Monterey Bay Aquarium Seafood Watch

Environmental sustainability assessment of wild-caught red swimming crab from China caught using bottom trawls and pots

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Species:	Red swimming crab *(Monomia haanii)*
Location:	China
Gear:	Bottom trawls, Pots
Type:	Wild Caught
Author:	Seafood Watch
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Assessed using Seafood Watch Fisheries Standard v3

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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 ratings for red swimming crab (*Monomia haanii*), which is a medium-bodied, benthic crustacean caught by bottom trawls and pots/cages. The fishery occurs in the East China Sea and the South China Sea.

There is no current formal stock assessment of red swimming crab in China that is available for use. Information is limited on stock abundance, as well as on red swimming crab life history characteristics in general. But, there are clear indications that >10% of crabs harvested were undersized, which could indicate that the stock is overfished. In addition, a red swimming crab assessment that was conducted over 10 years ago indicated the potential overfishing likelihood for red swimming crab.

The Chinese red swimming crab fishery is a multispecies fishery that targets not only red swimming crab but also a variety of species, such as round sardinella (*Sardinella aurita*), Pacific chub mackerel (*Scomber japonicus*), striped bonito (*Sarda orientalis*), common Chinese/mitre squid (*Loligo chinensis*), neon flying squid (*Ommastrephes bartramii*), and rigid swimming crab (*Charybdis natator*). These species have been included in Criterion 2 (rigid swimming crab as "true crabs" and round sardinella as "herrings") because they represent >5% of the total catch. Other species of high conservation concern that are likely to interact with this fishery and are included as bycatch are coral and other biogenic habitats, mammals, rays, turtles, and sharks. Sharks, rays, mitre squid, and chub mackerel limit the Criterion 2 score for the bottom trawl fishery, and marine mammals limit the score for the pot fishery.

There is no specific fishery management plan for red swimming crab, so there are no reference points or species-specific harvest strategies. The only effective management tool is the summer fishing moratorium, which is a 3-month closure every summer for most fisheries, and fishers believe it could be made more effective. Because there is no management strategy, management is considered ineffective.

It is not apparent whether exceptional species are caught in the Chinese red swimming crab trap fishery; in contrast, several species that play an important role in ecosystem functioning are caught in the red swimming crab trawl fishery. But, there are no efforts as of yet to fully assess the ecological impacts of the fishery. For these reasons, management of the ecosystem and food web impacts of the fishery is deemed a moderate concern for the trap fishery and a high concern for the trawl fishery. Overall, the Chinese red swimming crab bottom trawl and pot fisheries 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
Red swimming crab | Northwest Pacific | Bottom trawls | China	1.732	1.000	1.000	2.000	**Avoid (1.364)**	Unknown
Red swimming crab | Northwest Pacific | Pots | China	1.732	1.732	1.000	3.000	**Avoid (1.732)**	Unknown

Summary

Red swimming crab (*Monomia hanaii*) is a medium-bodied, benthic crustacean common throughout the Indo-Pacific. This report covers red swimming crab caught by crab pots and bottom trawls in the East and South China Sea (mainly in the southern portion of the Taiwan Strait, in the northern South China Sea). The **Red** rating for red swimming crab is driven by high conservation concerns over the stock status (in addition to a paucity of stock status information), the impacts on other species, the management of the fishery's impacts on crab populations, and for the trawl fishery, the impact on habitat.

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 ratings for red swimming crab (*Monomia haanii*; formerly known as *Portunus haanii*), which is a medium-bodied, benthic crustacean caught by bottom trawls and pots/cages. The fishery occurs in the East China Sea and the South China Sea, but takes place mainly in the southern portion of the Taiwan Strait, in the northern South China Sea.

Species Overview

Red swimming crab is a brachyuran crab that belongs to the Portunidae family. Crabs from this family are usually recognized by their flat, disc-shaped hind legs, which are used as paddles for swimming, and by the nine spikes (aka horns) along their carapace, on either side of their eyes (GWA DOF 2011). Red swimming crab is common throughout the Indo-Pacific in inshore and continental shelf habitats, including sand, mud, algae, and seagrass near reefs and mangrove areas, and is found in the intertidal zone to depths of 70 m {Ingles 1988}{Germano et al. 2006}. In China, red swimming crab is distributed throughout the coastal waters in the East China Sea, the South China Sea, and the Yellow Sea (SFCNM 2017). Like blue swimming crab, red swimming crab matures quickly (about 1 year), has a short lifespan (about 3 years), and is a partial brooder (Kangas 2000)(Josileen and Menon 2007) (pers. comm., F. Chen August 17, 2017). Red swimming crab has a relatively long spawning period; it is estimated to be as long as 11 months. In China, red swimming crab spawns in February to April and in October, formulating two peak spawning seasons, as previously published in Zhang 1997 (Zhang 1997) and found by the Xiamen University research team (pers. comm., QMCS 2023). But, because surveys have not been conducted during the summer fishing moratorium (from May to mid-August), it is unknown if there is another spawning peak during this time (pers. comm., QMCS 2023). The red swimming crab fishery usually harvests crab throughout the year, except during the summer fishing moratorium; the catch is dominated by zero and 1-year old individuals; and the catch volume from August to December is high (pers. comm., QMCS 2023). For this fishery, there are currently approximately 1,000 vessels using bottom trawls and 80 vessels using pots/cages; bottom trawls account for 60% of the red swimming crab catch (Chen and Wang 2016).

Management

There is no unified worldwide body that manages fisheries for red swimming crab and blue swimming crab. Instead, each country has its individual management system. Red swimming crab in China is managed by the central government and is based on regulations and legislation, such as restricted zones and a licensing system (i.e., a license to fish), which is passed from the central government to the states to follow (Yu and Yu 2008){Hangzhou 2015}. But, China is starting to strengthen its management efforts, and in 2018, Fujian Province implemented a red swimming crab total allowable catch (TAC) pilot project (https://www.moa.gov.cn/xw/zwdt/201807/t20180731_6155032.htm) (pers. comm., QMCS 2023).

FIP

A fishery improvement project (FIP) was initiated in 2016 by the National Fisheries Institute Crab Council (NFICC) and Ocean Outcomes, a nonprofit organization dedicated to improving global high-risk fisheries. The FIP was officially started in 2018 (fisheryprogress.org 2023) and the target area for the Chinese red swimming crab fishery is the Taiwan–Minnan Bank (fishing ground) and the Zhangzhou Municipality (fishing and processing hub), which produces 7,300 tons, or 64%, of red swimming crab in China (Figure 1) (Chen and Wang 2016). The FIP is a multistage, 10-year, step-wise effort (Chen and Wang 2016). To

date, the FIP has completed the pre-assessment, supply chain scoping and preparation work, identification and development stages, and is currently at step four of the FIP (pers. comm., F. Chen August 17, 2017).

Figure 1: Source fishery for the FIP. From (Chen and Wang 2016).

Production Statistics

The total annual crab landings in China in 2015 were over 60,000 tons (t), with red swimming crab accounting for 70% and three-spotted swimming crab (*Portunus sanguinolentus*) accounting for 15% (Chen and Wang 2016). Although there are no recently available production statistics of red swimming crab from China, experts from Xiamen University estimated through port-based surveys that the total annual capture volume of red swimming crab in 2019 from Donshan County (one of the main red swimming crab fishing regions) was 20,592 t (pers. comm., QMCS 2022).

Importance to the US/North American market.

The United States is the major export destination for pasteurized crabmeat; hence, the U.S. market drives the global swimming crab demand {BFAR 2012}. Imports of Portunid crabs (species not identified) from China into the United States have been variable from 2000 to 2020; in 2015 and 2018, there were marked increases in imports, after which they declined (Figure 2). China is currently the third major supplier of Portunid crab imports to the United States, with Indonesia and the Philippines ranking first and second, respectively (Figure 3).

In 2021, 3,270.56 t of Portunid crabs (species unspecified) with a value of about USD58 million were

imported into the United States from China; this amount represents 13% of Portunid crabs by volume and 8% by value (Figures 3 and 4) (NMFS 2022)(NMFS 2022b).

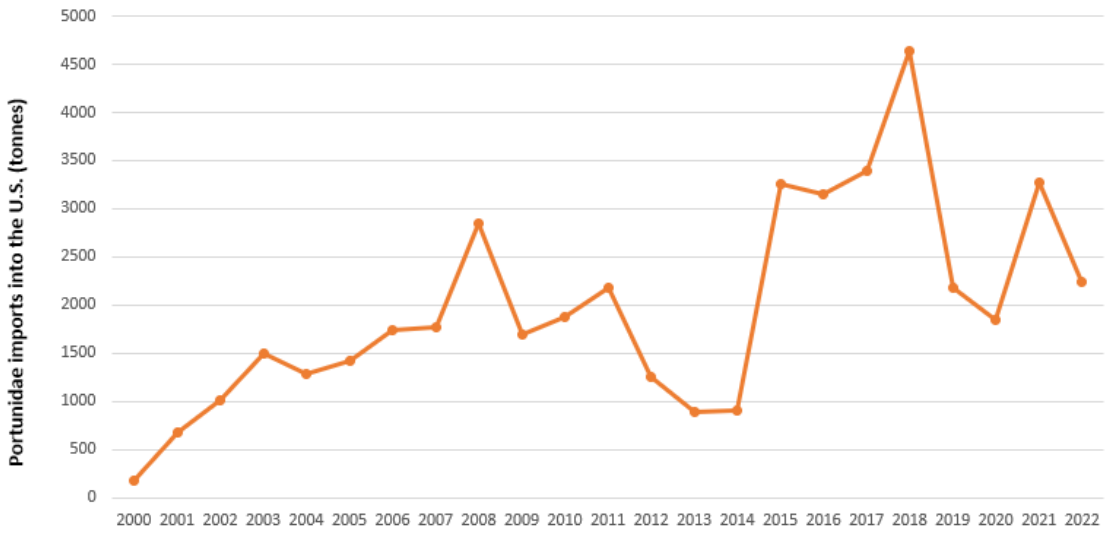

Figure 2: Portunidae (swimming crab) imports from China into the United States by weight (tonnes) from 2000 to 2022. Data from (NMFS 2022b).

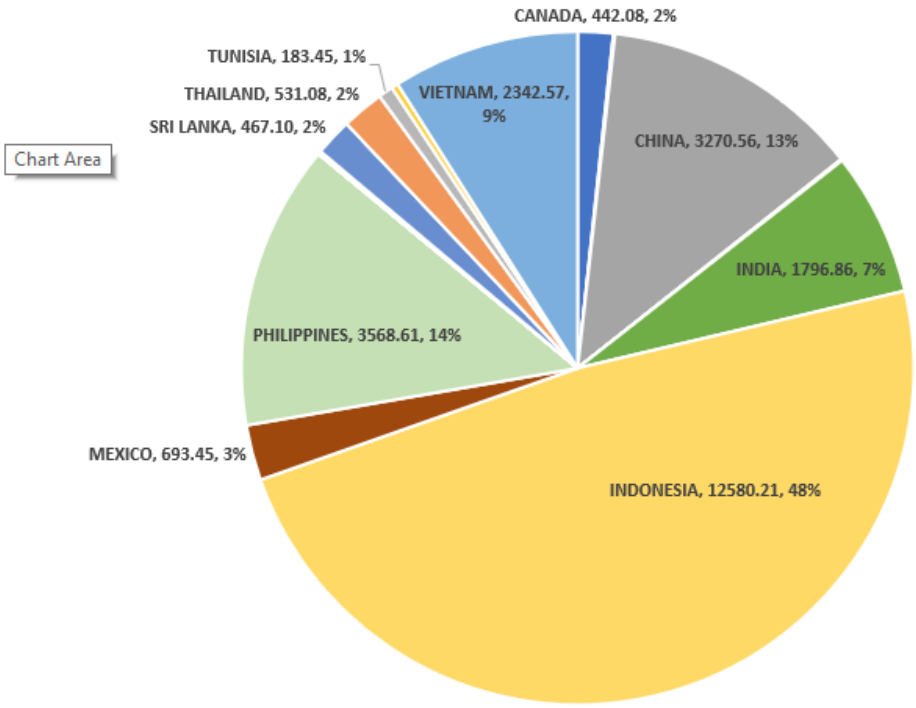

Figure 3: Portunid crab imports into the United States by weight (tonnes) in 2021. Data from (NMFS 2022).

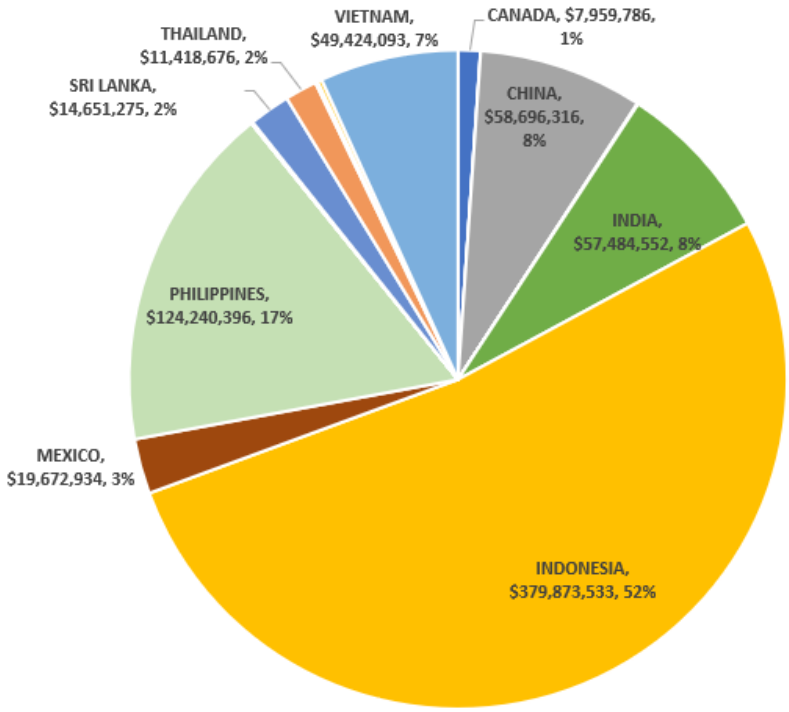

Figure 4: Portunid crab imports into the United States by value (USD) in 2021. Data from (NMFS 2022).

Common and market names.

Red swimming crab was formerly also known as warty swimming crab (FDA 2016). In Chinese, red swimming crab is called Yong Jian Suo Zi Xie (pers. comm., F. Chen April 18, 2018).

Primary product forms

Portunid crabs are sold interchangeably, and these species can include red swimming crab, blue swimming crab, and others, such as *Portunis sanguinolentus* and *P. trituberculatus* (Lai et al. 2010)(Sea Fare Group 2011). Swimming crab is exported by seafood companies as fresh, frozen, and canned products. Fresh crab is either exported as "head on" or "cut crab" products. Cut crab is processed by removing the top shell, guts, and gills, then brushed clean and cut into two sections. Canned crab is a pasteurized product that involves picking the meat from boiled crabs. Crabmeat 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 the designations 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

RED SWIMMING CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwest Pacific | Bottom trawls | China	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Northwest Pacific | Pots | China	1.000: High Concern	3.000: Moderate Concern	Red (1.732)

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.*

Red swimming crab

Factor 1.1 - Abundance

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

High Concern

There is limited information about Chinese red swimming crab stock abundance, as well as its life-history characteristics in general. A recent study that sampled Chinese red swimming crab from trawls in Dongshan County found that more than 10% of the crabs sampled were undersized and below the size at 50% sexual maturity (Figure 5) (Liu et al. 2022), which is an indicator that the stock is likely overfished. Further, a productivity-susceptibility analysis (PSA) was used that was based on blue swimming crab life-history characteristics (which are similar to those of red swimming crab), per the Seafood Watch criteria. The PSA score = 3.23, or high vulnerability. The detailed scoring of each attribute is shown in the Justification. Abundance is unknown, red swimming crab is highly vulnerable, and the proportion of juvenile crabs in the catch >10%, so this factor is scored a high concern.

Justification:

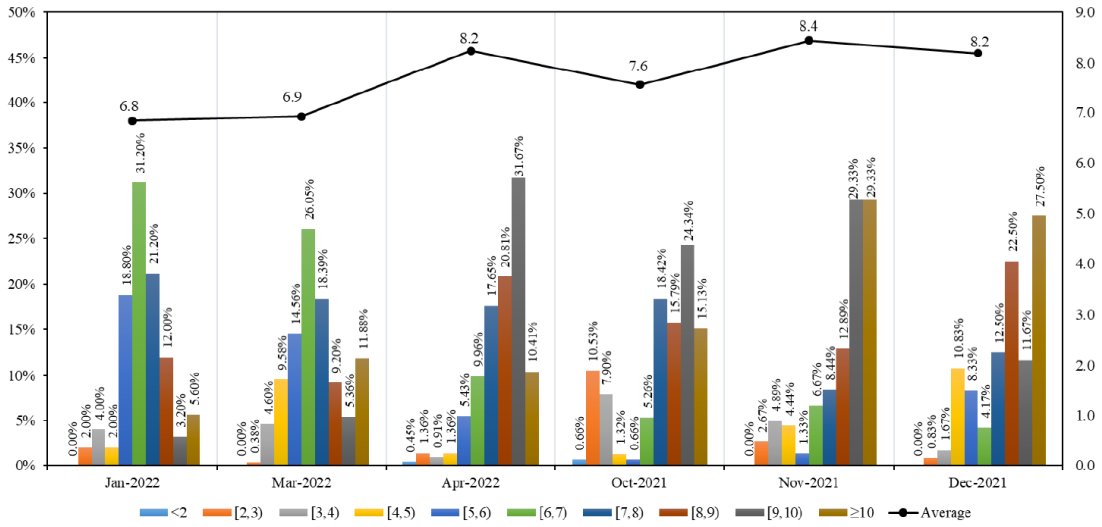

Figure 5: Proportions of different size classes of red swimming crab and monthly average sizes (cm) in the trawl fishery in Dongshan County from October 2021 to April 2022. Taken from (Liu et al. 2022).

There are clear indications that crabs of processable size in the catch have been in decline, as acknowledged by both processors and fishers (Chen and Wang 2016).

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: $S = (s1 \times s2 \times s3 \times s4 - 1) \div 40 + 1$

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

Productivity Attribute	**Relevant Information**	**Reference(s)**	**Score (1 = low, 2 = medium, 3 = high)**
Average age at maturity	<5 years (likely ≈1 year)	(Josileen and Menon 2007) (Kangas 2000)	1
Average maximum age	<10 years (likely ≈3 years)	(Josileen and Menon 2007) (Kangas 2000)	1
Fecundity	>20,000 eggs/batch	{Zairon et al. 2015}	1
Average maximum size (fish only)	—		—
Average size at maturity (fish only)	—		—
Reproductive strategy	Brooder	(Froese and Pauly 2017)	2
Trophic level	2.38	Reference in Chinese (from Fenjie Chen)	1
Density dependence (invertebrates only)	Unknown, therefore not scored		—
Total Productivity (average)			**1.2***

*Estimates roughly based on blue swimming crab life-history characteristics, because no life-history characteristics are available for red swimming crab (besides trophic level).

Susceptibility Attribute	**Relevant Information**	**Reference(s)**	**Score (1 = low, 2 = medium, 3 = high)**
Areal overlap (considers all fisheries)	>30% overlap	SFW default	3
Vertical overlap (considers all fisheries)	High overlap w/fishing gear (target species)	SFW default	3
Selectivity of fishery (specific to fishery under assessment)	Targeted species; net mesh size allows retention of individuals below size at maturation	(pers. comm., F. Chen August 31, 2017)	3
Post-capture mortality (specific to fishery under assessment)	Retained species	(Chen and Wang 2016)	3
Total Susceptibility (multiplicative)			**3**

The PSA score for red swimming crab in Chinese bottom trawl and pot/cage fisheries is calculated as follows:

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

$V = \sqrt{(1.2^2 + 3^2)}$

$V = 3.23$

Factor 1.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Moderate Concern
Information is quite limited for Chinese red swimming crab: there is a lack of historic and current stock status information, as well as a lack of information on the impact of fishing mortality on stocks. Therefore, fishing mortality is unknown and is scored a moderate concern.

Justification:
A red swimming crab assessment conducted over 10 years ago (documents confidential) indicated the potential overfishing likelihood for this species; it suggested protecting the spawning shoal and avoiding the capture of the concentrated foraging group as solutions for better resource utilization (pers. comm., F. Chen August 17, 2017). More recently, efforts have been made to conduct a stock assessment for Chinese red swimming crab; however, the results are not yet available for use.

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.

RED SWIMMING CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwest Pacific | Bottom trawls | China	1.000	1.000: < 100%	Red (1.000)
Northwest Pacific | Pots | China	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.

NORTHWEST PACIFIC | BOTTOM TRAWLS | CHINA			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Mitre squid	1.000: High Concern	1.000: High Concern	Red (1.000)
Finfish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Marine mammals	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Rays	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Red swimming crab	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Sea turtles	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Seahorses	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Sharks	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Spear shrimp	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Benthic invertebrates	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

NORTHWEST PACIFIC | POTS | CHINA			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Finfish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Marine mammals	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Red swimming crab	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Seahorses	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Benthic invertebrates	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Catch composition data for 3 years (2020–22) for the trawl fishery were analyzed, and for 2 years for the trap fishery (2020–21) (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022). In addition, the Seafood Watch Unknown Bycatch Matrix (SFW UBM) was used to assess the impact of the trawl and the pot fisheries on bycatch species such as marine mammals (which are typically not recorded in the catch) because evidence is lacking that they are not affected by the fisheries. Based on the catch composition data and the SFW UBM, for the trawl fishery, sharks, rays, finfish, seahorses, sea turtles, marine mammals, mitre squid (*Uroteuthis chinensis*), and spear shrimp *(Mierspenaeopsis hardwickii*; formerly known as *Parapenaeopsis cultrirostris*) were added as Criterion 2 species or species groups, because they are of high concern. Similarly, based on the catch composition data and the SFW UBM, for the pot fishery, finfish, seahorses, and marine mammals were added as Criterion 2 species groups, because they included species of high concern. For both the trawl and the pot fisheries, benthic invertebrates were added as a Criterion 2 species group, even though they did not include species of high concern, because catch composition data did not include the proportions of catch, and both trawls and pots could potentially catch high proportions of benthic invertebrates. Corals were not included in this bycatch assessment, because a recent study showed that red swimming crab fishing grounds (for both trawls and pots) did not overlap with the Dongshan Coral Nature Reserve (Figure 6; reproduced by QMCS, from (Huang et al. 1999)). Further, the distribution of corals is in shallow nearshore regions, where trawls cannot operate (pers. comm., QMCS 2023).

For the trawl fishery, mitre squid limits the Criterion 2 score because the species is overfished and is undergoing high fishing pressure. For the pot fishery, finfish and seahorses limit the Criterion 2 score as a result of their status as listed by the International Union for the Conservation of Nature (IUCN) and/or their overfished status, and marine mammals limit the score because of their inherent vulnerability.

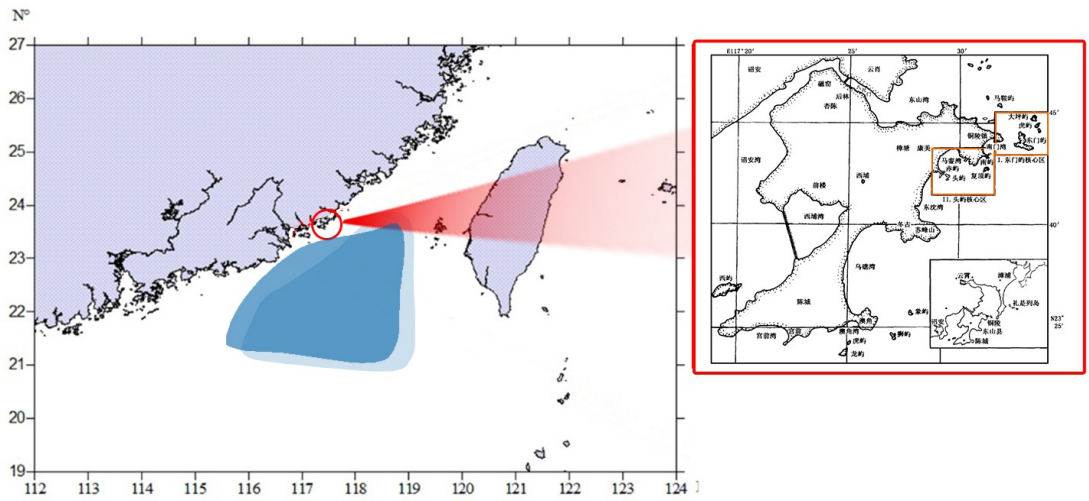

Figure 6: Overlap between the Dongshan Coral Reserve (red circle) and the fishing areas used by red swimming crab trawl fishers (deep blue region) and pot fishers (light blue region), showing no overlap with the coral reserve. Reproduced by QMCS, from (Huang et al. 1999).

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

Benthic invertebrates

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China

Moderate Concern

Although several species of invertebrates, including *Penaeus* species, *Portunid* species, and *Charybdis* species, were found in the red swimming crab trawl catch composition data published in 2020, 2021, and 2022 (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022), most of these species were not assessed by the IUCN or were designated as "Data Deficient," and no stock assessments were conducted on them. But, two species of octopus, *Amphioctopus aegina* and *Hapalochlaena lunulata*, were listed as "Least Concern" by the IUCN (Allcock et al. 2018)(Allcock et al. 2018b). Hence, a score of moderate concern has been assigned to abundance of benthic invertebrates caught in trawl nets.

Northwest Pacific | Pots | China

Moderate Concern

Although several species of invertebrates, including *Panulirus* species, *Portunid* species, *Calappa* species, and *Charybdis* species, were found in the red swimming crab pot fishery catch composition data published in 2020 and 2021 (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022), most of these species were either not assessed by the IUCN or were designated as "Data Deficient," and no stock assessments were conducted on them. But, one species of octopus, *Amphioctopus aegina*, is listed as "Least Concern" by the IUCN (Allcock et al. 2018). Therefore, a score of moderate concern has been assigned to abundance of benthic invertebrates caught in pots.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Moderate Concern

Because the fishing mortalities of benthic invertebrates in trawl nets and pots of the red swimming crab fishery are unknown, this factor has been scored a moderate concern.

Finfish

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China

High Concern

Catch composition data from 2020, 2021, and 2022 that were analyzed indicate that several finfish species that are globally listed by the IUCN as "Near Threatened" (NT), "Endangered" (EN), or "Critically Endangered" (CR) and/or species that are overfished were present in the catch (Table 1)

(Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022). Hence, abundance of finfish caught in trawls has been scored a high concern.

Justification:

Table 1: Finfish species in trawl fishery catch composition data, 2020 to 2022, IUCN status, and local fishery status.

Scientific Name of Species	Year in which Data Were Taken (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022)	Global IUCN Status (IUCN 2023)	Local Status of the Fishery
Epinephelus akaara	2020, 2021	EN	
Epinephelus bruneus	2020, 2021	VU	
Trachurus japonicus	2020, 2021, 2022	NT	Overfished {Hou et al. 2021}
Nemipterus virgatus	2021	VU	
Acanthopagrus schelegeli	2022	LC	Severely overfished (Ju et al. 2020b)(Kuo et al. 2023)
Pennahia argentata	2022	LC	Collapsed (Ju et al. 2020b)
Evynnis cardinalis	2020, 2021, 2022	EN	
Argyrosomus japonicus	2020, 2021	EN	
Scomberomorus commerson	2020, 2021, 2022	NT	Collapsed (Ju et al. 2020b)(Kuo et al. 2023)
Scomberomorus niphonius	2022	DD	Overfished (Ju et al. 2020b)(Wang et al. 2022)
Mene maculata	2020, 2021	Not assessed	Overfished (Ju et al. 2020b)(Kuo et al. 2023)
Psenopsis anomala	2020, 2021, 2022	LC	Collapsed (Ju et al. 2020b)
Larimichthys crocea	2022	CR	
Parastromateus niger	2020, 2022	LC	Collapsed (Ju et al. 2020b)
Pampus argenteus	2020, 2022	NE	Collapsed (Ju et al. 2020b)(Kuo et al. 2023)
Ilisha elongata	2022	LC	Overfished (Wang et al. 2022)
Engraulis japonicus	2021	LC	Overfished
Priacanthus macracanthus	2020, 2022	LC	Overfished (Kuo et al. 2023)
Decapterus maruadsi	2021	LC	Slightly overfished (Wang et al. 2022)
Scomber japonicus	2020	LC	Slightly overfished (Wang et al. 2022)
Polydactylus sextarius	2020, 2022	NE	Collapsed (Wang et al. 2020)
Johnius trewavasae	2022	LC	Overfished (Zhang et al. 2020)
Pennahia anea	2020, 2022	LC	Overfished {Hou et al. 2021}
Siganus fuscescens	2022	LC	Grossly overfished {Hou et al. 2021}
Engraulis japonicus	2020	LC	Overfished (Wang et al. 2022)
Amblychaeturichthys hexanema	2020	Not assessed	Overfished (Wang et al. 2020)
Trichiurus japonicus	2020	LC	Overfished {Hou et al. 2021}

Northwest Pacific | Pots | China

High Concern

Catch composition data analyzed from 2020 and 2021 indicate that several finfish species that are globally listed by the IUCN as "Near Threatened" (NT) or "Endangered" (EN), and/or species that are overfished, were present in the catch (Table 2) (Liu and Lin 2020)(Liu and Lin 2021). Thus, abundance of finfish caught in pots has been scored a high concern.

Justification:

Table 2: Finfish species in pots fishery catch composition data, 2020 to 2021, IUCN status, and local fishery status.

Scientific Name of Species	Year in which Data Were Taken (Liu and Lin 2020)(Liu and Lin 2021)	Global IUCN Status (IUCN 2023)	Local Status of the Fishery
Epinephelus akaara	2020, 2021	EN	
Trachurus japonicus	2020, 2021	NT	Overfished {Hou et al. 2021}
Evynnis cardinalis	2020, 2021	EN	Overfished (Liang et al. 2020)
Muraenesox cinereus	2020, 2021	LC	Overfished (Liang et al. 2020)
Scomber japonicus	2020	LC	Overfished (Wang et al. 2022)
Priacanthus macracanthus	2020	LC	Overfished (Liang et al. 2020)
Siganus fuscescens	2020	LC	Overfished {Hou et al. 2021}
Nemipterus japonicus	2020	LC	Overfished {Hou et al. 2021}

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China

Moderate Concern

Because the fishing mortality of finfish in trawls is unknown, this factor has been scored a moderate concern.

Northwest Pacific | Pots | China

Moderate Concern

Because the fishing mortality of finfish in pots is unknown, this factor has been scored a moderate concern.

Marine mammals

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

High Concern

Per the Seafood Watch criteria, unknown bycatch species such as marine mammals are considered highly vulnerable; therefore, an abundance score of high concern is given.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Moderate Concern
It is unlikely that marine mammals such as dugong are retained. Dugong populations are not found in proximity to red swimming crab fishing areas (rather, dugong are found onshore, near Guangxi). In addition, there are no known reports of dugong bycatch historically in the red swimming crab fishery (pers. comm., F. Chen November 28, 2017). The Chinese white dolphin (*Sousa chinensis*) is a nationally protected species living in the area where red swimming crab is fished. The IUCN lists this species as "Vulnerable," with a decreasing population trend (Jefferson et al. 2017). Dolphin bycatch has not been reported in the red swimming crab fishery, and fishers believe that the Chinese white dolphin does not appear in the Minnan fishing ground (pers. comm., QMCS 2023). Nevertheless, the impact on this species is unknown {pers. comm., F. Chen April 18, 2018}. Marine mammal fishing mortality is scored a moderate concern, because there is insufficient evidence to support a score of low concern or to remove them from the report entirely.

Mitre squid

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China

High Concern
Common Chinese/mitre squid (*Uroteuthis chinensis*) is targeted in the red swimming crab fishery (pers. comm., F. Chen September 9, 2017) (Liu and Lin 2021)(Liu et al. 2022). An FIP for common Chinese/mitre squid was initiated in November 2013, and a stock pre-assessment was conducted from March to June 2013 by the Sustainable Fisheries Partnership (SFP) (SFP 2013). Overall annual landings were stable until 2003; however, other research has shown that there has been body size miniaturization since the mid-1990s, in addition to smaller mantle lengths in sexually mature females (SFP 2013). A more recent study using length-based Bayesian biomass estimation tools also indicates that the stock of mitre squid has been overfished since the 1980s, and B/B_{MSY} in 2018–19 was 0.12 (Wang et al. 2021). As a result, abundance is scored a high concern.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China

High Concern
Fishing mortality for common Chinese squid is unknown, but a pre-assessment of the stock indicates that it is likely undergoing overfishing (SFP 2013). A recent study indicates that the stock is under high fishing pressure, and F/M in 2018–19 was 3.22 (Wang et al. 2021). Hence, this factor has been scored a high concern.

Rays

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China

High Concern

Per catch composition data published in 2020, 2021, and 2022, several species of rays were caught in trawl nets (Table 3) (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022). The species caught were listed as "Near Threatened" (NT), "Vulnerable" (VU), "Endangered" (EN) and/or "Critically Endangered" (CR) by the IUCN (IUCN 2023). Therefore, abundance has been scored a high concern.

Justification:

Table 3: Ray species in trawl fishery catch composition data, 2020 to 2022, and IUCN status.

Scientific Name of Species	Year in which Data Were Taken (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022)	Global IUCN Status (IUCN 2023)
Narcine lingula	2020, 2021, 2022	VU
Narcine maculata	2021, 2022	VU
Rhynchobatus djiddensis	2021	CR
Rhynchobatus australiae	2020, 2021, 2022	CR
Rhynchobatus immaculatus	2020, 2022	CR
Rhinobatos schlegelii	2021	CR
Rhinobatos hynnicephalus	2020, 2021, 2022	EN
Okamejei boesemani	2020, 2021, 2022	VU
Platyrhina sinensis	2020, 2021, 2022	EN
Platyrhina tangi	2022	VU
Urolophus aurantiacus	2020, 2021	VU
Dasyatis akajei	2020, 2021, 2022	NT
Dasyatis zugei	2020, 2021	VU
Taeniura meyeni	2020, 2021, 2022	VU
Himantura uarnak	2021	EN
Maculabatis macrura	2021	EN
Gymnura japonica	2020, 2021	VU
Aetobatus flagellum	2020, 2021	EN
Aetobatus narinari	2020, 2021	EN

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China

Moderate Concern

Because the fishing mortality of rays in trawl nets is unknown, this factor has been scored a moderate concern.

Sea turtles

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China

High Concern

Sea turtles are listed as endangered or threatened throughout the world (NOAA 2016), and are therefore of high conservation concern. In particular, olive ridley turtle was found in trawl catch composition data from 2021 (Liu and Lin 2021); this species is listed as globally "Vulnerable" by the IUCN (Abreu-Grobois and Plotkin 2008) and as "Threatened" under the U.S. Endangered Species Act (NOAA Fisheries 2022). Thus, abundance has been scored a high concern.

Justification:

Five of the seven worldwide sea turtle species are found in the blue swimming crab and red swimming crab fishing regions (SOWT 2016). A review by Wallace et al. (Wallace et al. 2010) found that sea turtles are caught as bycatch in longlines, gillnets, and trawls in the blue swimming crab fishing regions. It is unknown how many sea turtles are actually caught as bycatch in the gillnet and trawl blue swimming crab and red swimming crab fisheries, but their vulnerability and the potential for them to be caught includes them in this analysis.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China

Moderate Concern

Because the fishing mortality of olive ridley turtle in trawl nets is unknown, this factor has been scored a moderate concern.

Seahorses

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China

High Concern

Following catch composition data published in 2020, 2021 and 2022, several species of seahorses were caught in trawl nets (Table 4) (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022). The species caught were listed as "Vulnerable" (VU) by the IUCN (IUCN 2023). Hence, abundance has been scored a high concern.

Justification:

Table 4: Seahorse species in trawl fishery catch composition data, 2020 to 2022, and IUCN status.

Scientific Name of Species	Year in which Data Were Taken (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022)	Global IUCN Status (IUCN 2023)
Hippocampus histrix	2021	VU
Hippocampus kuda	2020, 2021	VU
Hippocampus trimaculatus	2020, 2021, 2022	VU
Hippocampus kelloggi	2020, 2021	VU

Northwest Pacific | Pots | China

High Concern

Following catch composition data published in 2020 and 2021, two species of seahorses were caught in pots: *Hippocampus histrix* and *Hippocampus trimaculatus* (Liu and Lin 2020)(Liu and Lin 2021). Both of these species are listed as "Vulnerable" by the IUCN (Pollom 2017)(Wiswedel 2015). Thus, abundance has been scored a high concern.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Moderate Concern

Because the fishing mortalities of seahorses in trawl nets and pots are unknown, this factor has been scored a moderate concern.

Sharks

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China

High Concern

Per catch composition data published in 2020, 2021, and 2022, several species of sharks were caught in trawl nets (Table 5) (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022). The species caught were listed as "Near Threatened" (NT), "Vulnerable" (VU), "Endangered" (EN) or "Critically Endangered" (CR) by the IUCN (IUCN 2023). As a result, abundance has been scored a high concern.

Justification:

Scientific Name of Species	Year in which Data Were Taken (Liu and Lin 2020)(Liu and Lin 2021)(Liu et al. 2022)	Global IUCN Status (IUCN 2023)
Carcharodon carcharias	2020, 2021	VU
Scoliodon macrorhynchos	2020, 2021, 2022	NT
Carcharhinus sorrah	2021	NT
Galeocerdo cuvier	2020, 2021	NT
Sphyrna lewini	2020, 2021, 2022	CR
Cephaloscyllium umbratile	2020, 2021, 2022	NT
Halaelurus buergeri	2020, 2021	EN
Mustelus griseus	2020, 2021	EN

Carcharhinus melanopterus	2022	VU

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China

Moderate Concern

Because the fishing mortality of sharks in trawl nets is unknown, this factor has been scored a moderate concern.

Spear shrimp

Factor 2.1 - Abundance

Northwest Pacific | Bottom trawls | China

High Concern

Spear shrimp (*Mierspenaeopsis hardwickii*; formerly known as *Parapenaeopsis cultrirostris*) is overfished according to a study with data from 2017 and 2018, where B/B_0 was 0.10 and B/B_{MSY} was 0.26 (Zhang et al. 2020). Therefore, abundance has been scored a high concern.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Bottom trawls | China

Moderate Concern

Because the fishing mortality of spear shrimp caught in the trawl fishery is unknown, this factor has been scored a moderate concern.

Factor 2.3 - Discard Rate/Landings

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

< 100%

There is typically no discarding in Chinese fisheries, because virtually everything valuable is retained (Chen and Wang 2016). Therefore, the ratio of discards/total catch is zero, and a multiplying factor of 1 is used.

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
Northwest Pacific | Bottom trawls | China	Ineffective	Ineffective	Ineffective	Ineffective	Moderately Effective	**Red (1.000)**
Northwest Pacific | Pots | China	Ineffective	Ineffective	Ineffective	Ineffective	Moderately Effective	**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

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Ineffective

Although broad national conventions for managing fisheries to ensure long-term viability exist, and there is an administrative structure, portunid crab fisheries are not appropriately regulated (Chen and Wang 2016). The red swimming crab fishery is subject to general fishery management including mesh size regulation, fishing permits, fishing zone regulations, seasonal fishing bans, and Fujian provincial regulations, such as minimum catchable size and marine protected areas (MPA) (pers. comm., F. Chen August 17, 2017).

There is no official stock assessment of red swimming crab in China and no management reference points. Harvest strategies, particularly species-specific harvest control rules, are generally lacking. The only effective management tool is the summer fishing moratorium, which is a 3-month closure every summer for most fisheries, but some leading crab processors believe that this closure can be made more effective if it can be extended, to allow most crabs to reach maturity/commercially valuable size (pers. comm., F. Chen August 17, 2017). Preliminary studies conducted by the College of Ocean and Earth Sciences of Xiamen University indicate that, when compared with data from 1993 to 1995, red swimming crab is significantly declining, and the main spawning season, which runs from February to April, does not coincide with the moratorium period (CAPPMA and QMCS 2021). In Fujian Province, per the Regulation on Minimum Allowable Catch Size and the Proportion of Juvenile Fish of 35 Economically Valuable Species in Fujian (enacted in 2018), the minimum landing size (MLS) of red swimming crab is 80 cm (GFP 2018)(pers. comm., QMCS 2023). The Regulation also stipulates that, in the years 2018, 2019, and 2020, the weight of juveniles of the 35 mentioned species (which include red swimming crab) must not exceed 50%, 30%, and 20%, respectively, of the total weight of the species in a single trip, and after 2020, the weight of juveniles must not exceed 20% of the total weight of the species (pers. comm., QMCS 2023). But, the proportion of individuals caught below the MLS in trawl gear is significant (CAPPMA and QMCS 2021).

Following the release of a letter by the General Office of the Ministry of Agriculture and Rural Affairs in 2017 on the need to implement total allowable catch (TAC) pilots within the marine fisheries sector, by 2020, there were 15 TAC pilot projects introduced in China, including a swimming crab TAC pilot project in Fujian Province (NRDC, EDF and QMCS 2021). Upon reviewing the project, and identifying gaps in the swimming crab fisheries, it was recommended that: 1) stock assessments needed to be conducted, based on which science-based harvest control rules needed to be developed, in order to set appropriate TACs; 2) regulations and mandatory measures needed to be put in place and training needed to be conducted to ensure that log books were completed in a timely manner; 3) the use of electronic logbooks needed to be explored; 4) transshipment vessels needed to be registered and use logbooks; 5) a suitable port needed to be designated as a catch landing site, with dockside monitoring; 6) trained observers needed to monitor catch onboard fishing and transshipment vessels; 7) at-sea and dockside enforcement and vessel monitoring systems (VMS) needed to be implemented; 8) the use of cameras could be piloted onboard vessels;

9) laws and regulations needed to be developed to ensure fishing rights and delineate an exclusive area for trap fishing that excludes trawling and other gear types; 10) pilot quotas could be allocated to trained fishers, and the possibility of expanding quota allocation could be explored; 11) the role of Chinese fishery cooperatives in management of the fishery needed to be explored; and 12) more training needed to be provided to fishers, and areas for training needed to be better identified (NRDC, EDF and QMCS 2021).

Because of the lack of a management strategy of the red swimming crab fishery, and the fact that the swimming crab TAC project in Fujian was in the pilot phase, Seafood Watch determines that China's management is insufficiently precautionary to protect red swimming crab populations, and therefore ranks this factor as ineffective.

Justification:
China as a whole is covered by the same national management strategies/policies, but the detailed management system is different based on regions, species, and other influential factors (pers. comm., F. Chen August 17, 2017). The Chinese seafood industry operates in the context of a hierarchical system of government at different levels: national, provincial (autonomous regions), and municipal. The Bureau of Fisheries within the Ministry of Agriculture is the main administrative body governing fisheries {Selfish 2015}(Chen and Wang 2016). The Fisheries Law Enforcement Command of China coordinates law enforcement. Chinese fisheries enforcement is currently undergoing reform, and responsibility will likely fall to the new Chinese Coast Guard system following this process (see https://zhidao.baidu.com/question/1834426523379149300.html and https://zh.wikipedia.org/wiki/%E4%B8%AD%E5%9C%8B%E6%B5%B7%E8%AD%A6).

Fisheries reform is taking place in China. For example, Zhejiang Province has also implemented a TAC pilot program for Gazami crab (*Portunus trituberculatus*) within its jurisdiction (special fishing permits with a monitoring system to track vessel movement and harvest volume). In addition, Chinese fisheries are more strictly combating illegal fishing gears, as well as implementing stricter marine enforcement, emphasis on green development, and so on (pers. comm., F. Chen April 18, 2018). Nonetheless, this reform is not directly applicable to the fishery being assessed.

Factor 3.2 - Bycatch Strategy

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Ineffective
Virtually all nontarget incidental species (if valuable) are retained. Several species of concern are caught in the red swimming crab fishery, based on recently collected bycatch data (Liu and Lin 2021). Article 28 of the Wildlife Protection Law of the People's Republic of China has recently been amended and restricts the capture and trade of endangered, threatened, and protected (ETP) species (SCNPC 2022). Fourteen seahorse species have been added to the Class II list of protected species in 2021 (GPRC 2021). Local groups (including fishers and conservationists) have worked together to create awareness on seahorse bycatch, and the Fujian Fisheries Bureau enforces the legislation by conducting inspections to ensure that there are no seahorses in the catch (fisheryprogress.org

2022). Nevertheless, seahorse bycatch still exists (but has been reduced), and other ETP species are still found in the catch, so mitigation strategies to reduce the impact of the trawl and trap fisheries on these species appear to be inadequate. Further, the proportion of juveniles caught in the trawl fishery in 2021–22 is high, contributing up to 50.52% of the total capture volumes (pers. comm., QMCS 2022), and there is an issue of gear loss in the trap fishery, which likely causes ghost fishing (CAPPMA and QMCS 2021). Hence, taken together, we have ranked this factor ineffective.

Factor 3.3 - Scientific Research And Monitoring

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Ineffective

No recent stock assessments have been published, and monitoring of the red swimming crab population and catch appears to be lacking (NRDC, EDF and QMCS 2021). Some amount of bycatch data are collected, although only qualitative and proportion data are presented (Liu and Lin 2021). Because some amount of data are collected on bycatch, but data on the status of the crab population are lacking, and neither stock assessments nor data limited assessments are published, this factor has been scored ineffective.

Factor 3.4 - Enforcement Of Management Regulations

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Ineffective

Because there is a shortage of enforcement officials, an inadequate enforcement budget, and a tendency of enforcement officials to be lenient to relatives and acquaintances, enforcement is weak (NRDC, EDF and QMCS 2021). For all these reasons, enforcement of management regulations has been rated ineffective.

Factor 3.5 - Stakeholder Inclusion

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Moderately Effective

Because there is no red swimming crab fishery management plan, the role of fisher cooperatives in managing the crab fisheries is still an unexplored area (NRDC, EDF and QMCS 2021). Nevertheless, industry representatives including the local fishing association (Fishing Association of Dongshan County) and the local processor association (Zhangzhou Aquatic Product Processing and Marketing Alliance, ZAPPMA) are engaged in public consultation (pers. comm., QMCS 2023). Fisher and processor representatives may submit their feedback about fishery management to both the

provincial and central government through regular video conferences with the Ministry of Agriculture and Rural Affairs (MARA) and surveys conducted by MARA, and through meetings with researchers from the Xiamen Fisheries Research Institute (pers. comm., QMCS 2023). Because there is some stakeholder inclusion in place, but it is unknown if all user groups are effectively considered and there is no mechanism to effectively address user conflicts, a score of moderately effective has been given to this factor.

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
Northwest Pacific | Bottom trawls | China	Score: 2	Score: 0	High Concern	**Red (2.000)**
Northwest Pacific | Pots | China	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

Northwest Pacific | Bottom trawls | China

Score: 2

The red swimming crab bottom trawl fishery takes place over sandy/muddy substrate where red swimming crabs reside. For this reason, it is deemed a 2 according to Seafood Watch criteria.

Justification:

Adverse impacts on benthic habitats are a concern for bottom trawling fisheries, but no studies of specific impacts attributed to the red swimming crab fishery are known. Ecosystem modeling has been conducted and it was concluded that overfishing has led to significant shifts in the ecosystem of the East China Sea (Cheng et al. 2009)(Li et al. 2009){Li and Zhang 2011).

Northwest Pacific | Pots | China

Score: 3

The pots/cages fishery takes place over sandy/muddy substrate and has less of an impact on the environment, because the gear contact the bottom but are not dragged like bottom trawls. This factor is therefore scored a 3, based on Seafood Watch criteria.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Northwest Pacific | Bottom trawls | China
Northwest Pacific | Pots | China

Score: 0

Based on available information, no red swimming crab fishing regions have effective mitigation in place to help reduce fishing gear impacts on the seafloor. Therefore, a score of 0, or no mitigation, is applied.

Justification:

To protect the environment, some gears have been prohibited, such as rakes (see http://jiuban.moa.gov.cn 2013 and http://blog.sina.com.cn 2010). But, these are not specific to red swimming crab, and the gears used in this report are not mitigated against, so they do not affect the scoring.

Factor 4.3 - Ecosystem-based Fisheries Management

Northwest Pacific | Bottom trawls | China

High Concern

Several threatened species, such as sharks and forage species that play an important role in ecosystem functioning, are caught in the red swimming crab trawl fishery (Liu and Lin 2021). But,

there appear to be no management policies in place to protect the ecosystem functioning of the fishery. Ecosystem modeling has concluded that overfishing has led to significant shifts in the ecosystem of the East China Sea (Cheng et al. 2009)(Li et al. 2009)(Li and Zhang 2011); plus, the likelihood of trophic cascades, alternative stable states, and other detrimental impacts from this fishery are high, yet conclusive scientific evidence of the same for this fishery is lacking. Therefore, ecosystem-based fishery management has been rated a high concern.

Northwest Pacific | Pots | China

Moderate Concern

It is inconclusive whether traps in the Chinese red swimming crab fishery affect species that are important for ecosystem functioning (Liu and Lin 2021), although there are no efforts as of yet to fully assess the ecological impacts of the fishery. For these reasons, the management of ecosystem and food web impacts of the fishery is deemed a moderate concern.

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Appendix A: Review Schedule

Appendix B: 2023 Update Summary

Updates to the December 19, 2018 red swimming crab report were made from March 24, 2022 through February 28, 2023. The report was updated in Version 3 of the Seafood Watch Fisheries Standard. **The overall recommendations for the red swimming crab trawl and pot fisheries in China are still Red**. Additional updates, if any, are described below:

Criterion 1

There was no improvement in the overall Criterion 1 score, which remained Red; however, new information was added to abundance (Factor 1.1).

Criterion 2

New catch composition data were incorporated into this assessment, but they did not change the rating of Criterion 2, which remained Red.

Criterion 3

There was no improvement in the overall Criterion 3 score, which remained Red; however, new information was added to management strategy and implementation (Factor 3.1) and bycatch strategy (Factor 3.2), and an ineffective rating was assigned for research and monitoring (Factor 3.3), enforcement (Factor 3.4), and stakeholder inclusion (Factor 3.5).

Criterion 4

The overall score of Criterion 4 for the trawl fishery was downgraded from Yellow to Red, because ecosystem-based management was rated a high concern for the trawl fishery. But, the overall score of Criterion 4 for the pot fishery remained Yellow.

Rating Review Summary Table

Report: Red swimming crab (China)		
Criteria	**Previous report (2018)**	**Current report (2022)**
Who conducted the stock assessment?	N/A	N/A, but information from Liu et al. 2022 was added to the text.
When was the stock assessment conducted?	N/A	N/A
Where/what are the catch composition data source(s)?	Pers. comm, F. Chen 2017	(Liu and Lin 2020)(Liu and Lin 2021) (Liu et al. 2022)
Who manages the fishery?	The Bureau of Fisheries (within the Ministry of Agriculture) at the national level, provincial governments, and municipal governments	The Bureau of Fisheries (within the Ministry of Agriculture) at the national level, provincial governments, and municipal governments
What is the date of the published management plan?	N/A	N/A

Are there any updates or amendments?	N/A	A TAC pilot project on swimming crabs was conducted in Fujian Province; this project helped identify gaps in the swimming crab fisheries, based on which recommendations for improvement of management and the fishery were drafted.