Retained species {Ha et al. 2015}	3
Total Susceptibility (multiplicative)		**1.28**

PSA score for scaly whipray in Vietnamese in gillnet fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

V = $\sqrt{(2.14^2 + 1.28)^2}$

V = 2.49

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on the scaly whipray is unknown and is therefore considered a "moderate" concern.

Sea turtles

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern

Sea turtles are listed as endangered or threatened throughout the world (NOAA 2016), and are therefore scored as "high" concern using the SFW criteria.

Justification:

The BSC fishery in Vietnam takes place close to green and hawksbill turtle nesting sites {Fish Source 2016}. Hawksbill turtles are known to feed on BSC (Kailola et al. 1993) (Poseidon ARM Ltd. 2010), which suggests that there are some risks of entanglement.

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern

For bottom-set gillnet fisheries in Southeast Asia, sea turtles are scored a 1 out of 5, or "high" concern, for fishing mortality using the SFW Unknown Bycatch Matrix.

Sharpnose stingray

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern

There is no stock assessment for the sharpnose stingray (*Dasyatis zugei*) in Vietnam waters, but the species is considered "Near Threatened" according to the IUCN Redlist (IUCN 2016). Due to the IUCN status, sharpnose stingray abundance is scored as "high" concern.

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

High Concern

Benthic vertebrates such as rays are not specifically included in the SFW Unknown Bycatch Matrices, but benthic invertebrates receive a fishing mortality score of 3 out of 5, and finfish are scored a 2 for bottom-set gillnets. We have therefore scored the sharpnose stingray as a 2 out of 5, or "high" concern.

Shortnose ponyfish

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

There is no stock assessment of Shortnose ponyfish (*Leiognathus brevirostris*) from Vietnam waters. Based on the SFW PSA score (1.83), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored shortnose ponyfish abundance as "moderate" concern.

Justification:

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<5 years {Mehanna et al. 2014}	1
Average maximum age	<10 years {Mehanna et al. 2014}	1
Fecundity	>20,000 eggs/year (Froese and Pauly 2016)	1
Average maximum size (fish only)	<100 cm (Froese and Pauly 2016)	1
Average size at maturity (fish only)	<40 cm (Froese and Pauly 2016)	1
Reproductive strategy	Broadcast spawner (Froese and Pauly 2016)	1
Trophic level	3.0 (Froese and Pauly 2016)	2
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.14**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	<10% overlap {Ha et al. 2015}	1
Vertical overlap (Considers all fisheries)	Medium overlap with fishing gear {Ha et al. 2015}	2
Selectivity of fishery (Specific to fishery under assessment)	Individuals < size at maturity are frequently caught (Dolawaththage 2015)	3
Post-capture mortality (Specific to fishery under assessment)	Retained species	3
Total Susceptibility (multiplicative)		**1.43**

PSA score for shortnose ponyfish in Vietnamese in trap fisheries is calculated as follows:

Vulnerability (V) =

$V = \sqrt{(P^2 + S)^2}$

$V = \sqrt{(1.14^2 + 1.43)^2}$

V = 1.83

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on the shortnose ponyfish is unknown, and therefore considered a "moderate" concern.

Smoothshelled swimming crab

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

There is no stock assessment for *Charybdis affinis* in Vietnam waters. Based on the SFW PSA score (2.89), the species is deemed medium vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of medium vulnerability, we have scored smoothshelled crab abundance as "moderate" concern.

Justification:

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = $\sqrt{(P^2 + S)^2}$

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	<5 years {Ha et al. 2015}	1
Average maximum age	<10 years {Ha et al. 2015}	1
Fecundity	100 to 20,000 eggs/year {Ha et al. 2015}	2
Average maximum size (fish only)	-	-
Average size at maturity (fish only)	-	-
Reproductive strategy	Brooder {Ha et al. 2015}	2
Trophic level	<2.75 {Ha et al. 2015}	1
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.4**

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	>30% overlap {Ha et al. 2015}	3
Vertical overlap (Considers all fisheries)	Medium overlap w/fishing gear {Ha et al. 2015}	2
Selectivity of fishery (Specific to fishery under assessment)	Traps: Can enter, but cannot easily escape (attracted either to the bait or the habitat provided by the trap; {Ha et al. 2015}	3
Post-capture mortality (Specific to fishery under assessment)	Traps: All are retained species {Ha et al. 2015}	3
Total Susceptibility (multiplicative)		**2.33**

PSA score for smoothshelled swimming crab in Vietnamese trap fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

$V = (1.4^2 + 2.33)^2$

$V = 2.89$

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern
The impact of the blue swimming crab fishery on smoothshelled swimming crab is unknown, and is therefore considered a "moderate" concern.

Spineless cuttlefish

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern
There is no stock assessment of spineless cuttlefish (*Sepia inermis*) from Vietnam waters. Based on the SFW PSA score (1.75), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored spineless cuttlefish abundance as "moderate" concern.

Justification:
Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

*2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 * ??2 * ??3 * ??4) – 1/ 40] + 1 .*

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	1 to 1.5 years (FAO 2005)	1
Average maximum age	<2 years (FAO 2005)	1
Fecundity	500 eggs/year (FAO 2005)	2
Average maximum size (fish only)	-	-
Average size at maturity (fish only)	-	-

Reproductive strategy	Demersal egg layer (FAO 2005)	2
Trophic level	<2.75 (Dolawaththage 2015)	1
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.4**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	<10% overlap {Ha et al. 2015}	1
Vertical overlap (Considers all fisheries)	Low overlap with fishing gear {Ha et al. 2015}	1
Selectivity of fishery (Specific to fishery under assessment)	Individuals < size at maturity are rarely caught {Ha et al. 2015}	1
Post-capture mortality (Specific to fishery under assessment)	Retained species {Ha et al. 2015}	3
Total Susceptibility (multiplicative)		**1.05**

PSA score for spineless cuttlefish in Vietnamese in trap fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

$V = \sqrt{(1.4^2 + 1.05)^2}$

V = 1.75

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on spineless cuttlefish is unknown, and is therefore considered a "moderate" concern.

Tigertooth croaker

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

There is no stock assessment for the tigertooth croaker (*Ostolithes ruber*) in Vietnam waters. Based on the SFW PSA score (2.02), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored tigertooth croaker abundance as "moderate" concern.

Justification:

Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<5 years {Ha et al. 2015}	1
Average maximum age	10 to 25 years {Ha et al. 2015}	2
Fecundity	>20,000 eggs/year (Froese and Pauly 2016)	1
Average maximum size (fish only)	<100 cm {Ha et al. 2015}	1
Average size at maturity (fish only)	<40 cm (Froese and Pauly 2016)	1
Reproductive strategy	Broadcast spawner {Ha et al. 2015}	1
Trophic level	3.6 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.43**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**

Areal overlap (Considers all fisheries)	<10% overlap {Ha et al. 2015}	1
Vertical overlap (Considers all fisheries)	Medium overlap w/fishing gear {Ha et al. 2015}	2
Selectivity of fishery (Specific to fishery under assessment)	Can enter, but cannot easily escape from the trap, and is attracted to either the bait, or the habitat provided by the trap {Vu et al. 2015}	3
Post-capture mortality (Specific to fishery under assessment)	Retained species	3
Total Susceptibility (multiplicative)		**1.43**

PSA score for tigertooth croaker in Vietnamese in trap fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

$V = (1.43^2 + 1.43)^2$

V = 2.02

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on tigertooth croaker is unknown, and is therefore considered a "moderate" concern.

Tropical sand goby

Factor 2.1 - Abundance

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

There is no stock assessment of tropical sand goby (*Acentrogobius caninus*) from Vietnam waters. Based on the SFW PSA score (2.02), the species is deemed low vulnerability. Detailed scoring of each attribute is shown below. Due to the lack of a stock assessment, and the fact that this species is of low vulnerability, we have scored tropical sand goby abundance as "moderate" concern.

Justification:
Productivity-Susceptibility Analysis:

Scoring Guidelines

1.) Productivity score (P) = average of the productivity attribute scores (p1, p2, p3, p4 (finfish only), p5 (finfish only), p6, p7, and p8 (invertebrates only))

2.) Susceptibility score (S) = product of the susceptibility attribute scores (s1, s2, s3, s4), rescaled as follows: ?? = [(??1 ∗ ??2 ∗ ??3 ∗ ??4) − 1/ 40] + 1 .

3.) Vulnerability score (V) = the Euclidean distance of P and S using the following formula: ?? = √(P² + S)²

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<5 years {Mehanna et al. 2014}	1
Average maximum age	<10 years {Mehanna et al. 2014}	1
Fecundity	100 to 20,000 eggs/year (Froese and Pauly 2016)	2
Average maximum size (fish only)	<100 cm (Froese and Pauly 2016)	1
Average size at maturity (fish only)	<40 cm (Froese and Pauly 2016)	1
Reproductive strategy	Demersal egg layer {Ha et al. 2015}	2
Trophic level	3.5 (Froese and Pauly 2016)	3
Density dependence (invertebrates only)	-	-
Total Productivity (average)		**1.57**

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	<10% overlap {Ha et al. 2015}	1
Vertical overlap (Considers all fisheries)	Medium overlap with fishing gear {Ha et al. 2015}	2
Selectivity of fishery (Specific to fishery under assessment)	Can enter and easily escape from the trap, but is attracted to the trap (e.g., does eat the bait, or trap is attractive as habitat {Ha et al. 2015}	2

Post-capture mortality (Specific to fishery under assessment)	Retained species	3
Total Susceptibility (multiplicative)		**1.28**

PSA score for tropical sand goby in Vietnamese in trap fisheries is calculated as follows:

Vulnerability (V) = $\sqrt{(P^2 + S)^2}$

V = $\sqrt{(1.57^2 + 1.28)^2}$

V = 2.02

Factor 2.2 - Fishing Mortality

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

The impact of the blue swimming crab fishery on tropical sand goby is unknown and is therefore considered a "moderate" concern.

Factor 2.3 - Discard Rate/Landings

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam

< 100%

All bycatch species in bottom-set gillnet fisheries are retained, dead or alive. Therefore, a modifying factor of 1 is used.

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam

< 100%

All bycatch species in crab traps are retained, dead or alive. There is not much information regarding bait use; however, in general, small amounts of fish pieces are thought to be used, so we have chosen a modifying factor of 1.

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

< 100%

All bycatch species in crab traps are retained, dead or alive. There is not much information regarding bait use; however, in general, small amounts of fish pieces are thought to be used, so we have chosen a modifying factor of 1.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam	Ineffective	Ineffective	Ineffective	N/A	N/A	**Red (1.000)**
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam	Ineffective	Ineffective	Ineffective	N/A	N/A	**Red (1.000)**
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam	Ineffective	Ineffective	Ineffective	N/A	N/A	**Red (1.000)**

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Ineffective

DARD, supported by the Provincial People's Committee, the crab processors and exporters, the fishers, the research institute, RIMF, as well as WWF, have developed a FMP, or CMP (Crab Management Plan), for the Kien Giang BSC fishery {Poseidon 2015b}. The Crab Advisory Council (CAC), which is comprised of all associated stakeholders, coordinates research (supported by RIMF) and provides advice to DARD (ibid).

Included in the CMP are regulations (Harvest Control Tools) such as: closed fishing seasons, closed fishing areas, a minimum landing size (MLS; 10cm CW), and minimum mesh sizes for gillnets and traps (nets 120 mm, traps 50 mm, Chinese traps 43 mm). Stock assessments will be carried out every 2 to 3 years and include preliminary limit and target reference points currently based on fishing mortality (however, it will be based on percentage of unexploited biomass in the long-term); further work to address uncertainties, standard errors, and information on bycatch are peer reviewed by a senior international crab stock assessment consultant {Poseidon 2015a} {Poseidon 2015b}.

In response to the stock officially being declared overfished and undergoing overfishing, the Harvest Control Strategy at present is to rebuild the stock to 50% B_{MSY}, which will require a reduction in fishing effort by at least 20% (Poseidon 2015a). Implementation of the Harvest Control Tools will be supported through an educational program to fishers and an outreach to middlemen/collectors (ibid). The CMP also suggests a limitation on entry licensing. Preliminary efforts have been made to restrict further expansion in the vessel sector <30HP in order to preserve the sensitive coastal habitat, which is fished by this sub-sector. However, it is possible that the harvest strategy will require further reduction in capacity, and mechanisms need to be evaluated on how to implement these {Poseidon 2015b}.

National policy is seeking to promote a community co-management structure between government and the community fishers in order to share the responsibility and authority for BSC management {Poseidon 2015a} {Poseidon 2015b}. The idea behind this is partially due to underlying weaknesses in enforcement of the regulations. Preliminary analysis from RIMF shows that the existing management measures (the minimum landing size and the closed season) are not being applied systematically (ibid). DARD has started to implement the commitment on a 10 cm CW limit by checking crabs at sea, as well as the minimum mesh size regulations, but these regulations are newer and have not been in place long enough to be evaluated (ibid).

Because there are concerns regarding implementation of the management plan stemming from poor compliance and enforcement, we have rated this factor "ineffective."

Factor 3.2 - Bycatch Strategy

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Ineffective

There are general BSC regulations that indirectly apply to bycatch (such as mesh size specifications and closed seasons/areas), but at this time, there are no bycatch-specific management measures in place for the Vietnam BSC fishery. Most incidental bycatch species are of a "low" to "moderate" conservation concern, but bycatch species that are considered "Vulnerable" or "Near Threatened" according to the IUCN Red List (IUCN 2022), and require management measures to be in place, are the brownbanded bamboo shark (*Chiloscyllium punctatum)*, the sharpnose stingray (*Dasyatis zugei*), scaly whipray (*Brevitrygon imbricata*), dwarf whipray (*Brevitrygon walga*), and thorny seahorse (*Hippocampus histrix*) (Ha et al. 2018). Poseidon (2015a) states that once these species are added to the Vietnamese Red List of protected species, catches will be continually monitored.

Ghost fishing has not yet been quantified. In addition, it is unclear as to whether sea turtles and dugongs, which are ETP species, are commonly caught as bycatch in the gillnet fishery.

Due to the above, this factor is scored "ineffective."

Factor 3.3 - Scientific Research And Monitoring

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Ineffective

No recent stock assessments and bycatch data have been published since 2018. There also appears to be no monitoring in place to ensure that the stock is maintained at a healthy level. For these reasons, data collection and monitoring are rated as "ineffective".

Factor 3.4 - Enforcement Of Management Regulations

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

N/A

No prior entry.

Factor 3.5 - Stakeholder Inclusion

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

N/A
No prior entry.

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam	Score: 3	Score: 0	Moderate Concern	**Yellow (3.000)**

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*

- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but*

detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.

- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Impact of Fishing Gear on the Habitat/Substrate

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Score: 3

Most BSC fishing for crab pots/traps and bottom-set gillnets is reported to be across sandy and muddy substrates, as mature crabs are most commonly found in these habitats (Ha et al. 2014). According to the SFW criteria, pots/traps and bottom-set gillnets fished over sand/mud (not on rocky reef/boulder and corals) are scored 3 out of 5.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Score: 0

There are no gear-specific modifications to reduce impacts to the seafloor, however there are a number of closed areas/seasons in the BSC fishery, which serve to decrease the impact of BSC fishing gear on the ecosystem. Because it is unlikely that seasonal closures result in a better quality habitat, we have scored this factor as "no effective mitigation."

Factor 4.3 - Ecosystem-based Fisheries Management

Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Gillnets and entangling nets | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Pots | Vietnam
Gulf of Siam (Gulf of Thailand) | Pacific, Western Central | Traps | Vietnam

Moderate Concern

BSC are often considered opportunistic, bottom-feeding carnivores and scavengers. They primarily consume various sessile and slow-moving prey such as, worms, mollusks, and crustaceans (Batoy et al. 1987), as well smaller fish, but not much is known about the role of BSC as prey in Vietnam waters. In Australia, BSC are prey to turtles, sharks, rays, large fish, birds and other BSC (GWA DOF 2011). Intense fishing pressure on BSC could alter the trophic structure and species composition by reducing predation on crab prey, and/or by reducing food for higher-level predators.

Although the CMP promotes the ecosystem-based approach to fisheries management, the full extent of the BSC fishery's impacts on the ecosystem is also not well known. Effects of the fishery on the ecosystem are thought to include ghost fishing, and traps without escape vents and biodegradable

panels (which could allow small incidental species and juvenile crabs to escape). In addition, it is unclear whether ETP species such as sea turtles and dugongs are commonly caught in the gillnet fishery.

The Vietnam BSC CMP policies are in place to protect ecosystem functioning and account for capture species' ecological roles, but have not yet proven to be effective. Because the full extent of the Vietnam BSC fishery's impact on the ecosystem is unknown, we have deemed this factor "moderate" concern.

Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch would like to thank the consulting researcher and author of this report, Rachel Simon, as well as several anonymous reviewers for graciously reviewing this report for scientific accuracy.

References

Batoy, C., J. Sarmago, B. Pilapil. 1987. Breeding Season, Sexual Maturity and Fecundity of the Blue Crab, Portunus pelagicus (L.) in selected coastal waters in Leyte and vicinity, Philippines. Annals of Tropical Research, 9,157-177.

BFAR (Bureau of Fisheries and Aquatic Resources, Department of Aquaculture). 2012. The Philippine Blue Swimming Crab Management Plan. 31pp. Available at: http://www.bfar.da.gov.ph/new/announcement_archive/1Final%20Approved%20Version%20BSCMP%20January%2024%202013.pdf.

Chembian, J.A., S. Mathew. 2011. Migration and Spawning Behavior of the Pharaoh Cuttlefish, Sepia pahraonis Ehrenberg, 1831 Along the South-west Coast of India. Indian Journal of Fisheries Biology 58:3, 1-8.

complete.

Creech, S. 2013. Final Report: Sri Lanka Blue Swimming Crab Fishery Assessment. Submitted to Seafood Exporters" Association of Sri Lanka. Revised on May 28, 2014. 81 pp.

Creech, S., J. Bandara, D.de Silva. 2016. Project Proposal: An assessment of the ecological impact (habitats & ecosystem) of the blue swimming crab (Portunus pelagicus) fishery in the Palk Bay (Bay of Bengal), Sri Lanka. Sri Lankan Blue Swimming Crab Fishery Improvement Project. 11pp.

Dolawaththage, D.D.W. 2015. Assessing The Ecological Impact of the Portunus pelagicus Fishery in Pesalai (Mannar District). Undergraduate thesis in the Department of Animal Science, Uva Wellassa University. 79pp.

FAO. 2005. Sepiella inermis. FAO Species Catalogue for Fishery Purposes 4:1. Available at: ftp://ftp.fao.org/docrep/fao/009/a0150e/a0150e16.pdf.

FAO. 2016a. Species Fact Sheet: Portunus pelagicus. Available at: http://www.fao.org/fishery/species/2629/en.

Food and Agricultural Organization. 2022. Fisheries and Aquaculture: *Portunus pelagicus* (Linnaeus, 1758).

Food and Agriculture Organization 2022. FishStatJ v4.02.07. Accessed from: https://www.fao.org/fishery/en/statistics/software/fishstatj/en

Froese, R., D. Pauly. 2016. Editors of Fishbase. World Wide Web electronic publication. Available at: www.fishbase.org, version (01/2016).

Germano, B. P., J.L.F. Melgo, J.C. Evangelio. 2006. Population, Reproduction and Fishery Biology of the Blue Crab Portunus pelagicus (Linnaeus 1758) in Eastern Visayas. Terminal Report, Volume 3. AFMA – Invertebrate Project of Leyte State University (LSU) and the Department of Agriculture – Bureau of Agriculture Research (DA-BAR). 116 pp.

GWA DOF (Government of Western Australia, Department of Fisheries). 2011. Fisheries Fact Sheet: Blue Swimmer Crab. Available at: http://www.fish.wa.gov.au/Documents/recreational_fishing/fact_sheets/fact_sheet_blue_swimmer.pdf.

Ha, V. V. T. U. Nhan, T. V. Cuong and N. S. Doan. 2018. Stock and fishery assessment report of blue swimming crab *Portunus pelagicus* (Linnaaeus, 1758) in Kien Giang, Viet Nam in 2017.

Ha. V.V., T.H. Nhan, T.V. Cuong, N.S. Doan. 2014. Stock And Fishery Assessment Report Of Blue Swimming Crab Portunus pelagicus (Linnaeus, 1758) in Kien Giang Waters, Viet Nam. DMFR. January. 52pp.

Ingles, J.A. 1996. The crab fishery off Bantayan, Cebu, Philippines. Report submitted to the Philippine Council for Marine and Aquatic Resources Research and Development. Institute of Marine Fisheries and Oceanology, University of the Philippines- Visayas, Iloiio, Philippines. 34pp.

International Union for Conservation of Nature. 2022. The IUCN Red List of Threatened Species. Version 2022-1. Available at: www.iucnredlist.org. Downloaded on 20 October 2022.

IUCN. 2016. The IUCN Red List of Threatened Species. Version 2015-4. Available at: www.iucnredlist.org. Downloaded on 13 June 2016.

Josileen J., N. G. Menon. 2007. Fishery and Growth Parameters of the Blue Swimmer Crab Portunus pelagicus (Linnaeus, 1758) along the Mandapam Coast, India. Journal Marine Biological Association of India 49:2, 159-165.

Kailola P. J., Williams M. J., Stewart P. C., Reichelt R. E., McNee A. and Grieve C. 1993. Australian Fisheries Resources. Bureau of Resource Sciences and Fisheries Research and Development Corporation, Canberra.

Kangas, M. I. 2000. Synopsis of the Biology and Exploitation of the Blue Swimmer Crab, Portunus pelagicus Linnaeus, in Western Australia. Fisheries Research Report 121, 1-22.

Lai, J. C. Y, P. K. L Ng, and P. J. F Davie. 2010. A revision of the Portunus pelagicus (Linnaeus, 1758) species complex (Crustacea: Brachyura: Portunidae), with the recognition of four species. The Raffles Bulletin of Zoology 58:2, 199-237.

National Marine Fisheries Service. 2022. US foreign trade data. Accessed from: https://www.fisheries.noaa.gov/foss/f?p=215:2:30851511883444::NO:::

National Marine Fisheries Service. 2022b. US foreign trade data: Portunid imports from Vietnam into the U.S. Accessed from: https://www.fisheries.noaa.gov/foss/f?p=215:2:30851511883444::NO:::

NFICC (National Fisheries Institute Crab Council). 2016. Projects for Blue Swimming Crabs; Philippines. Available at: http://www.committedtocrab.org/projects/phillippine-blue-swimming-crab-fishery-improvement-project/.

NOAA (National Oceanic and Atmospheric Administration). 2016. Sea Turtles. Available at: http://www.nmfs.noaa.gov/pr/species/turtles/.

Poseidon ARM Ltd. 2010. Blue swimming Crab Scoping for Fishery Improvement Project: Kien Giang Province, Vietnam. Final Report. Richard Banks, Poseidon Aquatic Resource Management Ltd. 22 April.

Poseidon ARM Ltd. 2015b. Blue Swimming Crab (Portunus pelagicus) Fishery Management Plan: Kien Giang Province, Vietnam. Final Report. Richard Banks, Poseidon Aquatic Resource Management Ltd. November. 35pp.

Sea Fare Group. 2011. Quantification and Market Analysis of the Top 30 Seafood Species/Categories Consumed in the U.S. Prepared by Sea Fare Group for Monterey Aquarium Seafood Watch®, March 15, 2011.

Tuuli, C.D., Y. Sadovy de Mitcheson, M. Liu. 2011. Reproductive Biology of the Griffin Croaker Pennahia anea in the Northern South China Sea. Ichthyological Research 58, 302–309.

Appendix A: Review Schedule

Appendix B: 2023 update summary

Updates to the blue swimming crab report:

Updates to the December 19th, 2018 blue swimming crab report were made on March 24th, 2022. The report was updated in v3 of the Seafood Watch Fisheries Standard. **Overall recommendations for the blue swimming crab gillnet, pot and trap fisheries in Vietnam are still "Avoid"**. Additional updates, if any, are described below:

Criterion 1

Blue swimming crab remained "red" for Criterion 1; although an updated stock assessment was conducted in 2018, no biological reference points were specified, hence a PSA was used for abundance (Factor 1.1) and the factor remained "high concern". Fishing mortality (Factor 1.2) also remained at "high concern", indicating that overfishing is occurring.

Criterion 2

Although recent catch composition data were available, the new information has not been incorporated into the text of this assessment as it does not change the rating of Criterion 2, which remains "red".

Criterion 3

There was no improvement in the overall Criterion 3 score, which remained "red"; however new information and an "ineffective" rating was added to research and monitoring (Factor 3.3).

Rating Review summary table:

Report: Blue swimming crab (Vietnam)		
Criteria	**Previous report (2018)**	**Current report (2022)**
Who conducted the stock assessment? And when was it conducted?	Department of Marine Fisheries Resources Research & Research Institute for Marine Fisheries; Ha et al. 2015.	Department of Marine Fisheries Resources Research & Research Institute for Marine Fisheries; Ha et al. 2015, Ha et al. 2018.
Where/ what are the catch composition data source(s)?	Ha et al. 2015	Ha et al. 2018
Who manages the fishery?	Department of Agriculture and Rural Development (DARD), the Crab Advisory Council (CAC)	DARD and CAC.
What is the date of the published management plan?	2015	2015
Are there any updates or amendments?	The detailed Crab Management Plan was outlined in Poseidon 2015b	No