Warty Swimming Crab

Portunus haanii

China

Bottom trawls, Pots

December 19, 2018

Seafood Watch Consulting Researcher

Disclaimer

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Seafood Watch Standard used in this assessment: Standard for Fisheries vF3
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About Seafood Watch

Monterey Bay Aquarium’s Seafood Watch program evaluates the ecological 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. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. 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.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Watch Assessment. Each assessment synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program’s conservation ethic to arrive at a recommendation of “Best Choices,” “Good Alternatives” or “Avoid.” This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch’s sustainability recommendations and the underlying assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.
**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, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and online guide:

**Best Choice/Green:** Are well managed and caught in ways that cause little harm to habitats or other wildlife.

**Good Alternative/Yellow:** Buy, but be aware there are concerns with how they’re caught.

**Avoid/Red** Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

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\(^1\) “Fish” is used throughout this document to refer to finfish, shellfish and other invertebrates
Summary

This report includes recommendations for the warty swimming crab (commonly known as red swimming crab), *Portunus haanii*, a medium-bodied, benthic crustacean caught by bottom trawl and pot/cage. 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. Information is very limited on Chinese RSC stock abundance, as well as RSC life history characteristics in general. However, there are clear indications that crabs of processable size in the catch have been in decline, as acknowledged by both processors and fishermen. In addition, a RSC assessment that was conducted over 10 years ago indicated the potential overfishing likelihood for RSC.

The Chinese RSC fishery is a multi-species fishery that not only targets RSC, but 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 crabs (*Charybdis natator*). These species have been included in Criterion 2 (rigid swimming crabs 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 also 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 RSC and therefore 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 RSC fishery and 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 "moderate."

Overall the Chinese RSC bottom trawl and pot fisheries are rated "red," or "avoid."
## Final Seafood Recommendations

<table>
<thead>
<tr>
<th>SPECIES/FISHERY</th>
<th>CRITERION 1: IMPACTS ON THE SPECIES</th>
<th>CRITERION 2: IMPACTS ON OTHER SPECIES</th>
<th>CRITERION 3: MANAGEMENT EFFECTIVENESS</th>
<th>CRITERION 4: HABITAT AND ECOSYSTEM</th>
<th>OVERALL RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warty swimming crab, China Northwest Pacific, Bottom trawls, China</td>
<td>Red (1.732)</td>
<td>Red (1.000)</td>
<td>Red (1.000)</td>
<td>Yellow (2.449)</td>
<td>Avoid (1.435)</td>
</tr>
<tr>
<td>Warty swimming crab, China Northwest Pacific, Pots, China</td>
<td>Red (1.730)</td>
<td>Red (1.730)</td>
<td>Red (1.000)</td>
<td>Yellow (3.000)</td>
<td>Avoid (1.731)</td>
</tr>
</tbody>
</table>

## Summary

The warty, or red, swimming crab (*Portunus hanaii*) is a medium-bodied, benthic crustacean common throughout the Indo-Pacific. This report covers RSC caught by crab pot and bottom trawl in East and South China Sea (taking place mainly in the southern portion of the Taiwan strait, in the northern South China Sea).

The "avoid" rank for RSC is driven by high conservation concerns over stock status (in addition to a paucity of stock status information), impacts on Pacific chub mackerel, mitre squid, ray and shark populations, and management of the fishery's impacts on crab populations.

## Eco-Certification Information

The Chinese RSC fishery is engaged in a fishery improvement project (FIP). 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.

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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 warty swimming crab (commonly known as red swimming crab), Portunus haanii, a medium-bodied, benthic crustacean caught by bottom trawl and pot/cage. 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 crabs (RSC) 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). RSC are common throughout the Indo-Pacific in inshore and continental shelf habitats including sand, mud, algae and seagrass near reefs and mangrove areas, and are found in the intertidal up to depths of 70 m (Ingles 1988) (Germano et al. 2006). In China, RSC 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 (BSC), RSC mature quickly (about 1 year), have short lifespans (about 3 years), and are partial brooders (Kangas 2000) (Josileen and Menon 2007) (pers. comm., F. Chen, 17 August 2017). RSC have a relatively long spawning period; it is estimated to be as long as 11 months. In China, RSC spawn in February to April and October, formulating two peak spawning seasons; the RSC fishery usually harvests crab from July to November and is comprised of zero and one-year old individuals (the concentrated foraging group (pers. comm., F. Chen, 17 August 2017).

For this fishery, there are currently approximately 1,000 vessels using bottom trawl and 80 vessels using pot/cage; bottom trawls account for 60% of crab catch (Chen and Wang 2016).

Management

There is no unified worldwide body that manages fisheries for BSC and RSC. Instead, each country has its own individual management system. RSC in China is managed by the central government and is based on regulations and legislation, such as restricted zones and a licensing system (e.g., a license to fish), which is passed down from the central government to the states to follow (Yu and Yu 2008) (Hangzhou 2015). However, China is starting to strengthen their management efforts, and in December 2017, Zhejiang province implemented their own management of RSC (http://www.zjoaf.gov.cn 2017).

FIP

A fishery improvement project (FIP) was initiated in 2016 by the National Fisheries Institute Crab Council (NFICC) and Ocean Outcomes, a non-profit organization dedicated to improving global high-risk fisheries. The FIP target area for the Chinese RSC fishery is Taiwan-Minnan Bank (fishing ground) and Zhangzhou Municipality (fishing and processing hub), which produce 7,300 tons, or 64%, of RSC in China (Chen and Wang 2016); Figure 1. The FIP is anticipated to be a 2-phase, 10-year, step-wise effort (ibid). To date, the FIP has completed the pre-assessment, supply chain scoping and preparation work, identification and development stages, and is starting to launch phase 2 of the FIP (pers. comm., F. Chen, 17 August 2017).
Production Statistics

Total annual crab landing in China in 2015 was over 60,000 tons (t), with RSC accounting for 70% and three-spotted swimming crab (TSC), *Portunus sanguinolentus*, accounting for 15% (Chen and Wang 2016).

Importance to the US/North American market.

The United States is the major export destination for pasteurized crabmeat; hence, the US market drives global swimming crab demand (BFAR 2012). Imports of portunid crabs (species not identified) from China into the US have been variable until 2015, when there was a marked increase (Figure 2). China is the second major supplier of portunid crab imports to the US, with Indonesia and Vietnam ranking in first and third (Figure 6a), and it has been the biggest exporter of fishery products in the world since 2002 (Hangzhou 2015).

In 2015, 3232 t of portunid crabs (species unspecified) were imported into the US from China, with a value of about USD 55 million (NMFS 2016); Figures 3, 4. On the US market, 10.4% of crab and 21.4% of swimming crab (species unspecified) is from China (NMFS 2016).
Figure 2 Imports of Portunidae (swimming crab) from China into the U.S. from 2005-2015 (data from NMFS 2016).

Figure 3 Portunid crab imports into the U.S. (by tons) in 2015 (data from NMFS 2016).
Common and market names.

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

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). Swimming crab 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

<table>
<thead>
<tr>
<th>WARTY SWIMMING CRAB</th>
<th>Region</th>
<th>Method</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>China/Northwest Pacific</td>
<td>Bottom trawls</td>
<td>1.00: High Concern</td>
<td>3.00: Moderate Concern</td>
<td>Red (1.732)</td>
</tr>
<tr>
<td></td>
<td>China/Northwest Pacific</td>
<td>Pots</td>
<td>1.00: High Concern</td>
<td>3.00: Moderate Concern</td>
<td>Red (1.730)</td>
</tr>
</tbody>
</table>

Criterion 1 Assessment

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.

**WARTY SWIMMING CRAB**

**Factor 1.1 - Abundance**

**CHINA/NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

**CHINA/NORTHWEST PACIFIC, POTS, CHINA**

**High Concern**

There is very limited information on Chinese RSC stock abundance, as well as RSC life history characteristics in general. Because of this, a Productivity Susceptibility Analysis (PSA) was used based on BSC life history characteristics (very similar to RSC) as per the SFW criteria. The PSA score = 3.23, or high vulnerability. Detailed scoring of each attribute is shown below. Because abundance is unknown and RSC is highly vulnerable, this factor is scored "high" concern.

**Justification:**

There are clear indications that processable-sized crabs in the catch have been in decline as acknowledged by both processors and fishermen (Chen and Wang 2016).

**Productivity-Susceptibility Analysis (if Applicable):**

**Scoring Guidelines**

1.) Productivity score \( (P) = \text{average of the productivity attribute scores} \) 

2.) Susceptibility score \( (S) = \text{product of the susceptibility attribute scores} \)

3.) Vulnerability score \( (V) = \text{Euclidean distance of} \ P \ \text{and} \ S \) using the following formula: 

<table>
<thead>
<tr>
<th>Productivity Attribute</th>
<th>Relevant Information</th>
<th>Reference(s)</th>
<th>Score (1 = low risk, 2 = medium risk, 3 = high risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age at maturity</td>
<td>&lt;5 years (likely ~1 year)</td>
<td>(Josileen and Menon 2007)(Kangas 2000)</td>
<td>1</td>
</tr>
<tr>
<td>Susceptibility Attribute</td>
<td>Relevant Information</td>
<td>Reference(s)</td>
<td>Score (1 = low risk, 2 = medium risk, 3 = high risk)</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Areal overlap (considers all fisheries)</td>
<td>&gt;30% overlap</td>
<td>SFW default</td>
<td>3</td>
</tr>
<tr>
<td>Vertical overlap (considers all fisheries)</td>
<td>High overlap w/fishing gear (target species)</td>
<td>SFW default</td>
<td>3</td>
</tr>
<tr>
<td>Selectivity of fishery (specific to fishery under assessment)</td>
<td>Targeted species; net mesh size allows retention of individuals below size at maturation</td>
<td>(pers. comm., F. Chen, 31 August 2017)</td>
<td>3</td>
</tr>
<tr>
<td>Post-capture mortality (specific to fishery under assessment)</td>
<td>Retained species</td>
<td>(Chen and Wang 2016)</td>
<td>3</td>
</tr>
<tr>
<td>Total Susceptibility (multiplicative)</td>
<td></td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

PSA score for RSC in Chinese bottom trawl and pot/cage fisheries is calculated as follows:

*Estimations roughly based on BSC life-history characteristics, as no life-history characteristics are available for RSC (besides trophic level).
Vulnerability \( V = \sqrt{P^2 + S^2} \)

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

\[ V = 3.23 \]

**Factor 1.2 - Fishing Mortality**

| CHINA/NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA |
| CHINA/NORTHWEST PACIFIC, POTS, CHINA |

**Moderate Concern**

Information is very limited for Chinese RSC; 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 as "moderate" concern.

**Justification:**

A RSC assessment conducted over 10 years ago (documents confidential) indicated the potential overfishing likelihood for RSC; 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, 17 August 2017).
**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 Critical

**Guiding Principles**

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

**Criterion 2 Summary**

Only the lowest scoring main species is/are listed in the table and text in this Criterion 2 section; a full list and assessment of the main species can be found in Appendix A.

### WARTY SWIMMING CRAB - CHINA/NORTHWEST PACIFIC - BOTTOM TRAWLS - CHINA

<table>
<thead>
<tr>
<th>Subscore:</th>
<th>1.000</th>
<th>Discard Rate:</th>
<th>1.00</th>
<th>C2 Rate:</th>
<th>1.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>Abundance</td>
<td>Fishing Mortality</td>
<td>Subscore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rays (unspecified)</td>
<td>1.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharks</td>
<td>1.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitre squid</td>
<td>1.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacific chub mackerel</td>
<td>1.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herrings (unspecified)</td>
<td>2.33:Moderate Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.526)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea turtle (unspecified)</td>
<td>1.00:High Concern</td>
<td>3.00:Moderate Concern</td>
<td>Red (1.732)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Striped bonito</td>
<td>1.00:High Concern</td>
<td>3.00:Moderate Concern</td>
<td>Red (1.732)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neon flying squid</td>
<td>5.00:Very Low Concern</td>
<td>5.00:Low Concern</td>
<td>Green (5.000)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### WARTY SWIMMING CRAB - CHINA/NORTHWEST PACIFIC - POTS - CHINA

<table>
<thead>
<tr>
<th>Subscore:</th>
<th>1.730</th>
<th>Discard Rate:</th>
<th>1.00</th>
<th>C2 Rate:</th>
<th>1.730</th>
</tr>
</thead>
</table>
There is little information on the impacts of the RSC fishery on other retained species and ETP species. Some of the other target species caught in the RSC bottom trawl fishery include: round sardinella (*Sardinella aurita*), Pacific chub mackerel (*Scomber japonicus*), striped bonito (*Sarda orientalis*), common Chinese/mitre squid (*Loligo chinensis*) and Neon flying squid (*Ommastrephes bartramii*; pers. comm., F. Chen, 17 August 2017). Pots are much more selective, with bycatch mostly consisting of other crab species, such as rigid swimming crab (*Charybdis natator*).

Bycatch species composition is variable based on season and harvest areas and the percentage of bycatch depends on the fishing gears used (ibid). It is likely that bottom trawls, accounting for 60% of crab catch, pose a larger threat given small mesh sizes and the generally unselective nature of the gear type (Chen and Wang 2016). Pots/cages have a relatively minor impact on bycatch because of their inherent selectivity, and virtually all bycatch in Chinese fisheries is retained (ibid).

Although it is unknown how many species of concern interact with the RSC fishery, turtles, marine mammals, sharks, rays, corals, and other biogenic habitats are included in this assessment since they are a high conservation concern, have low inherent resilience, lack regional information on stock health, and have the potential to be caught in swimming crab fisheries. Sharks, rays, mitre squid, and chub mackerel limit the score for Criterion 2 due to their conservation status.

### 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)*

**RAYS (UNSPECIFIED)**

#### Factor 2.1 - Abundance

**CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

**High Concern**

Most rays are highly inherently vulnerable and are classified as "Near Threatened" (Dulvy et al. 2008). According to the Seafood Watch criteria, rays are listed as "high" concern for abundance.
**Factor 2.2 - Fishing Mortality**

**CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

**High Concern**

Although it is unknown whether sharks are caught as bycatch in the Chinese RSC fishery, sharks are known to interact with bottom trawls, and certain species, such as the shortfin mako (*Isurus oxyrinchus*) and the whale shark (*Rhincodon typus*), are found in the waters off China (Camhi et al. 2009). Most pelagic sharks and rays are classified as "Near Threatened" (Dulvy et al. 2008); therefore, they are ranked as "high" conservation concern.

**Factor 2.3 - Modifying Factor: Discards and Bait Use**

**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.

<table>
<thead>
<tr>
<th>RATIO OF BAIT + DISCARDS/LANDINGS</th>
<th>FACTOR 2.3 SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100%</td>
<td>1</td>
</tr>
<tr>
<td>&gt;=100</td>
<td>0.75</td>
</tr>
</tbody>
</table>

**CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

< 100%

There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.

**SHARKS**

**Factor 2.1 - Abundance**

**CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

**High Concern**

Although it is unknown whether sharks are caught as bycatch in the Chinese RSC fishery, sharks are known to interact with bottom trawls, and certain species, such as the shortfin mako (*Isurus oxyrinchus*) and the whale shark (*Rhincodon typus*), are found in the waters off China (Camhi et al. 2009). Most pelagic sharks and rays are classified as "Near Threatened" (Dulvy et al. 2008); therefore, they are ranked as "high" conservation concern.

**Factor 2.2 - Fishing Mortality**

**CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

**High Concern**

According to the Seafood Watch Unknown Bycatch Matrices, shark fishing mortality from Northwest Pacific bottom trawls scores a 1 out of 5, or "high" concern. Pot fisheries are not expected to interact negatively with sharks and are therefore not ranked.
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.

<table>
<thead>
<tr>
<th>Ratio of Bait + Discards/Landings</th>
<th>Factor 2.3 Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100%</td>
<td>1</td>
</tr>
<tr>
<td>&gt;=100</td>
<td>0.75</td>
</tr>
</tbody>
</table>

CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

< 100%

There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.

MAMMALS

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC, POTS, CHINA

High Concern

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

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC, POTS, CHINA

Moderate Concern

It is unlikely that marine mammals such as dugong are retained. Dugong populations are not found in close proximity to RSC fishing areas (rather onshore, near Guangxi). In addition, there are no known reports of dugong bycatch historically in the RSC fishery (pers. comm., F. Chen 28 November 2017). The Chinese white dolphin (Sousa chinensis) is a nationally protected species living in the area where RSC are fished. The IUCN lists this species as "Vulnerable," with a decreasing population trend (Jefferson et al. 2017). The impact on this species is unknown (pers. comm., F. Chen, 18 April 2018).

Marine mammal fishing mortality is scored as a "moderate" concern, since there is insufficient evidence to support a score of "low" concern or to remove them from the report entirely.

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.
Score 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.

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<tr>
<th>RATIO OF BAIT + DISCARDS/LANDINGS</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>&gt;=100</td>
<td>0.75</td>
</tr>
</tbody>
</table>

CHINA / NORTHWEST PACIFIC, POTS, CHINA

< 100%

There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.

MITRE SQUID

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

High Concern

Common Chinese/mitre squid (Loligo chinensis) are targeted in the RSC fishery (pers. comm., F. Chen, 9 September 2017).

A 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 (ibid). These observations indicate a significant prematurity in the stock, which could signal potential stock depletion (ibid). As a result, abundance is scored as "high" concern.

Factor 2.2 - Fishing Mortality

CHINA / 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).

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.

Score 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.
PACIFIC CHUB MACKEREL

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

High Concern

Pacific chub mackerel (*Scomber japonicas*) are targeted in the RSC fishery (pers. comm., F. Chen, 9 September 2017).

A 2013 stock assessment on Pacific chub mackerel in the central East China Sea indicated that the stock is likely overexploited and has little potential for further utilization unless fishing mortality is reduced (Wang et al. 2014); therefore, abundance is scored as "high" concern.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

High Concern

The 2013 stock assessment found the current fishing mortality ($F_{curr} = 0.7$) to be higher than the fishing mortality at maximum sustainable yield ($F_{MSY} = 0.4$). Since $F/F_{MSY} = 1.75$, fishing mortality is scored as "high" concern.

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.

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</thead>
<tbody>
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</tr>
<tr>
<td>=100</td>
<td>0.75</td>
</tr>
</tbody>
</table>

CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

< 100%

There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.
There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, 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.

Criterion 3 Summary

<table>
<thead>
<tr>
<th>Fishery</th>
<th>Management Strategy</th>
<th>Bycatch Strategy</th>
<th>Research and Monitoring</th>
<th>Enforcement</th>
<th>Stakeholder Inclusion</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishery 1: China / Northwest Pacific</td>
<td>Ineffective</td>
<td>Ineffective</td>
<td></td>
<td></td>
<td></td>
<td>Red (1.000)</td>
</tr>
<tr>
<td>Bottom trawls</td>
<td>China</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishery 2: China / Northwest Pacific</td>
<td>Ineffective</td>
<td>Ineffective</td>
<td></td>
<td></td>
<td></td>
<td>Red (1.000)</td>
</tr>
<tr>
<td>Pots</td>
<td>China</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Criterion 3 Assessment

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 managers 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.
Ineffective

While 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 RSC 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, MPAs, etc. (pers. comm., F. Chen 17 August 2017).

There is no official stock assessment of RSC 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 this closure can be made more effective if it can be extended further to allow most crabs to reach maturity/commercially valuable size (ibid). There may be more recent studies and stock assessments available, however it is unclear from publicly available information.

As of late 2017, Zhejiang province has implemented their own RSC management (http://www.zjoaf.gov.cn 2017). The total number of allowable crab protected areas in 2017 will be controlled, as will the number of issuing certificates (104 ships in the previous year). There will be special fishing permit application conditions, strict control of fishing gear specifications (ginger wire mesh should be set for single-chip gill nets, mesh size of no less than 110 mm, total length of mesh control within 20,000 m (ibid). In addition, disabled gear will be remediated, illegal fishing gears, like bottom trawl, will be strictly prohibited, and enforcement will be intensified (http://www.moa.gov.cn 2018). Nevertheless, it is unclear whether these measures will be effective or what the level of compliance will be.

Due to the lack of a management strategy for other parts of the RSC fishery, and the unknown effectiveness of the newly implemented management strategies in Zhejiang province, Seafood Watch determines that China’s management is insufficiently precautionary to protect RSC 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, 17 August 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 Coastguard system following this process (see https://zhidao.baidu.com/question/1834426523379149300.html and https://zh.wikipedia.org/wiki/%E4%88%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 18 April 2018). Nonetheless, this reform is not directly applicable to the fishery being assessed.
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.

### CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA
### CHINA / NORTHWEST PACIFIC, POTS, CHINA

**Ineffective**

Virtually all non-target incidental species (if valuable) are retained. It is unclear whether there are species of concern caught in the RSC fishery. There does not appear to be any regular collection or analysis of incidental species data, and therefore, no bycatch management is in place. Thus, we have ranked this factor as "ineffective."

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.
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

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Gear Type and Substrate</th>
<th>Mitigation of Gear Impacts</th>
<th>EBFM</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>China / Northwest Pacific / Pots / China</td>
<td>3</td>
<td>0</td>
<td>Moderate Concern</td>
<td>Yellow (3.000)</td>
</tr>
<tr>
<td>China / Northwest Pacific / Bottom trawls / China</td>
<td>2</td>
<td>0</td>
<td>Moderate Concern</td>
<td>Yellow (2.449)</td>
</tr>
</tbody>
</table>

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 - Physical Impact of Fishing Gear on the Habitat/Substrate

<table>
<thead>
<tr>
<th>Location</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA</td>
<td>2</td>
<td>The RSC bottom trawl fishery takes place over sandy/muddy substrate where RSC reside. For this reason, it is deemed as 2 according to Seafood Watch Criteria.</td>
</tr>
<tr>
<td>CHINA / NORTHWEST PACIFIC, POTS, CHINA</td>
<td>3</td>
<td>The pot/cage fishery takes place over sandy/muddy substrate and has less of an impact on the environment as they contact the bottom, but are not dragged like bottom trawls. This factor is therefore scored as 3, based on Seafood Watch criteria.</td>
</tr>
</tbody>
</table>

### Justification:
Adverse impacts on benthic habitats are a concern for bottom trawling fisheries, but no studies of specific impacts attributed to the RSC 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).

<table>
<thead>
<tr>
<th>Location</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA</td>
<td>0</td>
<td>Based on available information, no RSC 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.</td>
</tr>
</tbody>
</table>

### Justification:
Some gears have been prohibited to protect the environment, like rakes (see (http://jiuban.moa.gov.cn 2013) and (http://blog.sina.com.cn 2010)), but these are not specific to RSC, and the gears being used for this report are not mitigated against, and therefore do not affect the scoring.

## Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

<table>
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<tr>
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## Factor 4.3 - Ecosystem-Based Fisheries Management

<table>
<thead>
<tr>
<th>Location</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA</td>
<td>Moderate Concern</td>
<td>It is not apparent whether exceptional species are caught in the Chinese RSC fishery, and 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 as &quot;moderate&quot; concern.</td>
</tr>
<tr>
<td>CHINA / NORTHWEST PACIFIC, POTS, CHINA</td>
<td>Moderate Concern</td>
<td>It is not apparent whether exceptional species are caught in the Chinese RSC fishery, and 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 as &quot;moderate&quot; concern.</td>
</tr>
</tbody>
</table>
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


Chang S., K Liu, Y. Song. 2010. Distant water fisheries development and vessel monitoring system implementation in Taiwan – History and driving forces. Marine Policy. 34, 541-548.


Lessers 3, 131-142.


Appendix A: Extra By Catch Species

SEA TURTLE (UNSPECIFIED)

Factor 2.1 - Abundance

| CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA |
| High Concern |

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

Justification:

Five of the seven worldwide sea turtle species are found in the BSC and RSC 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 BSC fishing regions. It is unknown how many sea turtles are actually caught as bycatch in the gillnet and trawl BSC/RSC fisheries, but their vulnerability and the potential for them to be caught includes them in this analysis.

Factor 2.2 - Fishing Mortality

| CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA |
| Moderate Concern |

According to the Seafood Watch Unknown Bycatch Matrices, sea turtle fishing mortality from North Pacific bottom trawls scores a 3 out of 5, or "moderate" concern. Pot fisheries are not expected to interact negatively with sea turtles and are therefore not ranked.

Factor 2.3 - Discard Rate

| CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA |
| < 100% |

There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.

HERRINGS (UNSPECIFIED)

Factor 2.1 - Abundance

| CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA |
| Moderate Concern |

According to the Seafood Watch criteria, finfish abundance is scored as "moderate" concern.

Justification:

Round sardinella, Sardinella aurita is one of the targeted finfish in the RSC bottom trawl fishery in China (pers. comm., F. Chen, 9 September 2017). However, there is no official stock assessment of round sardinella in China.
**Factor 2.2 - Fishing Mortality**

**CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

**High Concern**

Finfish caught as bycatch in bottom trawls receive a fishing mortality of 2 out of 5, or "high" concern, using the Unknown Bycatch Matrices.

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**Factor 2.3 - Discard Rate**

**CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

**< 100%**

There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.

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**TRUE CRABS (UNSPECIFIED)**

**Factor 2.1 - Abundance**

**CHINA / NORTHWEST PACIFIC, POTS, CHINA**

**Moderate Concern**

Benthic invertebrates are ranked as "moderate" concern for abundance as per the Seafood Watch criteria.

**Justification:**

Rigid swimming crabs (*Charybdis natator*), three-spot crabs (*Portunus sanguinolentus*), and blue swimming crabs (*BSC; Portunis peglagicus*) are targeted in the RSC pot fishery (pers. comm., F. Chen, 9 August 2017). However, there are no formal stock assessments of these crabs in China.

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**Factor 2.2 - Fishing Mortality**

**CHINA / NORTHWEST PACIFIC, POTS, CHINA**

**Moderate Concern**

Benthic invertebrates are ranked as 3 out of 5, or "moderate" concern for bottom gillnets, and a 3.5 out of 5 for traps, or "low" concern, according to the Seafood Watch Unknown Bycatch Matrices.

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**Factor 2.3 - Discard Rate**

**CHINA / NORTHWEST PACIFIC, POTS, CHINA**

**< 100%**

There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.

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**NEON FLYING SQUID**

**Factor 2.1 - Abundance**
CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

Very Low Concern

Neon flying squid (*Ommastrephes bartramii*) are targeted in the RSC fishery (pers. comm., F. Chen, 9 September 2017).

A stock assessment of the western winter-spring cohort of neon flying squid, one of the four North Pacific stocks that has become a traditional fishing target for the Chinese squid-jigging fleets, was completed in 2015, using the period from 2003 to 2013 (Wang et al. 2016). Yearly stock biomass (in all four surplus production models) was higher than B_{MSY} (see values for all four models below), indicating that the stock is not overfished and has been at a high level of abundance in recent years (*ibid*). Therefore, abundance for neon flying squid is scored as "very low" concern.

Justification:

\[
\frac{B_{2013}}{B_{MSY}} \text{ for}
\]

(A) SP model: \( \frac{62.23}{32.5} = 1.9 \)

(B) \( \Phi_s \)-model: \( \frac{80.74}{40} = 2.0 \)

(C) \( \Phi_f \)-model: \( \frac{76.86}{42.75} = 1.8 \)

(D) \( \Phi_s - \Phi_f \)-model: \( \frac{82.88}{42.75} = 1.9 \)

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

Low Concern

The 2015 stock assessment of the western winter-spring cohort of neon flying squid found that fishing mortality rates of neon flying squid from 2003 to 2013 were much lower compared to the fishing mortality at target level (in all four surplus production models; see details below), indicating that the stock is not undergoing overfishing (Wang et al. 2016). Therefore, a score of "low" concern was given.

Justification:

\[
\frac{F_{2013}}{F_{MSY}} \text{ for}
\]

(A) SP model: \( \frac{0.13}{0.88} = 0.15 \)

(B) \( \Phi_s \)-model: \( \frac{0.10}{0.87} = 0.11 \)

(C) \( \Phi_f \)-model: \( \frac{0.10}{0.70} =0.14 \)

(D) \( \Phi_s - \Phi_f \)-model: \( \frac{0.10}{0.71} = 0.14 \)

Factor 2.3 - Discard Rate

CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

< 100%
There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.

STRIPED BONITO

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA

High Concern

Striped bonito (Sarda orientalis) are targeted in the RSC fishery (pers. comm., F. Chen, 9 September 2017).

There is no formal stock assessment of striped bonito in China, so a productivity-susceptibility analysis (PSA) was calculated. The PSA score = 3.39 (detailed scoring of each PSA attribute is shown below). Striped bonito is deemed to have high inherent vulnerability based on the PSA scoring tool. In combination with an unknown stock abundance, striped bonito abundance in China is considered a "high" concern.

Justification:

Productivity-Susceptibility Analysis

Scoring Guidelines

1.) Productivity score \( (P) = \) average of the productivity attribute scores \( (p_{1}, p_{2}, p_{3}, p_{4} \text{ (finfish only)}, p_{5} \text{ (finfish only)}, p_{6}, p_{7}, \text{ and } p_{8} \text{ (invertebrates only)}) \)

2.) Susceptibility score \( (S) = \) product of the susceptibility attribute scores \( (s_{1}, s_{2}, s_{3}, s_{4}) \), rescaled as follows: 
\[
S = \left[ \left( s_{1} \times s_{2} \times s_{3} \times s_{4} \right) - \frac{1}{40} \right] + 1.
\]

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

<table>
<thead>
<tr>
<th>Productivity Attribute</th>
<th>Relevant Information</th>
<th>Reference(s)</th>
<th>Score (1 = low risk, 2 = medium risk, 3 = high risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average age at maturity</td>
<td>1 year old</td>
<td>(Sivadas 2012)</td>
<td>1</td>
</tr>
<tr>
<td>Average maximum age</td>
<td>4+ years</td>
<td>(Sivadas 2012)</td>
<td>1</td>
</tr>
<tr>
<td>Fecundity</td>
<td>80,000 and 115,000 eggs per year</td>
<td>(Snow 2017)</td>
<td>1</td>
</tr>
<tr>
<td>Average maximum size</td>
<td>102 cm</td>
<td>(Froese and Pauly 2017)</td>
<td>2</td>
</tr>
<tr>
<td>(fish only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average size at maturity</td>
<td>42 cm</td>
<td>(Sivadas 2012)</td>
<td>2</td>
</tr>
<tr>
<td>(fish only)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproductive strategy</td>
<td>Broadcast spawner</td>
<td>(Froese and Pauly 2017)</td>
<td>1</td>
</tr>
</tbody>
</table>
### Factor 2.2 - Fishing Mortality

**PSA score for Striped bonito in Chinese RS bottom trawl fishery is calculated as follows:**

Vulnerability ($V$) = $\frac{3.39}{1.57} = 2.16$  

<table>
<thead>
<tr>
<th>Trophic level</th>
<th>4.2</th>
<th>(Froese and Pauly 2017)</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density dependence (invertebrates only)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Productivity (average)</strong></td>
<td></td>
<td>1.57</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Susceptibility Attribute</th>
<th>Relevant Information</th>
<th>Reference(s)</th>
<th>Score (1 = low risk, 2 = medium risk, 3 = high risk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areal overlap (Considers all fisheries)</td>
<td>&gt;30% overlap</td>
<td>SFW default</td>
<td>3</td>
</tr>
<tr>
<td>Vertical overlap (Considers all fisheries)</td>
<td>High overlap w/fishing gear (target species)</td>
<td>SFW default</td>
<td>3</td>
</tr>
<tr>
<td>Selectivity of fishery (Specific to fishery under assessment)</td>
<td>Species is targeted and juveniles are retained</td>
<td>(pers. comm., F. Chen 2017)</td>
<td>3</td>
</tr>
<tr>
<td>Post-capture mortality (Specific to fishery under assessment)</td>
<td>Retained species</td>
<td>(pers. comm., F. Chen 2017)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Susceptibility (multiplicative)</strong></td>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA**

**Moderate Concern**

Striped bonito fishing mortality is unknown; hence, a score of "moderate" concern is given.
**Factor 2.3 - Discard Rate**

| CHINA / NORTHWEST PACIFIC, BOTTOM TRAWLS, CHINA |
| < 100% |

There is typically no bycatch in Chinese fisheries, as virtually everything valuable is retained (Chen and Wang 2016). Therefore discards/total catch is nil, and a multiplying factor of 1 is used.