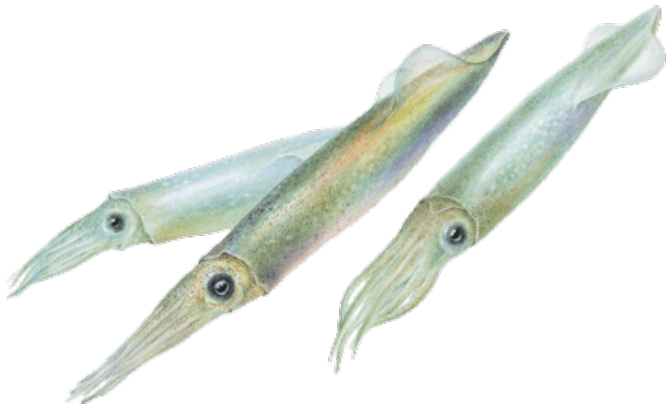
Monterey Bay Aquarium

Seafood Watch®

Squid

Indian squid (*Uroteuthis duvauceli*)
Mitre squid (*Uroteuthis chinensis*)
Swordtip squid (*Uroteuthis edulis*)



India/Indian Ocean, Thailand/Western Central Pacific, Indonesia/Western Central Pacific

Bottom trawls, Jig, Cast nets

March 2, 2020

Seafood Watch Consulting Researcher

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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 major commercially imported squid species to the United States: the Indian squid (*Uroteuthis duvaucelli*), the mitre squid (*U. chinesis*) and the swordtip squid (*U. edulis*). These are inshore Indo-Pacific species, extending from the west of the Indian Ocean to the western Pacific, which are targeted by a number of traditional and industrial fleets in Southern Asia. Indian squid is the most abundant squid species in Indian and Thai waters where it is heavily exploited, representing up to 70% of the catches off central west India and up to 90% of the catches in the Gulf of Thailand. It is caught using a wide range of gears, including bottom trawls, push and cast nets and jigs. Mitre squid and swordtip squid are caught in Thai and Indonesian waters using cast nets and jigs, and also bottom trawls in Thailand (bottom trawling is banned in Indonesia).

The combination of individual criteria results in an overall rating of "Avoid" for all squid fisheries in the area. Criterion 1, "Impacts of the Fishery on the Stock," ranks as Red for all the species due to the combination of "high" concern for stock status for all the target species and "high" concern for fishing mortality for all the species in India and Thailand, and a "moderate" concern for mitre and swordtip squids in Indonesia. Criterion 2, "Impacts of the Fishery on Bycatch and Other Retained Species," also ranks as Red for all the fisheries. Bottom trawl fisheries are widely recognized as having a high impact on benthic invertebrates, corals, biogenic habitats, and bycatch species, such as sharks and turtles. Although cast and jig fisheries have low levels of bycatch, the Red score in these fisheries is mainly driven by the worrying status of the target squid species. Although fisheries management in India, Thailand, and Indonesia has improved in recent years with new management and regulations, Criterion 3, "Effectiveness of Fishery Management," is considered "ineffective" for all the countries, due to the lack of effective measures to address overcapacity of the fleets and reducing fishing effort, which has driven the overall overexploitation of the fishing resources in these countries. Finally, Criterion 4, "Impacts on Habitat and Ecosystem," scores as Green for jigs and cast nets used to catch squid in Thailand and Indonesia due to the minimal impact of these gears on the habitat, and Red for bottom trawl fisheries due to the potential physical damage of this fishing method on sensitive habitats (corals and other biogenic habitats) in the area.

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 India/Indian Ocean | Bottom trawls	Red (1.000)	Red (1.000)	Red (1.000)	Red (1.732)	**Avoid (1.147)**
Indian squid Thailand/Western Central Pacific | Bottom trawls	Red (1.000)	Red (1.000)	Red (1.000)	Red (1.732)	**Avoid (1.147)**
Indian squid Thailand/Western Central Pacific | Jig	Red (1.000)	Red (1.000)	Red (1.000)	Green (3.873)	**Avoid (1.402)**
Indian squid Thailand/Western Central Pacific | Cast nets	Red (1.000)	Red (1.000)	Red (1.000)	Green (3.464)	**Avoid (1.364)**
Mitre squid Thailand/Western Central Pacific | Bottom trawls	Red (1.000)	Red (1.000)	Red (1.000)	Red (1.732)	**Avoid (1.147)**
Mitre squid Thailand/Western Central Pacific | Jig	Red (1.000)	Red (1.000)	Red (1.000)	Green (3.873)	**Avoid (1.402)**
Mitre squid Thailand/Western Central Pacific | Cast nets	Red (1.000)	Red (1.000)	Red (1.000)	Green (3.464)	**Avoid (1.364)**
Mitre squid Indonesia/Western Central Pacific | Jig	Red (1.732)	Red (1.732)	Red (1.000)	Green (3.873)	**Avoid (2.275)**
Mitre squid Indonesia/Western Central Pacific | Cast nets	Red (1.732)	Red (1.732)	Red (1.000)	Green (3.464)	**Avoid (1.795)**

Swordtip squid Indonesia/Western Central Pacific | Jig	Red (1.732)	Red (1.732)	Red (1.000)	Green (3.873)	**Avoid (2.275)**
Swordtip squid Indonesia/Western Central Pacific | Cast nets	Red (1.732)	Red (1.732)	Red (1.000)	Green (3.464)	**Avoid (1.795)**
Swordtip squid Thailand/Western Central Pacific | Bottom trawls	Red (1.000)	Red (1.000)	Red (1.000)	Red (1.732)	**Avoid (1.147)**
Swordtip squid Thailand/Western Central Pacific | Cast nets	Red (1.000)	Red (1.000)	Red (1.000)	Green (3.464)	**Avoid (1.364)**
Swordtip squid Thailand/Western Central Pacific | Jig	Red (1.000)	Red (1.000)	Red (1.000)	Green (3.873)	**Avoid (1.402)**

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

The following Seafood Watch report provides recommendations for three squid species of commercial importance for the US market, namely: Indian (*Uroteuthis duvaucelii*), mitre (*U. chinesis*) and swordtip (*U. edulis*) squids. These species are caught in Southern Asian countries using a wide range of traditional and industrial fishing gears, such as otter and pair trawls, push and cast nets, purse seines, and hooks and lines. Taking into account the known distribution of these species in the Indian Ocean, the main fishing gears used to catch them, and the principal countries exporting squid into the US from that area, fourteen fisheries are assessed in this report: the Indian squid trawl fishery in India; the Indian, mitre, and swordtip squid trawls, cast nets, and jig fisheries in Thailand; and the mitre and swordtip squids cast net and jig fisheries in Indonesia.

Species Overview

The commercial importance of cephalopod species as a fishery resource has increased over the last decades and many cephalopod species are currently taken both as target and bycatch species in numerous fisheries around the world (Pierce and Guerra 1994). The proportion of squid in total landings has increased steadily over the last decades, in many cases due to the decrease of fish stocks as a consequence of overfishing (Caddy and Rodhouse 1998) (FAO 2011). In 2010, total global squid capture was 2.98 million tonnes, which was about 82% of the total cephalopod production in that year (Arkhipkin et al. 2015).

In South Asian countries squid is a commercially important resource for coastal fisheries, which fetches high domestic and exporting prices (Arkronrat et al. 2017). Although up to nine commercial squid species are present in the Indo-Pacific area (*Uroteuthis chinensis* (Gray 1849); *U. duvaucelii* (Orbigny 1835); *U. edulis* (Hoyle 1885); *U. singhalensis* (Ortmann 1891); *U. sibogae* (Adam 1954); *Loliolus affinis* (Steenstrup 1856); *Loliolus sumatrensis* (Orbigny 1835); *L. beka* (Sasaki 1929), and *S. lessoniana* (Ferussac 1831) (Arkhipkin et al. 2015)); the three species that represent the bulk of the catches in the area are: *Uroteuthis chinensis*, *Uroteuthis duvaucelii* and *Urotheutis edulis* (Hoyle 1885) (Sukramongkol et al. 2007) (Arkhipkin et al. 2015). These species are generally found together in the same geographical area, thus presumably regularly encountering one another (Chotiyaputta 1993) (Futuyma and Agrawal 2009) (Islam et al. 2017). They are described below:

- The Indian squid (*U. duvaucelii*) is an Indo-Pacific loliginid distributed in coastal waters within depths of 0 to 170 m (Bergman 2013), from Madagascar to the Andaman Sea (West Thailand) (Jereb and Roper 2006). Indian squid is the most abundant squid species in Indian and Thai waters (Meiyappan et al. 1993) (Sukramongkol et al. 2007) where it is heavily exploited representing up to 70% of the catches off central west India and up to 90% of the catches in the Gulf of Thailand (Arkhipkin et al. 2015).

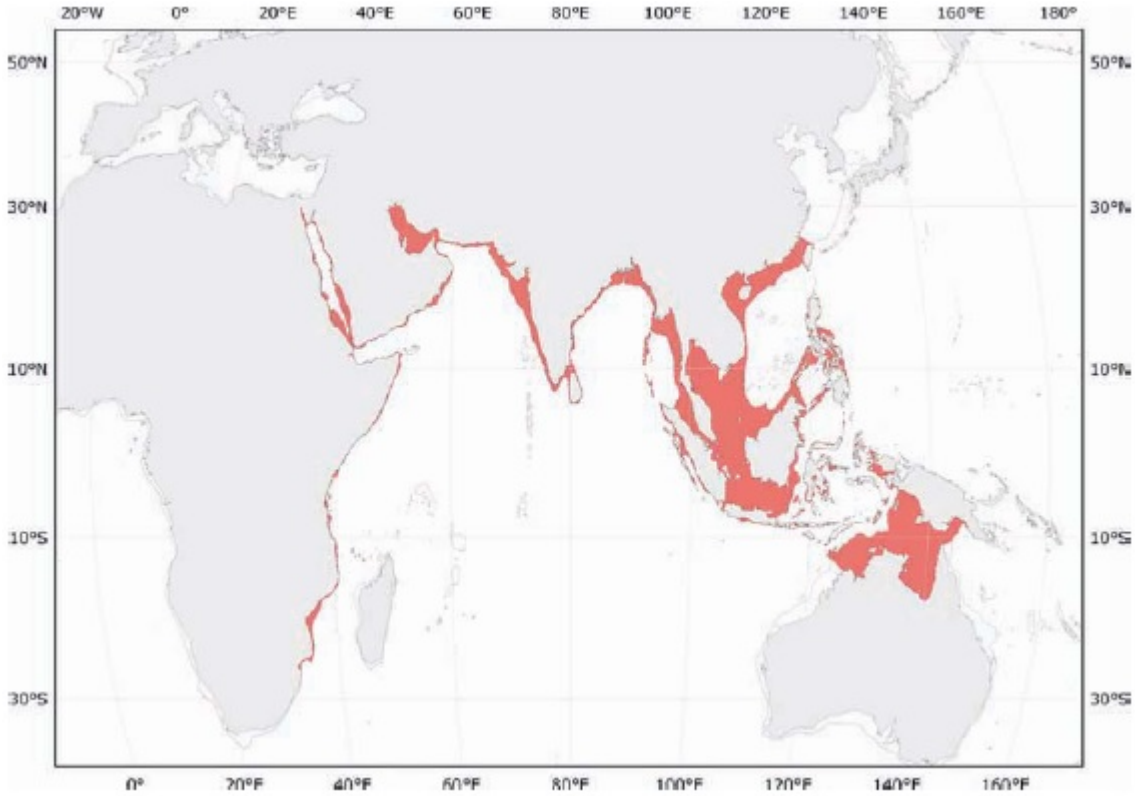

Figure 1 Indian squid distribution (Jereb & Roper

2010)

- Mitre squid (*U. chinensis*) is more abundant in shallower waters (10 to 30 m) and it has a more restricted distribution than the previous species (Arkhipkin et al. 2015). This is an Indo-Pacific species, extending from the western Pacific (Japan, South China Sea, Hong Kong, Philippines, Indonesia, northern, western, and eastern Australian waters), to the Indian Ocean (Andaman Sea, Thailand, and the Bay of Bengal) (Jereb and Roper 2010). Mitre squid is one of the major squid species in the Gulf of Thailand, where it is taken in waters between 15 and 30 m depth and amounts to between 15 and 40–52% of the trawl catch (Arkhipkin 2015) (Jereb and Roper 2010).

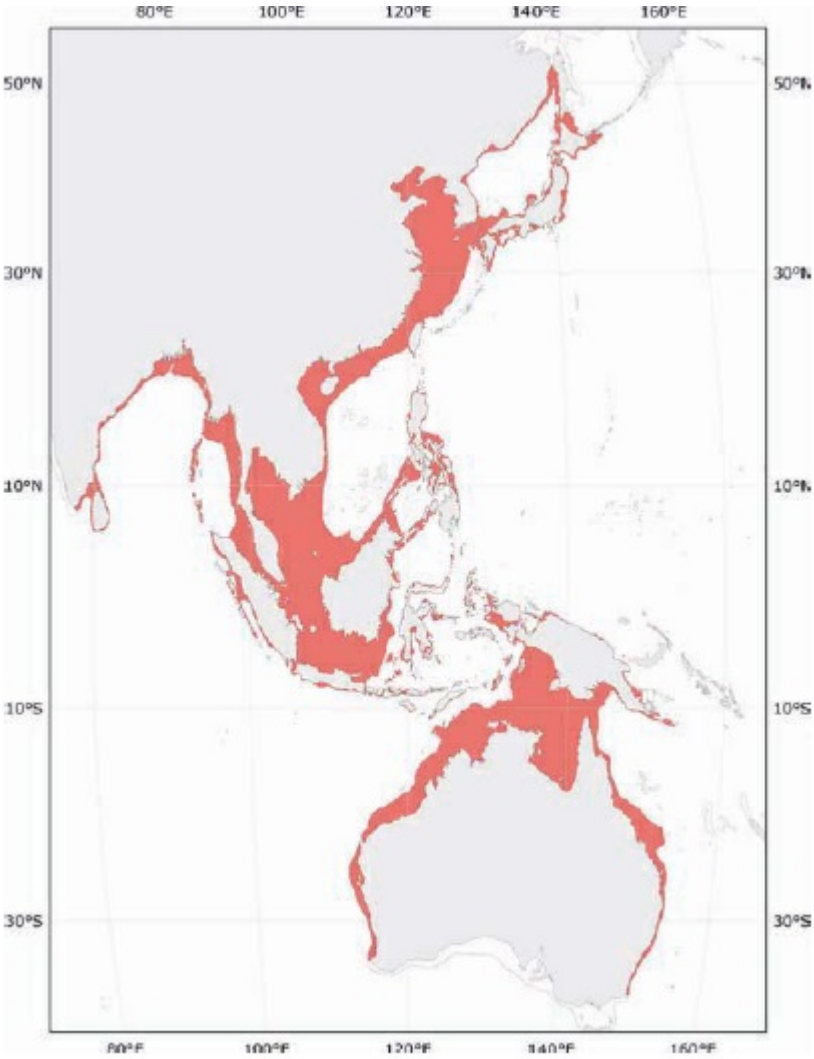

Figure 2 Mitre squid distribution (Jereb & Roper

2010)

- The swordtip squid (*U. edulis*) is relatively abundant in the western Pacific. Its range extends from northern (southern Sea of Japan and the East China Sea) to tropical regions (the Java Sea and coastal waters of Indonesia, Malaysia, and Thailand), and as far south as the waters off northern Australia. Its distribution, although unclear, seems to extend throughout the Indian Ocean, from its southeastern waters to Mozambique (Jereb and Roper 2010). The species is highly abundant in the Andaman Sea, where it represents one of the main Thai squid resources. However, it is not mentioned among the squid resources of either India nor the Gulf of Thailand (Jereb and Roper 2010).

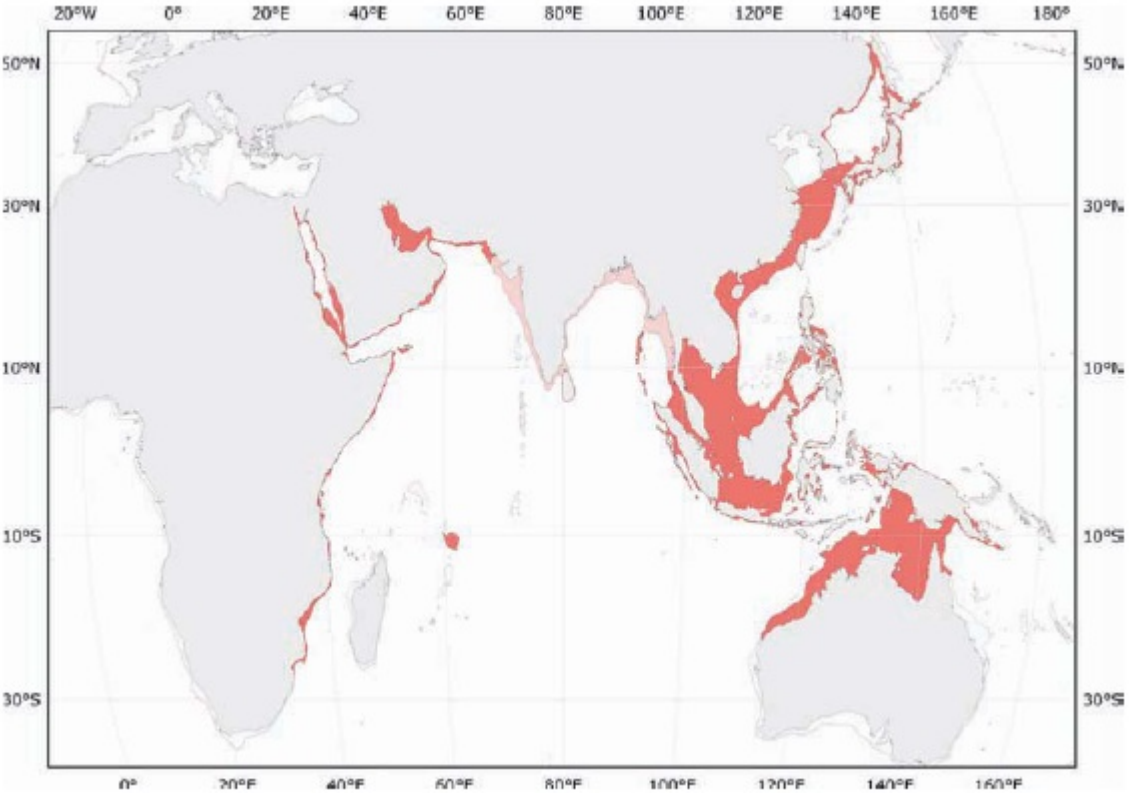

Figure 3 Swordtip squid distribution (Jereb & Roper

2010)

Production Statistics

Official landing data in South Asian countries is inaccurate due to the limited resources and systems to collect and report catch data. Squid species are not adequately identified in those countries when caught and all the species are pulled together in the production statistics. The top three countries landing squid in South Asia (including the FAO categories various squid nei and common squid nei) between 2012 and 2016 were: China, which reported an average of 423,000 MT of squid landed per year, a volume higher than the sum of the volumes reported by the other top five countries; Indonesia (164,000 MT per year) and Thailand (75,000 MT per year). Then followed Malaysia, the Philippines, and India. Indonesia, Thailand, and India are the countries included in this report.

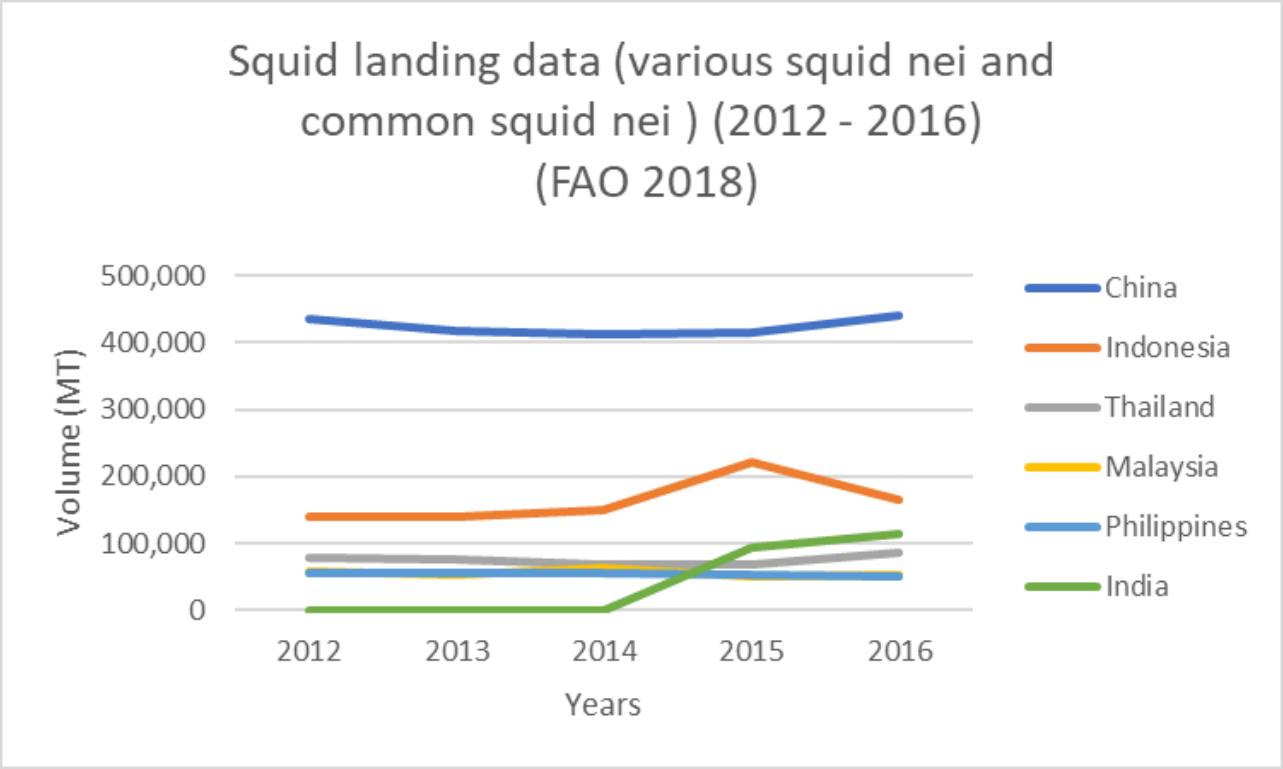

Figure 4 Squid landings from 2012 to 2016 in South Asian countries (FAO 2018)

According to the Indonesian fisheries resources statistics, squid landings increased between 2012 and 2015 in the country, reaching a 12% increase in volume per year, the largest increment of all the fishing resources exploited in the country. In 2015, 221,484 MT of squid were landed in Indonesia. In that year, 46% and 13% of the catch came from the northern Java and southern Java fisheries areas respectively (CFMRI 2017).
In Thailand all the catch is reported to FAO as "common squid nei." Reported landings increased from 67,687 MT in 2014 to 86,381 MT in 2016 (FAO 2018). Over 95% of the squid landed could be Indian squid (Choi 2007). Approximately 90% of the catch comes from the Gulf of Thailand (East of the country) and 10% from the East Andaman Sea (Arkhipkin et al. 2015).

Finally, In India squid landings are reported to FAO as "various squids nei." According to the CMFRI, 94,222, 114,886 and 131,774 MT of squid were landed in India in 2015, 2016, and 2017 respectively (FRAD 2017) (CMFRI 2017) (CMFRI 2018). The amount of Indian squid is unknown, but it could represent around 70% of this catch (Arkhipkin 2015). In 2016, 85% of the catch came from the Western coast of the country (FAO area 51). Around 42% of the squid caught in the country was landed in the Gurujat and Kerala provinces (North and South West India respectively) (CMFRI 2017).

Importance to the US/North American market.

US squid imports are largely not identified by species and only four categories are used in the National Marine Fisheries Service database when referring to these species: a general category named "squid NSPF" (where NSPF stands for "not specifically provided for"), two specific categories for "*Loligo opalescens*" and "*Loligo pealei*" of no interest for this report, and finally a category for other Loligo species named "squid (Loligo)."

In 2017, 73,217 MT of squid were imported into the United States, valued at USD 375 million (NMFS 2017). The

top five nations exporting squid (squid NSPF and squid [Loligo] included) in 2016 and 2017 into the United States were China (63%), Taiwan (10%), India (7%), Peru (4%), and Thailand (4%) (see table below) (NFMS 2018). The species were mainly imported as dried/salted/brine (38%), frozen (20%) and prepared/preserved (12.5%). Very few squid were imported as fresh/live (NFMS 2018).

Squid imports into the U.S. in 2017 (MT)		
Country	**Volume**	**% total**
China	43,384,148	62.6
Taiwan	7,513,859	10.8
India	4,468,014	6.4
Peru	2,692,973	3.9
Thailand	2,530,587	3.6
Spain	1,911,924	2.8
New Zealand	1,814,077	2.6
South Korea	1,567,985	2.3
Argentina	1,485,973	2.1
Vietnam	538,101	0.8
Indonesia	507,283	0.7
Japan	504,688	0.7
Chile	425,904	0.6
Total	69,345,516	~98%

Figure 5 Squid imports into the U.S. in 2017 (MT) (NFMS 2018)

Squid imports from the three countries covered in this report: India, Thailand, and Indonesia, between 2013 and 2017, as shown in the table and figure below (adapted from (NFMS 2018)). As explained above, no specific information about species is shown in the US database, but given that the major squid species caught in those countries are Indian, mitre, and short-fin squid it is assumed that the majority of the squid imports into the US correspond to these species. The exact volume of each species cannot be determined.

Squid imports into the U.S. form selected countries (MT) (2013-2017)				
Year	**India**	**Thailand**	**Indonesia**	**Total**
2013	4,427	3,415	217	8,059
2014	3,877	3,273	152	7,302
2015	4,357	3,240	221	7,818
2016	3,934	2,897	448	7,279
2017	4,481	2,531	524	7,536

Figure 6 Squid imports into the U.S. form selected countries (MT) (2013-2017) (NFMS 2018)

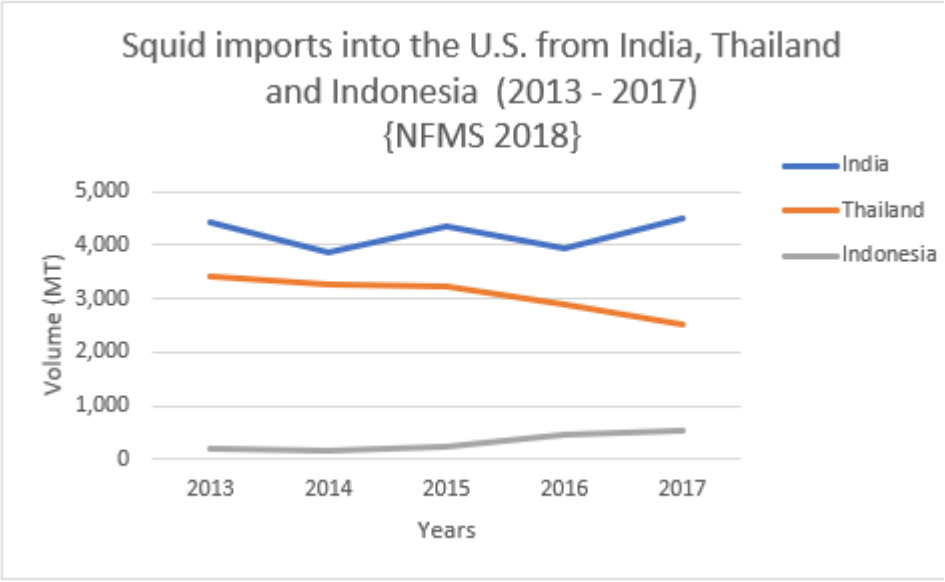

Figure 7 Squid imports into the U.S. from India, Thailand and Indonesia (2013-2017) (NFMS 2018)

Squid imports from India into the US remained constant between 2013 and 2017, at an average of 4,200 MT per year. Squid imports from Thailand, although still relatively high, decreased by 25% from 3,415 MT imported in 2013, to 2,531 MT in 2017. Squid imports into the US from Indonesia were lower than from the two previous countries, although they doubled in recent years from 2,165 MT imported in 2013 to 523,6 MT in 2017. An average total annual volume of 7,500 MT of squid were imported into the United States by the three countries assessed between 2013 and 2017

Common and market names.

The commercial name used in the US for squid species is just "squid" or "calamari." No other names have been reported.

Primary product forms

Squid is available in seafood markets or specialty grocery stores mainly frozen (entire or in tubes). Other products identified in US supermarkets are canned squid in sauce (olive or sunflower oil, spiced, garlic sauce, etc.).

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**
India/Indian Ocean | Bottom trawls	1.00: High Concern	1.00: High Concern	Red (1.000)
Thailand/Western Central Pacific | Bottom trawls	1.00: High Concern	1.00: High Concern	Red (1.000)
Thailand/Western Central Pacific | Jig	1.00: High Concern	1.00: High Concern	Red (1.000)
Thailand/Western Central Pacific | Cast nets	1.00: High Concern	1.00: High Concern	Red (1.000)

MITRE SQUID			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
Thailand/Western Central Pacific | Bottom trawls	1.00: High Concern	1.00: High Concern	Red (1.000)

Thailand/Western Central Pacific | Jig	1.00: High Concern	1.00: High Concern	Red (1.000)
Thailand/Western Central Pacific | Cast nets	1.00: High Concern	1.00: High Concern	Red (1.000)
Indonesia/Western Central Pacific | Jig	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
Indonesia/Western Central Pacific | Cast nets	1.00: High Concern	3.00: Moderate Concern	Red (1.732)

SWORDTIP SQUID			
Region | Method	**Abundance**	**Fishing Mortality**	**Score**
Indonesia/Western Central Pacific | Jig	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
Indonesia/Western Central Pacific | Cast nets	1.00: High Concern	3.00: Moderate Concern	Red (1.732)
Thailand/Western Central Pacific | Bottom trawls	1.00: High Concern	1.00: High Concern	Red (1.000)
Thailand/Western Central Pacific | Cast nets	1.00: High Concern	1.00: High Concern	Red (1.000)
Thailand/Western Central Pacific | Jig	1.00: High Concern	1.00: High Concern	Red (1.000)

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

INDIA / INDIAN OCEAN
Bottom Trawls
THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls
THAILAND / WESTERN CENTRAL PACIFIC
Jig
THAILAND / WESTERN CENTRAL PACIFIC
Cast Nets

High Concern

Cephalopod species are characterized by short-life cycles and variable growth rates influenced by environmental variability (Rodhouse 2010), which makes them both potentially susceptible to overfishing but also capable of rapid recovery (Pierce and Guerra 1994). No recent stock-wide assessments are available for any of the three species. There are indications that one or more of the species is overfished in some areas, including the three countries reviewed in this assessment, but the picture is far from clear.

In the Seafood Watch Standard for Fisheries, a Productivity-Susceptibility Analysis is conducted where stock status is not clear. PSA suggests that, despite having biological characteristics that indicate high productivity, susceptibility to fisheries mortality is also high, and so overall vulnerability to being overfished is high. We were not able to find at least 2 appropriate data-limited assessment methods based on distinct data sources that suggest the stocks are healthy as required by the Seafood Watch Standard for Fisheries to score better than a "high" concern. Therefore, a score of "high" concern was assigned.

Justification:

The last stock assessment for the entire Indian squid stock (Meiyappan et al.1993) considered that the species was exploited at optimum levels. However, this stock assessment was published more than 20 years ago. The most recent assessment, carried out at the regional level in India (Karnataka, Maharashtra) (Mohamed and Rao 1997) (Nitin et al. 2014) (Sundaram and Mane 2019) or in surrounding countries (Pakistan) (Soomro et al. 2015) (Mohsin et al. 2018) suggest that the species is overexploited but no information is reported about the stock status. The most recent stock assessment for mitre and Indian squid in Thai waters dates back from 2010 (Boonsuk et al. 2010) (Kongprom et al. 2010). In that assessment, fishing effort was considered to be 15% below MSY in the Gulf of Thailand and 25% above the MSY in the Andaman Sea, but no information was reported about the stock status (these reports are not publicly available).

Since 2017, the Indonesian MMAF National Commission on Stock Assessments has used a new stock assessment methodology, based on acoustic surveys, to evaluate the state of the resources in the country (CEA 2018). The MMFA groups fisheries resources by categories (i.e., demersal, small pelagics, and squid) which prevents an adequate analysis about the state of the stocks at the species level. The tables below show the potential catch per year, total allowable catch (TAC), and utilization rate by WPP for 2017 (CEA 2018). As seen, the majority of targeted fish stocks in Indonesia are fully or over-exploited. Squid is considered overfished in seven of Indonesia's 11 WPPs, including the Java Sea where nearly 50% of the national catch comes from.

Very few reports make reference to swordtip fisheries in Thai waters. However, as the species is found in the area, it is considered that it is caught and probably mixed with Indian and mitre squid. According to (Arkhipkin et al. 2015), 70% of the squid catch in the Andaman Sea could be made of swordtip squid. Therefore, no stock assessment exists for the species in the country.

PSA

The default scores for Areal Overlap and Vertical Overlap were used since no evidence was found to indicate they should be scored otherwise (indeed, the evidence suggests that the species are fished extensively throughout their ranges e.g., (Allcock et al. 2019a)(Allcock et al. 2019c). Post-Capture Mortality was also scored the default score for retained species. Selectivity, however, was scored as higher than the default (default is 2, we have scored 3) to reflect the likelihood that all fisheries likely catch the squid before spawning (the time period between spawning and dying is very short for these species, and we were not able to find any policies or other evidence that fisheries do catch squid during this very short time period).

Productivity Analysis		
Criterion		**Score**
Average age at maturity	<1 year	1
Average maximum age	~1 year	1
Fecundity	Variable (between 2,000 and 10,000 eggs (Petsut et al. 2013)	2
Reproductive strategy	Demersal or pelagic egg mass (Petsut et al. 2013)	2
Trophic level	<2.75	1
Density dependence	No dispensatory or compensatory dynamics at low populations	2
Productivity score		**1.5**
Susceptibility Analysis		
Criterion		**Score**
Areal overlap (Considers all fisheries)	>30% of the species concentration is fished, considering all fisheries. **Default score if unknown**	3

Vertical overlap (Considers all fisheries)	High degree of overlap between fishing depths and depth range of species **Default score if unknown**	3
Selectivity of fishery (Specific to fishery under assessment)	Individuals < size at maturity are frequently caught	3
Post-capture mortality (Specific to fishery under assessment)	Retained species or majority dead when released	3
Susceptibility score		**2.32**
PSA score		**3.26**
PSA category		**High**

Figure 13 Stock Status marine resources in Indonesia by WPP in 2017 (CEA 2018).

Indonesian WPP (Fisheries Management Area)		SMALL PELAGICS	BIG PELAGICS	DEMERSAL FISH	REEF FISH	PENAEID SHRIMP	LOBSTER	BLUE SWIMMING CRAB	3- SPOT SWIMMING CRAB	SQUID	TOTAL
Strait of Malacca and Andaman Sea	Potential catch (ton)	99,865	64,444	145,495	20,030	59,455	673	12,829	13,614	9,038	**425,444**
	Total allowable catch (ton)	79,892	51,556	116,396	16,024	47,564	539	10,263	10,891	7,230	
WPP 571	Utilization rate	0.83	0.52	0.33	0.34	1.59	1.3	1	0.93	0.62	
Indian Ocean: West of Sumatra and the Sunda Straight	Potential catch (ton)	527,029	276,755	362,005	40,570	8,023	1,483	9,543	989	14,579	**1,240,975**
	Total allowable catch (ton)	421,623	221,404	289,604	32,456	6,418	1,186	7,634	791	11,663	
WPP 572	Utilization rate	0.5	0.95	0.57	0.33	1.53	0.93	0.18	0.49	0.39	
Indian Ocean: South of Java	Potential catch (ton)	630,521	586,128	7,902	22,045	7,340	970	526	3,913	8,195	**1,267,540**
	Total allowable catch (ton)	504,417	468,902	6,322	17,636	5,872	776	421	3,130	6,556	
WPP 573	Utilization rate	1.5	1.06	0.39	1.09	1.7	0.61	0.28	0.98	1.11	
South China Sea: Karimata Strait, Natuna Sea	Potential catch (ton)	330,284	185,855	131,070	20,625	62,342	1,421	2,318	9,711	23,499	**767,126**
	Total allowable catch (ton)	264,227	148,684	104,856	16,500	49,873	1,137	1,854	7,769	18,799	
WPP 711	Utilization rate	1.41	0.93	0.61	1.53	0.53	0.54	1.09	1.18	1.84	
Java Sea	Potential catch (ton)	364,663	72,812	657,525	29,951	57,965	989	7,664	23,508	126,554	**1,341,632**
	Total allowable catch (ton)	291,730	58,250	526,020	23,961	46,372	791	6,131	18,806	101,244	
WPP 712	Utilization rate	0.38	0.63	0.83	1.22	1.11	1.36	0.7	0.65	2.02	
Makassar Strait, Bone Bay, Flores Sea, and Bali Sea	Potential catch (ton)	208,414	645,058	252,869	19,856	30,404	927	4,347	5,463	10,519	**1,177,857**
	Total allowable catch (ton)	1	516,046	202,295	15,885	24,324	742	3,477	4,370	8,415	
WPP 713	Utilization rate	1.23	1.13	0.96	1.27	0.52	1.4	0.83	0.73	1.19	

Figure 8 Stock Status marine resources in Indonesia by WPP in 2017 (CEA and Green, S.J.)

Indonesian WPP (Fisheries Management Area)		SMALL PELAGICS	BIG PELAGICS	DEMERSAL FISH	REEF FISH	PENAEID SHRIMP	LOBSTER	BLUE SWIMMING CRAB	3- SPOT SWIMMING CRAB	SQUID	TOTAL
Banda Sea and Tolo Bay	Potential catch (ton)	165,944	304,293	98,010	145,530	3,180	724	1,145	1,669	68,444	788,939
	Total allowable catch (ton)	132,755	243,435	78,408	116,424	2,544	579	916	1,335	54,755	
WPP 714	Utilization rate	0.44	0.78	0.58	0.76	0.39	1.73	1.55	0.77	1	
Tomini Bay, Maluku Sea, Halmahera Sea, Seram Sea, and Berau Bay	Potential catch (ton)	555,982	31,659	325,080	310,866	6,436	846	891	495	10,272	1,242,526
	Total allowable catch (ton)	444,786	25,327	260,064	248,693	5,149	677	712	396	8,217	
WPP 715	Utilization rate	0.88	0.97	0.22	0.34	0.78	1.32	1.19	0.98	1.86	
Sulawesi Sea and North of Halmahera	Potential catch (ton)	332,635	181,491	36,142	34,440	7,945	894	2,196	294	1,103	597,139
	Total allowable catch (ton)	266,108	145,193	28,914	27,552	6,356	715	1,756	235	883	
WPP 716	Utilization rate	0.48	0.63	0.45	1.45	0.5	0.75	0.38	0.5	1.42	
Pacific Ocean, Cendrawasih Gulf	Potential catch (ton)	829,188	65,935	131,675	15,016	9,150	1,044	489	58	2,140	1,054,695
	Total allowable catch (ton)	663,350	52,748	105,340	12,013	7,320	835	391	46	1,712	
WPP 717	Utilization rate	0.7	1	0.39	0.91	0.46	1.04	0.87	1.21	1.09	
Arafuru Sea, East Timor Sea, Aru Sea	Potential catch (ton)	836,973	818,870	876,722	29,485	62,842	1,187	1,498	775	9,212	2,637,565
	Total allowable catch (ton)	669,579	655,096	701,378	23,588	50,274	950	1,198	620	7,370	
WPP 718	Utilization rate	0.51	0.99	0.67	1.07	0.86	0.97	0.85	0.77	1.28	
TOTAL ALLOWABLE CATCH (TON)											12,541,438

Moderately exploited
Fully exploited
Overexploited

Figure 9 Stock Status marine resources in Indonesia by WPP in 2017 (CEA and Green, S.J.)

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Factor 1.2 - Fishing Mortality

INDIA / INDIAN OCEAN
Bottom Trawls

High Concern

The last stock assessment published by the CMFRI for the entire Indian squid stock (Meiyappan et al. 1993) indicated that the exploitation rate on Indian squid harvested on both coasts of India was at optimum levels. A most recent stock assessment of the east coast of India undertaken by (Abdussamad and Somayajulu 2004) revealed large size differences of squid caught in comparison to the west coast, suggesting that this was either a result of size overfishing on the east coast or two separate stocks existing on the east and west coasts of India (Arkhipkin et al. 2015). Since the (Meiyappan et al. 1993) assessment, the CMFRI has undertaken a series of studies on population dynamics of this species in specific regions along the west coast of India that have mainly recommended that harvest rates on Indian squid should be reduced

(Mohamed 1996) (Mohamad and Rao 1997) (Karnik et al 2003) (Thomas and Kizhakudan 2006) (Mohan 2007) (Sasikumar and Mohamed 2012) (Nitin et al. 2014) (Sundaram and Mane 2019).

The current level of mortality is unknown, but recent studies recommended that harvest rates should be reduced so a score of "high" concern is given.

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls
THAILAND/WESTERN CENTRAL PACIFIC
Jig
THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets

High Concern

No recent stock assessment has been found for mitre squid and Indian squids in Thai waters. The most recent stock assessments for mitre and Indian squid in Thai waters were undertaken in 2010 using fishing data until 2008 (Boonsuk et al. 2010) (Kongprom et al. 2010). In those assessments, the MSY from trawling and cast netting of mitre squid and Indian squid was estimated at 37,179 MT when the relative fishing effort (RFE) equals 1.15 in the Gulf of Thailand (Kongprom et al. 2010) and 1,728 MT at a RFE of 0.75 in the Andaman Sea (Boonsuk et al. 2010). In 2010, fishing mortality of mitre squid and Indian squid was estimated at 2.48 and 4.41 in the Gulf of Thailand and 8.60 and 4.83 in the Andaman Sea respectively (Boonsuk et al. 2010) (Kongprom et al. 2010); fishing effort was considered to be 15% below MSY in the Gulf of Thailand, but 25% above the MSY in the Andaman Sea. According to (Kaewnuratchadasorn et al. 2003) in (Choi 2007), over 95% of the squid landed in Thailand could be Indian squid and approximately 90% of the catch comes from the Gulf of Thailand (Arkhipkin et al. 2015). Due to overfishing, squid catches have shown a downward trend in Thailand since 2009 (Arkronrat et al. 2017).

A recent quantitative stock assessment for the Indian and mitre squid stocks have not been found. In the 2010 assessments, it was found that fishing mortality was around F_{MSY}, depending on the area assessed. The current level of mortality is unknown but squid catches have decreased in the country due to overfishing; therefore, a score of "high" concern was given.

MITRE SQUID

Factor 1.1 - Abundance

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls
THAILAND/WESTERN CENTRAL PACIFIC
Jig
THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets
INDONESIA/WESTERN CENTRAL PACIFIC
Jig
INDONESIA/WESTERN CENTRAL PACIFIC
Cast Nets

High Concern

See Indian squid above.

Factor 1.2 - Fishing Mortality

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls
THAILAND/WESTERN CENTRAL PACIFIC
Jig
THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets

High Concern

See answer for Indian squid above.

INDONESIA/WESTERN CENTRAL PACIFIC
Jig
INDONESIA/WESTERN CENTRAL PACIFIC
Cast Nets

Moderate Concern

The main species exploited in Indonesian waters are shrimps, demersal fish, small pelagics, large tunas, and squids. Exploitation of these resources in the country increased an average of 3.23% per year between 2012 and 2015. Squid exploitation experienced the largest increase in the same period at a rate of 12% per year (BPS 2016). According to the Indonesian fisheries resources statistics, 221,484 MT of *cumi-cumi* (squid) were landed in the country in 2015, 46% of that catch coming from the Northern Java fisheries area, where the squid stock was already considered overfished (BPS 2016). Since no information on F (fishing mortality) is available, a score of "moderate" concern was given.

SWORDTIP SQUID

Factor 1.1 - Abundance

INDONESIA/WESTERN CENTRAL PACIFIC
Jig
INDONESIA/WESTERN CENTRAL PACIFIC
Cast Nets
THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls
THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets
THAILAND/WESTERN CENTRAL PACIFIC
Jig

High Concern

See Indian squid above.

Factor 1.2 - Fishing Mortality

INDONESIA / WESTERN CENTRAL PACIFIC
Jig
INDONESIA / WESTERN CENTRAL PACIFIC
Cast Nets

Moderate Concern

See answer for mitre squid above.

THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls
THAILAND / WESTERN CENTRAL PACIFIC
Cast Nets
THAILAND / WESTERN CENTRAL PACIFIC
Jig

High Concern

Again, no references to this species is made in the country. However, it is suspected that fishing mortality from all sources could be above a sustainable level. Therefore, a score of "high" concern was given.

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 India/Indian Ocean | 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)
Turtles (unspecified)	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)
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)
Benthic inverts	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

INDIAN SQUID Thailand/Western Central Pacific | Bottom Trawls					
Subscore:	**1.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.000**

Species | Stock	Abundance	Fishing Mortality	Subscore
Mitre squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Sharks	1.00:High Concern	1.00:High Concern	Red (1.000)
Turtles (unspecified)	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)
Swordtip squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Forage fish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Finfish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Benthic inverts	2.33:Moderate Concern	1.00:High Concern	Red (1.526)

INDIAN SQUID
Thailand/Western Central Pacific | Cast Nets

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Mitre squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Swordtip squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Forage fish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

INDIAN SQUID
Thailand/Western Central Pacific | Jig

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Mitre squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Swordtip squid	1.00:High Concern	1.00:High Concern	Red (1.000)

MITRE SQUID
Indonesia/Western Central Pacific | Cast Nets

Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732

Species | Stock	Abundance	Fishing Mortality	Subscore
Swordtip squid	1.00:High Concern	3.00:Moderate Concern	Red (1.732)
Forage fish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

MITRE SQUID
Indonesia/Western Central Pacific | Jig

Subscore:	1.732	Discard Rate:	1.00	C2 Rate:	1.732

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

MITRE SQUID
Thailand/Western Central Pacific | Bottom Trawls

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Indian squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Sharks	1.00:High Concern	1.00:High Concern	Red (1.000)
Turtles (unspecified)	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)
Swordtip squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Forage fish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Finfish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Benthic inverts	2.33:Moderate Concern	1.00:High Concern	Red (1.526)

MITRE SQUID
Thailand/Western Central Pacific | Cast Nets

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Indian squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Swordtip squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Forage fish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

MITRE SQUID
Thailand/Western Central Pacific | Jig

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Indian squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Swordtip squid	1.00:High Concern	1.00:High Concern	Red (1.000)

SWORDTIP SQUID
Indonesia/Western Central Pacific | Cast Nets

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)
Forage fish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

SWORDTIP SQUID
Indonesia/Western Central 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
Thailand/Western Central Pacific | Bottom Trawls

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Indian squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Mitre squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Sharks	1.00:High Concern	1.00:High Concern	Red (1.000)
Turtles (unspecified)	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)
Forage fish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Finfish	2.33:Moderate Concern	1.00:High Concern	Red (1.526)
Benthic inverts	2.33:Moderate Concern	1.00:High Concern	Red (1.526)

SWORDTIP SQUID
Thailand/Western Central Pacific | Cast Nets

Subscore:	1.000	Discard Rate:	1.00	C2 Rate:	1.000

Species | Stock	Abundance	Fishing Mortality	Subscore
Indian squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Mitre squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Forage fish	2.33:Moderate Concern	3.00:Moderate Concern	Yellow (2.644)

SWORDTIP SQUID Thailand/Western Central Pacific | Jig					
Subscore:	**1.000**	**Discard Rate:**	**1.00**	**C2 Rate:**	**1.000**

Species | Stock	Abundance	Fishing Mortality	Subscore
Indian squid	1.00:High Concern	1.00:High Concern	Red (1.000)
Mitre squid	1.00:High Concern	1.00:High Concern	Red (1.000)

As explained in the introduction section, Indian, mitre and swordtip squid are largely caught via epibenthic otter trawls, nets (falling, cast nets, and purse seiners) and jigs using light luring techniques (Jereb and Roper 2010) (Arkhipkin et al. 2015). Very few specific reports on bycatch and discards are available for squid fisheries in the three countries assessed.

In tropical countries like Thailand and India, the bycatch problem is a complex issue due to the multi-species and multi-gear nature of the fisheries (Gibinkumar et al. 2012). An exact catch profile for the commercial trawl fisheries targeting squid in India and the Gulf of Thailand has not been found. According to (Zeller et al. 2017), in SouthEast Asia and the western Pacific, the bulk of the catch in trawl fisheries is dominated by families that are wide-spread in these tropical waters, such as pony fishes (Leiognathidae, 9% of the catch), threadfin breams (Nemipteridae, 6%), lizardfishes (Synodontidae, 6%), drums (Sciaenidae, 3%) and scads (yellowstripe scad (*Selaroides leptolesis*, carangidae, 7%). These species can be sometimes retained or in many cases discarded.

The most complete catch profile for the Thai trawl fishery is shown in (Supongpan and Boonchuwong 2010). This report is based on a research trawl survey undertaken in Thai waters between 2003 and 2005. Although the catch composition varied by area, year, and size of the trawler, cephalopod species (mainly Indian and mitre squid) represented around 20% of the catch; demersal fish 30%; trash fish (formed by juveniles of commercial and non-commercial fish species) 40%; and pelagic species (scads, mackerels, etc) 4% of the total catch (Supongpan and Boonchuwong 2010). The demersal species group was composed of a mix of species, which included Nemipterus (threadfin bream), Priacanthus, Saurida, Carrangidae, Scolopsis, etc. Of the trash fish, 75% was composed by ponyfish (*Leiognatus* spp.), which represented 30% of the total catch. In those surveys the catch of rays (*Rajidae* spp.) was also reported.

In India, threadfin breams, ribbon fishes and penaeid prawns, followed by sciaenids, squids, and cuttlefishes were the major groups in the trawl fishery on the west coast between 2008 and 2012 (Dishbabu 2013). These groups represented more than 50% of the total catch. The most abundant species was Indian mackerel, which represented nearly 5% of the trawl catch (depending on the area) (Dineshbabu 2013). A complete list of bycatch species in the Indian shrimp trawl fishery on the southwest coast of India can be found in (Gibinkumar et al. 2012). In this report, the bycatch of more than 280 species is reported including skates and rays, such as: *Dasyatis kuhlii, Himantura bleekeri, H. uarnak, H. gerrardi* or *Aetobatus narinari*); sharks, such as Carcharhinidae (*Rhizoprionodon acutus* and *Scoliodon laticaudus)* and Sphyrnidae (*Eusphyra blochii* and *Sphyrna zygaena*); invertebrates: shrimps, lobsters, crabs, stomatopods, etc (Gibinkumar et al. 2012); and sea turtles (Lepidochelys olivacea). Although a low percentage of the squid is caught as a bycatch in the shrimp trawl fishery, this report has been used because it gives us an idea of the bycatch species caught in trawl fisheries in the area. Trawls also have an impact on corals and biogenic habitats in both countries.

Since no specific stock assessment exists for any of the bycatch species in these countries, they have been grouped under the common denomination "forage fish" (which includes small to medium pelagic species, such as sardines, anchovies or mackerels), “finfish” (which refers to demersal species) or “sharks” (includes both rays and sharks); the unknown bycatch matrix has been used in some cases to assess their stock status.

(Supongpan et al. 1992) undertook a catch analysis of the Indian Squid light luring net fishery in the Gulf of Thailand. According to that study, Indian squid, represents over 50% of the catch. Other main (>3% of the catch) fish species caught in the fishery are: Indian and short mackerels (*Rastregiller kanagurta*, which represents 10% of the total catch, and *Rastregiller brachysoma*, 3%), yellowtail and torpedo scad (*Atule mate*, 7%, and *Megalaspis cordyla*, 3%) and *Sardinella* spp. (5%) (see table below for a complete catch profile). A similar catch profile is expected for the squid fishery in Indonesia. Thus, (Ghofar 2002) reports that the species caught by "jala-oras" in the Alas Strait in Indonesia include squid and other species such as Sardinella (*Sardinella lemuru and Sardinella fimbriata*), scads (*Decapterus* spp.), and mackerels (*Rastrelliger* spp.). These studies have therefore been used to characterize the bycatch species in cast net fisheries in both Thailand and Indonesia.

As above, since no specific stock assessment exists for any of these bycatch species, they have been grouped under the common denomination "forage fish" and the unknown bycatch matrix has been used to assess their stock status. No other bycatch species are thought to be caught in this fishery.

Jigs are considered an environmentally friendly gear, with very low bycatch. In the squid fishery no bait is used. Thus, it is considered that no other fisheries apart from squid are caught.

Therefore, based on the above reports regarding gear type, fishing area, regional expert opinion, and the Seafood Watch criteria, the likely species interactions with these gear types include:

- Indian and Thai squid trawl fisheries: benthic invertebrates, corals/biogenic habitat, forage fish, finfish, sharks and turtles;
- Thai and Indonesian squid cast net fisheries: forage fish;
- Thai and Indonesian jig fisheries: no bycatch.

For the Indian and Thai trawl fisheries, coral/biogenic habitat, sharks, and turtles limit the score for Criterion 2 due to the high vulnerability of these species and the high potential to interact with this gear type in the area.

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

INDIA / INDIAN OCEAN
Bottom Trawls

High Concern

Around 160 species of sharks are reported in Indian waters (Akhilesh et al. 2010). Shark landings along the north-west coast of the country are dominated by the milk sharks (*Rhizoprionodon oligolinx and R. acutus*) and

the spade-nose shark (*Scoliodon laticaudus*). Landings along the south-west and south-east coasts are dominated by requiem sharks of the genus Carcharhinus. Landing of thresher and mackerel sharks and the oceanic white tip shark (*Carcharhinus longimanus*) have been found to be increasing in recent years, with increased operations in oceanic waters (Kizhakudan et al. 2015). The contribution of trawl fisheries to total catches between 1985 to 2013, ranged from 19% in West Bengal to around 60% in the state of Tamil Nadu and Puducherry (Kizhakudan et al. 2015). The distribution of Indian sharks classified under IUCN categories indicates that 24% of the species in Indian waters are "Near Threatened," 26% are "Vulnerable," and 3% "Critically endangered." Among the hammerheads *Sphyrna lewini*, *Sphyrna mokarran,* and *Sphyrna zygaena*, all three of which have been included in the CITES Appendix II listing that came into effect in September 2014, S. lewini and S. mokarran are classified as "Endangered" and *S. zygaena* is classfied as "Vulnerable" (Kizhakudan et al. 2015).

A Rapid Stock Assessment of sharks based on data for the period 1985 to 2013 and following the classification criteria suggested by (Mohamed et al. 2010) indicates the delicate status of sharks in Indian waters. Sharks were either "less abundant" or "declining" along the Indian coast, except in Tamil Nadu and Puducherry, where, the 3-year average being only 7.6% of the historic maximum, they could be classified as "depleted" (see table below) (Kizhakudan et al. 2015). According to the CMFRI, the main cause behind this reduction in sharks landings is the indiscriminate exploitation of these species in the past decades due to the increasing number and efficiency of large-mechanised fishing vessels and the expansion of fishing to deep-water areas (CMFRI 2017).

The exact species and volumes caught as a bycatch in the squid fishery are unclear, but several species of sharks present in the area are endangered. Therefore, according to the SFW criteria, abundance of this group of species is scored as "high" concern.

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

In Thailand and adjacent waters, 19 families, 64 species of sharks, and 71 species of rays have been described (Krajangdara 2014); of these, 19 of the sharks and 29 of the rays are listed as "Threatened" species in the IUCN red list. A number of endangered species are also present in the area, including hammerhead shark (*Sphyrna lewini*), great hammerhead shark (*S. mokarran*), Maekong freshwater stingray (*Dasyatis laosensis*), Maeklong whipray (*Himantura kittipongi*), longnose marble whipray (*H. oxyrhynchus*), white-edge freshwater whipray (*H. signifier*), mottled eagle ray (*Aetomylaeus maculatus*), and ornate eagle ray (*A. vespertilio*) (Krajangdara 2014).

A number of near threatened and endangered species are caught in Thai waters. Based on the SFW criteria, status of this group is therefore scored as "high" concern.

Factor 2.2 - Fishing Mortality

INDIA/INDIAN OCEAN
Bottom Trawls

High Concern

According to CMFRI figures, landing of elasmobranch species in the country peaked at 74,943 MT in 1998 and

after that year, they started to decline (CMFRI 2017). In 2016, 52,840 MT of elasmobranch were reported in the country, 45% of them corresponding to sharks and 51% to rays. The dominant shark species in the landings were *Carcharhinus falciformis* (37.25%), *Alopias superciliosus* (11.85%), *Sphyrna lewini* (11.53%), and *Alopias pelagicus* (8.53%). The major ray families were *Dasyatidae, Mobulidae, Myliobatidae, Gymnuridae, and Rhinopteridae* (Zacharia and Najmudeen 2017). In spite of attempts to increase production in the country, shark landings in India are declining. Sharks constituted just 1.4% of the total marine landing last year (CMFRI 2017). Time series also indicate that small-sized sharks have increased in the landings as opposed to larger sharks (Zacharia and Vivekanandan 2013). These factors seem to be indicate that shark abundance in Indian seas is dwindling.

Fishing mortality in the trawl fishery is unknown, therefore the unknown bycatch matrix is used to score fishing mortality for these species and a score of "high" concern was given.

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

From 2000 to 2009, Thailand reported an average of 20,749 tonnes (MT) of shark catches per year to FAO. The reported catches declined considerably from 32,540 MT in 2003 to 9,025 MT in 2010 . According to (Krajangdara 2014), trawls represented more than 80% of both shark and ray landings. Survival in these fisheries is affected by several factors, including the duration of the trawl, the size of the catch, and the amount of time used to sort the catch (Cosandey-Godin and Morgan undated). The DoF established the NPOA-Sharks of Thailand in 2005 (Krajangdara 2014). However, at present, the only shark management measure in Thailand relates to whale shark (*Rhincodon typus*), whose fishery is prohibited. The most landed species of sharks and rays in Thai ports are spottail shark (*Carcharhinus sorrah),* near threatened *(Pillans et al. 2009);* grey carpetshark *(Chiloscyllium punctatum),* near threatened *(Dudgeon et al. 2016);* grey bamboo shark *(C. griseum),* near threatened *(Lisney and Cavanagh 2003);* Kuhl's maskray *(Neotrygon kuhlii);* sharpnose stingray *(Telatrygon zugei),* near threatened *(White 2016);* scaly whipray *(Brevitrygon imbricata), H. walga and H. gerrardi* (Krajangdara 2014).

Endangered species are regularly caught in Thailand by trawl fisheries and no effective management measures to reduce the catch of these species are implemented. Based on the SFW criteria, this issue is scored as "high" concern.

Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

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

INDIA / INDIAN OCEAN
Bottom Trawls

< 100%

A study of the west coast of India trawl fishery, where the majority of the squid catch occurs, found that in this fishery 62% of the catch was landed for edible purposes (Dineshbabu 2013). Due to the growing demand of low value fish by the fishmeal industry (aquaculture, etc.), the percentage of low value bycatch (LVB) species landed increased from 16% in 2008 to 27% in 2011. Only 13% of the bycatch was discarded during this study. Therefore, it is considered that the discard rate in this fishery is lower than 100%.

Justification:

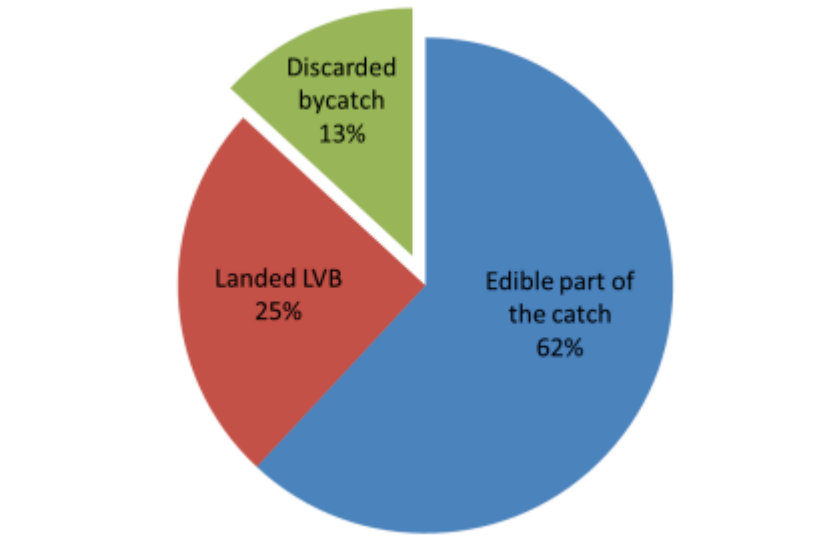

Figure 10 Catch composition of the trawl fishery in West India (Dineshbabu, A.P. 2013)

THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls

< 100%

Research on the composition of trawl catches in Thailand have found that the proportion of fish that have economic value (targeted species) is 33.3%, and the remaining 66.7% is trash fish (Supongpan and Boonchuwong 2010) (Nettasna 2014). In Thailand, as in other countries in the area, this trash fish (bycatch) is largely utilized for animal feed and it is not discarded (Chanrachkij 2015). Therefore, this bycatch is considered to be part of the total catch and the discard rate in the fishery is thought to be lower than 100%.

TURTLES (UNSPECIFIED)

Factor 2.1 - Abundance

INDIA / INDIAN OCEAN
Bottom Trawls

High Concern

Six species of sea turtles are present in Southeast Asia, including leatherback turtle (*Dermochelys*

coriacea), globally vulnerable (although the status of the Northeast Indian Ocean population is unknown) (Wallace et al. 2013); green turtle (*Chelonia mydas*), endangered (Seminoff 2004); hawksbill turtle (*Eretmochelys imbricata*), critically endangered (Mortimer and Donnelly 2008); or olive ridley turtle (*Lepidochelys olivacea*), vulnerable (Abreu-Grobois and Plotkin 2008). This last species is known to congregate in especially large numbers along the coast of Orissa in East India (Savio Lobo 2007). The status of the Northeast Indian Ocean population of Leatherback turtle is unknown (Wallace et al. 2013). Based on the actual and extrapolated changes in subpopulation size, the global mean annual number of green turtle nesting females has declined by 48 to 67% over the last three generations (Seminoff 2004). Hawksbill populations have continued to decline since 1999 and the losses in losses in numbers in the southeast Asia area are of particular concern (Mortimer and Donnelly 2008). Although olive ridley turtle is globally decreasing, no evidence of decline has been observed in Indian rockeries (Abreu-Grobois and Plotkin 2008).

The status of sea turtles ranges from vulnerable to critically endangered; therefore, this taxonomic group is scored as "high" concern.

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

Six species of sea turtles are present in Southeast Asia, including leatherback turtle (*Dermochelys coriacea*), globally vulnerable (although the status of the Northeast Indian Ocean population is unknown) (Wallace et al. 2013); green turtle (*Chelonia mydas*), endangered (Seminoff 2004); hawksbill turtle (*Eretmochelys imbricata*), critically endangered (Mortimer and Donnelly 2008); or olive ridley turtle (*Lepidochelys olivacea*), vulnerable (Abreu-Grobois and Plotkin 2008). The status of the Northeast Indian Ocean population of leatherback turtle is unknown (Wallace et al. 2013). Based on the actual and extrapolated changes in subpopulation size, the global mean annual number of green turtle nesting females has declined by 48 to 67% over the last three generations (Seminoff 2004). Hawksbill populations have continued to decline since 1999 and the losses in numbers in the southeast Asia area are of particular concern (Mortimer and Donnelly 2008). Although olive ridley turtle is globally decreasing, no evidence of decline has been observed in Indian rockeries (Abreu-Grobois and Plotkin 2008).

The status of sea turtles ranges from vulnerable to critically endangered. Most of these species are highly vulnerable to interactions with trawl gears (Wallace et al. 2010). Therefore, this taxonomic group is scored as "high" concern.

Factor 2.2 - Fishing Mortality

INDIA/INDIAN OCEAN
Bottom Trawls

High Concern

According to a survey conducted by CMFRI, along the coastline of India, barring Gahirmatha coast during 1997 to 1998, trawls accounted for 13.1% of the incidental catch of sea turtles in fishing gears (Boopendranath et. 2010). The mortality of 90,000 marine turtles, mostly olive ridleys, was recorded on the shores of Orissa in a span of eight years. Shore based mortality estimates usually capture 7 to 14% of all mortality at sea (Shanker et al. 2006). Thus the total mortality during the same time period would be estimated to be between just over 642, 857 and 1,285,714, and 80,357 to 160,714 per year (Helmbrecht 2011). It seems that the incidence of turtle bycatch in trawlers along the west coast of India has been reduced. Several maritime states such as West Bengal, Orissa, Andhra Pradesh and Kerala in India have TED regulations, under the Marine Fisheries

Regulation Acts. Moreover, due to its mythological status in the Hindu religion, the turtles caught are quickly released by most of the fishermen (A.P. Dineshbabu pers. comm. 2019). However, implementation of the TED regulations has not been sufficiently effective so far (Boopendranath et al. 2010) (Helmbrecht 2011) and this issue is assessed as a "high" concern.

THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

Fishing activity is thought to be one of the main causes of decline in the turtle population of Thailand (Polunin 1975), although little data is available to estimate the rate of mortality of these species (Aureggi 2018). Along the Andaman Sea coast, 214 stranded turtles were recorded between 1991 and 2002; 26.2% of these turtles were washed ashore by gill nets and another 7% by miscellaneous fishing gear (Adulyanukosol and Ruangkaew 2002). Fisheries bycatch, associated with entanglement in drift nets, shrimp trawling, long-lines, etc., has been classified as one of the highest threats to sea turtles globally (Wallace et al. 2013) (Seminoff 2004) (Mortimer 1998). In response to the US shrimp embargo in 1996, SEAFDEC, in collaboration with Thailand and other countries in the area, conducted a regional collaborative program on the development and application of TEDs in shrimp trawls (Chokesanguan 2008). The major activities included the design, development, and implementation of the "Thai Turtle Free Device" (TTFD) in shrimp trawl fisheries and experiments on various designs of TEDs. It is unclear if the TEDs are currently in use in all the trawl fisheries in the country, and current mortality of sea turtles in Thai trawl fisheries in unknown. According to the SFW criteria, this issue is assessed as "high" concern.

Factor 2.3 - Modifying Factor: Discards and Bait Use

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

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

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

INDIA / INDIAN OCEAN
Bottom Trawls

< 100%

A study of the west coast of India trawl fishery, where the majority of the squid catch occurs, found that in this fishery 62% of the catch was landed for edible purposes (Dineshbabu 2013). Due to the growing demand of low value fish by the fishmeal industry (aquaculture, etc.), the percentage of low value bycatch (LVB) species landed increased from 16% in 2008 to 27% in 2011. Only 13% of the bycatch was discarded during this study. Therefore, it is considered that the discard rate in this fishery is lower than 100%.

Justification:

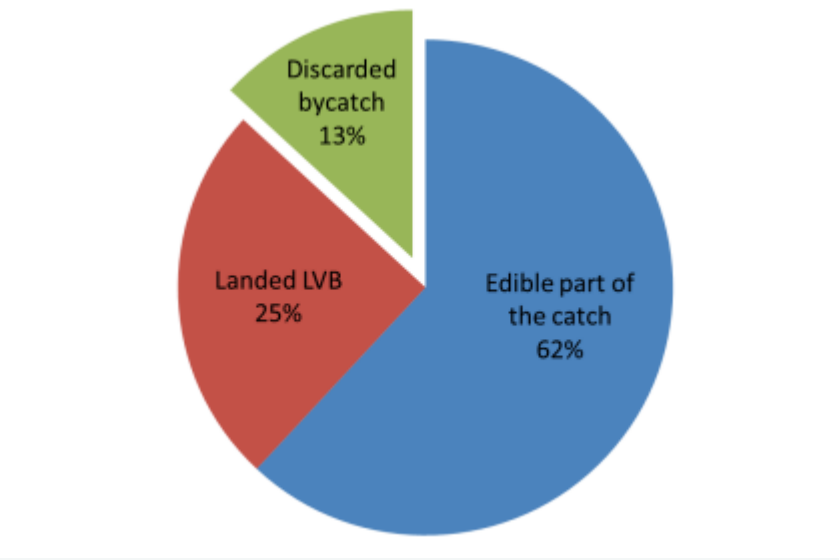

Figure 11 Catch composition of the trawl fishery in West India (Dineshbabu, A.P. 2013)

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

< 100%

Research on the composition of trawl catches in Thailand have found that the proportion of fish that have economic value (targeted species) is 33.3%, and the remaining 66.7% is trash fish (Supongpan and Boonchuwong 2010) (Nettasna 2014). In Thailand, as in other countries in the area, this trash fish (bycatch) is largely utilized for animal feed and it is not discarded (Chanrachkij 2015). Therefore, this bycatch is considered to be part of the total catch and the discard rate in the fishery is thought to be lower than 100%.

CORALS AND OTHER BIOGENIC HABITATS

Factor 2.1 - Abundance

INDIA / INDIAN OCEAN
Bottom Trawls

High Concern

Coral reefs are some of the most diverse and valuable ecosystems along the 8,000 km coastline of India. The major reef formations in India are restricted to the Gulf of Mannar, Palk Bay, Gulf of Kutch, Andaman and Nicobar Islands, and the Lakshadweep islands (Saroj et al. 2016). The west coast of India between Bombay and Goa is also reported to have submerged banks with isolated coral formations (Nair and Qasim 1978). A total of 199 species of coral have been found in Indian waters; the richer biodiversity is found in the coral reefs of the Andaman and Nicobar Islands, with 135 species identified, versus the 29 and 37 species found on the west coast of Kerala/Tamil Nadu and in the Gulf of Kutch**.** In India, coral reefs face a number of anthropogenic threats such as bleaching, destructive fishing, pollution, and climate change (Saroj et al. 2016). In general, the condition of the coral reefs in nearshore waters is poor and declining (Saroj et al. 2016). Based on the SFW criteria, coral species are considered highly vulnerable taxa and this group is scored as "high" concern.

Justification:

Figure 12 Coral reef in India (Saroj et al. 2016)

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

In 2015, Thailand had an area of 238.33 km^2 of coral reef in nearshore waters, but it was estimated that in the Andaman Sea coast only 12% of that coral reef was in good condition (DOF 2015). In general, the reefs in the Andaman Sea seem to be considered in better condition than those in the Gulf of Thailand (Phongsuwan et al. 2013). All these habitats are threatened by overexploitation, physical modification of the area due to trawling, nutrient and sediment pollution, and coral bleaching (DOF 2015) (Phongsuwan et al. 2013). Corals are considered to be high vulnerability species by the SFW standards. Based on the unknown bycatch matrix, this issue is scored as "high" concern.

Factor 2.2 - Fishing Mortality

INDIA/INDIAN OCEAN
Bottom Trawls

High Concern

No protection has been established for the coral reef patches on the west coast of India, where the main squid bottom trawl fishery occurs (Saroj et al. 2016). Along the west coast of India, coral patches are normally avoided by bottom trawlers to protect their valuable nets (A.P. Dineshbabu, pers. comm. 2019). Moreover, high speed bottom trawling adopted by trawl fishers has enabled the trawlers to exploit coral patches while reducing the impact on the bottom (A.P. Dineshbabu, pers. comm. 2019) (A.P. Dineshbabu et al.

2016). However, although the impact on the corals may be reduced in recent times, the trawl fishery that it is still working in these areas is scored as "high" concern.

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

Thailand has declared a series of marine protected areas. However, the government set as a goal of its marine strategy directive to have 4% of coral reefs under effective management by 2019 (DOF 2015), an objective that seems to fall short of protecting this country's important habitat. Therefore, it appears that bottom trawl in these areas is still having an impact on the habitat. Using the unknown bycatch matrix from the SFW criteria, the impact of bottom tropical fish trawl fisheries is scored as "1" resulting in a score of "high" concern for fishing mortality.

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

INDIA / INDIAN OCEAN
Bottom Trawls

< 100%

A study of the west coast of India trawl fishery, where the majority of the squid catch occurs, found that in this fishery 62% of the catch was landed for edible purposes (Dineshbabu 2013). Due to the growing demand of low value fish by the fishmeal industry (aquaculture, etc.), the percentage of low value bycatch (LVB) species landed increased from 16% in 2008 to 27% in 2011. Only 13% of the bycatch was discarded during this study. Therefore, it is considered that the discard rate in this fishery is lower than 100%.

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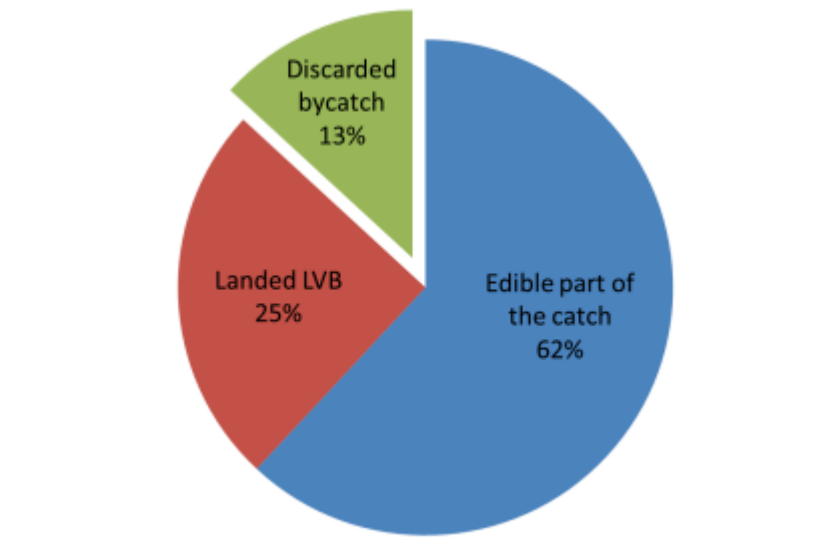

Figure 13 Catch composition of the trawl fishery in West India (Dineshbabu, A.P. 2013)

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

< 100%

Research on the composition of trawl catches in Thailand have found that the proportion of fish that have economic value (targeted species) is 33.3%, and the remaining 66.7% is trash fish (Supongpan and Boonchuwong 2010) (Nettasna 2014). In Thailand, as in other countries in the area, this trash fish (bycatch) is largely utilized for animal feed and it is not discarded (Chanrachkij 2015). Therefore, this bycatch is considered to be part of the total catch and the discard rate in the fishery is thought to be lower than 100%.

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: India/Indian Ocean | Bottom trawls	Ineffective	Ineffective	NA			Red (1.000)
Fishery 2: Indonesia/Western Central Pacific | Cast nets	Ineffective	Highly Effective	NA	NA	NA	Red (1.000)
Fishery 3: Indonesia/Western Central Pacific | Jig	Ineffective	Highly Effective	NA	NA	NA	Red (1.000)
Fishery 4: Thailand/Western Central Pacific | Bottom trawls	Ineffective	Ineffective				Red (1.000)
Fishery 5: Thailand/Western Central Pacific | Cast nets	Ineffective	Highly Effective				Red (1.000)

Fishery 6: Thailand/Western Central Pacific | Jig	Ineffective	Highly Effective				Red (1.000)

Criterion 3 assesses the effectiveness of management in ensuring there are conservation goals and that those goals are being met. The Criterion is broken into five components, as seen in the headers to the table above. Where C3.1 Management Strategy and/or C3.2 Bycatch Strategy are deemed "ineffective," the remaining factors (C3.3-3.5) are not assessed (as for India and Thailand in this assessment).

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.

INDIA / INDIAN OCEAN
Bottom Trawls

Ineffective

While there has been considerable effort to update and improve fisheries management in India over the last few years (see below), there are no comprehensive stock assessments for squid and no reference points have been set. Despite the indications of overexploitation, no limitations in effort and no harvest control rules are in place for these species. Therefore, management strategy for the country's squid fisheries is considered "ineffective."

Justification:

According to the constitution of India, the central government's Department of Animal Husbandry Dairying & Fisheries (DADF) under the Ministry of Agriculture, has jurisdiction over the fisheries in the EEZ, while the state/provincial governments have jurisdiction over fisheries in the territorial waters (ICSF 2014). This fishery operates in both waters. A review of economic, social and environmental performance undertaken by the World Bank in 2010 suggested that fisheries management in India, focused on increasing fish production, was meeting only a few policy outcomes against the goals established by the government (World Bank 2010). Despite attaining a reasonably good rate of growth in primary fisheries production and exports in the country, the marine fisheries sector in India faces several problems, such as the overcapacity in territorial waters for all maritime states, conflicts between artisanal and commercial fisheries, reduction in capital investment in the artisanal fisheries, overexploitation of several marine resources, etc. (Baiju 2013).

In 2017, the Government of India published the new "National Policy on Marine Fisheries, 2017" (NPMF), which provides guidance for promoting the "Blue Growth Initiative" in the country. The overarching goal of the NPMF is to ensure the health and ecological integrity of the marine living resources of India's Exclusive Economic Zone (EEZ) through sustainable harvests for the benefit of present and future generations of the nation (NPMF 2017). The strategy of this NPMF is based on seven pillars: sustainable development, socio-economic upliftment of fishers, the principle of subsidiarity, partnership, inter-generational equity, gender justice, and a

precautionary approach. These seven pillars will guide the actions of various stakeholders in meeting the vision and mission set for the marine fisheries sector of the country (NFMS 2017). According to this document, to extract the full potential of marine fisheries, management will focus on control fishing effort, optimize fleet size, develop species and area-specific management plans, promote conservation of Ecologically and Biologically Significant Areas (EBSAs), protect Vulnerable Marine Ecosystems (VMEs) and endangered and threatened (ETP) species, implement the Ecosystem Approach to Fisheries Management (EAFM), etc. (NFMS 2017). The current approach to fisheries management ("Blue revolution") in the country seems to continue in the same line and it is not addressing overexploitation, nor contributing to more positive economic and social outcomes, especially for inshore fisheries (Scroll.in 2018). Target species are overexploited and reductions on effort and more management measures to protect species and habitats have been suggested by various authors (Mohamed 1996) (Mohamed and Rao 1997) (Karnik et al. 2003) (Thomas and Kizhakudan 2006) (Mohan 2007) (Sasikumar and Mohamed 2012) (Saroj et al. 2016).

INDONESIA / WESTERN CENTRAL PACIFIC
Cast Nets
INDONESIA / WESTERN CENTRAL PACIFIC
Jig

Ineffective

Although it is considered that fisheries management has improved in recent years in Indonesia, there are no comprehensive stock assessments for squid and no reference points have been set. The effectiveness of the new management measures introduced (none specific to squid) in improving the condition of squid stocks (which is poor in many fisheries management areas in Indonesia, see Criterion 1) is unknown. Therefore, fisheries management is rated as "ineffective."

Justification:

The Ministry of Marine Affairs and Fisheries (MMAF), along with its counterparts, the fisheries services at the provincial and district levels controlled by local governments, are the main government agencies responsible for the administration and management of capture and culture fisheries in Indonesia (OECD 2013). Fishing management in Indonesia is established according to the distance to the coast: coastal waters up to 4 nm are managed by municipalities; waters from 4 to 12 nm are controlled by provinces; and the whole of the exclusive economic zone is managed by the national government. However, some jurisdictional overlap exists with the nearshore fisheries and marine resources, particularly between subnational governments and the Ministry of Marine Affairs and Fisheries (CCIF 2013) (Nurhidayah 2010). Squid is caught in both nearshore and offshore areas.

The main laws regulating fisheries in Indonesia are Law 31/2004 and its amendment law 45/2009. These laws provide a legal basis for a range of fishery management measures in marine, brackish, and public inland waters, including effort control through licensing and quota, gear restrictions, etc. (OECD 2013) (CCIF 2013). Law 31/2004 set out the requirement for fishery management areas and fishery management plans. It specifically stated the responsibility of the Minister in allocating catches based on fisheries' potential and sustainability issues (Dudley and Ghofar 2007). Marine protected areas in Indonesia have also been established under conservation law 5/1990 and are managed by the Ministry of Forestry (OECD 2013). Many other regulations apply to the fishing activity in the country defining fishery management areas (see figure below), designating periods where fishing is limited, and regulating the fishing gears permitted in each area (Reg. number PER.02/MEN/2011). That regulation further provides a framework for monitoring and evaluating fishing activities and contains provisions relating to sanctions for offences of the fishing regulations (FAOLEX 2012) (CCIF 2013).

Since 2014, when President Widodo was elected, maritime and fisheries policy has been a central priority for

the Indonesian government (OECD 2018). The MMAF's 2015–2019 strategic plan highlights sustainability, sovereignty, and prosperity as its three major pillars (CEA 2018). The new fisheries ministry adopted as a central objective its mandate to fight illegal fishing through the Presidential Task Force to combat illegal fishing, created to coordinate the actions of all the administrative bodies involved in this area (OECD 2018). In 2014 and 2015 a permanent moratorium on fishing by ex-foreign vessels operating within the exclusive economic zone (EEZ) and a ban on transhipment at sea were adopted and the budget of the Ministry of Marine Affairs and Fisheries (MMAF) doubled (OECD 2018). The trawl ban, in place since 1980, was also reinforced with ministerial regulation number KP No. 2/PERMEN-KP/2015 in order to prevent the degradation of fish resources caused by the widespread use of trawling in the country (FAO 2017). However, a number of constraints affect fisheries management in Indonesia, including overlapping and conflicting laws regarding marine and coastal management, unclear roles and responsibilities of institutions managing marine and coastal resources, lack of coordination and capacity of local governments, lack of financial support, weak monitoring, surveillance and enforcement (MCS), lack of public participation, low income and standard of living for fishers and fish farmers, etc. (Nurhidayah 2010) (CCIF 2013) (FAO 2017). Despite reducing the level of IUU fishing by foreign vessels, the new fisheries management regime has had very limited success in reducing illegal fishing by nationals (including the use of destructive fishing practices) and limiting fishing effort in EEZ waters (CEA 2018) and overfishing in both marine and inland nearshore fishing resources is still a problem (Nurhidayah 2010) (CEA 2018).

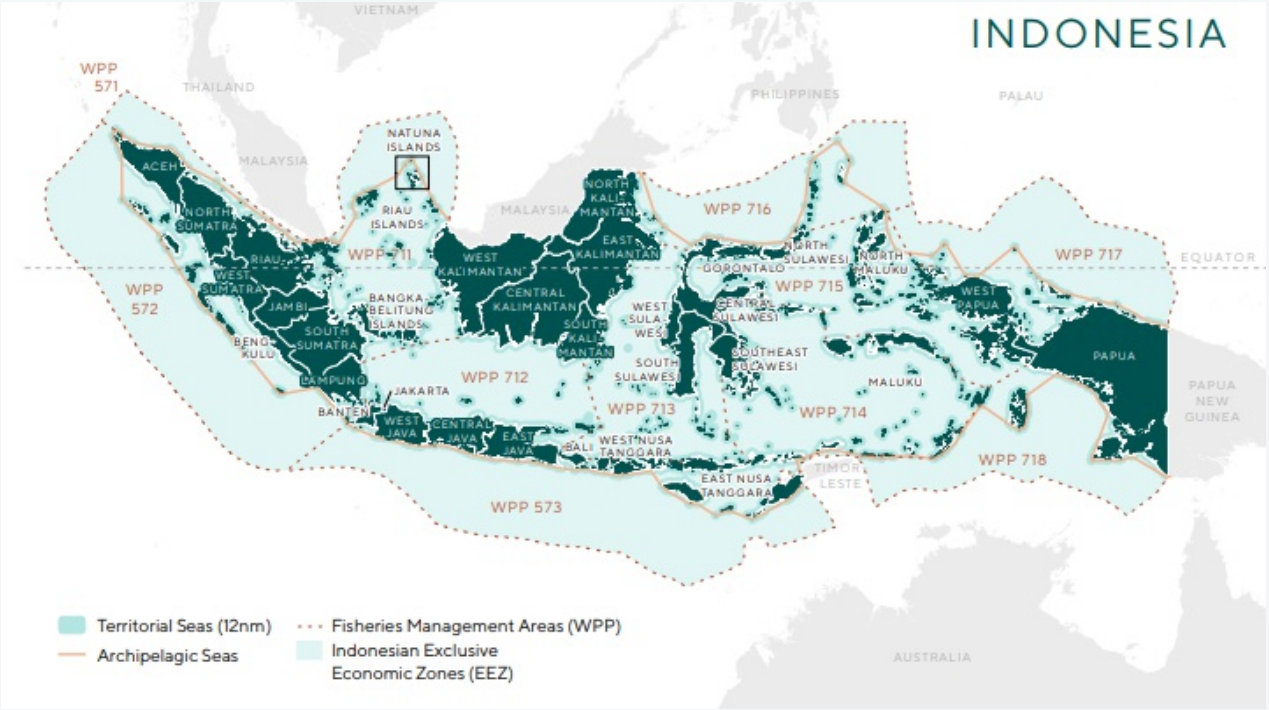

Figure 21 Fisheries management areas in indonesia (CEA 2018)

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls
THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets
THAILAND/WESTERN CENTRAL PACIFIC
Jig

Ineffective

A number of important issues have been identified in Thai fisheries, including inconsistencies between policies and the practice of government, inadequate law enforcement, excessive fishing capacity and lack of capacity to reduce fishing effort, etc. (Nettasna 2014) (Khemakorn 2015) (EFJ 2019). It has resulted in the overexploitation of fisheries resources in the country. Although a new strategy and related measures have been implemented in recent years that may help improve fisheries management in the country, it is too early to tell whether they will be successful, and none are specific to squid fisheries. For now, management of this country's squid fisheries is considered "ineffective."

Justification:

Thailand's marine fisheries are managed by the Department of Fisheries (DOF) of the Ministry of Agriculture and Cooperatives (MOAC), which is responsible for new vessel registration, vessel permit renewal, change of vessel lists, etc. (DOF 2015). Management of the marine environment is the responsibility the Department of Marine and Coastal Resources (DMCR) under the Ministry of Natural Resources and Environment (MNRE) (DOF 2015).

Thailand's governance and fisheries management framework was structurally reformed between 2015 and 2016 to promote sustainable and responsible practices throughout the sector (OECD 2018). These changes included the Adoption of the Royal Ordinance on Fisheries (ROF) B.E. 2558 in 2015; its primary aim was to empower authorities to combat IUU fishing and unlawful labour practices in the fishing and seafood industries (OECD 2018). The new law was designed to achieve its objectives through five mechanisms: a licensing system, a vessel monitoring system, vessel inspection, a traceability system, and effective law enforcement (SEAFDEC 2017). A National Plan of Action to Prevent, Deter, and Eliminate IUU Fishing was also adopted, while a Command Centre for Combating Illegal Fishing (CCCIF) was established under the leadership of the Royal Thai Navy (OECD 2018). A Marine Fisheries Management Plan (MFP), which aimed to tackle overfishing and overcapacity of the Thai fishing fleet was also implemented in 2015 (DOF 2015). It banned new vessel registration from 2015 and introduced a vessel buy-back scheme, more stringent gear regulations, limits on days at sea and Total Allowable Catch (TAC) limits with a maximum sustainable yield (MSY) objective. The specific capacity reduction targets in the MFP included (i) for demersal fish, 40% in the Gulf of Thailand and 10% in the Andaman Sea; and (ii) for pelagic fish, 30% in the Gulf of Thailand and 20% in the Andaman Sea by 2018 (OECD 2018) (DOF 2015).

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.

INDIA / INDIAN OCEAN
Bottom Trawls

Ineffective

The main management measures implemented by the Indian government to manage trawl fisheries and reduce the impact of the fishery on target and non-target species during spawning are a series of seasonal closures for mechanized vessels (mainly trawl vessels) introduced in the eastern Arabian Sea from 1988 (Kerala State, southwest Coast of India). However, these seasonal fishing bans are not adequately enforced. In 1983, depth restrictions beyond 80 m were implemented resulting in many foreign vessels leaving the country. However, the “Deep Sea Policy” was rescinded in 1997 after protests from local fishers (Hornby et al. 2015). A combination of other regulatory measures such as: MLS, mesh size regulation, temporary closures or moving rules for areas with a high proportion of juveniles, licensing to limit the number of vessels, in

addition to the seasonal ban, have been proposed by several authors (Kumar and Deepthi 2006) (Dineshbabu 2013). A minimum diamond mesh size of 35 mm in the codend to avoid the catch of juveniles was recommended for trawls (Mohamed et al. 2013). MLS of 8 cm and 11.5 cm were also recommended for squid and cuttlefish (Dineshbabu 2013). However, these recommendations have not become operational due to the multi-species, multi-gear nature of trawl fisheries. A strong market demand also exists for Low Value Bycatch (LVB) in India, as a result of the increased demand from fish meal plants operating in the country, which have incremented the landings of low value/trash, putting more pressure on the ecosystem (Dineshbabu 2013). Measures implemented in the country to manage bycatch species are therefore considered "ineffective" given the potential impacts of the fishery.

INDONESIA / WESTERN CENTRAL PACIFIC
Cast Nets

Highly Effective

As indicated in the management strategy section, a series of management measures have been implemented in Indonesia to reduce the impact of trawls and purse seines on fish resources, such as minimum mesh size, permitted areas, and the trawl ban (implemented since the 80s but reinforced in 2015). However, no information has been found about management measures in place for the cast net fishery. Anyway, cast nets are considered an environmentally friendly fishing gear, with low impact on bycatch, since the target species are attracted to the net by luring them with lights. Therefore, a score of "highly effective" was assigned to this fishing gear for the bycatch strategy.

INDONESIA / WESTERN CENTRAL PACIFIC
Jig
THAILAND / WESTERN CENTRAL PACIFIC
Jig

Highly Effective

A jig is a type of grapnel (or grappling hook), which is attached to a fishing line. Jigging for squid is done at night with lights to attract the squid closer to the surface (SFW 2018). Although other species, such as small pelagics, can be attracted by the lights used to lure squid, the hooks used in this fishery are not baited and there's virtually no bycatch. Therefore, a score of "highly effective" is assigned.

THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls

Ineffective

Trawl fishing was introduced in Thai waters by the Fisheries Act B.E. 2490 in 1947 to increment catches in the country (Nettasna 2014). Thailand is reported to be a participant of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), United Nations Convention on Law of the Sea (UNCLOS), and is a signatory to the Convention on Biodiversity. Thailand has taken action to address the International Plans of Action (IPOA-sharks) for conservation and management of sharks through the implementation of statistics collection, biological studies, and development of a national plan of action (DOF 2015b). Since 1972, the Department of Fisheries has issued legal measures to control fishing trawlers, prohibiting the use of this gear and push nest in some fishing areas, establishing closed areas in the Gulf of Thailand and extending the coastal conservation zone (Nettasna 2014). In 2013, the authorities also proposed to enlarge the minimum trawl mesh size to 4 cm in order to reduce the amount of trash fish caught during fishing operations, and the possession of trawl nets with codend mesh sizes less than 5 cm was prohibited by

the National Council for Peace and Order's (NCPO) Order No. 24/2558 in 2015. This measure was later reviewed and the minimum allowed codend mesh size was changed from 5 cm to 4 cm (Nettasna 2014). A series of other measures (closed seasons and areas) are also in place to protect spawners and juveniles (DOF 2015). However, in a study undertaken under the REBYC-II CTI Project (FAO 2017), it was found that 87% of the fishermen interviewed still used codend less than 4 cm. Closed areas are also usually invaded by commercial fishers who want to catch more fish without awareness of depletion of fish stocks (Supongpan and Boonchuwong 2010).

It seems that there are some inconsistencies between the policies set by the Thai authorities (such as setting a minimum codend size); and enforcement of bycatch regulations in the country is inadequate. For now, the bycatch strategy for the Thai trawl fishery is considered "ineffective."

THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets

Highly Effective

As indicated in the trawl section, a series of management measures have been implemented in the country to reduce the impact of trawls on trash fish, such as minimum mesh size, closed areas, etc. However, no information has been found about management measures specifically implemented to reduce the catch of non-target species in the cast net fishery. Nevertheless, cast nets are considered an environmental friendly fishing gear, with low level of bycatch, since target species are attracted to the net by luring them with lights. Therefore, a score of "highly effective" was assigned to this fishing gear for Bycatch Strategy.

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
India/Indian Ocean | Bottom trawls	1	0	Moderate Concern	Red (1.732)
Indonesia/Western Central Pacific | Cast nets	4	0	Moderate Concern	Green (3.464)
Indonesia/Western Central Pacific | Jig	5	0	Moderate Concern	Green (3.873)
Thailand/Western Central Pacific | Bottom trawls	1	0	Moderate Concern	Red (1.732)
Thailand/Western Central Pacific | Cast nets	4	0	Moderate Concern	Green (3.464)
Thailand/Western Central Pacific | Jig	5	0	Moderate Concern	Green (3.873)

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

INDIA / INDIAN OCEAN
Bottom Trawls
THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls

1

The impact of bottom trawling on the habitat is well documented. All the components involved in trawling (doors, chain, weights, etc) have the capability to affect the seabed, destroying benthic ecosystems (Oceana 2008). Bottom trawling reduces habitat complexity, species richness, and biomass, and increases the presence of opportunistic species by altering the species composition (Morgan and Chuenpagdee 2003). Homogenization of habitats risks loss of ecological function and natural heritage values reducing resilience, thereby predisposing the system to sudden and dramatic change (Hiscock et al. 2006). Commercial trawl fisheries for squid species most often employ shallow bottom trawls that catch squid populations during the day when squid is close to the seabed. Trawls designed for squid fishing generally have a higher head rope than is usual for finfish, avoiding the contact of the gear with the substrate (FAO 2005) (Stobutzki et al. 2006) (Thomas et al. 2006). However, this is a mixed fishery, in which squid is caught as a bycatch of the target fish fishery and it is considered that the gear come in direct contact with the benthos. Although some areas have been protected in both India and Thailand to protect vulnerable habitats, information is limited and there is the potential for the gear to contact sensitive habitat. Therefore, a score of "1" is given for the Indian and Thai trawl fisheries in this section.

INDONESIA / WESTERN CENTRAL PACIFIC
Cast Nets
THAILAND / WESTERN CENTRAL PACIFIC
Cast Nets

4

Squid fishing is usually done at night using lights to attract the squid to the surface. When the squid is concentrated around the fishing boat, falling nets (cast nets) or lift nets are used to catch it. Cast nets catch the squid by falling and closing in on them (FAO 2018) and although it can contact the seabed when used in shallow waters, the impact of this net on the habitats seems to be low or nonexistent.

INDONESIA / WESTERN CENTRAL PACIFIC
Jig
THAILAND / WESTERN CENTRAL PACIFIC
Jig

5

Jigging for squid is usually done at night using lights to atract the squid to the surface where it is caught with a kind of grappling hook attached to a fishing line. This fishing method is considered environmentally responsible because there's virtually no catch of unwanted marine life or habitat impacts (SFW 2018).

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

INDIA / INDIAN OCEAN
Bottom Trawls

0

The Indian authorities have implemented a series of management measures to reduce the impact of the trawl fishery on the habitat. The technical management measures implemented include seasonal closures for mechanized vessels, depth restrictions, etc. However, these seasonal fishing bans are not adequately enforced. A series of alternative measures (closures or moving rules for areas with a high proportion of juveniles) have been proposed by several authors but are not yet implemented (Kumar and Deepthi 2006) (Dineshbabu 2013). In 2015, there were a total of 128 marine Protected Areas in India. Of these, there were four Marine National Parks; sixty-seven Marine Sanctuaries, National Parks, and Wild Life Sanctuaries; and three Marine Biosphere Reserves (Laxmilatha et al. 2015). These MPAs protect coral reefs, seagrass beds, mangroves, and other areas. However, more work is still necessary to assess the status of the resources and the habitats in India, and monitor the impact of the conservation measures implemented within the protected areas (Laxmilatha et al. 2015). Although institutions and laws are in theory sufficient to manage and protect these features in Indian waters, authorities have taken little effective action in implementing these laws, which has resulted in an increasing rate of destruction to these marine habitats (Saroj et al. 2016). Therefore, it is considered that mitigation of gear impacts in this fishery are not adequate and no extra points are given in this section.

INDONESIA / WESTERN CENTRAL PACIFIC
Cast Nets
INDONESIA / WESTERN CENTRAL PACIFIC
Jig
THAILAND / WESTERN CENTRAL PACIFIC
Cast Nets
THAILAND / WESTERN CENTRAL PACIFIC
Jig

0

Cast nets and jigs do not impact, or have minimal impact, on the seabed. Therefore this issue is not scored.

THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls

0

Thailand has put in place a range of management and technical measures through the Fisheries Act B.E. 2558 (2015). The technical management measures implemented include to control the number and size of fishing gears (trawls and other gears), the freezing of the number of trawl licenses, protection of spawning stock and juveniles through closed seasons and areas, demarcation zones between artisanal and commercial fisheries; and increasing the mesh size to reduce the catch of juveniles (DOF 2015). Marine Protected Areas (MPAs) have been declared in the country covering about 25% of the total marine area (DOF 2015). However, as

explained in the previous sections, these measures are not adequately enforced in the country and closed areas seem to be usually invaded by commercial fishers. The benefit of closed seasons/closed areas in terms of fishing capacity reduction is small because fishing vessels moving to operate in other fishing grounds worsen the problem of overfishing in other areas; as soon as the closed area is opened, they move back to race for fish in their usual fishing grounds (Khemakorn 2015). Therefore, it is considered that mitigation of gear impacts in this fishery are not adequate and no extra points are given in this section.

Justification:

The total area covered by Marine Protected Areas (marine sanctuaries, non-hunting areas, marine national parks, mangrove swamps, coral reef areas, sea grass bed, etc.) in Thailand is around 79,756.72 km^2; about 25.23% of the total sea area of Thai waters (DOF 2015). However, in the year 2015, Thailand had 2,455.34 km^2 of mangroves along the coasts of the Gulf of Thailand and the Andaman Sea. However, approximately 80 to 90% and 20% of mangrove forests had disappeared in the previous 20 to 30 years along the Gulf of Thailand and the Andaman coast respectively (DOF 2015). In the same year, the country had 238.33 km2 and 255.73 km2 of coral reef and seagrass beds respectively, but it was estimated that in the Andaman Sea coast only 12% of that coral reef was in good condition. All these habitats were threatened by overexploitation, physical modification of the area due to trawling, nutrient and sediment pollution, etc. (DOF 2015).

Factor 4.3 - Ecosystem-Based Fisheries Management

INDIA / INDIAN OCEAN
Bottom Trawls

Moderate Concern

A number of FAO projects, such as the Bay of Bengal Large Marine Ecosystem project (BOBLME) or the Strategies for Trawl Fisheries Bycatch Management (REBYC II CTI) introduced the EAFM concept in South Asia, including India, thorough a series of initiatives on EAFM for scientist and fisheries managers in South Asia, including India (Muralidharan 2017). For 2018 and 2019, the Indian government has also embarked on the "Blue Revolution: Integrated Development and Management of Fisheries" initiative which aim is to achieve economic prosperity for the country and the fishers and fish farmers, as well as contribute towards food and nutritional security through full potential utilization of water resources for fisheries development in a sustainable manner, keeping in view the bio-security and environmental concerns (DAHD 2018).

Some management measures aimed to protect the ecosystem have been implemented in the country, such as: protected areas, trawl ban during the monsoon season, and a new ban for ring seiners in Kerala, and other areas. The CMFRI has also undertaken a series of studies to understand the impact of fisheries on marine resources and the ecosystem (CMFRI 2018). Therefore, although it cannot be considered that an EAFM is implemented in the country, some policies aimed to protect the ecosystem have been implemented but their effectiveness has not yet been proven. However, as stated in the previous section, it appears that the laws aimed to protect the ecosystem are not adequately enforced by the authorities (Saroj et al. 2016).

Detrimental food web impacts are possible, and there is some ecosystem-based management in place; however, stronger policies may be needed to fully protect the ecological role of harvested species. Therefore, this issue is scored as a "moderate" concern.

INDONESIA / WESTERN CENTRAL PACIFIC
Cast Nets
INDONESIA / WESTERN CENTRAL PACIFIC
Jig

Moderate Concern

The Indonesia Coral Triangle Initiative on Coral Reefs (CTI-CFF) National Coordinating Committee (NCC) was formed in 2009 to lead the in-country implementation of the CTI-CFF Regional Plan of Action and the Indonesia CTI-CFF National Plan of Action (NPOA), a multi-government partnership aiming to safeguard the region's marine and coastal resources (Pomeroy et al. 2013). Under this initiative, six countries in the area adopted a regional plan of action with five overarching goals: 1) strengthening management of seascapes; 2) applying an ecosystem approach to fisheries management (EAFM); 3) developing and strengthening the management of marine protected areas; 4) implementing climate change adaptation measures, and 5) protecting threatened marine species. Specifically, the CTICFF agreed to work collaboratively to "develop a common regional framework for legislation and policy that would support EAFM and strengthen regional and national legislation, policies, and regulations" (Pomeroy et al. 2013). The government of Indonesia is implementing a roadmap toward EAFM, the progress of which is supported by key stakeholders including the Ministry of Marine Affairs and Fisheries, Marine and Fisheries Research Agency, District and Provincial Fisheries Agencies, scientific institutes, universities, and NGOs. At the national level, the NCC has led the following successful efforts: identification of priority seascapes; completion of zoning regulations for fishing gears that support sustainable fisheries; designating a 1.2 million hectare marine park as a protected area; conduct of community information campaigns on climate change; development of a school for marine conservation and the institutionalization of a marine protected area training curriculum (Coral Triangle Initiative 2018).

Scientific assessments and management efforts to account for ecological roles of marine species in Indonesia are underway. The sustainability of marine ecosystem has become a major concern to the Indonesian government (Kirana et al. 2016). However, it seems that regulations to support the adoption and implementation of an EBFM have not yet been fully implemented in the country. As detrimental food web impacts are possible, and there is some ecosystem-based management in place, but stronger policies may be needed to fully protect the ecological role of squid, this section is scored as "moderate" concern.

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls
THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets
THAILAND/WESTERN CENTRAL PACIFIC
Jig

Moderate Concern

Thailand's governance and management framework for fisheries and aquaculture was structurally reformed to promote sustainable and responsible practices throughout the new Royal Ordinance on Fisheries B.E. 2558 (2015) adopted in November 2015. One of the key objectives of that law makes specific reference to the EBFM "use of best available scientific evidence to achieve long-term economic, social, and environmental sustainability, in line with the ecosystem-based approach and precautionary approach, to ensure that fisheries resources are maintained or restored to a level that can produce the maximum sustainable yields" (Royal Ordinance on Fisheries 2015). A series of measures aiming to protect the ecosystem are in place in the country, such as: closed areas and closed seasons, including limitations for certain fishing methods; a reserved zone within 3 km from shoreline where engine-powered boats cannot fish to preserve nursing areas of juvenile fish and invertebrates; installation of artificial reef to obstruct trawling. A Marine Fisheries Management Plan was also developed and more stringent gear regulations implemented, including limits on days at sea and Total Allowable Catch (TAC) limits based on the maximum sustainable yield (MSY) with the objective of reducing overfishing and overcapacity of the Thai fleet (DOF 2015) (OECD 2017).

As detrimental food web impacts are possible, and there is some ecosystem-based management in place, but stronger policies may be needed to fully protect the ecological role of squid (and other species caught in the trawl fishery), this issue is scored as "moderate" concern.

Acknowledgements

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

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

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Appendix A: Extra By Catch Species

FORAGE FISH

Factor 2.1 - Abundance

INDONESIA / WESTERN CENTRAL PACIFIC
Cast Nets

Moderate Concern

(Ghofar 2002) reports that the species caught by "jala-oras" in the Alas Strait in Indonesia include squid and other species such as Sardinella (*Sardinella lemuru* and *S. fimbriata*), scad (*Decapterus* spp.), and mackerel (*Rastrelliger* spp.). The relatively short lifespan and high fecundity of these species makes them relatively resilient to fishing pressure. Status of these resources in the area varies from year to year due to variations in stock density, which is related to fishery independent and fishery dependent factors (BOBLME 2011). The Indonesian MMFA groups fisheries resources by categories (i.e, demersal, small pelagics, squid) which prevents an adequate analysis about the state of the stocks at the species level. The table included in Criterion 1 for Indonesian mitre squid show the potential catch per year, total allowable catch (TAC), and utilization rate by WPP for 2017 for small pelagic species, which includes anchovy, sardine, mackerel, and scad (CEA 2018). As seen in that table, small pelagics are fully exploited or overexploited in 4 and 5 of the Indonesian fisheries management areas respectively (CEA 2018). In the Java Sea, where nearly 50% of the squid catch occurs, small pelagics are considered as moderately exploited.

Because the pelagic stocks are not highly vulnerable and they are considered by the management body as not overfished in that area, this section is scored as "moderate" concern.

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INDIA / INDIAN OCEAN
Bottom Trawls

High Concern

Defining "forage species" can be a difficult task and this definition is many times applied only to small, energy-rich, schooling fishes like sardines or anchovies (Pikitch et al. 2012). In this report, this group refers to small to medium pelagic species, including anchovy, mackerel, scad, and ribbonfish. The relatively short lifespan and high fecundity of these species makes most of them relatively resilient to fishing pressure (except ribbonfish; see table below), although some of these stocks are heavily affected by environmental conditions (Hilborn et al. 2017). As explained in the finfish section, rapid stock assessments are conducted by the authorities In India at the state level but not on a regular basis in all the coastal states, making it very difficult to know the current status of the stocks (CFMRI 2018). Therefore, we will look at the status of pelagic species in the Gurujat and Kerala provinces, where the majority of the squid is caught (CMFRI 2017). Status of the pelagic resources in these areas varies from year to year due to variations in stock density, which are related to fishery independent and fishery dependent factors (BOBLME 2011). For example, a recent stock assessment of oil sardine along the Kerala coast indicated that the stock had fallen below MSY levels due to a combination of adverse environmental factors in 2013 and intense fishing pressure during 2009 to 2012 (CMFRI 2018). For Indian mackerel, the annual total stock available along the Indian coast was estimated in 2011 at around 400,000 MT of which 190,000 MT are exploited. Under the present age at capture, the maximum sustainable yield from the resource was estimated at 220,000 MT (BOBLME 2011). In Kerala province, all these resources are declining (see table below).

The most vulnerable species of this group, ribbonfish, show a high vulnerability to fisheries; trawl catches of this species seem to be high and the stock is declining in the Kerala province (no information found in other provinces). Therefore, based on the SFW criteria, abundance of this group is scored as a "high" concern.

Justification:

Species	Indian mackerel (*R. kanagurta*)	Round sardinella (*S. gurita*)	Yellowtail scad (*Atule mate*)	Ribbonfish (*T. lepturus*)
t_m	0.5 – 1	1	Unknown	2 – 3.7
t_{max}	4	7	unknown	15
Fecundity	37,000-170,000	14,000-200,000	63,000-161,000	23,000 -208,000
Trophic level	3.2	3.4	4.2	4.4
Vulnerability	Low	Moderate	Low	High

Figure 14 Vulnerability of pelagic species caught in the Indian and Thai trawl fisheries (Fishbase 2018)

THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets
THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

Moderate Concern

As defined above, in this report, forage fish refers to pelagic species, including anchovy, mackerel and scad. Forage species' stocks are much more affected by environmental conditions than by fishing (Hilborn et al. 2017). The relatively short lifespan and high fecundity of these species makes them relatively resilient to fishing pressure. Status of these resources in the area varies from year to year due to variations in stock density, which is related to fishery independent and fishery dependent factors (BOBLME 2011). It is indicated in (DOF 2016) that Indo-Pacific mackerel (*Rastrelliger brachysoma*) stocks in Thai waters had been fully exploited, sardine (*Sardinella spp.*) has been over-exploited, whereas anchovy (*Encrasicholina* spp. and *Stolephorus* spp.) resources have likewise been fully exploited. The small tuna and round scad stocks have also been fully exploited and other pelagic fish stocks including the Spanish mackerel (*Scomberomorus commersoni)*, carangids and hardtail scads (*Megalaspis cordyla*) have not yet been fully exploited (DOF). However, as no adequate recent stock assessments are available for these species; therefore, based on the SFW criteria, this issue is scored as "moderate" concern.

Factor 2.2 - Fishing Mortality

INDONESIA/WESTERN CENTRAL PACIFIC
Cast Nets

Moderate Concern

Indonesia has a marine resources potential of 6.5 million MT per year, of which 1.15 million MT would correspond to large pelagic fish (tuna and tuna-like species), 3.65 million MT to small pelagic fish (anchovy, sardine, mackerel and scad), 1.45 million MT to demersal fish, and 145,000 to reef fish. In 2016, 72% of the resources in Indonesia (97 out of 127 species) were considered fully or overexploited (BPS 2016).

Approximately 43% of the small pelagic catch in Indonesia is made of mackerel (both *R. kanagurta* and *R. brachysoma*). Elefan based assessments have been conducted in the country in different periods, which indicate that this resource has been exploited at a rate between 0.61 and 0.68 between 1984 to 2009. This is too high for the resource; thus, it was considered as being overexploited (BOBML 2011). No specific information has been found for other small pelagic species but exploitation of fish resources (including small pelagics) in the country increased an average of 3.23 percent per year between 2012 and 2015 (BPS 2016). The bulk of the catch of small pelagics in Indonesia seems to be taken by purse seines (BOBML 2011). Current fishing mortality for this group is increasing but the cast net fishery is not considered a substantial contributor to fishing mortality of small pelagics. Based on the SFW criteria, this issue is scored as "moderate" concern.

INDIA / INDIAN OCEAN
Bottom Trawls

Moderate Concern

In 2017, 3.83 million MT of forage fish were landed in India, of which 564,360 MT were sardine, 145,213 MT anchovy, 296,230 MT scad and 287,880 MT mackerel; an increase of 5.6% compared to the 2016 landings (CMFRI 2018). In that year, 82.6% of the total catch was reported by the mechanized sector, of which nearly 60% was made by multi-day and single-day trawlers (CMFRI 2018). Multi-day trawls contributed to 28% of the total catch of mackerel, but to a very low percentage of the catch of oil sardine (in this case purse seines represent around 93% of the catch). In Gujarat, ribbonfish accounted for 40% of the pelagic fish landings and mechanized multi-day trawlers alone contributed to 78.7% of these landings (CMFRI 2018). As explained above, around 42% of the squid caught in the country were landed in the Gurujat and Kerala provinces (CMFRI 2017). Catches of ribbonfish (the most vulnerable species) in Gujarat and Kerala increased by 19% and 63% respectively in 2017 with respect to the previous year (CMFRI 2018). Changes in fish landings in 2017 with respect to 2016 are shown in the figure below (CFMRI 2018).

Due to the lack of reference points, it is difficult to know if fishing mortality for small pelagic species is over a sustainable level. Therefore based on the SFW criteria, a score of "moderate" concern (unknown mortality) is given for this issue.

THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets

Moderate Concern

In the Thai marine strategy plan of 2015 to 2019, the MSY for pelagic resources are estimated at 191,785 MT and 32,944 MT for anchovy, and 248,176 MT and 118,477 MT for other pelagic resources, for the Gulf of Thailand and the Andaman Sea respectively (DOF 2015). Based on fishing effort, anchovies are considered fully exploited whereas the fishing effort for other pelagic resources is estimated at around 27 and 16.5% over the MSY for the Gulf of Thailand and the Andaman Sea (DOF 2015). Thompson and Bell assessed Indian mackerel in 2007 and considered that the fishery was over-exploited (F=0.7, yield of 12,999 t) (Thompson and Bell 2007). Recent estimates indicated that F were over the sustainable rates (0.83) indicating that the resource is being over-exploited (BOBMLE 2011).

As stated above, pelagic resources in Thai waters are considered either fully exploited or over-exploited (DOF 2015). The Thai marine strategy set a goal of 30% a reduction in fishing effort in the Gulf of Thailand and a 20% reduction in Andaman Sea for pelagic species, which should be reached before the end of 2018 by freezing the number of fishing licenses, reducing the number of allowable fishing days for purse seines targeting these species and controlling IUU fishing (DOF). It is unclear if this objective have been reached and fishing mortality for this group of species have been reduced.

Fishing mortality of pelagic (forage) species in Thai waters seems to be considerable. However, as no specific information about fishing mortality for specific species is available and these species have been grouped together in this report, based on the SFW criteria a score of "moderate" concern is given to this taxonomic group.

THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

In the Thai marine strategy plan 2015 to 2019, the MSY for pelagic resources are estimated 191,785 MT and 32,944 MT for anchovies, and 248,176 MT and 118,477 MT for other pelagic resources, for the Gulf of Thailand and the Andaman Sea respectively (DOF 2015). Based on fishing effort, anchovies are considered fully exploited, whereas the fishing effort for other pelagic resources is estimated at around 27 and 16.5% over the MSY for the Gulf of Thailand and the Andaman Sea (DOF 2015). Thompson and Bell assessed Indian mackerel in 2007 and they considered that the fishery was over-exploited (F=0.7, yield of 12,999 tons) (Thompson and Bell 2007). Recent estimates indicated that F were over the sustainable rates (0.83) indicating that the resource is being over-exploited (BOBMLE 2011).

As stated above, pelagic resources in Thai waters are considered either fully exploited or over-exploited (DOF 2015). The Thai marine strategy set a goal of 30% reduction in fishing effort in the Gulf of Thailand and a 20% reduction in Andaman Sea for pelagic species, which should be reached before the end of 2018 by freezing the number of fishing licenses, reducing the number of allowable fishing days for purse seines targeting these species, and controlling IUU fishing (DOF). It is unclear if this objective has been reached and fishing mortality for this group of species has been reduced.

Fishing mortality of pelagic (forage) species in Thai waters seems to be considerable. No specific information about fishing mortality for specific species is available. However, it seems that fishing mortality in the trawl fishery could be high. Therefore, a score of "high" concern is given to this taxonomic group.

Factor 2.3 - Discard Rate

INDONESIA / WESTERN CENTRAL PACIFIC
Cast Nets

< 100%

Squid fishing most often takes place at night when fishermen use overhead lights to lure the squid, and other small pelagic species, to concentrate them near the boat. Falling nets (i.e., cast nets) and lifting nets are then used to catch them. The lights also attract predator species, such as small tuna or cuttlefish, which prey on these small fish and squid and which are also retained when caught. Although information about the catch composition of the Indonesian cast-net fishery for squid is not available, this is an environmentally friendly gear in which very few non-target species are caught. Therefore, the discard rate in this fishery seems to be low.

INDIA / INDIAN OCEAN
Bottom Trawls

< 100%

A study of the west coast of India trawl fishery, where the majority of the squid catch occurs, found that in this

fishery 62% of the catch was landed for edible purposes (Dineshbabu 2013). Due to the growing demand of low value fish by the fishmeal industry (aquaculture, etc.), the percentage of low value bycatch (LVB) species landed increased from 16% in 2008 to 27% in 2011. Only 13% of the bycatch was discarded during this study. Therefore, it is considered that the discard rate in this fishery is lower than 100%.

Justification:

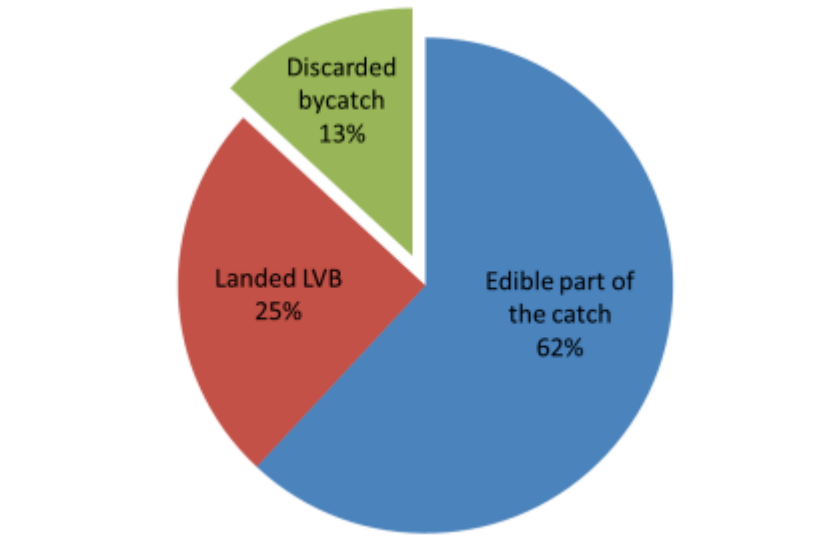

Figure 15 Catch composition of the trawl fishery in West India (Dineshbabu, A.P. 2013)

THAILAND/WESTERN CENTRAL PACIFIC
Cast Nets

< 100%

In a catch analysis of the Indian squid cast-net fishery in the Gulf of Thailand undertaken by (Supongan et al. 1992), Indian squid represented approximately 50.1% of the catch. Other species retained in the fishery were Indian mackerel and yellowtail scad, which represented around 10% and 7% of the catch, respectively. Considering that only these three species were retained, it seems clear that the discard ratio in this fishery is lower than 100%. No bait is used in cast net fishing.

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

< 100%

Research on the composition of trawl catches in Thailand have found that the proportion of fish that have economic value (targeted species) is 33.3%, and the remaining 66.7% is trash fish (Supongpan and Boonchuwong 2010) (Nettasna 2014). In Thailand, as in other countries in the area, this trash fish (bycatch) is largely utilized for animal feed and it is not discarded (Chanrachkij 2015). Therefore, this bycatch is considered to be part of the total catch and the discard rate in the fishery is thought to be lower than 100%.

FINFISH

Factor 2.1 - Abundance

INDIA / INDIAN OCEAN
Bottom Trawls

High Concern

In this report, finfish refers to demersal species. As explained in the summary section, in India, threadfin breams, ribbon fishes, and penaeid prawns, followed by sciaenids, squids, and cuttlefishes were the major groups in the trawl fishery in the west coast of the country between 2008 and 2012 (Dineshbabu 2013). These groups represented more than 50% of the total catch (Dineshbabu 2013). In India, both the Fishery Survey of India and The Central Marine Fisheries Research Institute (CMFRI) conduct fisheries stock assessments (rapid stock assessments) and provide advice for management (Fishsource 2018). However, stock assessments are normally conducted at the state level and not on a regular basis in all the coastal states, making it very difficult to know the current status of the stocks (CFMRI 2018). In 2018, the Department of Animal Husbandry Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, estimated the MSY for these resources based on the new models developed, using time series data on fish catch and fishing effort during 1997 to 2016. However, this information was not published in the last CMFRI annual report (CMFRI 2018). Since around 42% of the squid caught in the country was landed in the Gujarat and Kerala provinces (CMFRI 2017), we will look at the status of the demersal resources in those provinces. Among demersal species caught in Gujarat in 2017, major resources were: croakers (*Jonhius* spp., *Otolithes* spp.), with a contribution of 19.67% to the demersal landings, followed by bull's eye (*Priacanthus hamrur*) (15.57%), catfishes (13.29%), threadfin breams (*Nempiterus* spp.) (12.47%) and rockcods (9.88%). Similar proportions are reported for the Kerala province. All these resources are declining in the area (see figure below) (CMFRI 2018).

According to the SFW criteria, finfish species should be scored by default as "moderate" concern. However, available data suggest that the status of the demersal resources in the country is poor, therefore a score of "high" concern is given for this taxonomic group because of the exploitation status.

Justification:

Resource	Stock Status
Oilsardine	Declining
Indian mackerel	Declining
Ribbonfishes	Declining
Indian scad	Less abundant
Stolephorus sp	Declining
Threadfin breams	Declining
Rockcods	Declining
Whitefish	Declining
Silver pomfret	Declining
Lizardfishes	Abundant
Croakers	Declining
Soles	Declining
Penaeid shrimps	Less abundant
Crabs	Less abundant
Squids	Less abundant
Cuttlefishes	Less abundant

Figure 16 Exploitation status of major fishery resources of Kerala (CMFRI 2018)

THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls

Moderate Concern

Catch composition of the Thai trawl fishery was studied by (Supongpan and Boonchuwong 2010) between 2003 and 2005. Cephalopod species represented around 20% of the catch; demersal fish 30%; trash fish, 40%; and pelagic species 4% of the total catch (Supongpan and Boonchuwong 2010). The demersal species group was composed by a mix of species, which included *Nemipterus* (threadfin bream)*, Priacanthus, Saurida, Carrangidae, Scolopsis*, etc. Orangefin ponifish (Photopectoralis bindus), whipfin ponyfish (*Equulites leuciscus*), and splendid ponyfish (*Eubleekeria splendens*) were the only fish species that represented more than 5% of the catch. Slender lizardfish (*Saurida elongata*), brushtooth lizardfish (*S. undosquamis*), lattice monocle bream (*Scolopsis taeniopterus*), and dark-barred goatfish (*Upeneus luzonius*) represented more than 2% of the catch (Supongpan and Boonchuwong 2010). Any of these species have been evaluated by the IUCN red list, but they show low to moderate vulnerability to fishing. There is no stock assessment, no reference points, and/or no evidence to suggest that stock is either above or below reference points. Therefore, the status of this taxonomic group is considered a "moderate" concern.

Factor 2.2 - Fishing Mortality

INDIA / INDIAN OCEAN
Bottom Trawls

Moderate Concern

In 2017, 3.83 million MT were landed in India, of which 157,773 MT were threadfin breams, 150,241 MT were croakers, 143,451 MT were bullseyes (CMFRI 2018). In that year, 82.6% of the total catch was reported by the mechanised sector, of which nearly 60% was made by multi-day and single-day trawlers (CMFRI 2018). In the Gujarat province, demersal fish landings accounted for 28.9% of the total fish landings in the province, a decline of 5.18% from the previous year. In Kerala, landings of croakers decreased by 44% whereas the landings of rock cod increased by 73% (CMFRI 2018). Trawlers contributed to around 74.5% of the demersal landings in the Gujarat province (CMFRI 2018).

Due to the lack of reference points, it is difficult to know if fishing mortality for demersal species is over a sustainable level. Therefore based on the SFW criteria, a score of "moderate" concern (unknown mortality) is given for this issue.

Justification:

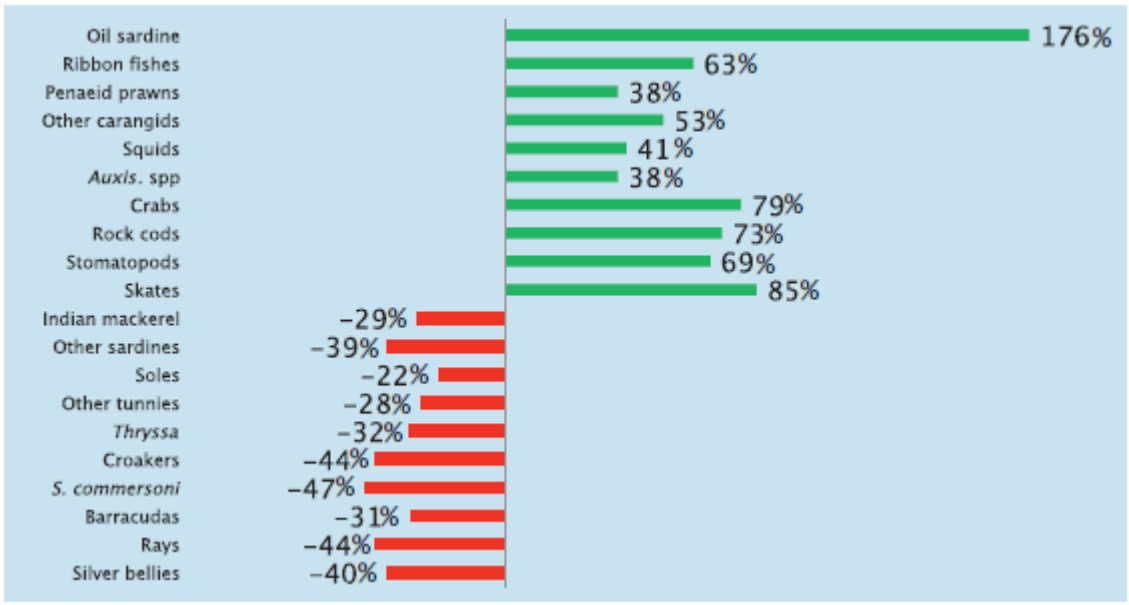

Figure 17 Variation in the landings of some of the major resources of Kerala during 2016 and 2017 period

(CMFRI 2018)

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

(Kongprom et al. 2008) assessed demersal fish caught by trawl fisheries in the Gulf of Thailand. That assessment gave a maximum sustainable yield (MSY) of 277,027 MT. Demersal catches in 2005 amounted for 315,418 MT, which mean that demersal fish were overexploited about 14% over the MSY. In that report, trash fish was also considered overexploited (Kongprom et al. 2008). Exploitation rates (E=F/Z) of 15 species of trash fish based on length frequency from 4 periods (1971, 1981, 1991 and 1995) were estimated by (Kongprom et al. 2003). Exploitation rates of those species increased over that period, reaching exploitation rates of around 83 to 98%, except for few species (*Scolopsis and Megalaspis*) in which exploitation rates were still considered low. The results of that study showed that most of the fish stocks of trash fish in Thai waters were severely overexploited (Kongprom et. al. 2003).

The most recent general estimate of the status of marine resources in Thai waters is shown in the Thai marine strategy plan 2015 to 2019 (DOF 2015) (see table below). According to that report the MSY for demersal resources is estimated at 794,771 MT and 240,519 MT in the Gulf of Thailand and Andaman Sea respectively, which would correspond to 24.33 and 4.81 million trawling hours. The current fishing effort (number of trawling hours) is considered to be at 32.8% and 5.3% over the MSY for the Gulf of Thailand and Andaman Sea respectively (DOF 2015).

The Thai marine strategy set as a goal the reduction of the fishing effort for demersal species of 40% in the Gulf of Thailand and 10% in the Andaman Sea to reduce overexploitation (DOF 2015).

Demersal resources in Thai waters seem to be overexploited. This group includes several species; the specific mortality for each species is unknown, but it is likely that some of the species in the group are being overfished. Therefore, fishing mortality for this taxonomic group is assessed as "high" concern.

Justification:

Location	MSY (tonnes)	Optimal Fishing Effort	Current Catch (tonnes)	Current Fishing Effort	Status of Fisheries	
					Exceeded/ Balanced/ Lower	Percentage
	(1) Demersal Fish*				Exceeded (million hours)	
Gulf of Thailand	794,771	24.33 mh**	503,276	36.20 mh	11.87	+32.8%
Andaman Sea	240,519	4.81 mh	177,684	5.09 mh	0.28	+5.3%
	(2) Anchovies				Lower/Exceeded (days)	
Gulf of Thailand	191,785	114,588 days	183,216	115,600 days	1,012	+0.9 %
Andaman Sea	32,944	52,014 days	33,903	51,520 days	494	-1.0%
	(3) Other pelagic fish				Exceeded (days)	
Gulf of Thailand	248,176	130,493 days	245,986	178,709 days	48,216	+27.0 %
Andaman Sea	118,477	54,238 days	99,039	64,925 days	10,687	+16.5 %

** Demersal fish refers to all bottom dwelling fish including crustacea and mollusks.*

*** mh = Million hours*

Figure 18 Status of the marine resources (demersal and pelagic fish) in Thailand (DOF 2015)

Factor 2.3 - Discard Rate

INDIA / INDIAN OCEAN
Bottom Trawls

< 100%

A study of the west coast of India trawl fishery, where the majority of the squid catch occurs, found that in this fishery 62% of the catch was landed for edible purposes (Dineshbabu 2013). Due to the growing demand of low value fish by the fishmeal industry (aquaculture, etc.), the percentage of low value bycatch (LVB) species landed increased from 16% in 2008 to 27% in 2011. Only 13% of the bycatch was discarded during this study. Therefore, it is considered that the discard rate in this fishery is lower than 100%.

Justification:

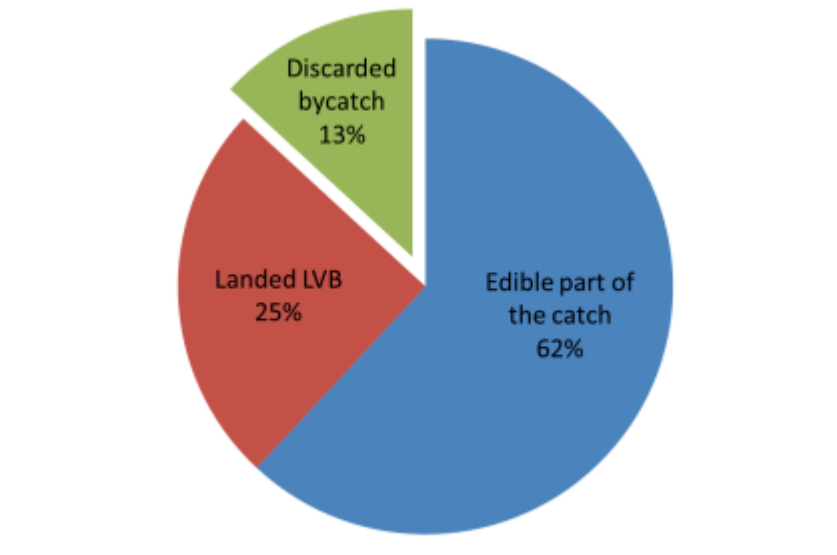

Figure 19 Catch composition of the trawl fishery in West India (Dineshbabu, A.P. 2013)

THAILAND / WESTERN CENTRAL PACIFIC
Bottom Trawls

< 100%

Research on the composition of trawl catches in Thailand have found that the proportion of fish that have economic value (targeted species) is 33.3%, and the remaining 66.7% is trash fish (Supongpan and Boonchuwong 2010) (Nettasna 2014). In Thailand, as in other countries in the area, this trash fish (bycatch) is largely utilized for animal feed and it is not discarded (Chanrachkij 2015). Therefore, this bycatch is considered to be part of the total catch and the discard rate in the fishery is thought to be lower than 100%.

BENTHIC INVERTS

Factor 2.1 - Abundance

INDIA / INDIAN OCEAN
Bottom Trawls

Moderate Concern

A series of studies have been undertaken in Indian waters to evaluate the impact of trawling on the ecosystem. According to (Bath 2003) and (Raman 2006) the most affected epifaunal component affected by trawling is the invertebrates group. Along the southwest coasts of India, 12% of the trawl landings were constituted of stomatopods and non-edible biota (Menon et al. 2006). In Kerala, the epibenthos discarded by trawlers was dominated by crabs (*Charybdis smithii*), stomatopods (*Oratosquilla nepa*) gastropods (*Turritella maculate*), juveniles of shrimps and finfish, etc. (Kurup et al. 2004) (Thomas and Kurup 2005) (Menon et al. 2006). Bottom trawling also affected the abundance and biomass of infauna, macrobenthos, and meiobenthos. However, although some groups, such as bivalves, gastropods or polychaetes, showed a general increase in abundance after trawling due to the survival of opportunistic species (Gowda 2003) (Kurup 2004), some species, such as *Cerithium* spp. or *Cavolina* ssp. decreased after trawling (Kurup et al. 2004) (Thomas and Kurup 2005). In general the diversity indices were reduced after trawling (Zacharia 2003) (Kurup 2004) (Bharathamia et al. 2008).

A list of macroinvertebrates caught in the Indian shrimp trawl fisheries can be found in (Gibinkumar et al. 2012) (see table below). Although the status of all these species has not been evaluated, they are not considered high vulnerable taxa. Therefore, based on the SFW criteria, this component is assessed as "moderate" concern.

Justification:

SHRIMPS	LOBSTERS	SHELLS	Family: Fasciolariidae	Order: VENEROIDA
Order: DECAPODA	Order: DECAPODA Family: Palinuridae	Order: ARCOIDA	*Fusinus nicobaricus* (Röding, 1798)	Family: Veneridae
Family: Penaeidae	*Palinurus homarus* (Linnaeus, 1758)	Family: Arcidae	Family: Melongenidae	*Dosinia cretacea* (Reeve, 1851)
Fenneropenaeus indicus (H. Milne Edwards, 1837)	*Palinurus ornatus* Fabricius, 1798	*Anadara (Cunearca) rhombea* Born, 1780	*Hemifusus pugilinus* (Born, 1778)	263. *Marcia opima* (Gmelin, 1791)
Metapenaeus affinis (H. Milne Edwards, 1837)	Family: Scyllaridae	*Anadara granosa* (Linnaeus, 1758)	*Pugilina cochlidium* (Linnaeus, 1758)	*Meretrix casta* (Chemnitz, 1782)
Metapenaeus dobsoni (Miers, 1878)	*Thenus orientalis* (Lund, 1793)	*Barbatia bistrigata* Dunker, 1866	Order: LITTORINIMORPHA	*Meretrix meretrix* (Linnaeus, 1758)
Metapenaeus monoceros (Fabricius, 1798)	CRABS	*Scapharca inaequivalvis* (Bruguiere, 1789)	Family: Bursidae	*Paphia malabarica* (Chemnitz, 1782)

Parapenaeopsis stylifera (H Milne Edwards, 1837)	Order: DECAPODA	*Trisidos tortuosa* (Linnaeus, 1758)	*Bufonaria echinata* (Link, 1807)	*Paphia textile* (Gmelin, 1791)
Penaeus semisulcatus (De Hann, 1844)	Family: Lucosidae	Order: NEOGASTROPODA	Family : Ficidae	*Sunetta scripta* (Linnaeus, 1758)
Penaeus monodon (Fabricius, 1798)	*Philyra scabriuscula* (Fabricius, 1798)	Family: Babyloniidae	*Ficus ficus* (Linnaeus, 1758)	Family: Donacidae
Trachypenaeus curvirostris (Stimpson, 1860)	Family: Calappidae	*Babylonia spirata* (Linnaeus, 1758)	*Ficus gracilis* (G.B. Sowerby I, 1825)	*Donax scortum* (Linnaeus, 1758)
Family: Hippolytidae	*Calappa lophos* (Herbst, 1782)	*Babylonia zeylanica* (Bruguiere, 1789)	Family: Naticidae	Order: MYOIDA
Exhippolysmata ensirostris (Kemp, 1914)	Family: Portunidae	Family: Buccinidae	*Glossaulax didyma* (Röding, 1798)	Family: Pholadidae
Family: Sergestidae	*Charybdis feriatus* (Linnaeus, 1758)	*Cantharus spiralis* Gray, 1839	*Natica lineata* Lamarck, 1838	*Pholas orientalis* Gmelin, 1791
Acetes indicus H. Milne Edwards, 1830	*Charybdis lucifeara* (Fabricius, 1798)	Family: Turridae	*Natica vitellus* (Linnaeus, 1758)	Family: Cardiidae
Family: Alphidae	*Charybdis natator* (Herbst, 1789)	*Lophiotoma indica* (Roding, 1798)	Famil : Cassidae	*Cardium flavum* Linnaeus, 1758
Alpheus malabaricus (Fabricius, 1775)	*Podophthalmus vigil* (Fabricius, 1798)	*Turricula javana* (Lamarck, 1816)	*Phalium canaliculatum* Bruguiere, 1792	Order: CAENOGASTROPODA
STOMATOPODS	*Portunus pelagicus* (Linnaeus, 1766)	*Turris amicta* (E.A. Smith, 1877)	*Semicassis bisulcata* (Schubert & Wagner, 1829)	Family: Turritellidae
Order: STOMATOPODA	*Portunus sanguinolentus* (Herbst, 1783)	Family: Harpidae	Family: Rostellariidae	*Turritella acutangula* (Linnaeus, 1758)
Family: Squillidae	*Scylla serrata* (Forskal, 1775)	*Harpa major* Roding, 1798	*Strombus plicatus sibbaldi* Sowerby, 1842	*Turritella attenuata* Reeve, 1849

Oratosquilla nepa (Latreille, 1828)	Family: Matutidae	Family: Clavatulidae	*Tibia curta* (G.B. Sowerby II, 1842)	Order: ARCHAEOGASTROPODA
Squilla sp.	*Ashtoret lunaris* (Forskål, 1775)	*Clavatula virgineus* (Dillwyn, 1817)	Family: Tonnidae	Family: Trochidae
CEPHALOPODS	*Matuta planipes* Fabricius, 1798	Family: Muricidae	*Tona dolium* (Linnaeus, 1758)	*Umbonium vestiarium* (Linnaeus, 1758)
Order: SEPIIDA	Family: Epialtidae	*Murex (Murex) carbonnieri* (Jousseaume, 1881)	ECHINODERMS	Order: DENTALIIDA
Family: Sepiidae	*Doclea ovis* (Fabricius, 1787)	*Rapana bulbosa* (Solander, 1817)	Order: PAXILLOSIDA and CLYPEASTEROIDA	Family: Dentaliidae
Sepia aculeata Van Hasselt, 1835	*Doclea rissoni* Leach, 1815	*Rapana rapiformis* (Born, 1778)	Family: Astropectinidae and Laganidae	*Dentalium octangulatum* Donovan, 1804
Sepia pharaonis Ehrenberg, 1831			*Astropecten* spp.	
Sepiella inermis (Van Hasselt, 1835)			*Laganum depressum* Lesson, 1841	

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

Moderate Concern

According to (FAO 2009) the species composition of benthos in Thailand has changed markedly as a result of fishing by trawlers. In 1976, 394 benthic species were recorded in the country whereas in 1995 only 88 species were found. In 1966, shellfish was the most abundant group, followed by sea stars, sea urchins, and polychaetes. By the 1990s, sea stars and sea urchins were still dominant but polychaetes had disappeared from Thai waters (FAO 2009). Based on the SFW criteria, since the species affected are not from high vulnerable taxa, this component is assessed as a "moderate" concern.

Factor 2.2 - Fishing Mortality

INDIA/INDIAN OCEAN
Bottom Trawls

Moderate Concern

Using the unknown bycatch matrix from the SFW criteria, the impact of bottom tropical fish trawl fisheries on benthic invertebrates is scored as "2" which results in a score of "high" concern for fishing mortality. According to Dineshbabu the fishery uses high speed trawls in deep water which decreases the impact on the bottom fauna, and pair trawling has also been banned forbidden since 2018 (A.P. Dineshbabu, pers. comm. 2019).

These measures moderate the level of concern somewhat.

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

High Concern

Using the unknown bycatch matrix from the SFW criteria, the impact of bottom tropical fish trawl fisheries is scored as "2" resulting in a score of "high" concern for this taxonomic group.

Factor 2.3 - Discard Rate

INDIA/INDIAN OCEAN
Bottom Trawls

< 100%

A study of the west coast of India trawl fishery, where the majority of the squid catch occurs, found that in this fishery 62% of the catch was landed for edible purposes (Dineshbabu 2013). Due to the growing demand of low value fish by the fishmeal industry (aquaculture, etc.), the percentage of low value bycatch (LVB) species landed increased from 16% in 2008 to 27% in 2011. Only 13% of the bycatch was discarded during this study. Therefore, it is considered that the discard rate in this fishery is lower than 100%.

Justification:

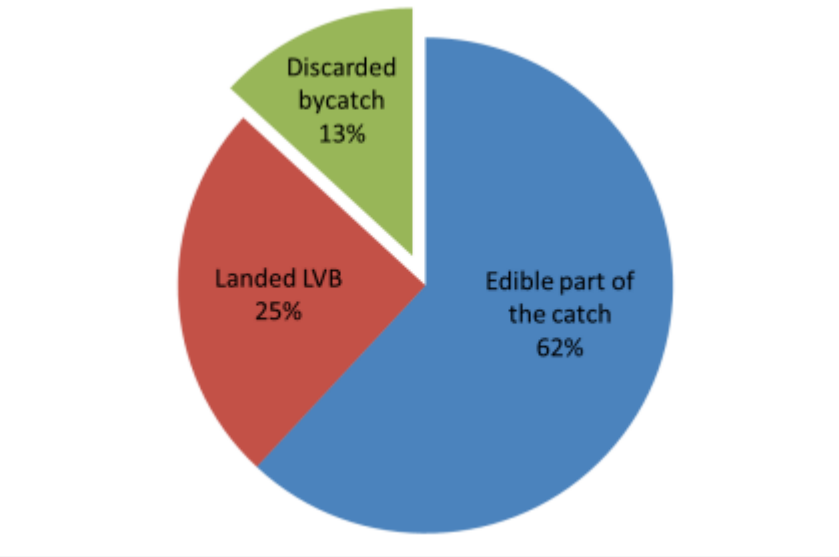

Figure 20 Catch composition of the trawl fishery in West India (Dineshbabu, A.P. 2013)

THAILAND/WESTERN CENTRAL PACIFIC
Bottom Trawls

< 100%

Research on the composition of trawl catches in Thailand have found that the proportion of fish that have economic value (targeted species) is 33.3%, and the remaining 66.7% is trash fish (Supongpan and Boonchuwong 2010) (Nettasna 2014). In Thailand, as in other countries in the area, this trash fish (bycatch) is largely utilized for animal feed and it is not discarded (Chanrachkij 2015). Therefore, this bycatch

is considered to be part of the total catch and the discard rate in the fishery is thought to be lower than 100%.