Monterey Bay Aquarium Seafood Watch®

Japanese flying squid



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Japan: Northwest Pacific

Purse seines, Jig, Bottom trawls, Trap (pound) nets

July 6, 2020

Seafood Watch Consulting Researchers

Disclaimer

Seafood Watch[®] strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch program or its recommendations on the part of the reviewing scientists. Seafood Watch is solely responsible for the conclusions reached in this report.

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

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

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

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished¹ 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 focuses on Japanese flying squid (*Todarodes pacificus*) captured in Japan by jiggers in the Sea of Japan; by jiggers, bottom trawlers, purse seiners, and trap/set/pound nets (referred to in this document as pound nets) in the North Pacific; and by jiggers and pound nets in the Sea of Okhotsk. Japanese flying squid comprises three or four cohorts based on spawning season, and is managed by the Japan Ministry of Agriculture, Forestry, and Fisheries as mainly two stocks: the autumn-spawning cohort and the winter-spawning cohort.

Stock assessments are performed annually by the Japan Fisheries Research and Education Agency (FRA) for both cohorts. The FRA utilizes scientific surveys and fishery-dependent data to calculate annual allowable biological catches and biomass estimates. Based on these assessments, population size of both cohorts appears to be declining during the past 5 years, especially the winter cohort where biomass is at historically low level. Even the fisheries' take has remained below the management threshold limits (TAC) for nearly the entire past decade, the biomass is estimated to decrease with high possibility if the current fishing mortality is maintained, suggesting the "high" concern of fishing mortality for both winter and autumn cohorts.

Because of the nature of the fishery and appropriate techniques, jigging results in little bycatch. Purse seiners, bottom trawling and pound nets are of a very high concern due to high risk to have incidental take of vulnerable species.

Management measures and tools are in place for Japanese flying squid in Japan, however, because the oceanic environment has significant impacts on the trend of the biomass, the biomass keeps declining in recent years. For incidental catch, the management has not made any known efforts to reduce incidental take associated with these fisheries. The probability of significant incidental take without proper monitoring are of a critical concern for the fishery.

Jigs and purse seines do not contact the ocean floor, so these gear types likely do not damage benthic habitats. On the other hand, trap nets rest on the substrate and could have significant impacts on kelp forests. Bottom trawling could leave lasting impacts on muddy and sandy substrates. The impact of bottom trawls on the ocean substrate is of a high concern, while the jigging and purse seine fishery have low concern, and pound nets have moderate concern.

All assessed fisheries are rated as a "Avoid" or "Red" due to due to declining stock abundance, insufficient monitoring of bycatch, impact concerns on benthic habitats that likely results in the capture of vulnerable species.

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
Japanese flying squid Japan/Northwest Pacific Bottom trawls Japanese Flying Squid, Winter Cohort	Red (1.000)	Red (1.000)	Red (2.000)	Red (1.414)	Avoid (1.296)
Japanese flying squid Japan/Northwest Pacific Jig Japanese Flying Squid, Autumn Cohort Autumn Cohort	Red (1.000)	Yellow (2.644)	Red (2.000)	Yellow (3.162)	Avoid (2.022)
Japanese flying squid Japan/Northwest Pacific Jig Japanese Flying Squid, Winter Cohort	Red (1.000)	Yellow (2.644)	Red (2.000)	Yellow (3.162)	Avoid (2.022)
Japanese flying squid Japan/Northwest Pacific Purse seines Japanese Flying Squid, Winter Cohort	Red (1.000)	Red (1.526)	Red (2.000)	Yellow (3.162)	Avoid (1.762)
Japanese flying squid Japan/Northwest Pacific Stationary uncovered pound nets Japanese Flying Squid, Winter Cohort	Red (1.000)	Red (1.000)	Red (1.000)	Yellow (2.449)	Avoid (1.250)

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 scope of this recommendation covers Japanese flying squid *(Todarodes pacificus)* captured in Japanese waters in the Pacific Ocean, the Sea of Japan, and the Sea of Okhotsk. The species is also fished in the East China Sea, where the total catches are relatively low. Several fishing methods are used. The main method is jigging, which is conducted in coastal waters around much of Japan and in offshore waters in the Sea of Japan. Other fisheries include purse seiners, trap/set/pound nets (hereafter referred to as pound nets), and bottom trawls in the Pacific, and bottom trawlers and trap nets in the Sea of Okhotsk (Arkhipkin et al. 2015).

Species Overview

Japanese flying squid is the most commercially important squid in Japan, making up 77% of the nation's total squid catch in 2015 (MAFF 2016). In Japan, it occurs west of Honshu in the Sea of Japan, east of Honshu and Hokkaido Island in the North Pacific Ocean, and north of Hokkaido Island in the Sea of Okhotsk . With an average life span of 1 year, Japanese flying squid is a highly fecund pelagic spawner, averaging a mantle length of 20–30 cm at maturity (Kidokoro and Hiyama 1996). Based on spawning seasons, the population comprises three or four cohorts, of which the autumn and winter cohorts are the largest (Arkhipkin et al. 2015). The autumn cohort is commercially fished primarily offshore in the Sea of Japan, and the winter cohort is fished in the North Pacific, Sea of Okhotsk, and coastal waters of the Sea of Japan (Arkhipkin et al. 2015). In Japan, the fishery is managed by the Japan Ministry of Agriculture, Forestry, and Fisheries (MAFF). The Japan Fisheries Research and Education Agency (FRA) performs annual stock assessments and issues allowable biological catch (ABC) recommendations for both cohorts, which are combined to determine the total allowable catch (TAC) amount for the two cohorts (Arkhipkin et al. 2015).



Figure 1 Spatial distribution and migration pattern of the autumn-spawning and winter-spawning stock of Japanese flying squid.

Historically, Japan and the Republic of Korea have been the largest commercial fishers of Japanese flying squid (Anderson 2003). Until the 1940s, small-scale anglers using 1–2 ton unpowered boats would haul in annual catches of less than 100,000 tons. But the introduction of engine-powered 10–30 ton fishing vessels in the

1950s, along with advancements in jigging machines and generated lighting in the 1960s, greatly expanded the fishery to over half a million tons annually (FAO 2015). Based on catch data since 1976, researchers have discovered a positive correlation between stock-spawning areas and ocean surface temperature, suggesting that climatic factors, especially the warm/cold regime shift, could have influenced historic fluctuating trends in the fishery (Sakurai et al. 2000).



Figure 2 Annual fluctuation in Japanese flying squid based on the catches in Japan and the Republic of Korea

Production Statistics

In 2016, the global capture of Japanese flying squid totaled194,921 tons, consisting of catches predominantly from Japan and the Republic of Korea (FAO 2019). Until the 1990s, Japan's fisheries accounted for roughly 85% of the total catches. In the past decade, Korea's fisheries have made significant strides in production and now account for about 40% of the total global production. Most of the catch since the 1980s has been exploited by jiggers, though the catch from other gears, primarily trawls and pound nets, has increased recently.

Based on the latest fisheries statistics published by MAFF, about 68% of the total catch of Japanese flying squid is taken by jigging, followed by bottom trawlers (approximately 18%), and purse seiners (approximately 9%).

Importance to the US/North American market.

In 2018, the United States imported a total of 755,264 kilograms of squid from Japan, valued at USD 7,104,239 (NOAA 2019). On the other hand, U.S. squid exports to Japan in 2018 totaled 4,495,378 kilograms with a value of USD 11,819,902. The majority of Japanese flying squid is consumed domestically, and Japan is one of the world's top importers of squid.

Common and market names.

Common and market names in the U.S. include Japanese flying squid, calamari, and squid (FDA 2015). Its most commonly used name in Japan is surume-ika. Other local names include ma-ika, matsu-ika, mugi-ika, tonkyuu,

and ganzeki (Okutani 1995).

Primary product forms

Popular product forms in the U.S. include sashimi, dried, grilled, tempura, and deep-fried calamari. In Japan, it is commonly consumed fresh (sushi, sashimi), dried, and in fermented products (e.g., shiokara).

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

JAPANESE FLYING SQUID			
Region Method	Abundance	Fishing Mortality	Score
Japan/Northwest Pacific Bottom trawls Japanese Flying Squid, Winter Cohort	1.00: High Concern	1.00: High Concern	Red (1.000)
Japan/Northwest Pacific Jig Japanese Flying Squid, Autumn Cohort	1.00: High Concern	1.00: High Concern	Red (1.000)
Japan/Northwest Pacific Jig Japanese Flying Squid, Winter Cohort	1.00: High Concern	1.00: High Concern	Red (1.000)
Japan/Northwest Pacific Purse seines Japanese Flying Squid, Winter Cohort	1.00: High Concern	1.00: High Concern	Red (1.000)

Japan/Northwest Pacific Stationary	1.00: High Concern	1.00: High Concern	Red (1.000)
uncovered pound nets			
Japanese Flying Squid, Winter Cohort			

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.

JAPANESE FLYING SQUID

Factor 1.1 - Abundance

JAPAN/ NORTHWEST PACIFIC Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

High Concern

The FRA has established a limit biomass reference point (B_{LIMIT}) for both the winter stock and the autumn stock. This is the minimum level of spawning biomass required to ensure sufficient reproduction for a healthy stock population (Myers et al. 1994) . Once the spawning biomass is lower than B_{LIMIT} , the action measures are required to help resources recovery. The government usually responds with setting a more conservative allowable biological catch (ABC) limit. The B_{LIMIT} is cumulative for both the Japanese and Republic of Korea fisheries, because the FRA also collects fisheries data from the Republic of Korea. For the winter stock, the B_{LIMIT} is set at 164,000 tons or 530,000,000 individuals for 2018. The latest 2018 stock assessment suggests that the current total spawning biomass is below B_{LIMIT} , amounting to 57,000 tons or 180,000,000 individuals. The total biomass in 2018 is estimated to be 153,000 tons or 490,000,000 individuals, which is at the lowest level since 1985 (Kaga et al. 2018). The winter stock is declining during the past 5 years. Because there is a reliable quantitative stock assessment estimating current spawning biomass to be below the B_{LIMIT} reference point, the abundance of winter stock is of a "High Concern".

Justification:

Historically, the FRA has estimated biomass annually based on catch per unit effort (CPUE) landings from the commercial jig fisheries. Commercial CPUE landings have been collected since 1972 (Kidokoro et al. 2013) and have shown a relatively strong correlation with total catch numbers (Yamashita et al. 2013), which could suggest that CPUE is directly proportional to abundance. The declining CPUE trend suggested that the winterspawning stock abundance is under decreasing in the past years.

Since 1972, the FRA has conducted annual scientific surveys throughout defined stations in the fishing zones. The surveys have collected jigging CPUE data throughout stations in a wide range of zones within the fishing grounds between June and September (mainly, June and August). Squid mantle lengths have been recorded, and annual scientific surveys for juveniles are also conducted by way of mid-water trawls in May and June. The two types of annual survey data are now used to estimate the present-year biomass and provide a more robust assessment of the fishery than data historically obtained from commercial jigging CPUE landings.

Factor 1.2 - Fishing Mortality

JAPAN/ NORTHWEST PACIFIC Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

High Concern

The FRA has established an F_{MED} reference point for each stock, which is the fishing level at which the stock is able to replace itself given the spawning-recruitment survival ratio (Caddy and Mahon 1995). For the winter stock, the F_{MED} is 0.38 and current fishing mortality ($F_{CURRENT}$) is 0.39 (Kaga et al. 2018). The $F_{CURRENT}$ is cumulative for both the Japanese and Republic of Korea Japanese flying squid fisheries, because the FRA also collects catch statistics from the Republic of Korea. Based on simulation models, the FRA predicts that the biomass of winter stock is below B_{LIMIT} and will keep declining if the current rate of fishing mortality continues for the next 5 years, and 13% chance for the winter stock to be above the B_{LIMIT} 5 years later. Because of the high probability that the biomass will keep decreasing with the current fishing mortality, fishing mortalities for winter stock is of a "High Concern".

Justification:

The FRA calculates an annual allowable biological catch (ABC) for the following year, using fishing mortality data from the past few years and with biomass estimations. In turn, the MAFF establishes the total allowable catch (TAC) after considering the ABC recommended by the FRA as well as socioeconomic factors. Though the TAC has not been exceeded in over a decade, the biomass is estimated to decrease with high possibility if the current fishing mortality is maintained.

JAPANESE FLYING SQUID

Factor 1.1 - Abundance

JAPAN/ NORTHWEST PACIFIC

Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort

High Concern

The FRA has established a limit biomass reference point (B_{LIMIT}) for both the winter stock and the autumn stock. This is the minimum level of spawning biomass required to ensure sufficient reproduction for a healthy stock population (Myers et al. 1994). Once the spawning biomass is lower than B_{LIMIT} , the action measures are required to help resources recovery. The government usually responds with setting a more conservative allowable biological catch (ABC) limit. The B_{LIMIT} is cumulative for both the Japanese and Republic of Korea fisheries, because the FRA also collects fisheries data from the Republic of Korea. For the autumn stock, B_{LIMIT} is set at 424,000 tons or 1,510,000,000 individuals. The latest 2018 stock assessment suggests that the current total spawning biomass is below B_{LIMIT} , amounting to 317,000 tons (Kubota et al. 2018) , while the total biomass is estimated to be 670,000 tons at the moderate level. The autumn stock is declining during the past 5 years. Because there is a reliable quantitative stock assessment estimating current spawning biomass to be below the B_{LIMIT} reference point, the abundance of autumn stock is of a "High Concern".

Justification:

The FRA estimates biomass by performing annual scientific surveys throughout defined stations in the fishing zones in the months of June and July (Kidokoro et al. 2014). Catch per unit effort (CPUE) data have been collected for jig surveys since 1979 (Kidokoro et al. 2013), and the CPUE landings have remained steady since inception. Squid mantle length has been recorded, and annual scientific surveys for juveniles and paralarvals are also conducted by way of mid-water trawls in April and plankton nets in October and November.

CPUE has also been collected annually from commercial jig landings since 1980. Commercial CPUE landings have shown a relatively strong correlation with total catch numbers, which could suggest that CPUE is directly proportional to abundance. The CPUE showed decreasing trend shortly, and increased to 2.24 tons in 2017.

Factor 1.2 - Fishing Mortality

JAPAN/ NORTHWEST PACIFIC

Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort

High Concern

The FRA has established an F_{MED} reference point for each stock, which is the fishing level at which the stock is able to replace itself given the spawning-recruitment survival ratio (Caddy and Mahon 1995). For the autumn stock, the F_{MED} is 0.14 and the $F_{CURRENT}$ is 0.15 (Kubota et al. 2018). The $F_{CURRENT}$ is cumulative for both the Japanese and Republic of Korea Japanese flying squid fisheries, because the FRA also collects catch statistics from the Republic of Korea. Based on simulation models, the FRA predicts that the biomass of autumn stock is below B_{LIMIT} and will keep declining if the current rate of fishing mortality continues for the next 5 years, and 66% chance for the autumn stock to be above the B_{LIMIT} 5 years later. Because of the high probability that the biomass will keep decreasing with the current fishing mortality, fishing mortalities for autumn stock is of a "High Concern".

Justification:

The FRA calculates an annual allowable biological catch (ABC) for the following year, using fishing mortality data from the past few years and with biomass estimations. In turn, the MAFF establishes the total allowable catch (TAC) after considering the ABC recommended by the FRA as well as socioeconomic factors. Though the TAC has not been exceeded in over a decade, the biomass is estimated to decrease with high possibility if the current fishing mortality is maintained.

Criterion 2: Impacts on Other Species

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

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

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

Guiding Principles

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

Criterion 2 Summary

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

JAPANESE FLYING SQUID Japan/Northwest Pacific Bottom Trawls Japanese Flying Squid, Winter Cohort								
Subscore:	1.000		Discard Rate:	1.00 C2 Rat		te:	1.000	
Species Stock		Abu	Indance	Fishing	y Mortality		Subscore	
Sharks		1.00):High Concern	1.00:⊦	ligh Concerr	ı	Red (1.000)
Mammals		1.00):High Concern	1.00:⊦	ligh Concerr	ı	Red (1.000)
Seabirds		1.00: High Concern		1.00:High Concern			Red (1.000)
Benthic inverts		2.33	3:Moderate Concern	1.00:⊦	ligh Concerr	ו	Red (1.526)
Finfish		2.33	3:Moderate Concern	1.00:⊦	ligh Concerr	ו	Red (1.526)
Sea turtle (unspecified	d)	1.00):High Concern	3.00:№	Ioderate Co	ncern	Red (1.732)
Forage fish		2.33	3:Moderate Concern	3.00:№	loderate Co	ncern	Yellow (2.6	44)

JAPANESE FLYING SQUID							
Japan/Northwest Paci	fic Jig Japa	inese Flying Squid, Autumn C	ohort Autu	ımn Cohort			
Subscore:	2.644	Discard Rate:	1.00	C2 Rate:	2.644		

Species Stock	Abundance	Fishing Mortality	Subscore
Finfish	2.33: Moderate Concern	3.00: Moderate Concern	Yellow (2.644)

JAPANESE FLYING SQUID Japan/Northwest Pacific Jig Japanese Flying Squid, Winter Cohort								
Subscore:	2.644		Discard Rate:	1.00	C2 Rate:		2.644	
Species Stock		Abu	Indance	Fishing	g Mortality		Subscore	
Finfish		2.33:Moderate Concern		3.00: Moderate Concern			Yellow (2.64	44)

JAPANESE FLYING SQUID Japan/Northwest Pacific Purse Seines Japanese Flying Squid, Winter Cohort								
Subscore:	1.526		Discard Rate:		1.00	C2 Ra	te:	1.526
Species Stock	1	Abu	Indance	Fishing	g Mortality		Subscore	
Finfish		2.33	B:Moderate Concern	1.00:⊦	ligh Concerr	n	Red (1.526)
Forage fish		2.33: Moderate Concern		1.00:High Concern			Red (1.526)	
Sharks		1.00):High Concern	3.00: Moderate Concern			Red (1.732)

JAPANESE FLYING SQUID Japan/Northwest Pacific Stationary Uncovered Pound Nets Japanese Flying Squid, Winter Cohort								
Subscore:	1.000		Discard Rate:		1.00	C2 Rate:		1.000
Species Stock	pecies Stock Abundance		Fishing Mortality			Subscore		
Mammals		1.00: High Concern 1.00:		1.00:+	1.00:High Concern		Red (1.000)	

TAXON	pound net	bottom trawl	purse seine	jig
Sharks	5	1	3	3.5
Seabird	4	2	5	4.5
Sea Turtles	5	3	4	4
Marine mammal	1	1	4	5
Forage fish	4	2	2	4
Finfish	3.5	2	2	3
Corals and other biogenic habitats	3.5	1	5	4.5
Benthic invertebrates	3.5	2	5	5

The bycatch and retained species caught in the Japanese flying squid fishery are generally unknown. Bycatch is

scored according to the Seafood Watch unknown bycatch matrix, based on a synthesis of peer reviewed literature and expert opinion on the bycatch impacts of each gear type. The Unknown Bycatch Matrix ranks the bycatch susceptibility of different taxonomic groups in various gear types. More information is available in Appendix 2 of the Seafood Watch criteria.

The taxa that are most likely to interact with the bottom trawl fisheries include: sharks, seabird, sea turtles, marine mammal, forage fish, finfish, corals and other biogenic habitats, benthic invertebrates. For the bottom trawl fishery, marine mammals, sea birds and sharks limit the score for Criterion 2 due to their high vulnerability and unknown stock status, and high potential to interact with this gear type.

The taxa that are most likely to interact with the pound net fisheries is marine mammal. For the pound net fishery, marine mammals limit the score for Criterion 2 due to their high vulnerability and unknown stock status, and high potential to interact with this gear type.

The taxa that are most likely to interact with the purse seine fisheries include: sharks, forage fish, finfish. For the purse seine fishery, sharks, forage fish and finfish limit the score for Criterion 2 due to their high vulnerability and unknown stock status, and high potential to interact with this gear type.

The taxa that are most likely to interact with the jigging fisheries is finfish. For the jigging fishery, finfish limit the score for Criterion 2 due to their high vulnerability and unknown stock status, and high potential to interact with this gear type.

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

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

High Concern

In the absence of species-specific information, sharks, sea turtles, marine mammals, seabirds, and coral, as well as families or genera of fish or invertebrates that are known to have high vulnerability are considered to be of "High Concern" of stock status.

JAPAN/ NORTHWEST PACIFIC

Purse Seines | Japanese Flying Squid, Winter Cohort

High Concern

Sharks are highly vulnerable to interactions with purse seiners.

Factor 2.2 - Fishing Mortality

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

High Concern

Sharks are highly susceptible to interactions with bottom trawls in many regions.

JAPAN/ NORTHWEST PACIFIC

Purse Seines | Japanese Flying Squid, Winter Cohort

Moderate Concern

Sharks have a moderate susceptibility to unassociated purse seines.

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

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid bottom trawl fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

JAPAN/ NORTHWEST PACIFIC

Purse Seines | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid purse seine

fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

FINFISH

Factor 2.1 - Abundance

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort

Moderate Concern

Most stocks of teleost fish or invertebrates that are not from highly vulnerable taxa as defined above are moderately vulnerable to interactions with fishing gear.

Factor 2.2 - Fishing Mortality

JAPAN/NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

High Concern

Finfish are highly susceptible to interactions with trawls.

JAPAN/ NORTHWEST PACIFIC

Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort

Moderate Concern

Given the unknown situation, the UBM assessment give out a score of "Moderate Concern" for finfish bycatch in jigging fishery.

JAPAN/ NORTHWEST PACIFIC

Purse Seines | Japanese Flying Squid, Winter Cohort

High Concern

Finfish and forage fish are highly susceptible to interactions with purse seines.

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

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid bottom trawl fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

JAPAN/ NORTHWEST PACIFIC

Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid jigging fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

JAPAN/ NORTHWEST PACIFIC

Purse Seines | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid purse seine fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

FORAGE FISH

Factor 2.1 - Abundance

JAPAN/ NORTHWEST PACIFIC Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort

Moderate Concern

Most stocks of teleost fish or invertebrates that are not from highly vulnerable taxa as defined above are moderately vulnerable to interactions with fishing gear.

Factor 2.2 - Fishing Mortality

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

Moderate Concern

Forage fish are considered moderately susceptible to interactions with trawls.

JAPAN/ NORTHWEST PACIFIC

Purse Seines | Japanese Flying Squid, Winter Cohort

High Concern

Finfish and forage fish are highly susceptible to interactions with purse seines.

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

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid bottom trawl fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

JAPAN/ NORTHWEST PACIFIC

Purse Seines | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid purse seine fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

MAMMALS

Factor 2.1 - Abundance

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

High Concern

In the absence of species-specific information, sharks, sea turtles, marine mammals, seabirds, and coral, as well as families or genera of fish or invertebrates that are known to have high vulnerability are considered to be of "High Concern" of stock status.

Factor 2.2 - Fishing Mortality

JAPAN/NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

High Concern

Marine mammals are highly susceptible to interactions with trawls in most regions.

JAPAN/ NORTHWEST PACIFIC

Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

High Concern

Marine mammals are highly susceptible to interactions with trap/pot fisheries (including pound nets) in nearly all regions.

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

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid bottom trawl fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain

species with market value, so it is possible that discard rates may be low.

JAPAN/ NORTHWEST PACIFIC

Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid pound net fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

SEABIRDS

Factor 2.1 - Abundance

JAPAN/ NORTHWEST PACIFIC Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

High Concern

In the absence of species-specific information, sharks, sea turtles, marine mammals, seabirds, and coral, as well as families or genera of fish or invertebrates that are known to have high vulnerability are considered to be of "High Concern" of stock status.

Factor 2.2 - Fishing Mortality

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

High Concern

Seabirds are highly susceptible to interactions with trawls in most regions.

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

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid bottom trawl fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

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: Japan/Northwest Pacific Bottom trawls Japanese Flying Squid, Winter Cohort	Moderately Effective	Moderately Effective	Ineffective	Highly Effective	Highly Effective	Red (2.000)
Fishery 2: Japan/Northwest Pacific Jig Japanese Flying Squid, Autumn Cohort Autumn Cohort	Moderately Effective	Moderately Effective	Ineffective	Highly Effective	Highly Effective	Red (2.000)
Fishery 3: Japan/Northwest Pacific Jig Japanese Flying Squid, Winter Cohort	Moderately Effective	Moderately Effective	Ineffective	Highly Effective	Highly Effective	Red (2.000)

Fishery 4: Japan/Northwest Pacific Purse seines Japanese Flying Squid, Winter Cohort	Moderately Effective	Moderately Effective	Ineffective	Highly Effective	Highly Effective	Red (2.000)
Fishery 5: Japan/Northwest Pacific Stationary uncovered pound nets Japanese Flying Squid, Winter Cohort	Moderately Effective	Ineffective				Red (1.000)

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.

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

Moderately Effective

Management is in place to curb excessive fisheries take. Reference points, including B_{LIMIT} , F_{LIMIT} , and TAC, and annual stock assessments are calculated and based on both fishery and scientific surveying data to ensure a high degree of accuracy (Kaga et al. 2018) (Kubota et al. 2018). Reference points are implemented annually for both the Japanese and Korean commercial squid fisheries to maintain a healthy population. TAC has not been exceeded in over a decade (MAFF 2016). However, the biomass keeps declining for both cohorts.

Justification:

MAFF establishes the TAC based on recommendations from the FRA's ABC limit calculations, socio-economic factors are also taken into consideration in implementing these catch limits (Arkhipkin et al. 2015) (MAFF 2016). The FRA also provides an ABC target, which is a reference number 20% lower than the ABC limit (Kidokoro et al. 2013)(Yamashita et al. 2013), as a more conservative catch limit. However, even though the TAC has been implemented successfully for the past years, and the actual catch was well below the catch limit, the biomass keeps declining.

Based on the recent stock assessment conducted by FRA, the stock abundance of the target species is below B_{LIMIT} , and showed the declining trend for the past five years (Kaga et al. 2018)(Kubota et al. 2018). To some extent the declining trend is influenced by the regime shift of climate, as the squid is a one year life span species, and its population fluctuates greatly with the changing of environment, which is one of the reasons caused declining biomass in recent years.

Under this situation, harvest strategy for this species has been adjusted and implemented in time to reduce the fishery impact to help the resource recovery. FRA provided the fishery harvest scenarios which can help the resource recovery, and MAFF set the catch limit to help resource recovery based on recommendations from the FRA. However the government will let this fishery continue with a more conservative catch limit but it won't be closed for avoiding the fishing impact on the resources (Kaga et al. 2018).

Since the fishery has regular track record and stock assessments, but less effective actions for poor resource condition, a "Moderately Effective" is given for this factor.

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.

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort

Moderately Effective

The interactions with bycatch species are not clear in this fishery. Management has not enacted any known guidelines or strategies related to bycatch for this fishery. For this unknown situation, "Moderately Effective" is scored.

JAPAN/ NORTHWEST PACIFIC

Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort

Moderately Effective

There are no known bycatch limits or reduction techniques in place, but there probably are not any major concerns that incidental take is likely occurring, based on the gear type in this area. Management has not enacted any known guidelines or strategies related to bycatch for this fishery.

JAPAN/ NORTHWEST PACIFIC

Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

Ineffective

The bycatch of sea turtle in the trap net fishery has been observed in Japan and some of the organizations is leading the sea turtle bycatch reduction campaign since 2013, which is supported by FRA financially on their

research and development of the sea turtle escape devices for trap nets. However management has not enacted for other bycatch species concerned in this fishery.

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.

JAPAN/ NORTHWEST PACIFIC Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort

Ineffective

Research is effective for targeted species because the FRA conducts annual and up-to-date stock assessments, using both fishery-dependent and scientific surveying data for both the winter and autumn cohort stocks . The FRA estimates biomass annually by performing annual scientific surveys throughout defined stations in the fishing zones during June and July (Kidokoro et al. 2014). Catch per unit effort (CPUE) data have been collected in jig surveys since 1980. Squid mantle lengths have been recorded, and annual scientific surveys for juveniles and paralarvals are also conducted using mid-water trawls in April and plankton nets in October and November. The ABC limit is calculated from the F_{LIMIT} and the forecasted stock abundance, which is in turn estimated based on the spawner-recruitment relationship (Arkhipkin et al. 2015).

Although long-term scientific research and monitoring of the fisheries' impact on Japanese flying squid populations is effective, scientific research for incidental take is not sufficient because there is no known collection and analysis of bycatch data associated with this fishery. For this reason, this factor is rated as "Ineffective".

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.

JAPAN/ NORTHWEST PACIFIC Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort

Highly Effective

Although monitoring is likely based more on a voluntary honor system for reporting (Arkhipkin et al. 2015), the

TAC has not been exceeded in over a decade (MAFF 2016). The fisheries also do not fish in closed areas and where there are moratoriums, so enforcement can be considered "Highly Effective".

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.

JAPAN/ NORTHWEST PACIFIC Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort

Highly Effective

The process of determining the annual ABC is completely open for public comment, and the meetings, which are open to the public, are held by the national and prefectural scientists, fishers, and other potential stakeholders. Public input is requested before the final ABC determinations. The MAFF proposes TACs while taking into consideration economic issues as well as stakeholder input. The Fisheries Policy Council, which includes well-informed and independent interested parties, fishermen, and other stakeholders, discusses the drafting of proposed TACs, which are then later finalized by the MAFF. Because stakeholder input is included and a vital aspect for fisheries management decisions, stakeholder inclusion is "Highly Effective".

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
Japan/Northwest Pacific Stationary uncovered pound nets Japanese Flying Squid, Winter Cohort	3	0	High Concern	Yellow (2.449)
Japan/Northwest Pacific Bottom trawls Japanese Flying Squid, Winter Cohort	1	0	High Concern	Red (1.414)
Japan/Northwest Pacific Jig Japanese Flying Squid, Winter Cohort	5	0	High Concern	Yellow (3.162)
Japan/Northwest Pacific Jig Japanese Flying Squid, Autumn Cohort	5	0	High Concern	Yellow (3.162)
Japan/Northwest Pacific Purse seines Japanese Flying Squid, Winter Cohort	5	0	High Concern	Yellow (3.162)

Criterion 4 Assessment

SCORING GUIDELINES

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

Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

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

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

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

Factor 4.3 - Ecosystem-Based Fisheries Management

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

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

and ecosystem functioning.

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

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

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

1

There are no known coldwater corals in this area (NOAA 2014). Seagrass bed are found in shallow water where sand and mud were piled up around the fishing area (Okuda 2008). Information about the contact between fishing gear and the sensitive habitat is generally limited, but there is a small quantity of Japanese flying squid are caught by small-scale bottom trawlers in the costal waters according to the statistical data published by MAFF(MAFF 2019). JFS bottom trawl fishery is considered to have the potential to contact the sensitive habitat, including the seagrass bed.

JAPAN/ NORTHWEST PACIFIC

Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort

5

Japanese flying squid is a pelagic species (Waska et al. 2008). Commercial jig fishermen mainly use overhead lights to attract the squid toward the surface near the fishing vessels during the evening, thus negating the need for jigs to come into contact with the bottom.

JAPAN/ NORTHWEST PACIFIC

Purse Seines | Japanese Flying Squid, Winter Cohort

5

The Japanese flying squid is a pelagic species (Waska et al. 2008). Commercial purse seiners, who are not permitted to use overhead lights in some prefectures, catch the squid gathered on the surface during the night. So their nets do not come into contact with the bottom.

JAPAN/ NORTHWEST PACIFIC

Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

3

There are no known coldwater corals in this area (NOAA 2014). But kelp forests are found in this area (Okuda 2008), and pound net fishing could be occurring in these habitats because adult Japanese flying squid are found in coastal waters (Kawabata et al. 2006).

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

JAPAN/ NORTHWEST PACIFIC

Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

0

No effective mitigation exists because there are no known controls on fishing efforts or modifications of fishing gear.

JAPAN/ NORTHWEST PACIFIC

Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort

0

The gear used is benign because it does not come into contact with the bottom substrate.

Factor 4.3 - Ecosystem-Based Fisheries Management

JAPAN/ NORTHWEST PACIFIC Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

High Concern

The Japanese flying squid is a species endemic to the northwest Pacific that possesses the potential to play a disproportionately important role relative to its biomass. As a generalist predator, an adult squid feeds primarily on zooplankton, crustaceans, smaller squids, and small fish, including juvenile walleye pollock, Pacific saury, and Japanese anchovies (Flores et al. 1977)(Hamabe and Shimizu 1966). In turn, Japanese flying squid may be an important food source for larger fish, including mackerel, yellowtail, bluefin tuna, and sharks , as well as marine mammals including Dall's porpoises and minke whales (Ohizumi et al. 2000) (Tamura and Fujise 2002). Thus, excess removal of Japanese flying squid could potentially result in serious ecosystem effects.

Currently, the ecosystem-based management for Japanese flying squid is lacking. Relevant studies mostly focus on understanding the ecological role of Japanese flying squid, while the fishing impact on the overall ecosystem is not widely evaluated. In the current management, the prediction of biomass and estimation of catch limit are determined considering the influence of environmental factors including temperature (Kaga et al. 2018). However, the potential influence of removing Japanese flying squid to the ecosystem has not been included in the management of this fishery.

The important ecological role of Japanese flying squid are recognized, while the ecosystem-based management for the assessed fisheries is lacking. For this reason, a score of "High Concern" is awarded at here.

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 researchers and authors of this report, Fenjie Chen and Lu Fang, as well as several anonymous reviewers for graciously reviewing this report for scientific accuracy.

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Appendix A: Extra By Catch Species

BENTHIC INVERTS

Factor 2.1 - Abundance

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Purse Seines | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Jig | Japanese Flying Squid, Autumn Cohort | Autumn Cohort

Moderate Concern

Most stocks of teleost fish or invertebrates that are not from highly vulnerable taxa as defined above are moderately vulnerable to interactions with fishing gear.

Factor 2.2 - Fishing Mortality

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

High Concern

Benthic invertebrates are highly susceptible to interactions with gears that touch the bottom including trawls and dredges.

Factor 2.3 - Discard Rate

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid bottom trawl fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.

SEA TURTLE (UNSPECIFIED)

Factor 2.1 - Abundance

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort JAPAN/ NORTHWEST PACIFIC Stationary Uncovered Pound Nets | Japanese Flying Squid, Winter Cohort

High Concern

In the absence of species-specific information, sharks, sea turtles, marine mammals, seabirds, and coral, as well as families or genera of fish or invertebrates that are known to have high vulnerability are considered to

be of "High Concern" of stock status.

Factor 2.2 - Fishing Mortality

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

Moderate Concern

Sea turtles are highly susceptible to interactions with trawls in most regions.

Factor 2.3 - Discard Rate

JAPAN/ NORTHWEST PACIFIC

Bottom Trawls | Japanese Flying Squid, Winter Cohort

< 100%

There are no reliable data on discard rates and landings associated with the Japanese flying squid bottom trawl fisheries. But Japanese fishermen are allowed to keep all captured species and are known to retain species with market value, so it is possible that discard rates may be low.