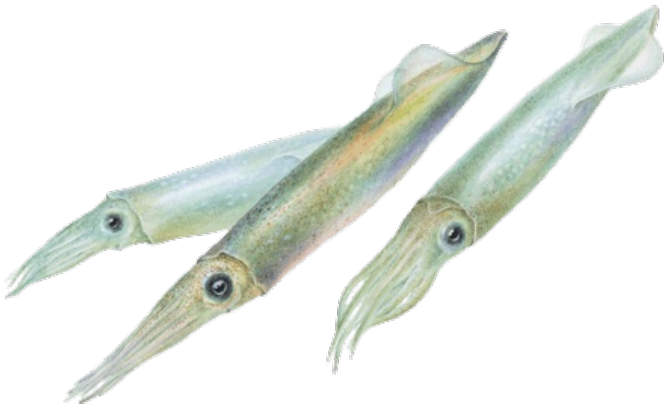
Monterey Bay Aquarium Seafood Watch®

Mitre, Indian and Swordtip squid

Uroteuthis chinensis
Uroteuthis duvauceli
Uroteuthis edulis



China

Bottom trawls, Jig, Purse seines

May 4, 2020

Seafood Watch Consulting Researcher

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.

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

Summary

This report provides recommendations for three commercially important loligo species to both the United States and China: mitre squid, Uroteuthis (Photololigo) chinensis, Indian squid, Uroteuthis (Photololigo) duvauceli, and swordtip squid Uroteuthis (Photololigo) edulis.

These are inshore species distributed throughout the coastal waters of the Indo-Pacific that are fished using a variety of gears including otter trawls, purse seines, handline jigging and others. The otter trawl is the dominant catch method for assessed squid in China coastal fishing, with purse seine (light lift net) second in importance. Jigging only takes place in the Minnan-Yuedong areas between the South China Sea and the East China Sea. These three fishing methods are assessed in this report. Notably, due to the popularity of unselective fishing gear operation (e.g., trawlers) on squid distribution zone and co-habit characteristic of assessed squid species group, the assessed squid tend to co-harvest on areas assessed fisheries. Stock assessments for all three loligo squids are generally lacking; only regional, out of date stock evaluation data exists. For evaluating stock status, a data-limited method (PSA) was used, and results suggested a score of high concern for all three squid species. Although they have high productivity, they are highly susceptible to intensive fishing. As there are also no data on fishing mortality rates, a score of moderate concern was given for all assessed squid species.

The more selective gear types have fewer by-catch concerns. Jigging for mitre, Indian, and swordtip squid is the most selective fishing method, with by-catch limited largely to other cephalopod species. Light purse seine (lift net) attracts other species with positive phototaxis, mostly fast-growing pelagic species like mackerel. Impacts on abundance of bycatch species turned out to be mostly high concern due to intensive fishing and moderate fishing mortality. As no data on bycatch composition in the trawl fisheries is collected, data limited methods were used to assess by-catch impacts, with results suggesting moderate-high concerns regarding bycatch species.

The assessed squid fisheries are managed under the Fishery Bureau in the Ministry of Agriculture and Rural Affairs and its local authorities. Currently almost only general fisheries management measures are applied to squid resources except one local regulation set catch limit to loligo squid but no data on enforcement level, and there is no effectiveness evaluation of general fisheries management at conserving squid resources. Bycatch management is missing even though most fishing methods for loligo are not selective.

Jigging and purse seine gears do not contact the sea floor. Thus, fisheries using these gears are have less influences to the benthic habitats. In contrast, otter trawling received a red score mainly due to gear's sea bed impacts and lack of impact mitigation efforts. Ecosystem based fisheries management is being researched but has not yet been implemented. The trawling and purse seine mitre/Indian/Swordtip squid fisheries are rated as a "Red" due to concerns about stock status and lack of management efforts to recover/rebuild the stock despite multiple signals of stock decline.

The Jigging of mitre/Indian/Swordtip Squid fisheries are rated as a "Red" also even though the bycatch and habitat impacts criteria received good scores, because there are still concerns about stock status and management.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1: Impacts on the Species	CRITERION 2: Impacts on Other Species	CRITERION 3: Management Effectiveness	CRITERION 4: Habitat and Ecosystem	OVERALL RECOMMENDATION
Indian squid China/Northwest Pacific | Bottom trawls	Red (1.732)	Red (1.000)	Red (1.000)	Red (1.414)	**Avoid (1.250)**
Indian squid China/Northwest Pacific | Jig	Red (1.732)	Red (1.732)	Red (1.000)	Yellow (3.162)	**Avoid (1.754)**
Indian squid China/Northwest Pacific | Purse seines	Red (1.732)	Red (1.732)	Red (1.000)	Yellow (3.162)	**Avoid (1.754)**
Mitre squid China/Northwest Pacific | Bottom trawls	Red (1.732)	Red (1.000)	Red (1.000)	Red (1.414)	**Avoid (1.250)**
Mitre squid China/Northwest Pacific | Jig	Red (1.732)	Red (1.732)	Red (1.000)	Yellow (3.162)	**Avoid (1.754)**
Mitre squid China/Northwest Pacific | Purse seines	Red (1.732)	Red (1.732)	Red (1.000)	Yellow (3.162)	**Avoid (1.754)**
Swordtip squid China/Northwest Pacific | Bottom trawls	Red (1.732)	Red (1.000)	Red (1.000)	Red (1.414)	**Avoid (1.250)**
Swordtip squid China/Northwest Pacific | Jig	Red (1.732)	Red (1.732)	Red (1.000)	Yellow (3.162)	**Avoid (1.754)**
Swordtip squid China/Northwest Pacific | Purse seines	Red (1.732)	Red (1.732)	Red (1.000)	Yellow (3.162)	**Avoid (1.754)**

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 provides recommendations for the three commercially imported loligo squid species from China, mitre squid, *Uroteuthis (Photololigo) chinensis*, Indian squid, *Uroteuthis* (*Photololigo) duvauceli and the swordtip squid Uroteuthis (Photololigo) edulis*. The assessed species are fished in large- or small-scale fisheries using a variety of gears including otter trawls, purse seines, light lift net, hook and line and artisanal fishing methods. Otter trawling is the primary commercial gear used (Jereb P., C.F.E. Roper 2010), followed by the light purse seine (life-net) (Bureau of Fisheries, n.d.). Squid jigging is also present, mainly in the Yuedong-Minan areas. Jigging is a popular squid fishing method especially the China summer fishing ban during which many other fishing gears cannot be operated in China coastal areas, as a way to conserve resources. This report focuses on three fishing methods, otter trawls, purse seine and Jigging for the mitre, Indian and swordtip fisheries.

China domestic squid fisheries harvest varying, large volumes of loligo squid species, commonly including beka squid (*Loliolus beka*), Japanese squid (*Loliolus japonica*), mitre squid (*Uroteuthis (Photololigo) chinensis*), Indian squid (*Uroteuthis* (*Photololigo) duvauceli*) and the swordtip squid *(Uroteuthis edulis)*; most of them are consumed in the domestic market and some species, like mitre squid, are also processed and exported to overseas markets.

Detailed official statistics are lacking for Chinese squid species-level harvests and species-based trade data (with similar lack of species-specific statistics on the US side). **The majority of squid imports into the U.S. from China are identified as either "Loligo NSPF" or "squid NSPF"** (where NSPF stands for "not specifically provided for"). Meanwhile US buyers who purchase loligo squid from China usually mark it as 'loligo spp.' (Anonymous 2018) instead providing species level details, but many have mentioned that the loligo squid they purchased from China is mitre squid. Based on research conducted by an NGO that recently interviewed squid fishery stakeholders and visited China local fishing operations, three main loligo species comprise US imports of loligo squid: mitre squid, *Uroteuthis (Photololigo) chinensis*; Indian squid, *Uroteuthis* (*Photololigo) duvauceli*; and the swordtip squid, *Uroteuthis edulis*. Among these, mitre squid (*Uroteuthis chinensis*) is believed to be the main loligo squid component. Published data do not include any more detailed information relating to these 'species mixtures'.

Species Overview

There are existing more than 300 known species of squids, distributed across almost every major marine habitat worldwide and ranging from the intertidal to over 5000m in depth. Considered subdominant predators, squids feed on crustaceans, fishes and other cephalopods (Rodhouse, P. G. et al. 1996). In turn, squids serve as prey for fishes, marine mammals, and seabirds (Clarke, M. R. 2006)(Jereb P. et al. 2010); cannibalism is also common (Christian M. Ibáñez et al. 2010). They are short-lived, semelparous and fast-growing, with high feeding rates and conversion efficiencies. They also have high reproductive rates. All these features have adapted squids to be ecological opportunists that can rapidly exploit favourable environmental conditions. Therefore recruitment and abundance may be highly variable on annual time scales (Rodhouse, P. G. et al. 2014).

Squid fisheries make a relatively small contribution to world landings from capture fisheries, as cephalopods were 4% of global fish trade, and 77% of the global catch comes from Asian countries (Funge Smith, Simon. 2012). The proportion of cephalopods in the global trade has increased steadily over recent decades, although landings have apparently levelled off recently (Arkhipkin, A. I. et al. 2015).

The bulk of the global squid catch comprises species from two families, the *Loliginidae and Ommastrephidae*, which are composed of coastal squid species and pelagic/oceanic squid species. Commercial squid fishing

operations are maintained by several countries in coastal and international waters worldwide, and small-scale squid fisheries exist in many parts of the world (Arkhipkin, A. I. et al. 2015). Globally, relatively few squid fisheries are actively managed due to the short lifespan of this species group and uncertain relationship to environmental variability (Chen, Fenjie et al. 2016).

The biological characteristics of the assessed loligo squid species are described below:

***U. chinensis* (mitre squid)** (formerly *Loligo chinensis*)– *U. chinensis* ranges from the western Pacific to the Indian Ocean (Figure 1) and is distributed throughout depths of 15–170 m, although the squid is most abundant in the 30–50 m depth range. Males mature at 105 mm Mantle Length (ML) and females at 90 mm ML. Female fecundity is 3000–20,000 eggs. It is a moderate sized squid, commonly harvested at 200 mm ML with an elongate slender, bluntly pointed mantle and long fins over two-thirds of the mantle length. Spawning occurs throughout the year with two minor peaks during March-July and August-December (Boonwanich, T. et al. 1998) (Chotiyaputta, C. 1995)(P.Jereb et al. 1984)(Suppanirun, T. et al. 2011). The mitre squid has a longevity of no more than 7 months (Jackson, George D. et al. 1992)(Sukramongkol et al. 2007). The size range of mature females is smaller than that of mature males. The mitre squid is the most targeted species in the Chinese loliginid fishery with a peak catch of 100,000 t (Chen, Xin-jun et al. 2013). The fishing of mitre squid is concentrated in the south part of China, mainly from the north of the Taiwan Strait to the South China Sea. Common fishing methods for the mitre squid include otter trawling, light purse seine (lift-net), and handline jigging. Significant catches of mitre squid have also been reported for the Gulf of Thailand, the Philippine Islands, Malaysia, Northern Australia, India and Sri Lanka (Jereb P. et al. 2010).

U. duvaucelii (**Indian squid**) (formerly *Loligo duvaucelli*)- Indian squid is one of the most common species of Indo-Pacific loliginids (Jereb, P. et al. 2006). It is distributed in coastal waters within depths of 0–170 m (Bergman, A. M. et al 2013), from Madagascar, the Red Sea and the Arabian Sea, eastward to the Bay of Bengal (Sri Lanka) and the Andaman Sea, with Taiwan being the northern limit (Figure 2) (Bergman, A. M. et al 2013)(Choi, K. S. 2007)(Jereb, P. et al. 2006)(Meiyappan, M. M. et al. 1993)(Sukramongkol et al. 2007). Length frequency analysis of U. duvaucelii from the waters of India suggests a lifecycle of more than 12 months (Jereb, P. 2006; Mohamed, K. S. 1997; Mohamed 1996). The maximum ML of *U. duvaucelii*(Choi, K. S. 2007) varies throughout its range with the largest specimens found in India (317 mm) (Choi, K. S. 2007). Spawning appears to occur throughout the year, with seasonal peaks depending on the region (Choi, K. S. 2007)(Meiyappan, M. M. et al. 2003)(Sukramongkol et al. 2007). *U. duvaucelli* have been found to prey on both fish and crustaceans, and cannibalism increases with size (>80 mm). It is one of the most important commercial cephalopod species in India(Jereb, P. et al. 2006), Thailand (Chotiyaputta, C. 1993), the Andaman Sea (Sukramongkol et al. 2007), Hong Kong (Choi, K. S. 2007), and the Gulf of Aden (P.Jereb et al. 1984). In China, its fishing grounds are predominantly from the southern East China Sea, along with the Taiwan Strait, and into the northern South China Sea.

***Uroteuthis edulis* (swordtip Squid)** (formerly *Loligo edulis*)- swordtip squid occurs in the Indo-West Pacific Ocean from central Japan to the South China Sea and northern Australia (P.Jereb et al. 1984)(Carpenter, K. E. et al. 1998). From the southwestern Sea of Japan and the East China Sea, this species has a continuous distribution (Figure 3). Despite large differences observed in size and maturation stage among several migrating groups, allozyme analysis indicates the stock consists of one population (Natsukari, Y. et al. 1986). The species has a one-year lifespan, typically lives at depths of 60-100 m, and usually dies after breeding. In China swordtip squid is mainly harvested in the East China Sea and South China Sea, with the central distribution of its fishing grounds being in the southern East China Sea (27°00′-28°30′,122°30′-124°30′) and middle of the East China Sea (28°00′-30°30′N,124°00′-126°30′E) (Yuan-Jia Zheng et al. 1999)(Song Hai-Tang et al. 2008)(Tian-Ming Ding et al. 2000). The hatching season is throughout the year but with spring and autumn as the main spawning seasons (Wang, Kae Yih et al. 2010). It is an important fishery species for Zhejiang and Fujian Provinces (Yuan-Jia Zheng et al. 1999)(Song Hai-Tang et al. 2008)(Tian-Ming Ding et al. 2000). Male and female swordtip have a similar length lifespan but different in maximum size (Wang, Kae-Yih, et al. 2013).Swordtip squid in the

northern South China Sea has a potential biomass of about 16 kilotons (Jian-Zhu Li et al. 2010). Recorded annual landings of swordtip squid in China have generally been more than 20,000 t (Song Hai-Tang et al. 2008) (Chen, Xin-jun et al. 2013).

At the national level, the Bureau of Fisheries (BOF) under the Ministry of Agriculture and Rural Affairs (MOAR) is responsible for China fisheries' development and administration. At the local level, the provincial and municipal/district BOFs are in charge of management implementation and local regulations. The assessed squid resources are subject to local BOF management under the relevant jurisdictions where squid stocks occur.

China employs a fishing permit system initiated in 1979 to regulate domestic fishing vessel behavior and control fishing capacity, and furthermore, has used a "double control" policy since 1997 to limit the country's vessel numbers and aggregate vessel power in order to guide coastal fishery development in a sustainable way. To conserve and utilize the fisheries resources in an orderly manner, China has established many regulations/laws to regulate fishing behaviors (Mu, Y. et al. 2007). The assessed squid fisheries are managed under some of these regulations, such as gear regulation, the mid-summer fishing moratorium, and MPAs. Fujian province, which is located in southern China where important loligo species fishing areas exist, has developed provincial level minimal allowable harvest sizes for mitre squid (Fujian Fisheries Bureau 2016).

There are no existing squid-specific management plans or regulations besides the local harvest size limitation in Fujian, China; the assessed squid species are subject to general Chinese fisheries management regulations. The total number of squid vessels and squid fishing capacity is also unknown as China's fisheries are nearly all multi-specific, and mitre/Indian/swordtip squid fisheries usually are caught along with other marine species that are economically important.

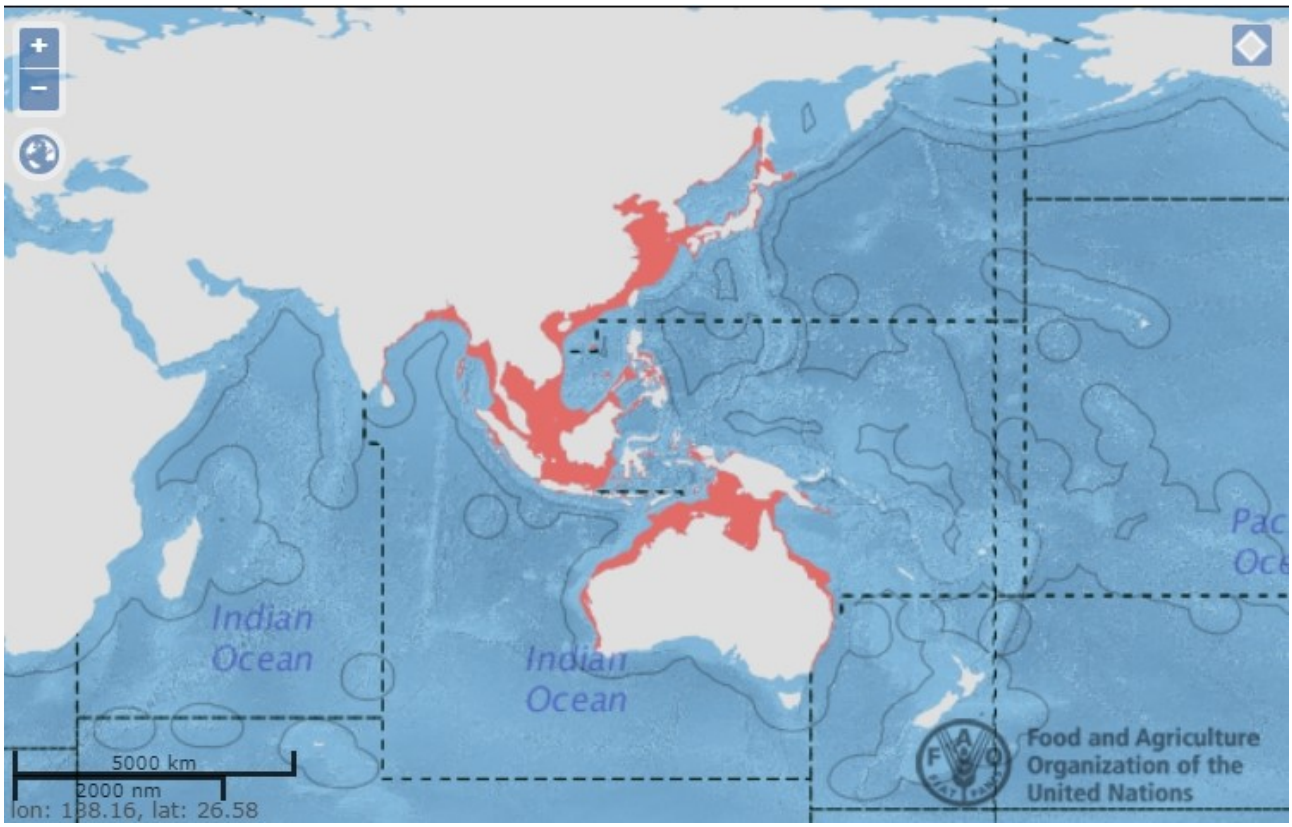

Figure 1 Distribution map for U. chinensis

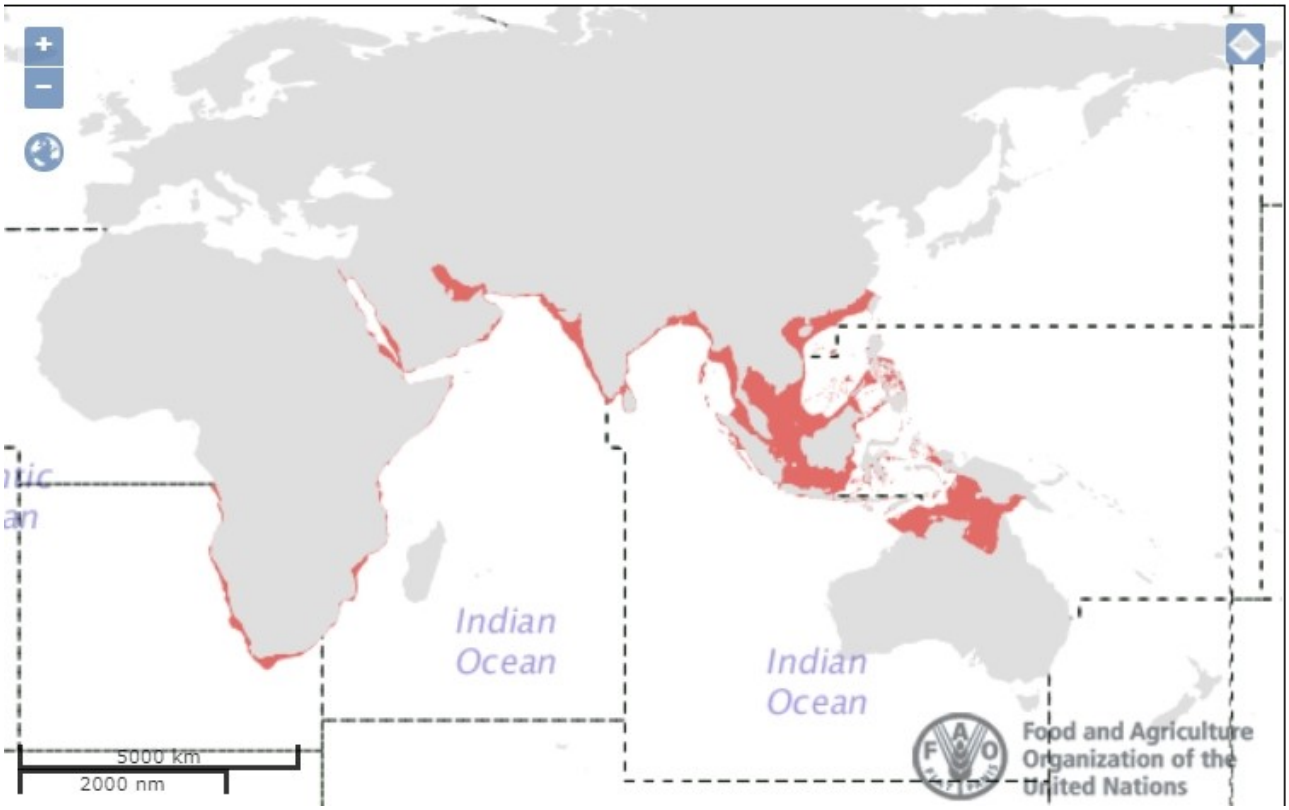

Figure 2 Distribution map for U. duvauceli

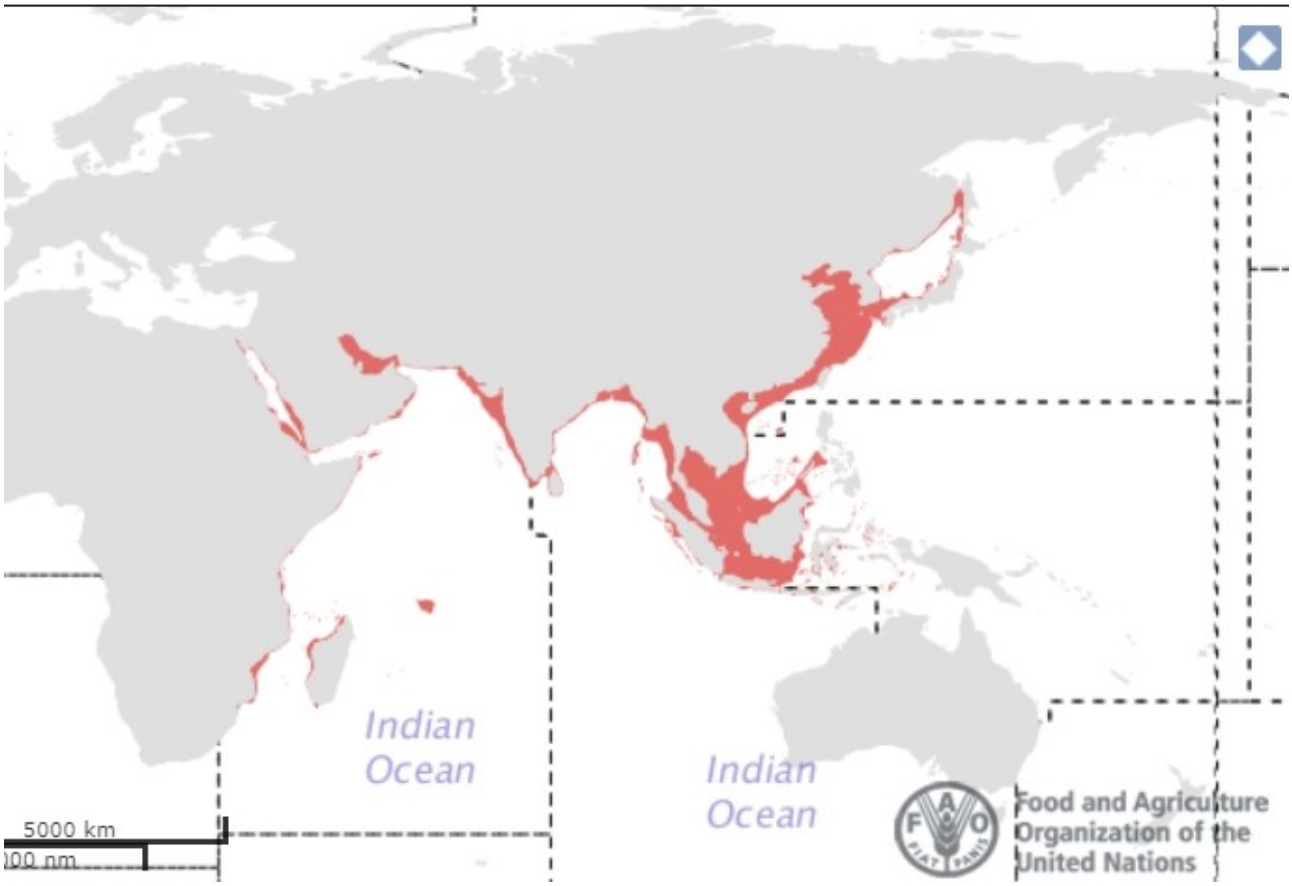

Figure 3 Distribution map for U. edulis

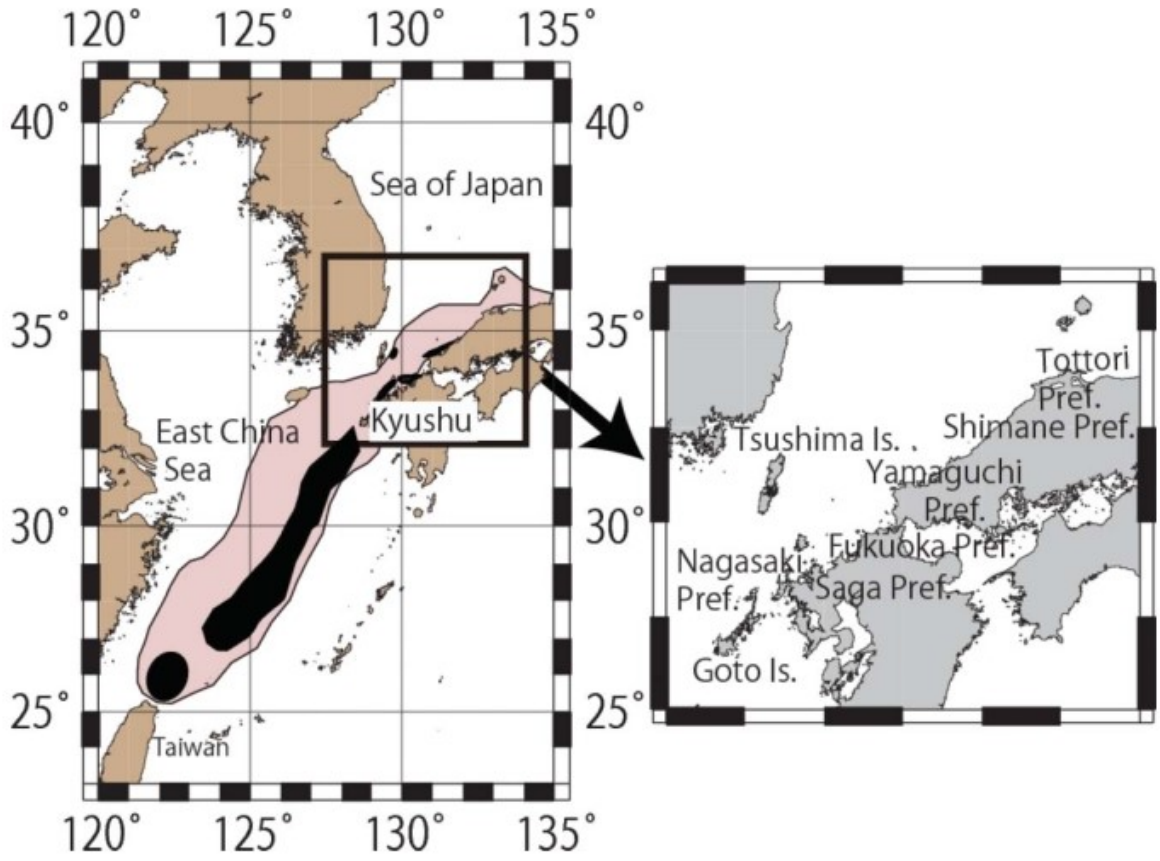

Figure 4 Main distribution area (shaded) and presumed spawning grounds (black) of Uroteuthis edulis (Arkhipkin, A. I.et al. 2015)

Production Statistics

Globally, cephalopod as fast-growing short-lived species that are strongly influenced by environmental variability, increase from approximately 1 million tons in 1970 to peak time 4.3 million tons in 2007 (Jereb P. et al. 2010) then fell sharply to under 3.5 million tons in 2009 (Arkhipkin, A. I. et al. 2015) and getting recover in recent decade (Figure 8). Also, the 2014 FAO data reported total global production of more than 3.7 million tones and more than 95 percent comes from only 18 countries. (SFP 2017) (Figure 5)

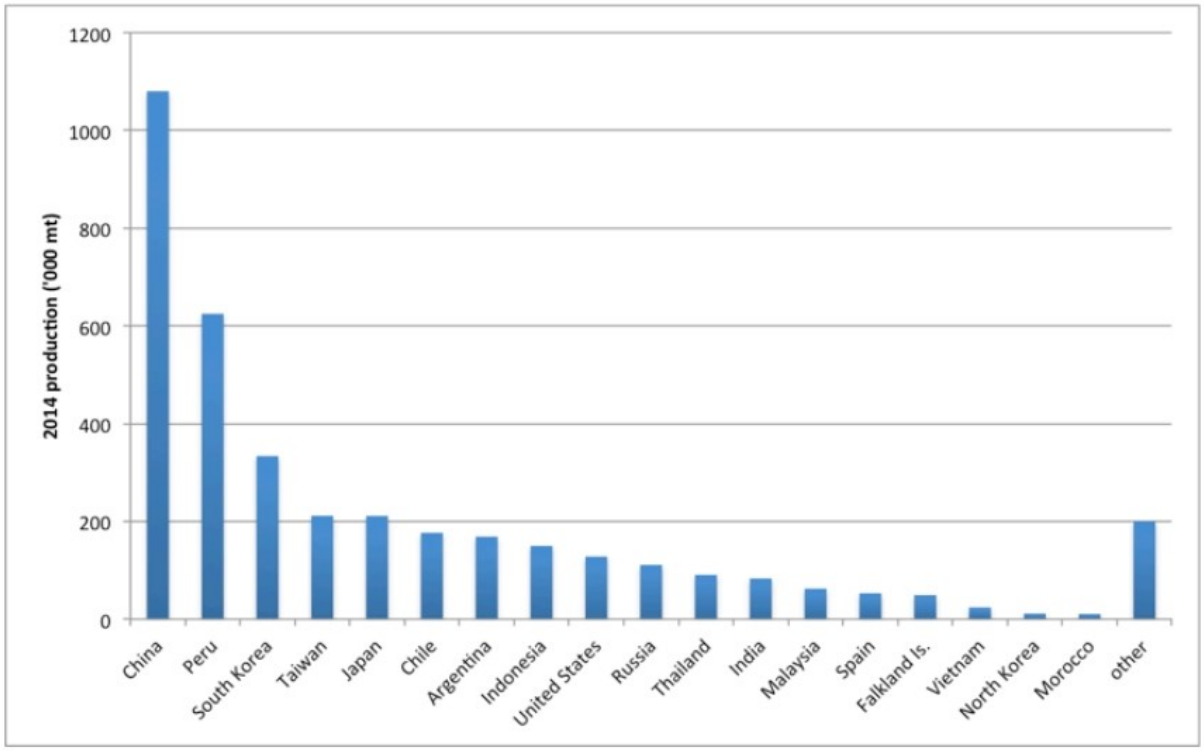

Figure 5 Top 18 squid-producing countries, 2014 production (Data source from SFP Target 75 Reports)

Uroteuthis chinensis (mitre squid) is the major commercially important loliginids species worldwide. The fishing of these squid species is concentrated in Indo-Pacific regions. China harvested mitre squid production is accounted for up to 90% of the Chinese loliginid catch (Chen, Xin-jun et al. 2013)which also represents about 3.7% of global squid production (SFP 2017).

Uroteuthis duvaucelii (Indian squid) is the major commercially important loliginids species on Southeastern Asia. The Indian squid is distributed along Indo-Pacific coastal waters and is an important fisheries resource for China, Thailand, India and other SE Asian countries.

Uroteuthis edulis (swordtip squid) is an important squid species for East China Sea coastal fishing, accounting for almost 80% of the southern East China Sea cephalopod harvest (Wang, You-xi 2002). It is also one of the most important marine products in six prefectures in Japan (Song Hai-Tang et al. 2008)(Arkhipkin, A. I. et al. 2015).

In China, the availability of detailed harvest data (i.e. by gear type, area, and/or species) for the assessed fisheries is extremely limited. Stock related research data is sparse or irregular for most geographic locations. The detailed species-based landings data do not exist, and official statistics only show aggregate data at the level of the species group. National fisheries statistics data exists for squid harvest volumes in China coastal fisheries, but the data are aggregated across all squid species, and there is limited published research on variation in production. This circumstance is common for most fisheries in China as well as many regions in southeast Asia.

Based on the limited data available, swordtip and mitre squid catch volumes gradually increased from 1996 to 2007 with some fluctuations, including a sharp decline in 1998 that was followed by a gradual recovery. Indian squid has only 3 years data, so a trend cannot be described ((Chen, Xin-Jun et al. 2013), Figure 6). The China national squid harvest statistics showed that the catch of squid from 2003 to 2016 peaked from 2003-07 then

sharply declined in 2008. The harvest volume of coastal squid has been mostly stable since then (Figure 7). The 2003-2016 national squid harvest statistics matched the mitre and swordtip squid independent production data from 2003 to 2010 to some degree, indicating that the assessed squid species are the main harvest components in China.

The slight harvest volume increases from 2008 to 2016 does not mean the stock resources are abundant. The development of fishing capacity, advancement of fishing technologies, and shifts in the ecosystem species composition are believed to be the main reasons for the squid harvest volume increase in China coastal fisheries. For instance, some degree of stock decreases has been reported for mitre squid despite the lack of a concrete stock assessment (Chen, Fenjie et al. 2016). There are also reports indicating that Indian squid is overexploited in some regions based on SFP's Indian squid assessment (FishSource 2014).

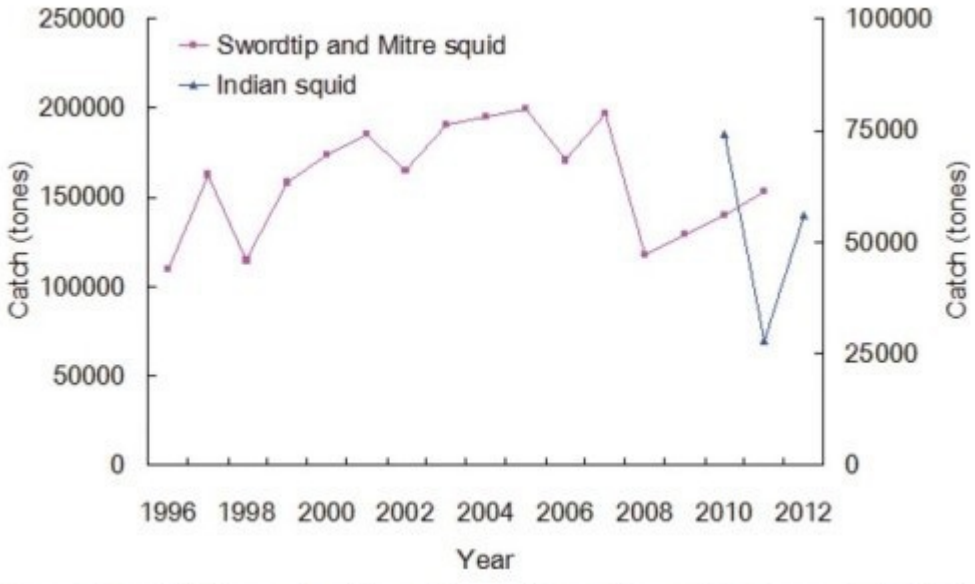

Figure 6 The total annual catches of swordtip, mitre, and Indian squid in China from 1996 to 2002.

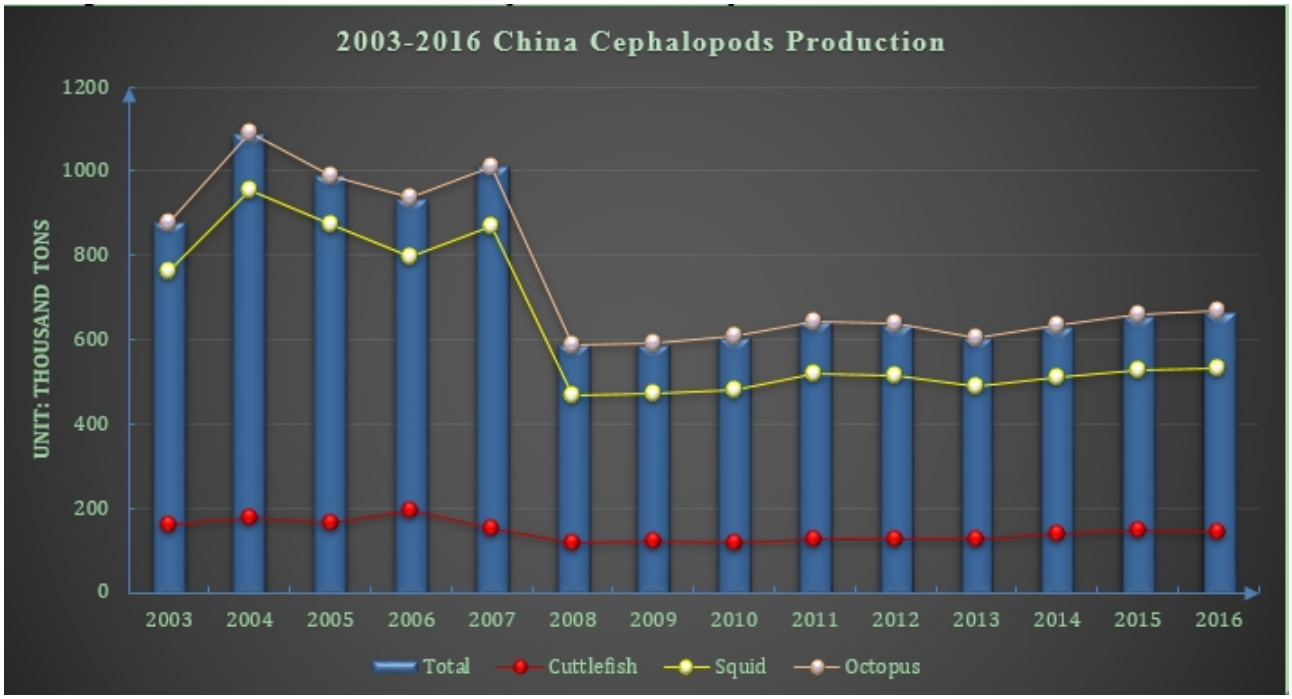

Figure 7 China domestic cephalopods (included squid) production from 2003-2016 (data source China fisheries statistics Yearbook)

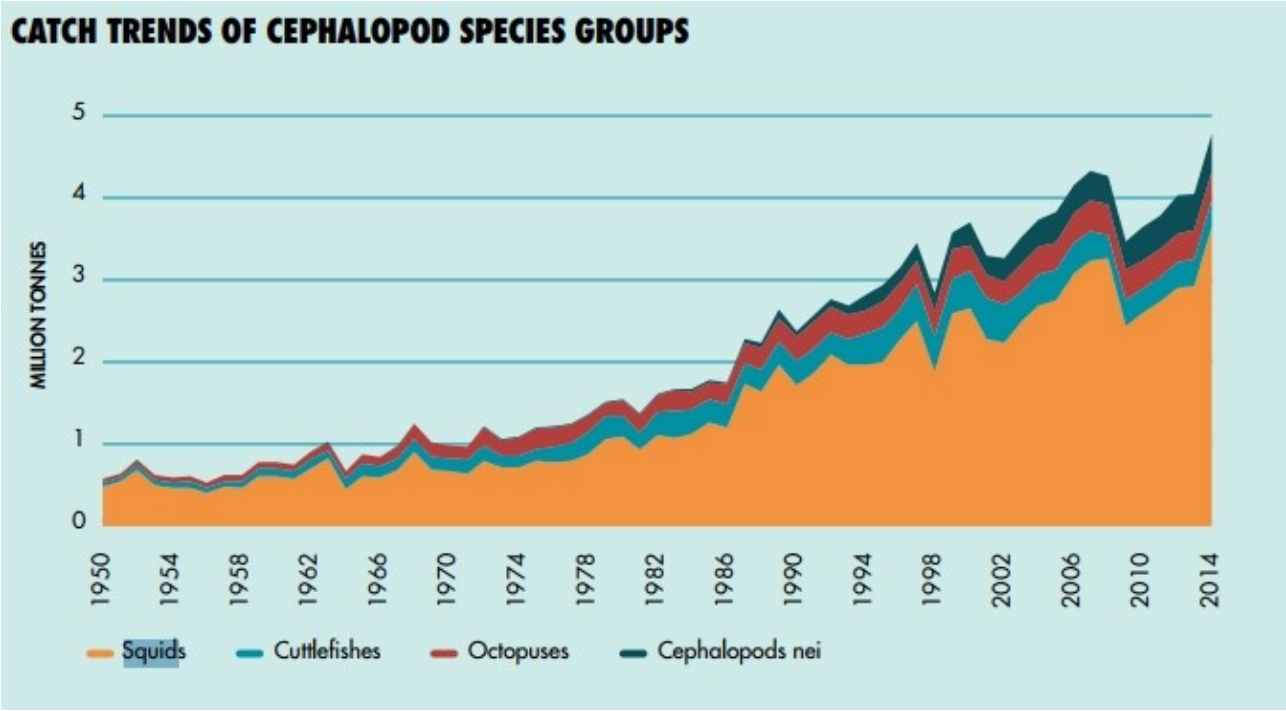

Figure 8 Global Cephalopod Capture Production (tons) (Data from FAO 2016)

Importance to the US/North American market.

The 1980-2017 United States imported squid volume is shown in Figure 9, including the proportion imported from China (Mainland China). The China source squid imports increased from only tiny percentage in 1986 to more than 50% of U.S market share in 2017. The China import squid volume quickly increased from 1990 to 2006, slightly decreased for three years, and then remained fairly stable until 2017. As NMFS's import data categorizes squid only as *Loligo* NSPF or squid NSPF for products imported from China, species-level import data are not available. In addition, it is known that *Loligo pealei* and *Loligo opalescens*, which do not occur in Asia, are re-exported products included in those product categories (they are processed in China and sent back to the U.S.). Nevertheless, China still owns huge share of the U.S. squid import market. Based on local interviews with *Loligo* squid processors (personal communication, Processor Owner Hongbin Li), the Yuedong-Minnan areas produced more than 20 kilotons of *Loligo* products in 2017, which is more than 40% of 2017 import volume from China to the US . However, there are not any concrete data to confirm this estimate.

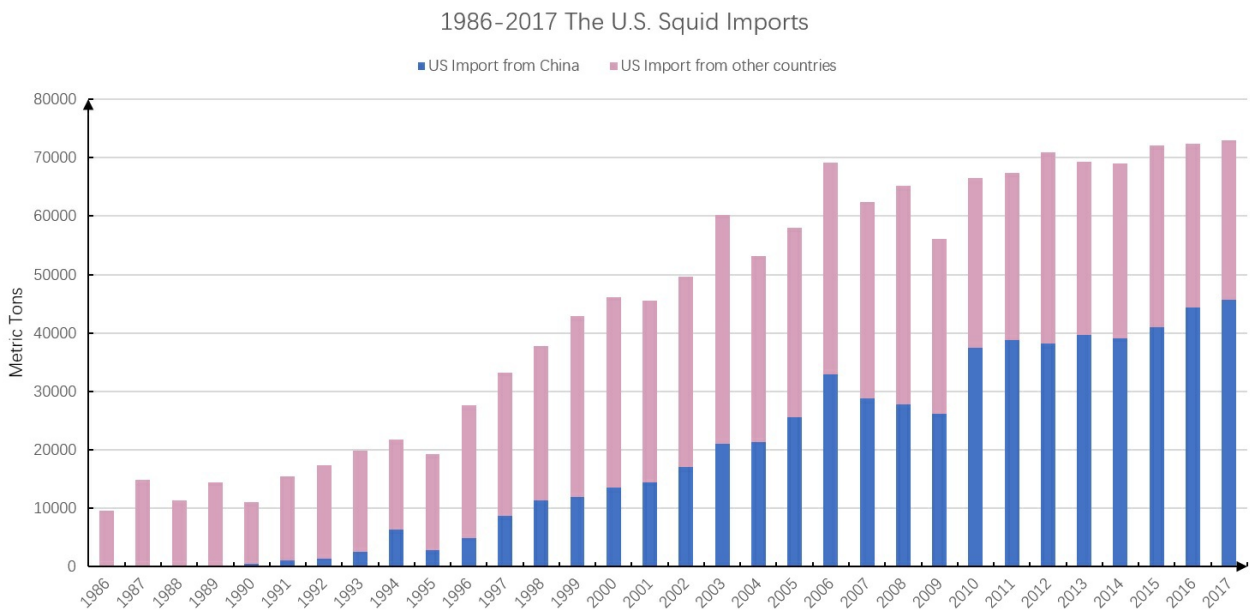

Figure 9 Total U.S. squid Imports 1986 – 2017 (Data from NMFS 2018)

Common and market names.

Uroteuthis chinensis (mitre squid): market names are Chinese squid, Chinese loligo squid, squid, calamari, Ika
Uroteuthis duvauceli (Indian squid): market name are Indian squid, Indian loligo squid, squid, calamari, Ika
Uroteuthis edulis (swordtip squid): market name are Kensaki Ika, calamari, Ika
*squid is commonly sold in the U.S. under the name calamari.

Primary product forms

The squid are sold as frozen whole, fillets, rings, and seafood mix as the most common market forms.

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

INDIAN SQUID			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
China/Northwest Pacific | Bottom trawls	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
China/Northwest Pacific | Jig	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
China/Northwest Pacific | Purse seines	1.00: High Concern	3.00: Moderate Concern	Red (1.732)

MITRE SQUID			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
China/Northwest Pacific | Bottom trawls	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
China/Northwest Pacific | Jig	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
China/Northwest Pacific | Purse seines	1.00: High Concern	3.00: Moderate Concern	Red (1.732)

SWORDTIP SQUID			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
China / Northwest Pacific | Bottom trawls	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
China / Northwest Pacific | Jig	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
China / Northwest Pacific | Purse seines	1.00: High Concern	3.00: Moderate Concern	Red (1.732)

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.*

INDIAN SQUID

Factor 1.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

High Concern

In China, there is no stock level management for mitre, Indian or swordtip squid. No stock reference points have been defined for Indian squid. Based on productivity-susceptibility analysis (PSA) (see below), the stock's high vulnerability to the fishery indicate that high concern is warranted despite the species having biological traits consistent with high productivity.

Justification:

Indian squid occurs at depths between 30 and 170 m. There is relatively little published data on Indian squid in China coastal areas stock compared to mitre and swordtip squid, although Indian squid is known to inhabit the same areas as mitre squid, and studies mentioned that *U. chinensis* and *U. duvaucelii* are the predominant species in Taiwan Strait fishing (Zhuang-li Zhang et al. 2008)(Zhuang-li Zhang et al. 2010). Indian squid is also studied by Taiwanese and Indian researchers, with most publications concentrating on understanding biological characteristics including but not limited to age, growth, foraging, and migration (Park, Young Cheol et al. 2002)(Nitin, Pawar et al. 2015).

Similar to other *Loligo* family species, Indian squid is harvested by trawls, purse seine and jigging. They have high productivity and high susceptibility to fishing operations, as they inhabit the same areas as mitre squid in the South China Sea and the East China Sea and are caught by the same fisheries. Research on Indian squid in the southern East China Sea has found that squid paralarvae are produced almost every month, and the species has high productivity characteristics. Research also mentioned that trawl fishing heavily exploits juvenile fish which are critical prey for squid paralarvae, suggesting that strict enforcement of the summer fishing ban for trawls and purse seine operations is necessary to conserve squid resources (Zhuang-li Zhang et al. 2010).

Trawl, Purse seine, and Jig all have high susceptibility attribute to squid species, purse seine and jigging are known to harvest squid utilize its light attraction characteristics, and able to follow squid's diurnal migration set the gear on the surface (purse seine, jig) or near the bottom for high harvest rate (jig in daytime fishing). Trawl is known to follow its aggregated living feature so able to harvest squid school included the juvenile individuals.

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	Less than 1 -year (Wang, Kae-yih et al. 2015)	1 (<5 years.)
Average maximum age	<= 4 -years (Jereb, P. et al. 2006) For the longevity it varies from 3.08 to 3.54 years based on published research (Sabrah, Manal M. et al. 2015)	1 (<10 years.)
Fecundity	Between 740-14,924 eggs, and each egg capsule contains 125-290 eggs (P.Jereb et al. 1984)(Anusha J.R. et al. 2014)	2 (100-20,000 eggs per year.)
Reproductive strategy	Demersal Egg Layer (Nidsaraporn Petsut et al. 2015)	2 (Demersal egg layer or brooder)
Trophic level	/ Refer to mitre squid data	2 (2.75-3.25)

Density dependence (invertebrates only)	No density or compensatory dynamics demonstrated or likely	2 (No depensatory or compensatory dynamics demonstrated or likely)
Quality of Habitat	Habitat impacts from fishing exist, but no other human interference is identified due to the distance between habitat and coastal zones where human activities are concentrated	1 (Habitat no known degradation from non-fishery impacts
Productivity		1.57

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	Unknown, default score used	MPAs areas cover less than 5% of China's entire EEZ (Liu, Chen-Yao 2015), and no other data is available. Thus the score of high risk (3) is given.
Vertical overlap (Considers all fisheries)	Fishing gear operation and species distribution	3 (Trawls, Jigging and Purse seine are the main fishing gear types for Indian squid which have high vertical overlap between fishing operations and species distribution.
Selectivity of fishery (Specific to fishery under assessment)	Fishing gear characteristic and fishing situation	3 Trawls, purse seine, and jigging gears are used to target Indian squid utilizing the species' biological behaviors/characteristics.
Post-capture mortality (Specific to fishery under assessment)	Retained species	All Indian squid are retained. A score of 3 is given.
Susceptibility		3.0

Factor 1.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

Moderate Concern

There are no quantitative data on squid fishing mortality for any of these three species of squid in China; F and F_{MSY} are not defined, and potential alternatives such as ICES reference points, MSY and SPR do not exist. The landings data from the national fisheries census and relevant research are only able to provide a partial understanding of harvest volumes, and since stock status is unknown, impacts of squid fishing mortality are difficult to assess. The fact that the assessed squid species are harvested using non-selective fishing methods further increases the challenges to understanding fishing mortality.

Some limited data can be used as a reference: within the main distribution areas for the three squid species (East China and South China seas), the occurrence of MPAs is quite low (Anonymous 2011). Some published research mentioned the phenomenon of smaller size at maturation for mitre squid individuals, indicating a need to apply and enforce appropriate stock-based management (Zhuang-li Zhang et al. 2008) (Yuan Li et al. 2011). Data-limited research also suggested that swordtip resource density decreased and harvest rate has declined in some regional surveys (Song Hai-Tang et al. 2008). No data relating to Indian squid stock information for the recent decade can be found; the previously existing data indicated that the species was abundant in the northern South China sea (Huang, Zi-Rong 2008)(Zhuang-li Zhang et al. 2010).

Sources of fishing morality beyond commercial fishing, such as recreational fishing, are not well understood. However, considering that the squid is mainly harvested commercially, no other fishing impacts will be considering here.

In summary, because the squid fishing mortality is unknown for all three species, a score of 'moderate concern' was awarded to this criterion following the SFW standard.

Justification:

The mitre squid, Indian squid, and swordtip squid are managed under the same general China fisheries resources management regulations, which do not directly address fishing mortality. There is a common lack of data and reference points for fishing mortality/exploitation rate, making it a challenge to understand the degree to which the assessed species are exploited.

Existing information about the squid fishing situation in China suggests that fishing may potentially be at unsustainable levels. While considering squid biomass has a strong relationship with environmental factors, high reproductive capacity and short lifespan are that high fishing mortality does not definitely result in low recruitment (Xin-jun Chen et al. 2009)(Wang, Kae-yih et al. 2015). Data from northern South China Sea regional research indicates that the squid resource abundance fluctuates continuously under relatively constant fishing capacity (Yuan Li et al. 2011).

Local surveys have recorded fishermen saying that the squid resources show natural variation as 'big year' and 'small year' harvests, which suggests that this variation regularly occurs even when the level of fishing effort stays somewhat constant (personal communication, Shantou Senior Fisheries Manager, Xiansen Zhu). Thus, it appears that natural variation in the resource may exceed variation in anthropogenic fishing mortality.

Factor 1.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

High Concern

In China, there is no stock level management for mitre, Indian or swordtip squid. Available data indicate there are two spawning groups of mitre squid, or cohorts, one in the spring and the other in the autumn (Chen, Xin-jun et al. 2013), but no stock reference points have been defined for either spawning group or for the stock as a whole. Based on productivity-susceptibility analysis (PSA), the stock's high vulnerability to the fishery indicates that high concern is warranted despite the species having biological traits consistent with high productivity.

Justification:

The mitre squid is the most targeted species in the Chinese *loliginid* fishery with a maximum historical catch of 100 kilotons, and it is the largest catch component in northern South China Sea cephalopod landings (Chen, Xin-jun et al. 2013)(Yuan Li et al. 2011). Squid have short life spans and usually die after spawning, which creates some challenges for the management of stock resources and conservation of spawning cohorts. Future squid recruitment not only depends on the survival rate of hatched paralarva but is also influenced by many other environmental factors that are not well-understood (Arkhipkin, A. I. et al. 2015). Surveys and regional stock analyses have also found that the stock of *U. chinensis* in Beibu Gulf has significantly fluctuated based on mean catch rates (Yuan Li et al. 2011).

The PSA analysis suggests the mitre squid is a highly productive species due to its short life-span and other life history characteristics. However, the PSA also indicates that it is highly susceptible to the squid fishery, as squid distribution areas highly overlap with the fishing zones, and the fishery uses specific measures to aggregate squid for capture (see PSA table below). In addition, relevant research suggests that mitre squid in Chinese waters may be overexploited:

- Research in the northern South China Sea found that the dominant cephalopod species are *Loligo edulis* and *L. duvaucelii* with the average harvest volume of cephalopods in the South China Sea increasing from 0.97% of the total marine harvest in 1995 to 4.69% in 2005, and landings of *loliginidae spp.* (mainly mitre and swordtip) increased from approximately 20k tons in the 1990's to 190k tons in 2008 (Jian-Zhu Li et al. 2010) (Figure 8). The increase of harvest from the research indicated is not necessarily connected to stock biomass abundance but is more likely due to greater fishing capacity and shifts in ecosystem species composition. In addition, researchers claimed that northern South China Sea cephalopod resources are over- or fully exploited (Huang, Zi-Rong 2008).
- Mitre squid in Minnan-Taiwan fishing grounds showed an average Mantle Length (ML) reduction from 211.7 mm in the 1970s to 150.3mm in the 1990s based on trawl surveys, and light lift-net surveys found the ML declined from 157.2mm in 2000 to 144.8mm in 2007. The minimum mature ML in 1976 was 114mm, then fell to 103mm in 2007, obviously suggesting that squid is maturing at smaller sizes and indicating a need to conserve the resources (Zhuang-li Zhang et al. 2008).
- Surveys in the northern South China Sea concluded the mitre squid harvest in Beibu Bay areas also showed indication of maturation at smaller sizes (Yuan Li et al. 2011)

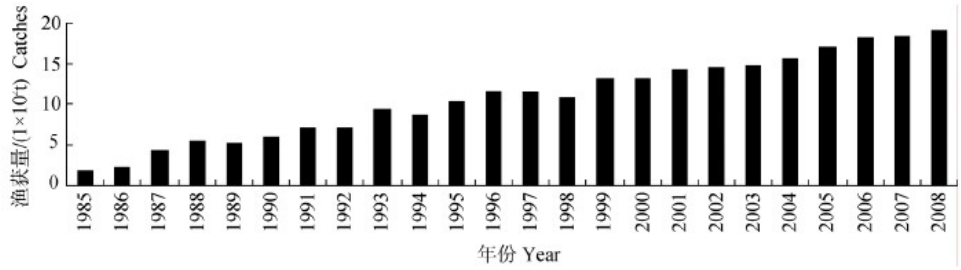

图 11　南海头足类(中国枪乌贼、剑尖枪乌贼为主要种类)渔获量的年变化[17]

Fig. 11　Catches of Cephalopods (*Loligo chinensis* and *Loligo edulis* are main species) in the north of South China Sea[17]

Figure 10 Catches of Cephalopods (Loligo chinensis and Loligo edulis are main species) in the northern South China Sea

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	The age of mature range from 87 to 125 days for males and 75-151 days for females (Sukramongkol et al. 2007)	1 (<5 years.)
Average maximum age	No more than 7 months (Jackson, George D. et al. 1992)	1 (<10 years.)
Fecundity	3,000~10,000 eggs (P.Jereb et al. 1984)	2 (100-20,000 eggs per year.)
Reproductive strategy	Demersal egg layer (Chen, Fenjie et al. 2016)	2 (Demersal egg layer or brooder)
Trophic level	3.15 (Yun-Rong Yan et al. 2013)	2 (2.75-3.25)
Density dependence (invertebrates only)	No density or compensatory dynamics demonstrated or likely	2 (No depensatory or compensatory dynamics demonstrated or likely)
Quality of Habitat	Habitat is impacted by fishing behaviors but no other human activities because the habitat is a certain distance from coastal zones	1 (Habitat no known degradation from non-fishery impacts
Productivity		1.57

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	Unknown, default score used	3, MPAs areas cover less than 5% of China's entire EEZ(Liu, Chen-Yao 2015). Since >30% of the species concentration in the East China Sea and the South China Sea is fished, the default score is applicable.

Vertical overlap (Considers all fisheries)	Fishing gear operation and species distribution range	The distribution deep for mitre squid ranges from 15-170 meters (P. Jereb et al. 1984). As the operation depth of trawls and jigging can be adjusted to overlap with squid distribution depth, a score of 3 is given. The purse seine is also suited for targeting pelagic species. A score of 3 is given considering the high degree of overlap between fishing depths and the depth range of this species.
Selectivity of fishery (Specific to fishery under assessment)	Fishing gear characteristic and fishing situation	Trawls are able to follow squid as they go through diurnal vertical migration patterns while jigging and purse seines utilize the positive phototaxis characteristic. As the assessed species is targeted utilizing the species' biological characteristics/behaviors (aggregation, phototaxis), a score of high risk is assigned.
Post-capture mortality (Specific to fishery under assessment)	Retained species	All squids will be retained after harvest, including other valuable by-catch species. A score of 3 is given.
Susceptibility		3.0

Factor 1.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

See Indian Squid above

CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

Moderate Concern

There are no quantitative data on squid fishing mortality for any of these three species of squid in China; F and F_{MSY} are not defined, and potential alternatives such as ICES reference points, MSY and SPR do not exist. The landings data from the national fisheries census and relevant research are only able to provide a partial understanding of harvest volumes, and since stock status is unknown, impacts of squid fishing mortality are difficult to assess. The fact that the assessed squid species are harvested using non-selective fishing methods further increases the challenges to understanding fishing mortality.

Some limited data can be used as a reference: within the main distribution areas for the three squid species (East China and South China seas), the occurrence of MPAs is quite low (Anonymous 2011). Some published research mentioned the phenomenon of smaller size at maturation for mitre squid individuals, indicating a need to apply and enforce appropriate stock-based management (Zhuang-li Zhang et al. 2008) (Yuan Li et al. 2011). Data-limited research also suggested that swordtip resource density decreased and harvest rate has declined in some regional surveys (Song Hai-Tang et al. 2008). No data relating to Indian squid stock information for the recent decade can be found; the previously existing data indicated that the species was abundant in the northern South China sea (Huang, Zi-Rong 2008)(Zhuang-li Zhang et al. 2010).

Sources of fishing morality beyond commercial fishing, such as recreational fishing, are not well understood. However, considering that the squid is mainly harvested commercially, no other fishing impacts will be considering here.

In summary, because the squid fishing mortality is unknown for all three species, a score of 'moderate concern' was awarded to this criterion following the SFW standard.

Justification:

The mitre squid, Indian squid, and swordtip squid are managed under the same general China fisheries resources management regulations, which do not directly address fishing mortality. There is a common lack of data and reference points for fishing mortality/exploitation rate, making it a challenge to understand the degree to which the assessed species are exploited.

Existing information about the squid fishing situation in China suggests that fishing may potentially be at unsustainable levels. While considering squid biomass has a strong relationship with environmental factors, high reproductive capacity and short lifespan are that high fishing mortality does not definitely result in low recruitment (Xin-jun Chen et al. 2009)(Wang, Kae-yih et al. 2015). Data from northern South China Sea regional research indicates that the squid resource abundance fluctuates continuously under relatively constant fishing capacity (Yuan Li et al. 2011).

Local surveys have recorded fishermen saying that the squid resources show natural variation as 'big year' and 'small year' harvests, which suggests that this variation regularly occurs even when the level of fishing effort stays somewhat constant (personal communication, Shantou Senior Fisheries Manager, Xiansen Zhu). Thus, it appears that natural variation in the resource may exceed variation in anthropogenic fishing mortality.

SWORDTIP SQUID

Factor 1.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

High Concern

In China, there is no stock level management for mitre, Indian or swordtip squid. Available data indicate there are two spawning groups of swordtip squid, or cohorts, one in the spring and the other in the autumn, but no stock reference points have been defined for either spawning group or for the stock as whole. Based on productivity-susceptibility analysis (PSA), the stock's high vulnerability to the fishery indicate that high concern is warranted despite the species having biological traits consistent with high productivity.

Justification:

Similar to mitre squid and Indian squid, there has generally been little research on the stock status of swordtip squid (Tian-Ming Ding et al. 2000). but there are comparatively more data for this species, probably because its annual harvest volume is about 20k tons, and it is an economically important species for East China Sea coastal fishing. (Yuan-Jia Zheng et al. 1999). Researchers have conducted some analysis of annual harvest age-composition (Tian-Ming Ding et al. 2000), growth rate and spatial/seasonal distribution variation in the East China Sea (Song Hai-Tang et al. 2008), and foraging and gonad maturity indices (Wang, You-xi 2002). Research in the East China Sea identified large spawning events occurring in spring and autumn in the inshore waters off northern Taiwan. Juveniles produced by spring and autumn squid spawning group aggregate on the shelf edge in the northern East China Sea, suggesting that spawning also occurs there (Wang, K. Y. et al. 2008). Similar biological research conducted by Taiwanese research focuses on understand stock composition and environmental factors influence on squid growth and migration is existing (Liao, ChengHsin, et al. 2018) (Wang, Kae-Yih, et al. 2013). However, no data on stock status and the current degree of stock utilization are available.

Productivity-Susceptibility Analysis

The PSA analysis suggested that swordtip has moderate to high productivity like other *loliginid spp.* and has high fishing vulnerability based on China's coastal fishing capacity, such that susceptibility was a high concern. Overall, the PSA analysis for swordtip squid produced a score of 3.86, or high concern for the stock abundance.

Productivity Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	<=1-year (Wang, Kae Yih et al. 2010)	1 (<5 years.)
Average maximum age	<= 1-year (Wang, Kae Yih et al. 2010)	1 (<10 years.)
Fecundity	/ Refer to mitre squid data	2 (100-20,000 eggs per year.)
Reproductive strategy	Demersal Egg Layer (Song Hai-Tang et al. 2008)	2 (Demersal egg layer or brooder)
Trophic level	/ No data and refer to mitre squid data	2 (2.75-3.25)
Density dependence (invertebrates only)	No density or compensatory dynamics demonstrated of likely	2 (No depensatory or compensatory dynamics demonstrated or likely)
Quality of Habitat	Habitat impact is caused by fishing behaviors but no other human activities due to the distance between habitat and main human activities areas	1 (Habitat no known degradation from non-fishery impacts
Productivity		1.57

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	Unknown, default score is used	3, MPAs areas cover less than 5% of China's entire EEZ. The degree of areal overlap is unknown, so the default score was used.
Vertical overlap (Considers all fisheries)	Refer to data of fishing gear operation and species distribution	3 Trawls and purse seine are the main fishing gear types for swordtip squid, and both have high vertical overlap between fishing operations and species distribution.
Selectivity of fishery (Specific to fishery under assessment)	Refer to data of fishing gear characteristic	3 Assessed fishing gears target squid by utilizing the species' biological behaviors.
Post-capture mortality (Specific to fishery under assessment)	Refer to local fishing facts	All swordtip squid are retained. A score of 3 is awarded.
Susceptibility		3.0

Other data-poor approaches

Beyond the PSA score, there is some research that provides some insight into the status of China coastal swordtip squid resources:

- In the East China Sea, the swordtip squid resource density index (CPUE indicator) declined from 8.2 kg/h in 1994-96 to 4.2kg/h in 2004-06 (Song Hai-Tang et al. 2008) (Figure 9)
- In the northern South China Sea, swordtip squid resource surveys, especially in the Beibu Gulf, showed that average CPUE was 0.36, 3.55, and 2.80 kg/hr in 1997–1999, 2000–2002, and 2007, respectively (Dian-Rong Sun et al. 2011). In the area west of 25°30'N and 3330'N, 12800'E of the East China Sea, the average CPUE was 8.2 and 4.2 kg/h in 1994–1996 and 2004–2006, respectively (Song Hai-Tang et al. 2008).

表 1　剑尖枪乌贼数量分布的季节变化(一)

Tab.1　Seasonal variation of quantity distribution of Loligo edulis(1)

Years	Spring		Summer		Autumn		Winter		Average	
	/kg	/kg·h^{-1}	/kg	/kg·h^{-1}	/kg	/kg·h^{-1}	/kg	/kg·h^{-1}	/kg	/kg·h^{-1}
1994~1995	12 364	6.9	41 938	19.3	11 830	4.6	5 284	3.0	17 854	8.5
1995~1996	11 199	4.0	47 934	21.3	21 756	5.5	3 479	2.2	21 092	7.9
Total	23 563	5.1	89 872	20.3	33 586	5.1	8 763	2.6	38 946	8.2

表 2　剑尖枪乌贼数量分布的季节变化(二)

Tab.2　Seasonal variation of quantity distribution of Loligo edulis(2)

Years	Spring		Summer		Autumn		Winter		Average	
	/kg	/kg·h^{-1}	/kg	/kg·h^{-1}	/kg	/kg·h^{-1}	/kg	/kg·h^{-1}	/kg	/kg·h^{-1}
2004	10 036	8.7	702	5.1	2 439	2.3	2 140	2.7	3 829	4.9
2005	2 439	3.2	/	/	4 295	5.3	2 056	3.0	2 198	3.9
2006	2 934	3.9	270	4.5	3 660	3.4	1 403	2.7	2 067	3.4
Total	15 409	5.8	972	4.9	10 394	3.5	5 599	2.8	8 094	4.2

* The remarked summer survey was conducted on early of June

Figure 11 The seasonal variation of loligo edulis resources from 1994-95 to 2004-06

The data-limited research showed that the density index of swordtip squid in the East China Sea fell from 1994-96 to 2004-06, and according to South China Sea regional surveys, the stock declined and then rebounded and fluctuated from 1997 to 2007. Even though the data was decades old, it indicated that the stock had same resilience despite being under high fishing pressure.

Factor 1.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

See Indian Squid above

CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

Moderate Concern

There are no quantitative data on squid fishing mortality for any of these three species of squid in China; F and F_{MSY} are not defined, and potential alternatives such as ICES reference points, MSY and SPR do not exist. The landings data from the national fisheries census and relevant research are only able to provide a partial understanding of harvest volumes, and since stock status is unknown, impacts of squid fishing mortality are difficult to assess. The fact that the assessed squid species are harvested using non-selective fishing methods further increases the challenges to understanding fishing mortality.

Some limited data can be used as a reference: within the main distribution areas for the three squid species (East China and South China seas), the occurrence of MPAs is quite low (Anonymous 2011). Some published research mentioned the phenomenon of smaller size at maturation for mitre squid individuals, indicating a need to apply and enforce appropriate stock-based management (Zhuang-li Zhang et al. 2008) (Yuan Li et al. 2011). Data-limited research also suggested that swordtip resource density decreased and harvest rate has declined in some regional surveys (Song Hai-Tang et al. 2008). No data relating to Indian squid stock information for the recent decade can be found; the previously existing data indicated that the species was abundant in the northern South China sea (Huang, Zi-Rong 2008)(Zhuang-li Zhang et al. 2010).

Sources of fishing morality beyond commercial fishing, such as recreational fishing, are not well understood. However, considering that the squid is mainly harvested commercially, no other fishing impacts will be considering here.

In summary, because the squid fishing mortality is unknown for all three species, a score of 'moderate concern' was awarded to this criterion following the SFW standard.

Justification:

The mitre squid, Indian squid, and swordtip squid are managed under the same general China fisheries resources management regulations, which do not directly address fishing mortality. There is a common lack of data and reference points for fishing mortality/exploitation rate, making it a challenge to understand the degree to which the assessed species are exploited.

Existing information about the squid fishing situation in China suggests that fishing may potentially be at unsustainable levels. While considering squid biomass has a strong relationship with environmental factors, high reproductive capacity and short lifespan are that high fishing mortality does not definitely result in low recruitment (Xin-jun Chen et al. 2009)(Wang, Kae-yih et al. 2015). Data from northern South China Sea regional research indicates that the squid resource abundance fluctuates continuously under relatively constant fishing capacity (Yuan Li et al. 2011).

Local surveys have recorded fishermen saying that the squid resources show natural variation as 'big year' and 'small year' harvests, which suggests that this variation regularly occurs even when the level of fishing effort stays somewhat constant (personal communication, Shantou Senior Fisheries Manager, Xiansen Zhu). Thus, it appears that natural variation in the resource may exceed variation in anthropogenic fishing mortality.

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

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.

INDIAN SQUID China/Northwest Pacific | Bottom Trawls					
Subscore:	**1.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.000**
Species | Stock	**Abundance**	**Fishing Mortality**	**Subscore**		
Sharks	1.00:High Concern	1.00:High Concern	Red (1.000)		
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)		
Mammals	1.00:High Concern	1.00:High Concern	Red (1.000)		
Benthic inverts	2.33:Moderate Concern	1.00:High Concern	Red (1.526)		
Forage fish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)		
Mitre squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Swordtip squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Sea turtle (unspecified)	1.00:High Concern	3.00:Moderate Concern	Red (1.732)		
Finfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)		

Seabirds	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

INDIAN SQUID
China/Northwest Pacific | Jig

Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732

Species | Stock	Abundance	Fishing Mortality	Subscore
Mitre squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Swordtip squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)

INDIAN SQUID
China/Northwest Pacific | Purse Seines

Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732

Species | Stock	Abundance	Fishing Mortality	Subscore
Mitre squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Swordtip squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Forage fish	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Finfish	1.00:High Concern	3.00:Moderate Concern	Red (1.732)

MITRE SQUID
China/Northwest Pacific | Bottom Trawls

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Sharks	1.00:High Concern	1.00:High Concern	Red (1.000)
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)
Mammals	1.00:High Concern	1.00:High Concern	Red (1.000)
Benthic inverts	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Forage fish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Indian squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Swordtip squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Sea turtle (unspecified)	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Finfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)
Seabirds	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

MITRE SQUID
China/Northwest Pacific | Jig

Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732

Species | Stock	Abundance	Fishing Mortality	Subscore
Indian squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Swordtip squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)

MITRE SQUID
China/Northwest Pacific | Purse Seines

Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732

Species | Stock	Abundance	Fishing Mortality	Subscore
Indian squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Swordtip squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Forage fish	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Finfish	1.00:High Concern	3.00:Moderate Concern	Red (1.732)

SWORDTIP SQUID
China/Northwest Pacific | Bottom Trawls

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Sharks	1.00:High Concern	1.00:High Concern	Red (1.000)
Corals and other biogenic habitats	1.00:High Concern	1.00:High Concern	Red (1.000)
Mammals	1.00:High Concern	1.00:High Concern	Red (1.000)
Benthic inverts	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Forage fish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Mitre squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Indian squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Sea turtle (unspecified)	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Finfish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)
Seabirds	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

SWORDTIP SQUID
China/Northwest Pacific | Jig

Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732

Species | Stock	Abundance	Fishing Mortality	Subscore
Mitre squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Indian squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)

SWORDTIP SQUID China/Northwest Pacific | Purse Seines					
Subscore:	**1.732**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.732**

Species | Stock	Abundance	Fishing Mortality	Subscore
Mitre squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Indian squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Forage fish	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Finfish	1.00:High Concern	3.00:Moderate Concern	Red (1.732)

The three most common fishing methods in China for the assessed squid species will be assessed in this section, to evaluate influences on other main retained/bycatch species. Trawling (mainly as otter trawling) and purse seine (or alternatively light lift net) are the main fishing methods for squid harvest. Jigging exists only in a small part of China, concentrated on the boundary between the East China Sea and South China Sea. A review of the literature suggests a lack of published information on the catch composition of the squid fisheries but does provide a sense of the types of species caught using bottom trawling and purse seines in the region more generally (see below for each gear). The species included here for each fishery were determined using the following approach:

1. It is assumed that all three squid species are caught together in all fisheries. No other species are included for the jig fishery since the gear is recognized as being very selective in squid fisheries across the globe (see Seafood Watch assessments for Argentinian shortfin squid, jumbo squid and Japanese flying squid).

2. The Seafood Watch unknown bycatch matrices (UBM) were used to identify additional taxa likely impacted by the fisheries. These matrices rate the bycatch susceptibility of different taxonomic groups based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type in the region being assessed. Scores are from 1-5, with 1 being high risk of impacts, and 5 being low risk of impacts. Taxa with scores of <=3.5 are included in the assessment for that gear type, with scores 1-2, 2.5-3 and 3.5 being a high concern (highlighted in red), moderate concern (highlighted in yellow) and low concern for fishing mortality (C2.2), respectively. More information is available in Appendix 2 of the Seafood Watch standard.

Taxon	Bottom trawl	Purse seine
Sea Turtle	3	4
Marine Mammal	1	4

Seabird	2	5
Shark	1	3
Benthic Invertebrates	2	5
Finfish	2.5	2
Forage fish	2	2
Corals and other biogenic habitats	1	5

3. As it is difficult to distinguish between target species in Chinese fisheries for these squid species, additional information on the likely taxa impacted supplements the approach above.

Otter trawl (Bottom trawl)

Otter trawling is the most prevalent squid fishing method in China, accounting for 19% of domestic fishing vessel composition. Otter trawling is a non-selective fishing method that harvests other species besides squids, and fishermen will retain everything that is economically valuable. When fishing operations target squid aggregations, usually the squid catch percentage is high, but it is hard to reach a level of 100% of squid harvest based on fishermen interviews (Personal communication, Senior Captain Junhao Cai). The geographic distribution of Indian, swordtip and mitre squids overlap, and within one fishing area fishers can usually harvest two or three squids together (Huang, 2008). Information on other retained species is lacking for mitre squid otter trawling, but research surveys on the continental shelf of the northern South China Sea in 2016-17 recorded 617 species caught via otter trawling. Among them, finfish, crustaceans, and cephalopods accounted for 79.42%, 16.05%, 4.54% of the catch respectively, and the predominant species for all four seasons included mitre squid [Yan-e Jiang, Zhao-jin Lin, 2009}. This research indicates high biodiversity in mitre squid habitat and potentially high rates of retention.

Swordtip squid trawling mainly takes place in the southern and central to far East China Sea (Yuan-jia Zheng, Jian-zhong LIng, 1999). Trawling is the major fishing method in the East China Sea and accounts for about 50% of the whole East China Sea squid harvest (Wei Fan, Su-fang Zhou, Xue-sen Cui, 2003). There are no data on bycatch or other retained species in swordtip squid otter trawling.

Indian squid is a widely distributed species with apparently high frequency in the southern East China Sea [Zhuang-li zhang, 2010} and northern South China Sea (Yong Li, Hui-quan Li, 2017). There has been no published research on retained species in Indian squid otter trawling fisheries in this region.

Jigging for squid

Jigging is a comparatively selective fishing method reported to be used in the Minnan-Yuedong areas seasonally during the summer fishing ban or winter season when squid tends to difficult to harvested by other gear types (Chen, 2016; J.-K. Gong, 1984). Jigging can be operated over different sea sediment types without impact to benthic ecosystem. Fishing follows the squid shoal migrations, utilizing the squids' attraction to light, and uses

hooks designed to harvest cephalopods (Ji. Gong, 1981). This is a highly selective fishing method, and although data are minimal, interviews suggest that harvests consist mostly of squid with some other cephalopods (e.g., cuttlefish) occasionally harvested as well (personal communication with Yuedong fishermen, Senior Captain Junhao Cai). The handline fishing area in Minnan-Yuedong overlaps with the distributions of mitre and Indian squid, and based on research, the swordtip squid has high abundance in the southern East China Sea (K. Wang et al., 2015).

UBM was used for scoring the handline squid as data on other retained species were unavailable. The results found UBM concluded the jigging bycatch risks for all potential species were small or low concern in jigging fishery. Thus the UBM score for jigging bycatch composition is out of consideration during this assessment.

Purse seine for Mitre/Indian/Swordtip squids

Purse seine fishing includes light purse seine and light lift net, which have similar fishing mechanisms and are categorized under the same gear group. The light purse seine (lift-net) vessels focus on fishing squid species, but they are also harvests other species generally, like *mackerel spp.* and hairtail, and usually catches more than one squid species.

Purse seines are reported used in the northern South China Sea, mainly off Fujian, Guangdong and Taiwan provinces for fishing loligo squid along with fishing other species with positive phototaxis, such as Japanese scads, Round Sardinella, red-eye round herring, and Pacific Chub mackerel etc. One study investigated the catch composition of squid light lift net in Fujian coastal fisheries and found that 9 species of cephalopods (Indian, mitre, and Beka are the predominant species), 35 species of fish, and 1 species of crustacean were harvested (Hong, 2002). The proportion of squid in harvests can vary from minor to more than 75% (J.-K. Gong, 1984). Another report confirmed the popularity of this fishing operations at east and south of Fujian province, as well as its use in harvesting other positive phototaxis species(J.-K. Gong, 1984).

The 1984 study also mentioned that light nets mainly target swordtip and Indian squid with other retained species. The Indian/swordtip squid percentage is highly variable depending on the season (Chang-chun Shen, Xin-hong Su, 2008). The East China Sea is an important swordtip fishing ground even though there are no published study research on by-catch data composition inside the swordtip purse seine fishing. In the South China Sea, purse seine is also reported as a key method for harvesting swordtip (Jian-zhu Li, Pi-mao Chen, Xiao-ping Jia, 2010). For the mitre squid, there are also existing research claimed the purse seine fishing has been found on Taiwan Strait [Zhuang-li Zhang, Sun-zhong Ye, 2008}. Common retained species in squid purse seine fisheries based on one published research survey in the northern South China Sea purse seine fishing are Cutlassfish (*Trichiurus haumela*), Japanese scad (*Decapterus maruadsi*), *Loligo spp.*, Japanese Horse Mackerel (*Trachurus japonicus*), Shortfin Scad (*Decapterus macrosoma*), Indian Mackerel (*Rastrelliger kanagurta*), Bigeye Scad (*Selar crumenophthalmus*). For *loligo spp.* the appearance frequency can be as high as about 90% of harvest as the main species (Lin Yang, Xu-feng Zhang, Yong-guang Tan, 9AD). The single survey listed more than 30 retained species based on sample collection, and no other similar research/data has been found.

Regarding the Indian squid, data are extremely limited within China domestic fisheries. Purse seine fishing in the southern Taiwan Strait is believed harvests mitre squid, Indian Squid together consider the overlap in biological distribution between Indian and mitre squid (Zhuang-li zhang, 2010).

Due to the high diversity of by-catch and retained species, species groups were used as elements to conduct Factor 2.2 assessment. The limited data available suggest that the main species groups in the assessed squid fisheries are *Mackerel spp.* (Chub mackerel, Indian mackerel), *Scads spp.* (Japanese Scad, Japanese horse mackerel), *Cutlass fishes spp.* (largehead hairtail, Chinese short-tailed hairtail), and *Clupeids* (Round Sardinella,

Red-eye round herring). The fisheries also generally harvest more than one kind of squid species (*loligo spp.*, e.g., Indian squid, mitre squid, swordtip etc.).

Notably, data limited method PSA is applied to main retained species groups inside squid purse seine based on available bycatch data, combine with UBM scores to determine retained species' abundance and fishing mortality. Also, most by-catch species are fast-growing, short-lived, and highly productive finfish species showing positive phototaxis.

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)

SHARKS

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

The influence of squid otter trawling on shark resources is unknown, and sharks are considered highly vulnerable accordingly to the SFW criteria; therefore an abundance score of high concern is given.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

The fishing mortality on sharks is unknown so the UBM was applied, giving a score of 1 or a high concern result.

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

CHINA / NORTHWEST PACIFIC
Bottom Trawls

< 100%

There is typically no discard in Chinese fisheries, as virtually everything is retained (Jun-Hao Chen et al.). Therefore discards/total catch is nil, and a multiplying factor of 1 is used. Also, all assessed fishing methods in this report do not involve bait use.

FINFISH

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

As there are no published data on finfish composition in squid otter trawling harvests, and available research suggests that the captured finfish species vary; a score of moderate concern is given based on SFW criteria.

CHINA / NORTHWEST PACIFIC
Purse Seines

High Concern

Stock status of the main finfish species caught in the purse seine fishery for squid is not well understood, with little in the way of recent stock assessment. However, there are some publications able to understand some of by-catch species composition, for example, Cutlass fish, which is also the common purse seine harvest species in China coastal fishing.

Justification:

Research on East China Sea largehead hairtail *Trichiurus lepturus* resources found that the exploitation rate on *T. lepturus* in the period of 2000-2003 was 0.864, which was greater than the optimum exploitation rate (EB) of 0.51, suggesting that the *T. lepturus* in East China Sea was over-fished (Yuan-Jia Zheng et al. 1999). However, some other studies have mentioned that current fishing rates are sustainable for the hairtail stock (Li-ping Yan et al. 2007), as illustrated by the stable production trend following 13 years of implementation of the China summer fishing moratorium (Wang, Yao 2010). The East China Sea is the main fishing area for largehead hairtail. For the South China Sea, the hairtail stock condition is unknown, but considering the similar levels of fishing capacity across China coastal fisheries, we suspect that fishing mortality for South China Sea hairtail is also above a sustainable level. Due to data limited on biomass and reference points, the PSA was used to assess this factor, and scores of 3.3-3.41 or high concern are given.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

Finfish got a score of 2.5 under UBM assessment, indicating moderate concern about fishing mortality.

CHINA / NORTHWEST PACIFIC
Purse Seines

Moderate Concern

Fishing mortality relative to a sustainable level is not well understood for the finfish fish species caught with squid. The score of moderate concern given here is driven by the stock assessment outcomes of Cutlass fish species ([Largehead Hairtail *(Trichiurus lepturus)*/Chinese short-tail Hairtail (*Trichiurus brevis*)]) (See associated justification section).

Justification:

Research on hairtail in the East China Sea from decades ago concluded that the fishing exploitation rate is over the optimum rate, suggested that over-fishing happened (Jian- Zhong Ling, Sheng-fa Li, 2008). However, a research conducted in 2010 concluded that the stock is stable, which conflicts with previous results. As the sustainability of current fishing rates is unknown, a score of moderate concern is appropriate.

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

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Purse Seines

< 100%

There is typically no discard in Chinese fisheries, as virtually everything is retained (Jun-Hao Chen et al.). Therefore discards/total catch is nil, and a multiplying factor of 1 is used. Also, all assessed fishing methods in this report do not involve bait use.

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

The forage fish score is moderate concern, according to the SFW criteria.

CHINA / NORTHWEST PACIFIC
Purse Seines

High Concern

Stock status of the main forage fish species caught in the purse seine fishery for squid is not well understood, with little in the way of recent stock assessment. However, there are indications that at least some of the stocks may be overexploited (e.g. stock assessment for Pacific chub mackerel (Wang, Y. et al. 2014), declines in data poor indices such as average age, weight at maturity, maximum weight, or body length in Japanese horse mackerel and the clupeids(Ning Cao et al. 2006)). A Productivity Susceptibility Analysis (PSA) concluded that despite these species being highly productive, their susceptibility to being subject to overfishing is high. For these reasons, a 'high concern' for abundance is appropriate.

Justification:

Mackerels - Pacific Chub mackerel (Scomber japonicus), Indian Mackerel (Rastrelliger kanagurta)

Pacific chub mackerel (*Scomber japonicus*) are targeted in the squid fishery (Gong, Jin-Ke et al. 1984). 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, Y. et al. 2014). However, the overall stock status in all squid fishing areas is unknown, and stock status of Indian mackerel is also unknown. Based on data-limited PSA assessment, the score for Chub/Indian mackerel varies from 3.2-3.25, or high vulnerability according to SFW criteria.

Scads - Japanese Scads (Decapterus maruadsi), Japanese horse mackerel (Trachurus japonicus)

Based on available research, Japanese scads are a main retained species in squid fisheries. The most recent information on stock condition is from 1980s research, and there have been no stock status updates in recent decades (Xu-Cai Xu et al. 1992), Research on part of the East China Sea (Zhejiang coastal fishing) on Japanese scads indicated that the stock still has potential for further exploitation (Ji Zheng et al. 2012).

The Japanese horse mackerel stock condition is unknown based on publicly available data, and the only abundance indicator is the range of body lengths of harvested individuals, which has been getting smaller based on surveys (Ning Cao et al. 2006). PSA was used to assess scads as a retained species, and the analysis produced a score of 3.25-3.3, or high concern for the stock abundance.

Cutlassfish - Largehead Hairtail *(Trichiurus lepturus)*/Chinese short-tail Hairtail (*Trichiurus brevis*)

Research on East China Sea *Trichiurus lepturus* resources found that the exploitation rate on *T. lepturus* in the period of 2000-2003 was 0.864, which was greater than the optimum exploitation rate (E_B) of 0.51, suggesting that the *T. lepturus* in East China Sea was over-fished (Yuan-Jia Zheng et al. 1999). However, some other studies have mentioned that current fishing rates are sustainable for the hairtail stock (Li-ping Yan et al. 2007), as illustrated by the stable production trend following 13 years of implementation of the China summer fishing moratorium (Wang, Yao 2010). The East China Sea is the main fishing area for largehead hairtail. For

the South China Sea, the hairtail stock condition is unknown, but considering the similar levels of fishing capacity across China coastal fisheries, we suspect that fishing mortality for South China Sea hairtail is also above a sustainable level. Due to data limited on biomass and reference points, the PSA was used to assess this factor, and scores of 3.3-3.41 or high concern are given.

Clupeids - Round Sardinella (Sardinella aurita), red-eye round herring (Etrumeus teres)

Research shows that the average age, weight at maturity, and maximum weight all have tended to decrease during the past decades, suggesting some degree of maturation at younger ages and smaller sizes (Hui-qi Zhong et al. 2014). No other information on stock condition is available. The PSA scores for the red-eye round herring and round sardinella are 3.25-3.31, or high concern.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

Forage fish received a score of 2, or high concern, for otter trawl fisheries according to the SFW unknown bycatch matrices.

CHINA / NORTHWEST PACIFIC
Purse Seines

Moderate Concern

Fishing mortality relative to a sustainable level is not well understood for the forage fish species caught with squid. The score of moderate concern given here is driven by the general stock assessment outcomes of limited known species except for Pacific chub mackerel (see the Justification section), which found fishing mortality to be higher than that at MSY.

Justification:

Mackerels - Pacific Chub mackerel (Scomber japonicus), Indian Mackerel (Rastrelliger kanagurta)

The 2013 stock assessment found that the current (2013) fishing mortality of Pacific chub mackerel (F_{curr} = 0.7) was higher than the fishing mortality at maximum sustainable yield (F_{MSY} = 0.4). Since this research confirmed the chub mackerel was overexploited in the East China Sea, fishing mortality is scored as high concern, as fishing mortality is higher than a sustainable level than is appropriate given the species' ecological role. For the Indian mackerel, there is no evidence to know the level of fishing mortality, which is scored as high concern as the co-inhabit species.

Scads - Japanese Scads (Decapterus maruadsi), Japanese horse mackerel (Trachurus japonicus)

As the fishing mortality of retained Japanese scad/Japanese horse mackerel is unknown, based on the Seafood Watch Standard a score of moderate concern is appropriate.

Clupeids - Round Sardinella (Sardinella aurita), red-eye round herring (Etrumeus teres)

The fishing mortality rate is unknown and is scored as moderate concern following Seafood Watch Standard.

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

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Purse Seines

< 100%

There is typically no discard in Chinese fisheries, as virtually everything is retained (Jun-Hao Chen et al.). Therefore discards/total catch is nil, and a multiplying factor of 1 is used. Also, all assessed fishing methods in this report do not involve bait use.

CORALS AND OTHER BIOGENIC HABITATS

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

The main coral habitats in the China coastal sea zone are concentrated in the southern part of the South China Sea, offshore areas near Taiwan and Hainan Islands, the East China Sea and some other parts of China coastal areas. Although there are some Chinese MPAs cover coral habitats, some areas had already been damaged following decades of trawling operations (Qiao-min Zhang et al. 2006). There is no research or data regarding connections between squid fisheries and coral ecosystems. The corals are received a default score of high concern.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

The UBM score for the corals is 1, equal to a high concern score under SFW criteria.

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

CHINA / NORTHWEST PACIFIC
Bottom Trawls

< 100%

There is typically no discard in Chinese fisheries, as virtually everything is retained (Jun-Hao Chen et al.). Therefore discards/total catch is nil, and a multiplying factor of 1 is used. Also, all assessed fishing methods in this report do not involve bait use.

MAMMALS

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

In the East China Sea and South China Sea where mitre, Indian and swordtip squid fishing occurs, there are some habitats for marine whales and dolphins (Xi Zhu et al. 2000). Marine mammals are considered highly vulnerable according to the SFW criteria; therefore, an abundance score of high concern is given.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

There are some marine mammal species (e.g., Chinese white dolphin) with geographic distributions that overlap with assessed squid fishing areas. However, there are no known reports of marine mammal bycatch historically in the squid fishery. Thus no evidence exists to support a score higher than the UBM score which is 1, or 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.

RATIO OF BAIT + DISCARDS/LANDINGS	FACTOR 2.3 SCORE
<100%	1
>=100	0.75

CHINA / NORTHWEST PACIFIC
Bottom Trawls

< 100%

There is typically no discard in Chinese fisheries, as virtually everything is retained (Jun-Hao Chen et al.). Therefore discards/total catch is nil, and a multiplying factor of 1 is used. Also, all assessed fishing methods in this report do not involve bait use.

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

Fishery	Management Strategy	Bycatch Strategy	Research and Monitoring	Enforcement	Stakeholder Inclusion	Score
Fishery 1: China/Northwest Pacific | Bottom trawls	Ineffective	Ineffective				Red (1.000)
Fishery 2: China/Northwest Pacific | Jig	Ineffective	Highly Effective				Red (1.000)
Fishery 3: China/Northwest Pacific | Purse seines	Ineffective	Ineffective				Red (1.000)

The Seafood Watch standard provides for a Score of 1 (red) for Criterion 3 if C3.1: Management Strategy and Implementation or C3.2: Bycatch Strategy are 'Ineffective.' That is the case in this report, so C3.3-3.5 are not assessed.

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 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.

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

Ineffective

Due to the lack of specific management strategies that are expected to be reasonably effective for the main harvested /retained species in mitre/Indian/swordtip squid fisheries, and the unknown effectiveness of the general fisheries management strategies to conserve squid resources, this criterion is assessed as ineffective. Furthermore, the previous regional stock evaluation (Zhuang-li Zhang et al. 2008)(Chen, Fenjie 2016)(Hai-tang Song et al. 2001) indicated that stocks are to some degree unhealthy because of the negative impact of high fishing capacity, with no measures available to rebuild stocks or limit the fishing capacity effectively.

Justification:

Chinese fisheries management strategies are mainly developed by the National Fishery Bureau under the Ministry of Agriculture and Rural Affairs (MoAR), with local authorities (provincial, autonomous region, municipal) implementing, supplementing, and enforcing these strategies. Feedback also is collected by local bureaus via submitting to central MoAR to improve fisheries management. As a short-lived and fast-growing species, squid have some management challenges not typically addressed by traditional fisheries management. Worldwide, some countries (e.g., Japan, Argentina) impose TACs or spawning cohort conservation measures to utilize squid resources more sustainably (Ministry of Agriculture 2017).

The squid fisheries, either trawls, purse seine or Jigging, are all subject to general Chinese coastal fisheries management rules under the China fishery resources management system structure without any squid-specific management strategies (Ministry of Agriculture 2014). The only squid specific harvest requirement is a local minimum allowable size regulation set up by Fujian Province for mitre squid in 2016 (harvested squid must have a mantle length (ML) >=12 cm) (Fujian Fisheries Bureau 2016), but the extent of implementation is unknown.

The general China coastal fisheries management system contains various management components, relying mainly on fishing input controls and supplemented by fishing output and gear controls (Li, Qianyun 2018). Fishing licenses, fishing behavior regulations, fishing ban regulations and regular inspection by fisheries enforcement helps ensure that fishing is conducted legally. (Mu, Y. et al. 2007). There are also a series of measures developed and implemented by local fisheries authorizes to regulating native fisheries resource utilization while none of them are known to specific on squid management yet.

Management measures that are applied to the assessed squid resources are described in details here. In terms of fishing gear regulations, there is a minimum mesh size and prohibition of destructive fishing gear. Stock enhancement and TAC pilots do not involve squid resources currently. Fishing zone regulations (e.g. MPAs) and marine conservation plans (e.g. reservations of aquatic germplasm resources) are applied in some marine water zones which overlap with squid distributions or spawning/foraging grounds which help conserve

the squid resources in some ways. In particular, the Chinese government believes the summer fishing moratorium is an effective measure to conserve the fisheries resource (Ministry of Agriculture 2009). The newest temporal fishing bans for Chinese water zones are shown in Table 1. They cover the spawning periods of most economically important species, including the assessed squid species, which helps protect the foraging/spawning cohorts, while the Jigging fishing as the only allowable fishing method during the summer fishing ban season turned out this regional fishing continually exploit the squid resources, possibly harvest the spawning cohorts due to time overlap of squid main spawning season (mainly concentrates on Minnan-Yuedong areas) put the summer fishing ban conservation effectiveness on squid resources into uncertain. It is possible that fishing on spawning individuals occurs during the summer ban season, especially when squid form spawning aggregations during the summer season (Chen, Fenjie 2016).

Table 1. Summer fishing ban regulations for China coastal fisheries (updated in Aug. 2018).

Time	Areas	Prohibited fishing types	Water Zone	Additional info	Remarks
12 PM 1st. May-12PM 1st Sep.	Northward of 35° N	All fishing gears except line fishing	The Bohai Sea & Northern Yellow Sea		• All China coastal set-net fishing is subject to the ban starting 12 PM 1st May for at least 3 months; details should be formulated by locals and submitted to the Central Fisheries Bureau • Species of specially economic importance may be subject to exclusive fishing license regulations (during the ban season), which require application from locals to the centrals in advance • Support vessels are required to follow respective fishing ban regulation; specific support vessel can apply for limited operation if it has rationality and exclusively supports to fishing vessel operates in a sustainable way. • Local bureaus are allowed to create stricter regulation for the fishing ban under
12 PM 1st. May-12PM 16th Sep.	35° N to 26°30′N	All fishing gears except line fishing	The Southern Yellow Sea & Northern East China Sea		
12 PM 1st. May-12PM 16th Aug.	26°30′N to 'Min-Yue Marine boundary'	All fishing gears except line fishing and these*	The Southern East China Sea	*These gears include Gillnet, Light purse seine (lift net), Pots & Cages, Beam shrimp trawl	
12 PM 1st. May-12PM 1st Aug.	26°30′N to 'Min-Yue Marine boundary'	Gillnet, Light Purse seine (lift net), Pots & Cages, Beam shrimp trawl	The Southern East China Sea	Min-Yue Marine Boundary is the connected line from 117º31'37.40"E, 23º09'42.60" N to 120º50'43"E, 21º54'15" N	

12 PM 1st. May-12PM 16th Sep.	From 'Min-Yue Marine Boundary' to 12°N	All fishing gears except line fishing	Beibu Bay & Northern South China Sea		the national regulations structure

squid-specific resource management measures, such as harvest control rules and monitoring of abundance indicators are generally missing. The effectiveness of general fisheries management measures to conserve squid resources is hard to evaluate, and their effectiveness for maintaining other fisheries resources is also uncertain. Meanwhile, the stock status of squid is limited to some regional assessments that do not include overall quantification of fishing effort, information on long-term variation, or regular update stock status is missing. Notably, China fisheries management now pays more attention to conservation of declining coastal resources by implementing measures such as limits on fishing vessel numbers and fishing capacity, which they attempt to coordinate with other measures for better achieve fisheries resource conservation goal (Ministry of Agriculture 2017)(Ministry of Agriculture 2017).

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 / NORTHWEST PACIFIC
Purse Seines

Ineffective

By-catch management is generally lacking in China, where non-selective fishing methods prevail and there is no quota-based management. The main fishing areas for mitre squid, Indian squid, and swordtip squid are north of the South China Sea and the East China Sea which covers Minnan, Taiwan Shallow Bank, Yuedong and others traditional fishing grounds where high biodiversity occurs (Cai-hua Ma et al. 2006)(Yong-jun Chen et al. 2016). Considering the non-selective natures of trawls and purse seines (which are not selective with regard to pelagic species that have positively phototaxic behavior), squid fishery harvests are unavoidably multi-species.

As China currently applies general fisheries resources management measures without TAC/quota-based management tools *in situ,* fishermen can retain all captured species as long as no ETP or prohibited species/size are caught. Some local enforcement entities add extra management measures regarding harvest of specific species, but there are none for squid besides the Fujian catch size limit (Bureau of Zhejiang Provincial Fisheries 2014). Trawls, purse seine also have regulated mesh sizes (Ministry of Agriculture 2013)

(Ministry of Agriculture 2018), but their effectiveness at reducing bycatch of juvenile/small-bodied individuals is unknown. Also, the fishing mortality rates from the assessed squid fisheries on main retained and bycatch species are unknown.

There are some regulations and laws to protect ETP species and juvenile fish, as well as education programs to increase fishermen's awareness of the need to conserve those species (Ministry of Agriculture 2017)(Kuan, Lao 2018). There is also existing minimal catch size regulation for several economically important aquatic species should able to address bycatch of juvenile individuals of listed species while the enforcement and effectiveness are unknown. The effectiveness of regulations to minimize the bycatch of ETP or protected species is unknown also. Data collection regarding ETP species, including by-catch evaluation and stock status assessment, is generally lacking. There are occasional reports of ETP species being harvested and traded (Observer 2017). There are currently no regulations to address abandoned fishing gear, and there are many reports of broken or useless fishing gear being discarded into the ocean (Anonymous 2017), which poses a risk of ghost fishing that has not been evaluated.

Considering the lack of bycatch management measures, ghost fishing mitigation measures, and quantification of fishing impacts on ETP species, the bycatch strategy is scored as ineffective.

CHINA / NORTHWEST PACIFIC
Jig

Highly Effective

In contrast to bottom trawls and purse seines, squid jigging is inherently a selective method selective method that seldom produces bycatch of other species including ETP species

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

Region | Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Score
China/Northwest Pacific | Bottom trawls	1	0	High Concern	Red (1.414)
China/Northwest Pacific | Jig	5	0	High Concern	Yellow (3.162)
China/Northwest Pacific | Purse seines	5	0	High Concern	Yellow (3.162)

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

CHINA / NORTHWEST PACIFIC
Bottom Trawls

1

Key relevant information:

Bottom trawls, which are the most commonly used fishing method, operate on the benthos and poses risks to the seafloor in fished areas. The traditional fishing ground for the assessed squid species covers both the northern South China Sea and southern East China Sea, so it is difficult to know how the fishing operations impact all relevant seafloor types. No published data on seafloor types can be found except for one study that described seafloor sediments in southeast China. Results suggested that the most common sediment types in the northern South China Sea and East China Sea are sand and silty clay (Bo Lu et al. 2006). Following the Seafood Watch criteria, a score of 1 is given to this factor.

Justification:

There are no published data on harvest impacts of bottom trawls for the assessed squid fisheries. The only data available is from fishermen interviews, which confirmed that trawls are the main gear type used to harvest squid (personal communication, Junhao Cai). From the limited research available, we know bottom trawls catch many other benthic species, confirming that trawls likely interact with the seabed. There are also reports of trawls accidentally catching squid egg capsules which contributes to loss of recruitment. Squid species generally require appropriate benthic substrate (e.g., rocks, corals) for egg laying, and thus long-term, unregulated trawling would likely reduce suitable squid spawning areas. Several reports have described damage to benthic ecosystems due to long-term trawling (Anonymous 2016).

It is worth highlighting that trawling is not only the primary squid harvest method, but it also is the most prevalent fishing method in general coastal fishing. Trawls have already been operated for decades on offshore seabed without evaluation of impacts on associated seabed. Some coral or biogenic habitat is believed be have been destroyed by decades of trawling operation. However, the Chinese government has been testing some mitigation measures, such as the construction of artificial reefs and establishment of MPAs to conserve important ecosystem areas. Still, most offshore areas are open to fisheries, and the influences from otter trawls on the seafloor habitat and ecosystem are unknown.

CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

5

Key relevant information:

Based on personal communication with fishermen (personal communication, Junhao Cai), the jig and purse seine fisheries for the mitre/swordtip/Indian squid do not contact the seafloor. Desktop literatures review based on limited squid purse seine research also confirmed that no benthic species were harvested based on catch composition (Lin Yang et al. 2009)(Lin, Yin-qi 1987). Similar fishing operations involving light lift-net also confirmed that this gear does not touch the sea bottom (Hong, Ming-jin 2002)(Chang-chun Shen et al. 2008) (Zhi-yong Wang et al. 1992).

Since squid purse seine and jigging fisheries both do not contact the seafloor, according to the Seafood Watch

Standard a score of 5 is given, and Factor 4.1b was skipped for the assessment.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

0

Key relevant information:

Some marine reserves have been set up within squid fishing grounds in the northern South China Sea and East China Sea, but their total size percentage of overall assessed fishing areas is unknown (Li, Qianyun 2018). One article mentioned that the total MPAs established in the China EEZ are less than 5% of the total water territory (Liu, Chen-Yao 2015). Many vulnerable habitats are protected under regulations, but the coverage of all offshore vulnerable habitats is unknown. One case report stated that the destruction of critically vulnerable habitat has occurred occasionally (The Central People's Government of the People's Republic of China. 2012). Fishing intensity has been continuously high even after years of the government's 'double control' regulation to limit the growth of fishing capacity and vessel numbers (Mu, Y. et al. 2007). Additionally, desktop research has not uncovered any gear modifications for reducing adverse impacts on the seafloor in the assessed fisheries. Other measures for mitigating adverse effects are missing as well. Since no effective measures or gear modifications have been implemented to reduce negative impacts on the seafloor, a score of 0 is given according to the Seafood Watch criteria.

Justification:

Through decades of high-intensity fishing operation, scientific research on the seafloor and benthic ecosystem impacts are limited. One article mentioned desertification of the seafloor in several China offshore areas, but it was a regional report that was not very comprehensive and robust (Wang, Yi-min 2011). Though fishery impacts on China offshore benthic ecosystems and habitats are unknown, it is important for the Chinese government to continue implementing and building on actions to conserve marine habitat via measures such as MPAs, conservation of aquatic genetic diversity, and protection of critical spawning grounds (Banyuetan 2017). No existing catch quota or protection measures are specifically aimed at conserving squid resources (e.g., squid spawning reserves), and the general fisheries management enforcement efficiency is uncertain. Although some marine conservation areas (e.g., reserves) overlap with the squid spawning/foraging zone, the total MPA size is tiny relative to overall squid distributions.

The desktop research did not locate any reports on gear modification/adjustment for minimizing trawls' impact on the seabed. Only reports focused on improving gear efficiency were found. The current lack of regulations on trawl operations will make implementation of any mitigation measures more challenging.

Factor 4.3 - Ecosystem-Based Fisheries Management

CHINA / NORTHWEST PACIFIC
Bottom Trawls
CHINA / NORTHWEST PACIFIC
Jig
CHINA / NORTHWEST PACIFIC
Purse Seines

High Concern

Key relevant information:

Mitre/Indian/Swordtip squid are opportunistic species with short life-spans occupying the middle-high trophic level, so that biomass levels affect relevant prey and predator species. Squid are food sources for many larger species, including mackerel, grouper, sharks, and protected marine mammals. Squid themselves prey on many small fish species and crustaceans. Thus large fishery removals of squid may affect the ecosystem.

In general, there are no policies in place to manage or assess squid fisheries at an ecosystem-based level that accounts for squid's ecological roles. There are only limited regional stock data available, and it is unknown whether fluctuations in squid stock abundance has detrimental impacts on the food web. In interviews, local fishermen mentioned that the squid resources have continued to fluctuate in recent years, and annual harvest volumes have gradually declined in the most recent decade. Such variation may contribute to detrimental food web impacts (Personal communication, Captain Junhao Cai).

Given the fact that squid fisheries lack spatial management and policies for protecting ecosystem functioning, detrimental food web impacts are possible. A score of 2 or high concern is assigned.

Justification:

Against the background of general declines in coastal Chinese fishery resources, squid resources have become more important due to their relatively high productivity and stock resilience to high fishing rates. Research has indicated that squids are becoming important fisheries resources in the global context as well, with global groundfish landings declining (Caddy, J. F. et al. 1998). Better squid resource management is therefore critical for future fisheries resource utilization.

Although ecosystem-based fisheries management is absent, the Chinese government has launched many new actions to protect environments, such as an ecological redline setup[j1] and aquatic pollution mitigation. These actions suggest that management is attempting to manage ecosystem impacts from different angles. Only limited stock assessment data exists, and it is not sufficient to support development of ecosystem-based management. Also, there is no research being conducted on squid ecological roles or squid fishing impacts on the overall ecosystem, beyond basic investigation of food chains. One research study claimed that China lacks the fisheries data foundation to implement ecosystem-based fisheries management, in addition to insufficient regulations and enforcement capacity (Guan-yu Wang et al. 2014). The summer fishing mortarium may able to protect squid for a certain period of time each year which includes the peak squid spawning season, but spatial management and other ecosystem-based measures are missing in the assessed fisheries.

China has started supporting efforts to investigate the possibility of integrating ecosystem-based fisheries management (EBFM) into East China Sea fishing regulations (Chu, Xiao-lin 2010). A proposal to integrate EBFM into Guangdong provincial fisheries management was also published in 2013 (Jin-zhou Pang et al. 2013). EBFM as a missing management component in China fisheries that may be developed in the future.

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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.

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Appendix A: Extra By Catch Species

BENTHIC INVERTS

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

Interviews with South China fishermen confirmed that bottom trawls will touch the bottom (personal communication with Fishermen, Huaseng Lin), causing some disturbance on the benthos and resulting in bycatch of benthic organisms (Stobutzki I.C. et al. 2006)(Thomas S. et al. 2006). As the stock condition of benthic inverts is unknown, a score of moderate concern is given based on SFW criteria.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

Under the UBM assessment, the benthic inverts in northwest Pacific otter trawl have a score of 2, equal to high concern following SFW criteria.

Factor 2.3 - Discard Rate

CHINA / NORTHWEST PACIFIC
Bottom Trawls

< 100%

There is typically no discard in Chinese fisheries, as virtually everything is retained (Jun-Hao Chen et al.). Therefore discards/total catch is nil, and a multiplying factor of 1 is used. Also, all assessed fishing methods in this report do not involve bait use.

SEA TURTLE (UNSPECIFIED)

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls

High Concern

Turtles were included as potential bycatch due to the severe threat posed by bottom trawling in tropical regions (Wallace B.P. et al. 2010). Reports identify five sea turtle species in China, all listed as critically endangered on the China Species Red List (Chan S.K. et al. 2007). Interaction rates between these species and the squid fisheries are unknown. Sea turtles are a possible by-catch species considering their habitat distributions, but there are no reports/published data that quantify sea turtle bycatch for these fishing gears. The Chinese government has set regulations to conserve sea turtle species even though their stock status is out of regulation consideration (Mou, Jian-Feng 2013). Abundance of sea turtles is rated as high concern based on SFW criteria.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

The UBM score for this is 3, or moderate concern.

Factor 2.3 - Discard Rate

CHINA / NORTHWEST PACIFIC
Bottom Trawls

< 100%

There is typically no discard in Chinese fisheries, as virtually everything is retained (Jun-Hao Chen et al.). Therefore discards/total catch is nil, and a multiplying factor of 1 is used. Also, all assessed fishing methods in this report do not involve bait use.

SEABIRDS

Factor 2.1 - Abundance

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

Sea bird abundance is scored as high concern according to the SFW criteria. However, the fisheries under discussion here are not within major albatross range (see Seafood Watch Wild Capture Standard V2, Appendix 2 figure 3 – page 77) and seabird interactions record is absent.

Factor 2.2 - Fishing Mortality

CHINA / NORTHWEST PACIFIC
Bottom Trawls

Moderate Concern

The UBM score is 2 or high concern for seabird fishing mortality. However, concerns are mitigated due the factors laid out in 2.1 Abundance above.

Factor 2.3 - Discard Rate

CHINA / NORTHWEST PACIFIC
Bottom Trawls

< 100%

There is typically no discard in Chinese fisheries, as virtually everything is retained (Jun-Hao Chen et al.). Therefore discards/total catch is nil, and a multiplying factor of 1 is used. Also, all assessed fishing methods in this report do not involve bait use.

Appendix B: C2 Bycatch species PSA score list

Fishery and species description					Productivity attributes			
Genus	Species	Common Name	Fish or Invertebrate	Fishery descriptor	Avg Age @ maturity; Tm (years)	Avg Max Age; Tmax (years)	Fecundity (Eggs/year)	Avg Max Size; Lmax (cm) (fish only)
Main harvest								
Uroteuthis	chinensis	mitre squid	Invertebrate	China domestic EEZ trawling/purse seine/Jigging	1	1	10000	
Uroteuthis	edulis	swordtip squid	Invertebrate	China domestic EEZ trawling/purse seine	1	1	10000	
Uroteuthis	duvauceli	indian squid	Invertebrate	China domestic EEZ trawling/purse seine	1	1	10,000	
By-catch								
Scomber	Japonicus	Chub mackerel	Fish	China domestic EEZ trawling/purse seine	2.23	13	100000	64
Rastrelliger	Kanagurta	Indian Mackerel	Fish	China domestic EEZ trawling/purse seine	3	4	56635	35
Decapterus	maruadsi	Japanese scad	Fish	China domestic EEZ trawling/purse seine	1.97	9	38000	35
Sardinella	aurita	Round Sardinella	Fish	China domestic EEZ trawling/purse seine	1.03	7	20000	30

Trachurus	Japonicus	Japanese horse mackerel	Fish	China domestic EEZ trawling/purse seine	2	12	100000	50
Trichiurus	lepturus	Largehead Hairtail	Fish	China domestic EEZ trawling/purse seine	2	15	130000	234
Trichiurus	nanhaiensis	Naihai cutlassfish	Fish	China domestic EEZ trawling/purse seine	2	15	49700	60
Etrumeus	teres	Red eye round herring	Fish	China domestic EEZ trawling/purse seine				33