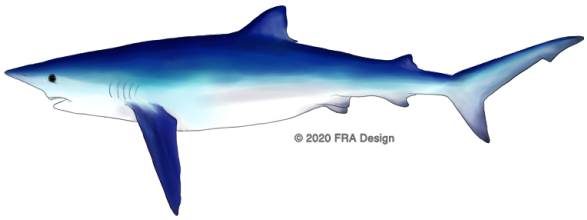

SH“U”N PROJECT ASSESSMENT REPORT

Blue Shark - North Pacific

Ver 1.0.0e

Japan Fisheries Research and Education Agency

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Table of Contents

Introduction

Characteristics of the Fish Species

[Classification and form]

The blue shark belongs to the order *Carcharhiniformes*, the family *Carcharhinidae*, and the genus *prionace*. Its scientific name is *Prionace glauca*. The maximum body length (pre-caudal fin length) and body weight of the blue shark in the North Pacific is 290 cm/251 kg for females and 243 cm/168 kg for males (Fujinami et al. 2019). Body shape is slender and streamlined, the snout is long and conical, and the eyes are relatively large. The body color on the dorsal side is bright indigo and the ventral side is white (Compagno 1984).

[Distribution]

This is a species of pelagic shark that is widely distributed from the tropical to temperate zones across the ocean, including the Southern and Northern Pacific (Compagno 1984). They are known to be densely distributed particularly in the temperate zone (Nakano 1996), and especially densely distributed around the Emperor Seamounts Chain (hot spot) (Kai et al. 2017). They mainly inhabit the open ocean but are also seen in coastal areas. Blue sharks are known to move across depths, often swimming in deep waters during the day and in shallow water at night (Stevens et al. 2010).

[Ecology]

The age of sexual maturity begins is five years for males and six years for females, with lifespans exceeding 20 years (Fujinami et al. 2017a, 2019). Feeding grounds are the tropical and temperate zones. Blue sharks prey primarily on fish and cephalopods, while juveniles are preyed upon by larger sharks or marine mammals (Fujinami et al. 2017b). The breeding season is early summer, the birth season is from May to June, and the mating season is from June to August. It is known that the breeding grounds are in the waters at latitude 30 - 40 degrees north, and vary according to sex and growth stages (Nakano, 1994).

[Fisheries]

This species is mainly caught as bycatch for tuna longline fishing vessels on the high seas or coastal areas of fishing countries, but some are caught as target species. In coastal areas of Japan, they are bycaught by small longliners, drift net fishing vessels or fixed fishing nets, etc. More than 90% of the total volume of landings in Japan come from Kesennuma, Miyagi Prefecture, but some are also caught in Shiogama and other areas. The volume of landings from longline fishing accounts for 80% to 90% of the volume of landings at Kesennuma, and those from drift net fishing accounts for 10 to 20% (Fisheries Research Agency 2019).

[Use Form]

Blue shark meat is processed into paste products while fins are dried, skins and vertebrae made into crafts, medicines and food additives (Kai and Fujinami 2020).

Resource Status

Based on the stock assessment results or future forecasts using the stock assessment model, current or future stock statuses can be determined to be sound with no problems. However, it is desirable to determine reference points and formulate fishery management rules within the framework of the international community as soon as possible. On the other hand, the Kesennuma Fleet, which lands a lot of this species in Japan, voluntarily manages and regulates stocks. This is a desirable initiative from the perspective of keeping stocks sustainable.

Marine environment and Ecosystem

Understanding the impact of blue shark fisheries on the ecosystem (in the North Pacific) requires the acquisition and monitoring of information. More specifically, the ecosystem model in the western and central Pacific is analyzed to obtain information on bycatch by longlines fishing and the like. Surveys by research vessels are conducted irregularly on the larvae and juveniles of tropical tunas and skipjack tuna. Zooplankton collection and marine environment surveys are also conducted. A scientific observer program was introduced in 2008, and a system has been established to acquire records of catch and bycatch by longlines and purse seine and size information, allowing information on bycatches and catch compositions to be partially collected.

Regarding the impact of blue shark longline fishing on other fish species, the stocks of albacore, bigeye tuna, yellowfin tuna, and swordfish, considered bycaught and are used, were not a matter of concern. Regarding the impact on bycaught and unused species, PSA assessments revealed that several species had a medium to high risk potential. More specifically, risk is high for green turtles, loggerhead turtles, hawksbill turtles, and olive ridley turtles, and moderate for *lampris guttatus* (moonfish) and false killer whales. According to the PSA assessment for endangered species designated by the Ministry of the Environment, the risk of sea turtles is high.

Regarding the indirect impact of fishing on the food web, the prey organisms of the blue shark (which near the top of the food chain), are smaller fish. Blue sharks are said to exhibit opportunistic feeding habits rather than targeting specific species. Given the total stock of high-catch small pelagic fishing the northwestern Pacific as an abundance of prey organisms, the total stock tends to be flat, so no adverse effect was found. Competitors include albacore, bigeye tuna, yellowfin tuna, and swordfish, which are bycatch species of tuna longlines, are caught in numbers and prey on smaller fish, similar to blue sharks, stocks were not of concern.

Regarding the impact of fisheries on the whole ecosystem, there is concern that the total catch and the mean trophic level of catches have been declining in the southern Pacific region since 2014. The impact on water quality was determined to be minor. However, the impact of longline vessels, which have relatively high emissions, on the atmospheric environment was a concern.

Fishery Management

Offshore tuna longline fishing is a designated fishery licensed by the Minister of Agriculture, Forestry and Fisheries. A longline fishery management plan for sharks has been prepared, with an annual landing limit of 7,000 tons. Fishing vessels of offshore longline fishery set as assessment target fishery are limited to less than 120 tons. The longline fishery management plan prohibits the use of shark lines and requires that fins not be cut from bodies until landing. There are restrictions on fishing gear for conservation and management measures for sea turtles and seabirds, and the catching of silky sharks and oceanic whitetip sharks is prohibited. Related fishermen's groups participate in the Kesennuma City Marine Plastics Countermeasures Promotion Council, and are working to reduce fuel consumption by 10%. Offshore tuna longline fishing is under the jurisdiction of the Skipjack and Tuna Fisheries Office, International Affairs Division, Fisheries Agency. The introduction of management measures in Japan based on recent discussions on stock assessment and conservation measures at WCPFC, etc. was evaluated as measures equivalent to adaptive management. In recent years, fishermen related to this fishery have been working on controlling the catch of blue sharks during birthing periods in addition to the contents of the longline fishery management plan. The Kesennuma Fisheries Cooperative takes a lead in implementing the Kesennuma Regional Fisheries Reconstruction Project (a reconstruction plan for offshore tuna longline fisheries and two plans for utilizing existing vessels) to found a cooperative corporation. Furthermore, the National Nearshore Skipjack and Tuna Fisheries Association takes the lead in demonstrating a planned and efficient introduction of stock management and fishing vessels for improving working environments. Special commissioners from various fields participate in the Stock Management Subcommittee of the Fisheries Policy Council. At the WCPFC, which was also attended by stakeholders, conservation and management measures were considered based on the stock assessment conducted at the International Scientific Subcommittee on Tuna in the North Pacific (ISC). In accordance with the conservation and management measures, the Stock Management Subcommittee is implementing a longline fishery management plan for sharks.

Regional Sustainability

The Pacific blue sharks landed in Japan are mostly caught by offshore tuna longline fishing in Miyagi Prefecture. The trend for fishery income is low, and the earning rate and fishery-related assets were also slightly low. Regarding the stability of management, the stability of income was rather low, and the stability of catches were moderate. The financial situation of the fishermen's organizations was generally rather high. Operational safety is high, and contributions to local employment are high. Regarding fairness of working conditions, there were no particular problems in the fishing industry. The Kesennuma market has a large volume of blue shark landings, the number of buyers in each market varies depending on volume, and the principle of competition is generally working through auction or bidding transactions. Hygiene management is thoroughly implemented in accordance with a wholesale market development project. The meat is processed before shipping, and shark fins are traded as high-

end food items. There were no problems with the fairness of working conditions in processing and distribution. The sustainability of the processing and distribution industry was evaluated as high. Advanced technologies are introduced, disseminated, and instructed. A distribution system is in place. The income level of fishery-related workers is relatively high.

Health, Safety and Security

The lipid of blue sharks contains EPA and DHA, while the cartilage contains functional components such as chondroitin sulfate. An actual blue shark season is unknown because they are mainly caught as bycatch in tuna longline fisheries. The points to keep in mind when consuming have mainly to do with selecting fresh specimens for consumption as soon as fishy odors are likely to occur due to ammonia and trimethylamine as freshness degrades. In addition, since blue sharks are more likely to accumulate methyl mercury than other fish species, pregnant women should adhere to the standard serving amounts publicized by the Ministry of Health, Labour and Welfare.

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1. Stock State

Overview

Biological Research and Monitoring of Target Species (section 1.1)

Information on distribution and migration is not sufficiently available for fish from newborn to aged fish (3 points for item 1.1.1.1), but research on age, growth, reproductive ecology, etc. in the northwestern Pacific has been accumulated (4 points for item 1.1.1.2, 5 points for item 1.1.1.3,). For scientific research, long-term data have been obtained from research vessels, charter vessels, and government vessels (4 points for item 1.1.2.1). The catches of longline fishing vessels (mainly in offshore waters), which account for most of the volume of landings, have been obtained for a long period (5 points for item 1.1.2.2). As for actual situation of fishing, detailed information is being collected at Kesennuma by Fisheries Research and Education Agency in addition to the catch report (5 points for 1.1.2.3). Long-term changes in body length have been observed by fishing method by body length observation. Age estimates by vertebrae and gonads examinations have been conducted (5 points for 1.1.2.4). The stock assessments were conducted using an integrated model (SS) from 1971 to 2015 (5 points for item 1.1.3.1), and the details of the stock assessment are publicized in the report from the International Scientific Subcommittee on Tuna in the North Pacific (ISC), on the websites of the Inter-American Tropical Tuna Commission (IATTC) and the Western & Central Pacific Fisheries Commission (WCPFC). The ISC has a system for peer review by third-party experts, but the system has not been applied to this species to date (1.1.3.2, 4 points).

Target Species Abundance and Trends (section 1.2)

At present, B_{2015}/B_{MSY} = 1.69 and the relative value of the fishing mortality coefficient (F) is $F_{2012\text{-}2014}/F_{MSY}$ = 0.38, so the current stocks are neither in a state of overfishing nor beyond permitted levels (5 points for item 1.2.1).

Impacts of Fisheries on Target Species (section 1.3)

At present, $B_{2015} > B_{msy}$ and $F_{2012\text{-}2014} < F_{msy}$ (5 points for item 1.3.1), and if the current fishing pressure continues, future median stocks are unlikely to fall below the MSY level (4 points for item 1.3.2). Since the stock status of this species is good, there is no immediate discussion on management at the WCPFC or IATTC. There are no fishery control rules established for bycatches of sharks (1 point for item 1.3.3.1), reference points are undecided, and there is no discussion on uncertainty (1 point for item 1.3.3.2). The impact of environmental changes on stocks are not considered severe (1 point for item 1.3.3.3). The Kesennuma Offshore Longline Fleet submitted a voluntary management plan to the WCPFC through the national government (5 points for item 1.3.3.4). Recreational fishing, fishing by foreign vessels, and IUU fishing need not be considered for the Kesennuma Inshore Longline Fleet (3 points for 1.3.3.5).

Outline

(1) Fishing and habitats of target species

Blue sharks are caught abundantly by tuna longline fisheries, but are still basically a bycatch species with the exception of fishing areas around Japan. In the temperate zone of the eastern Pacific (east of 180 degrees), they are bycaught mainly by the longline (shallow rope) fisheries of Mexico and the United States. In the temperate zone of the western Pacific (west of 180 degrees), they are caught and bycaught mainly by the longlines (shallow ropes) fisheries of Japan and Taiwan (ISC 2017). Blue sharks landed in the Tohoku region are caught mostly by longline fisheries targeting this fish, but some are also caught by drift nets (within 200 nautical miles) or by small longline or fixed fishing nets in coastal areas. Kesennuma's longline vessels operate fisheries targeting this fish in the waters around 33 - 40 degrees north latitude mainly from spring to autumn. In winter, they move to the south waters around 30 - 35 degrees north latitude, targeting swordfish, and occasionally operates for this species (Kai and Shiozaki 2016).

(2) Collection of statistics on the catch of target species

The number of fish caught and the amount of effort documented in catch reports, which record information on the operation of the longline fisheries, are useful as catch statistics. However, most of the operations aim at tuna, so multiple reliable vessels should be selected to determine the catch of this species used in the stock assessments. Catch data are calculated by estimating a reliable abundance index and multiplying it by the amount of effort (Kai 2016a). On the other hand, for the catches of drift nets, small longlines, fixed fishing nets, etc., from coastal fisheries, the data from the Sea Surface Fishery Production Statistics conducted by the Ministry of Agriculture, Forestry and Fisheries is used. Unfortunately, the data do not include data by species. So, the catch of this species by fishing method is estimated using the information on the catch by fishing method and by species collected by a Fisheries Agency project (Kai 2016b).

(3) Collection of stock assessment data about target species

Under the commission of the Fisheries Agency, the Japan Fisheries Research and Education Agency (hereinafter referred to as the JFREA) is conducting surveys and research on stocks and taking other necessary measures to contribute to the proper conservation and management of this species. As part of that effort, the JFREA conducts stock assessments in collaboration with ISC member countries and related organizations, and publishes the results in a Japanese report as “current status of international fishery resources” (Kai and Fujinami 2020).

(4) Collection of data about the research and monitoring activities for the target species

Collect academic papers and reports on monitoring research conducted for the target species.

(5) Collection of information on physiological and ecological research conducted for the target species

Collect academic papers and reports on physiological and ecological research conducted for the target species.

1.1 Biological Research and Monitoring of Target Species

1.1.1 Overview of Biological Information

Basic information on the target species, such as life history and ecology, is crucial for stock management and conducting surveys (Tanaka 1998). Whether the physiological and ecological information necessary for evaluating the stock status of the target species after 1.2 is sufficiently accumulated is evaluated from four perspectives set forth in 1.1.1.1 to 1.1.1.4. The perspectives are (1) distribution and migration, (2) age, growth, and life span, and (3) maturity and spawning. For fish species involving juvenile release, (4) basic information necessary for releasing juveniles is also included. The total score is calculated by simply averaging the scores of individual items.

1.1.1.1 Distribution and Migration

The data collected for the analysis of fishery data (Nakano 1994) or the stock assessment of ISC (2017) include information on distribution and migration by gender and growth stage. However, the detailed distribution and direct migration routes of 0-years-old and aged fish are not clear except for in some waters (off the west coast of the United States and the northwestern Pacific Ocean). Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information available	Some information regarding some life stages, but insufficient for stock assessment	Information on most or all life stages, at the minimum required for stock assessment	Detailed information on some stages of life history including data about changes in environmental factors, highly accurate information can be used	Detailed information on all or near all stages of life history including data on effects of changes in environmental factors, sufficient and highly accurate information can be used

1.1.1.2 Age, Growth, and Lifespan

The latest studies on age and growth (Fujinami et al. 2019) conducted in the northwestern Pacific are reliable in terms of data quality and their analytical methods. On the other hand, lifespan is estimated from an empirical formula based on age assessment information obtained in the process of estimating the growth curve, and the uncertainty is large. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information available	Some information outside of the target sea area available, but not sufficient	Sufficient information on the target area, at the minimum required for stock assessment	Detailed information on the target area, highly accurate information can be used	Detailed information on the target area including data on effects of environmental factors sufficient and highly accurate information can be used

1.1.1.3 Maturity and Spawning

The latest studies on reproductive ecology, including maturity and reproductive cycles, conducted in the northwestern Pacific (Fujinami et al. 2017) and studies on productivity and parent-recruitment relationships (Yokoi et al. 2017, Kai and Fujinami 2018) are considered to be highly reliable in terms of data quality and quantity and analysis methods. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information available	Some information outside of the target sea area available, but not sufficient	Sufficient information on the target area, at the minimum required for stock assessment	Detailed information on the target area, highly accurate information can be used	Detailed information on the target area including data on effects of environmental factors sufficient and highly accurate information can be used

1.1.1.4 Stock Enhancement

This item is not assessed because no juvenile release is conducted for this species.

1 Point	2 Points	3 Points	4 Points	5 Points
Not Under-stood	Data available but not analyzed	Data available on appropriate stocking numbers, suitable stocking locations, and release sizes, and analysis is ongoing	Appropriate stocking numbers, suitable stocking locations, and release sizes are empirically understood	Appropriate stocking numbers, suitable stocking locations, and release sizes are understood through surveys and research

1.1.2 Monitoring Implementation System

A large amount of useful information necessary for understanding the target species and implementing stock management is obtained from monitoring surveys for collecting stock biological information. Regarding the items and periods of the monitoring system, whether or not the information necessary for conducting stock assessments is in place is evaluated from the six perspectives set forth in 1.1.2.1 to 1.1.2.6. The information to be assessed is (1) scientific research, (2) survey of catch data, (3) survey of fishing operations, and (4) biological survey of landed catches. For fish species involving juvenile release, (5) understanding the results of juvenile release and (6) the status of distinction between natural fish and artificially released fish are also included. The total score is calculated by simply averaging the scores of individual items. The length of the period mentioned here is about five years or three generations (IUCN 2019) required to determine the trend.

1.1.2.1 Scientific Research

Long-term data have been obtained from surveys by research vessels, charter vessels, and government vessels to date. On the other hand, the information is not sufficient for stock assessment because the seasons and surveyed sea areas are limited. The size data of the catches by commercial vessels of offshore longline vessels, which are the target fisheries, are measured by sex at the Kesennuma market. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information is available	Some short-term information required for stock assessment is available	Sufficient short-term information required for stock assessment is available	Some long-term information required for stock assessment is available	Sufficient long-term information required for stock assessment is available

1.1.2.2 Survey of Catch Data

Since this species is mostly bycaught, the total catch shown in the landing data is underestimated. Operational data, including area coverage, period, etc. of longline fishing vessels (mainly operated in offshore waters) belonging to Kesennuma, which accounts for most of the volume of landings, and other major fishing ports is highly reliable. An abundance index is estimated from these data, and the catch is estimated by multiplying the abundance index by the total effort of longline fishery (Kai and Fujinami 2020, Figure 1.1.2.2). Consequently, the reliability of Japanese catches used in stock assessment is high. The catches from coastal fisheries, such those using drift nets and fixed fishing nets, are calculated based on sharks catch data from agriculture, forestry and fisheries statistics. Since the percent of catches of this species account for a large portion of sharks, the estimation error considered to be small. The proportion of the catches of coastal fisheries to the total catch is low, and the impact of the estimation error on the stock assessment is small compared to the uncertainty of the catches from longline fishing vessels. On the other hand, the estimation accuracy of the volume of catch and dumping of this species by pelagic vessels that bycatch this species on the high seas and by longline vessels that target bigeye tuna, etc. using deep ropes in the offshore waters must be improved in the future. Consequently, a score of 5 points is given.

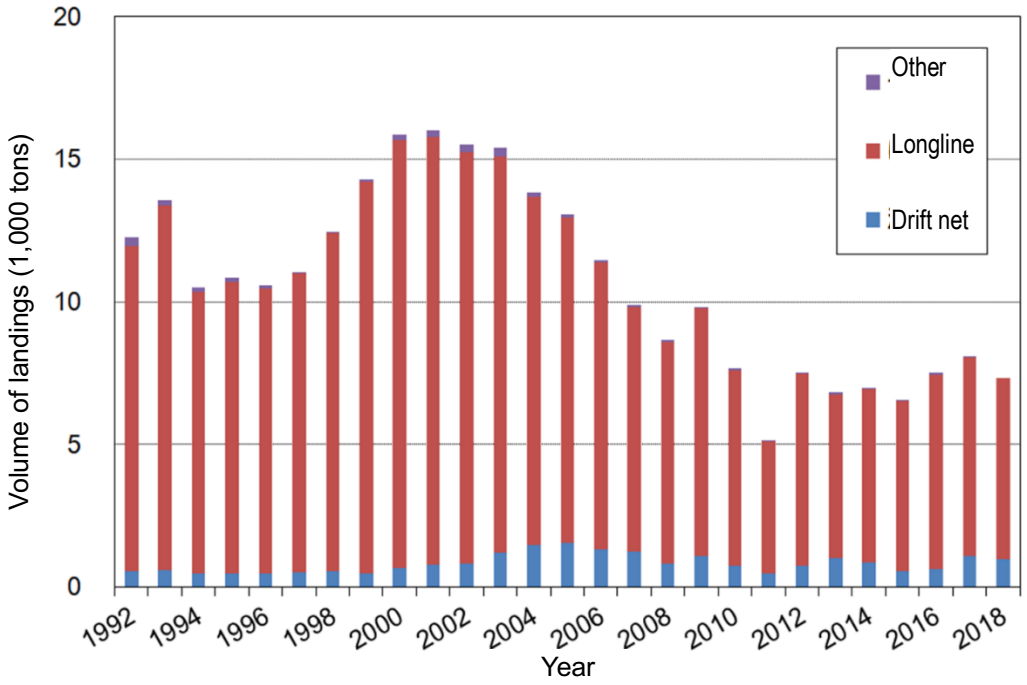

Fig. 1.1.2.2 Landings of blue shark in prefectures with major Japanese fishing ports (Aomori, Iwate, Miyagi, Chiba, Kanagawa, Shizuoka, and Wakayama) (1992-2018)

1 Point	2 Points	3 Points	4 Points	5 Points
Catches are unknown	Catches are partially known for a short term	Catches are partially known for a long term but the total catch is unknown	Total catch is known for a short term	Total catch is known for a long term

1.1.2.3 Survey of Fishing Operations

The Kesennuma Offshore Longline Fleet prepares a catch report that must be submitted, and the JFREA collects more detailed operational information and information on catch and dumping (Fig. 1.1.2.3). This information was used for spatiotemporal statistical analysis (Kai et al. 2017). Consequently, a score of 5 points is given.

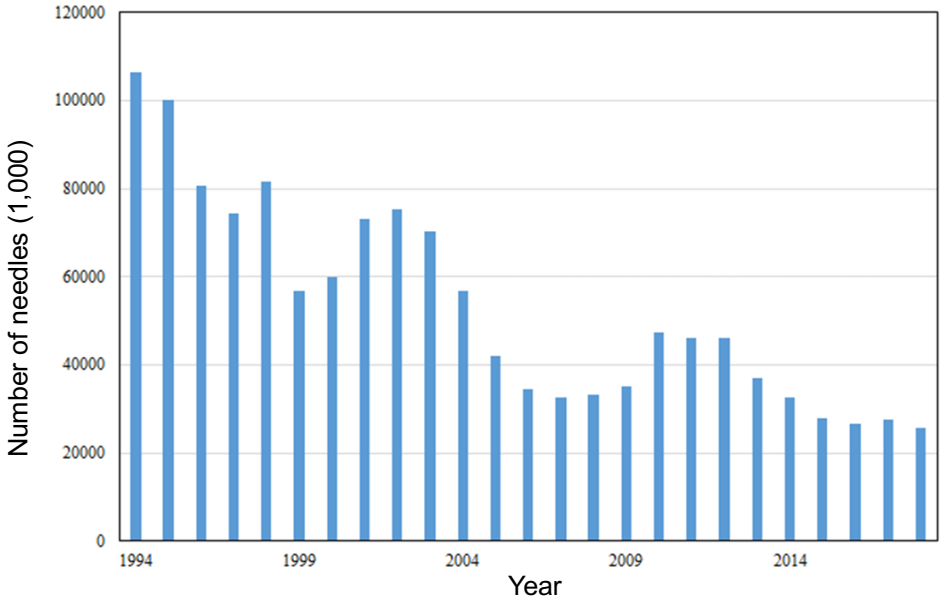

Fig. 1.1.2.3 Number of hooks used by longline fishing vessels belonging to prefectures (Aomori, Iwate, Miyagi, Chiba, Kanagawa, Shizuoka, and Wakayama) where major Japanese fishing ports are located (1994-2018)

1 Point	2 Points	3 Points	4 Points	5 Points
No information is available	Short-term information covering part of the distribution area is available	Short-term information covering the entire distribution area is available	Long-term information covering part of the distribution area is available	Long-term information covering the entire distribution area is available

1.1.2.4 Biological Investigations on Landed Fish

The data obtained by the body length measurement performed in Kesennuma are useful source of information for understanding long-term changes in body length by fishing method, and are used in the stock assessment model (ISC 2017). Vertebrae are examined for age assessment studies and gonad samples used for reproductive ecology studies. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information is available	Short-term information covering part of the distribution area is available	Short-term information covering the entire distribution area is available	Long-term information covering part of the distribution area is available	Long-term information covering the entire distribution area is available

1.1.2.5 Stock Enhancement Performance

This item is not assessed because no juvenile release is conducted for this species.

1 Point	2 Points	3 Points	4 Points	5 Points
Near no record of release data		Some information available but data on area, time of release, etc. are not recorded	Most information on origins of broodstock, number of broodstock, number of fish released, size at release, and location of release is recorded	All information on origins of broodstock, number of broodstock, number of fish released, size at release, and location of release is recorded

1.1.2.6 Identification of Naturally and Artificially Spawned Fishes

This item is not assessed because no juvenile release is conducted for this species.

1 Point	2 Points	3 Points	4 Points	5 Points
Unable to distinguish between naturally and artificially spawned fish		Able to distinguish between naturally and artificially spawned fish through tags or markings		The release history (date, location, etc.) of artificially released fish can be ascertained through tags or markings

1.1.3 Stock Assessment Methods and Objectivity of Assessment

Stock assessment represents collection and analysis of catch statistics and various survey data to understand how marine resources have been changed due to the impacts from fisheries and to predict future trends. This assessment is very important for stock (fishery) management (Matsumiya 1996). The stock assessment methods and objectivity of the assessment results are evaluated from the two perspectives set forth in 1.1.3.1 and 1.1.3.2.

1.1.3.1 Stock Assessment Methods

Stock assessments were conducted from 1971 to 2015 using the integrated model (SS) (ISC 2017). The SS was established in consideration of the best possible biological findings of today and contains abundance indices (CPUE), catch size data and total catch statistics reported by Japan, Taiwan, Mexico, the United States and the SPC (Pacific Community). This model is complex and can take into account catch, CPUE and biological parameters, as well as age, length and structure. Since these data are sufficiently available for fish species in the North Pacific, stock assessment using the SS is possible. The impact of estimation accuracy and uncertainty due to diagnosis using multiple models was considered in stock assessment results. There are some minor issues to be addressed, but there are no major problems that have a significant impact on the stock assessment results. Consequently, the assessment was made by the assessment method 1 and a score of 5 points is given.

Method	1 Point	2 Points	3 Points	4 Points	5 Points
①				Assessment based on simple annual change of biomass	Assessment based on detailed analysis of annual changes in standing stock taking into account effort
②			Assessment based on simple analysis of CPUE annual changes	Assessment based on detailed analysis of CPUE annual changes with standardization	
③		Assessment based on annual changes in catch at some landing sites with limited information	Assessment based on annual changes in the entire catch with limited information		
④				Assessment based on scientific survey data from some parts of the distribution area	Assessment based on scientific survey data from the whole distribution area
⑤	No stock assessment				

1.1.3.2 Objectivity of Stock Assessment

Regarding details on stock assessments, a report is available on the ISC website (ISC 2019). The report on the stock assessment results is also available on the website of the Inter-American Tropical Tuna Commission (IATTC), an international treaty body that has jurisdiction over the Pacific Ocean, and on the website of WCPFC (IATTC 2019, WCPFC 2020). This report describes the analytical method and details of the data. In the process of preparing the report, participants of the ISC, WCPFC, and IATTC discussed the data and analytical methods that were used for stock assessment and the interpretation of the results. The report will eventually be approved and published. The ISC has a system for peer review by third-party experts, but it has not been applied to this species to date. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Data and discussions are private, and no peer reviews of reports are conducted	.	Data and discussions are open to the public conditionally, and internal peer reviews are conducted on the stock assessment methods and results	.	Data and discussions are open to the public, and external peer views are conducted on the stock assessment methods and results

1.1.4 Effects of Stock Enhancement

This item is not assessed because no juvenile release is conducted for this species.

1.2 Target Species Abundance and Trends

1.2.1 Target Species Abundance and Trends

The relative value of the current stock (B) to the stock that achieves maximum sustainable yield (MSY) is B_{2015}/B_{MSY} = 1.69, and the relative value of the fishing mortality coefficient (F) is F_{2011}/F_{MSY} = 0.38 (See Fig. 1.2.1). The conclusion of the stock assessment using the MSY as a reference point is as follows: The current stock (2012-2015) is neither in a state of overfishing nor beyond a permitted level (ISC 2017). Consequently, a score of 5 points is given.

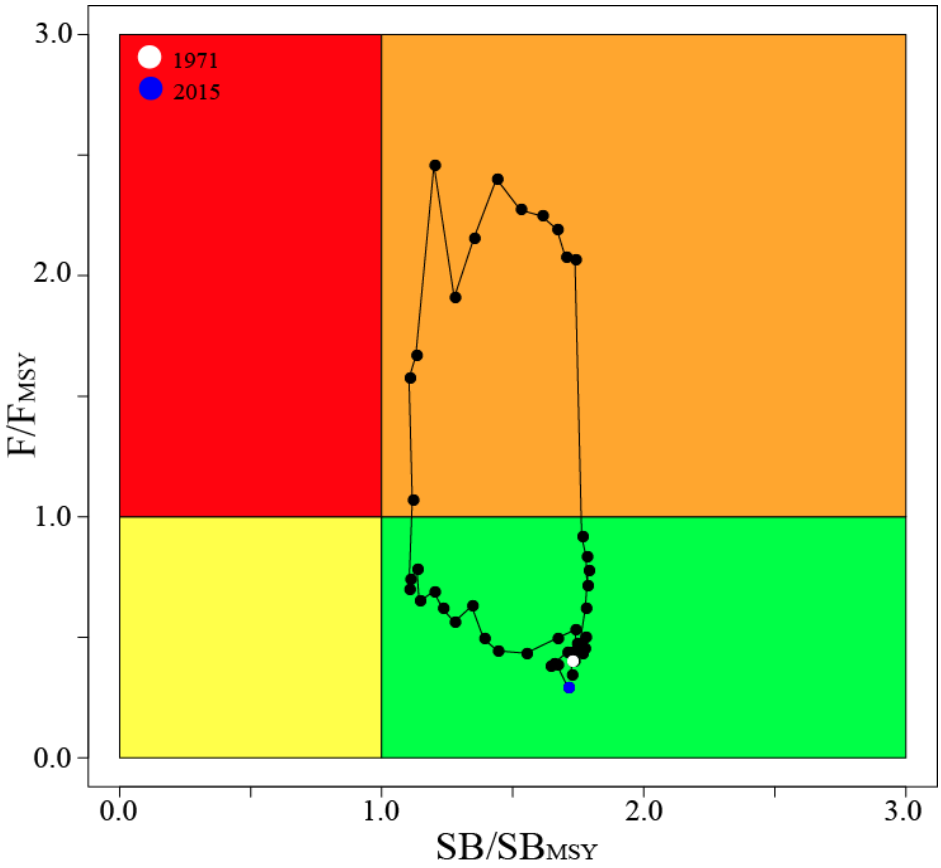

Figure 1.2.1 Kobe plot
The horizontal axis indicates a relative ratio of the amount of blue shark parent fish stock in each year to the amount of blue shark parent fish stock at the MSY level. If this value is greater than 1, it means that the amount of parent fish stock is higher than the MSY level.
The vertical axis indicates a relative ratio of the blue shark fishing intensity of each year to the fishing intensity at the MSY level. If this value is greater than 1, it means that the fishing intensity is higher than the MSY level. Each background color represents the stock status. Green indicates that the amount of parent fish stock and the fishing intensity are both sound, and neither in a state of overfishing nor in a state beyond a permitted level. Red indicates that the fish are overfished and the catch exceeds the permissible level.

Method	1 Point	2 Points	3 Points	4 Points	5 Points
①	Below the limit reference point	Target reference point – limit reference point / Decreasing	Target reference point – limit reference point / Flat	Target reference point – limit reference point / Increase	Above the target reference point
②	Low / Decreasing, Low / Flat, Indeterminable	Low / Increasing, Medium / Decreasing	Medium / Flat	High / Decreasing, Medium / Increasing	High / Increasing, High / Flat

1.3 Impacts of Fisheries on Target Species

1.3.1 Impacts of Current Fishery Pressures on Sustainable Production of Target Species

The WCPFC and IATTC have not determined reference points for sharks but have determined the

stock status based on the MSY to date. Management recommendations are often issued when the stocks fall below the MSY level, so the MSY level should be considered the Limit Reference Point (SBlimit). Consequently, the assessment was made by the assessment method 2 and a score of 5 points is given.

Method	1 Point	2 Points	3 Points	4 Points	5 Points
①	$SB_{cur} \leqq SB_{target}$ $F_{cur} > F_{msy}$		$SB_{cur} > SB_{target}$ $F_{cur} > F_{msy}$ or $SB_{cur} \leqq SB_{target}$ $F_{cur} \leqq F_{msyt}$		$SB_{cur} > SB_{target}$ $F_{cur} \leqq F_{msy}$
②	$B_{cur} \leqq B_{limit}$ $F_{cur} > F_{limit}$		$B_{cur} > B_{limit}$ $F_{cur} > F_{limit}$ or $B_{cur} \leqq B_{limt}$ $F_{cur} \leqq F_{limit}$		$B_{cur} > B_{limit}$ $F_{cur} \leqq F_{limit}$
③	$C_{cur} > ABC$			$C_{cur} \leqq ABC$	
④	Large impact from fisheries		Small impact from fisheries		
⑤	Indeterminable				

1.3.2 Stock Depletion Risk at Current Fishery Pressure

Stock in 2015 was above the MSY level and the fishing pressure from 2012 to 2014 below the MSY level. As shown in Figure 1.3.2, the future forecast shows that the median future stock is unlikely to fall below the MSY level in different fishing pressure scenarios (± 20% of the current MSY level) (ISC 2017). Consequently, the assessment was made by the assessment method 2 and a score of 4 points is given.

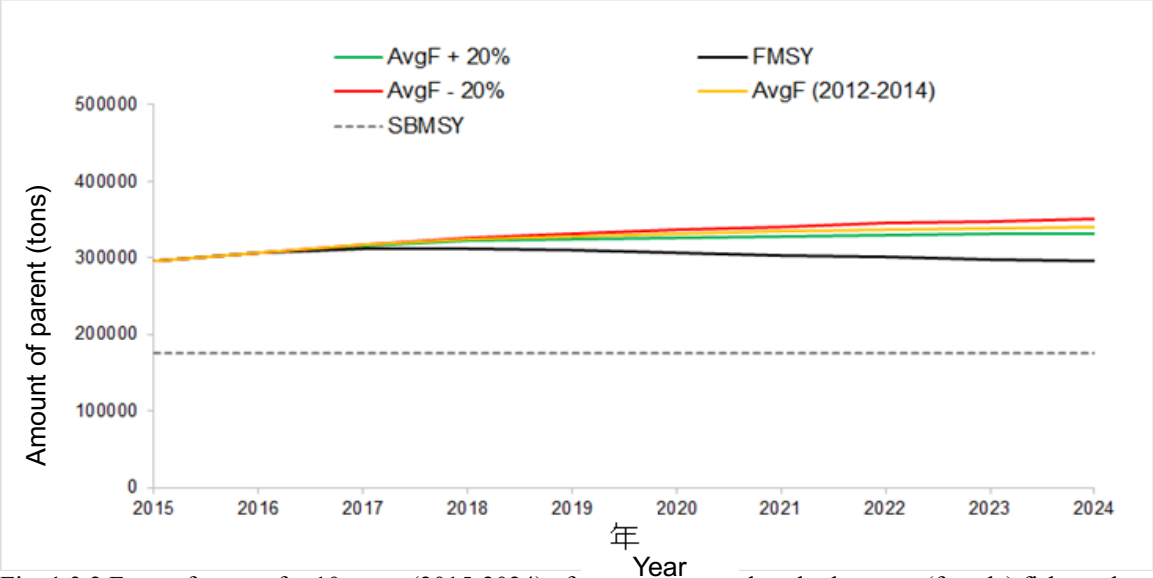

Fig. 1.3.2 Future forecast for 10 years (2015-2024) of the amount of blue shark parent (female) fish stock under four different fishing strategies. AveF (2012-2014) indicates the amount of parent fish stock if fishery is conducted with the average fishing intensity F from 2012 to 2014. FMSY indicates the same with the fishing intensity F at the MSY level. AveF + 20 indicates the same if the current average F is increased by 20%. AveF-20 indicates the same if the current average F is decreased by 20%. The horizontal dotted line represents the amount of parent fish stock at the MSY level.

Method	1 Point	2 Points	3 Points	4 Points	5 Points
①	High stock depletion risk	.	Moderate stock depletion risk	.	Almost no risk of stock depletion
②③	High stock depletion risk	Moderate stock depletion risk	.	Low stock depletion risk	.
④	Undetermined	.	.	.	.

1.3.3 Influence of Stock Assessment on Fisheries Management

A stock assessment itself is not the ultimate goal but part of an effort to increase the amount of information available for stock management and fishery management (Matsumiya 1996). This subsection evaluates how stock assessment results are reflected in the formulation of fishery management measures in terms of rules and procedures.

1.3.3.1 Presence of Fishery Management Measures

With the exception of the voluntary management described below, harvest control rules formulated by the WCPFC or IATTC are not available. This is because the species is generally caught as bycatch and the stock status is good. For bycatch species (international stocks) with poor stock status, measures, such as restrictions on the catch and prohibition of retention (recommendation of live release) have been taken for such bycatch species. Consequently, a score of 1 point is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No harvest control rules exist	Harvest control rules exist but are not reflected in fisheries management		Harvest control rules exist and some are reflected in fisheries management	Harvest control rules are well reflected in fisheries management, or control measures are not reflected in management due to good resource status

1.3.3.2 Presence of Precautionary Measures

Since the reference points have not been officially decided, there is no discussion about uncertainty. Consequently, a score of 1 point is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No precautionary measures are taken into account	Precautionary measures are taken into account but not reflected in fishery management	.	Precautionary measures are taken into account and partially reflected in fishery management	Precautionary measures are taken into account and adequately reflected in fishery management

1.3.3.3 Considering Impacts of Climate Change

This species has a wide distribution area and is considered to have a strong parent-recruitment relationship in that the number of recruitment is determined by the number of parents (Kai and Fujinami, 2018). So, the impacts of environmental changes on this stock are considered limited but are not actually considered. Consequently, a score of 1 point is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Impacts of environmental changes have not been investigated	It seems that impacts of environmental changes exist but no information is available	Impacts of environmental changes are known but are not currently considered in management	Impacts of environmental changes are known and are somewhat considered in management	Impacts of environmental changes are known and are fully considered in management

1.3.3.4 Formulation of Fishery Management Measures

The Kesennuma Offshore Longline Fleet has submitted a voluntary management plan to the WCPFC through the government. In this plan, the Kesennuma Offshore Longline Fleet voluntarily determines the upper limit of shark catches, including this species, and reports the current state of catch to the WCPFC every year (Japan Fisheries Agency 2019). Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No input from external experts or stakeholders has been incorporated, or stock assessment results have not been incorporated in fisheries management		Management measures are formulated based upon consideration of internal persons concerned	Considerations from external experts or stakeholders are included in management measures	A functioning place for review involving external experts and stakeholders is included in management

1.3.3.5 Considerations of Recreational, Foreign Commercial, and IUU Fishing for Fisheries Management Procedures

Illegal, Unreported and Unregulated (IUU) vessels are notated and the list is available on the WCPFC website. Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Impacts of recreational fishing, foreign fishing vessels, and IUU catch are not considered	Efforts are being made to propose management measures that take into account recreational fishing, foreign fishing vessels, and IUU fishing	It is necessary to consider fishing by recreational fishing, foreign fishing vessels, and IUU fishing, and some management measures have been proposed	There is little need to consider fishing by recreational fishing, foreign fishing vessels, and IUU fishing, or proposals have been made for management measures that give reasonable consideration	It is not necessary to consider fishing by recreational fishing, foreign fishing vessels, and IUU fishing, or proposals have been made for management measures that fully consider them

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2. Marine Environment and Ecosystems

Overview

Environment and Ecosystem Data, Research, and Monitoring in the Focal Sea Area (section 2.1)

This subsection describes the information necessary for understanding the impact of blue shark fishing in the North Pacific on the ecosystem, and whether or not monitoring is being carried out. Information on problems in the ecosystem and bycatches in the western and central Pacific, ecosystem model analysis and catch from longlines, etc. have been obtained (5 points for item 2.1.1). Research vessel surveys targeting tropical tunas and Skipjack tuna larvae and juveniles are conducted irregularly and zooplankton collection and marine environment surveys are also conducted (3 points for item 2.1.2). A scientific observer program was introduced in 2008, and a system has been established to acquire records of catch and bycatch by longlines and purse seine and size information, allowing information on bycatch and catch composition to be partially collected (3 points for item 2.1.3).

Bycatch (section 2.2)

Regarding the impact of the longline blue shark fisheries on other fish species, the stocks of albacore, bigeye tuna, yellowfin tuna, and swordfish, which are considered to be usable bycatch species, were not concerns (4 points for item 2.2.1). The impact on unusable bycatch species was assessed by Productivity Susceptibility Analysis (PSA). As a result, potential risk of longline fisheries was determined to be middle-to-high for some species. More specifically, potential risk is high for green turtles, loggerhead turtles, hawksbill turtles, and olive ridley turtles, and moderate for *lampris guttatus* (moonfish) and false killer whales (2 points for item 2.2.2). The impact on endangered species were determined to be low on average, but the risk of sea turtles was determined to be high (3 points for item 2.2.3).

Ecosystems and Environments (section 2.3)

This subsection describes the indirect impacts of blue shark catch within the food web. Blue sharks, which are near the top of the food chain, are thought to have few predators that depend on them (5 points for item 2.3.1.1). Prey organisms are smaller fish and the like. Blue sharks are said to exhibit opportunistic eating habits rather than targeting specific species. Given the total stock of high-catch small pelagic fish in the northwestern Pacific as the abundance of prey organisms, the total stock tends to be flat (4 points for item 2.3.1.2). Competitors include albacore, bigeye tuna, yellowfin tuna, and swordfish, which have high catches as bycatch species of tuna longline and are highly fish-eating like blue sharks. These stocks were not concerns (4 points for item 2.3.1.3). The total catch and the mean trophic level of the catch have been declining in the southern Pacific region since 2004 and the intensity of the impact of the target fishery is not significant, but some changes in ecosystem characteristics are concerns (3 points for item 2.3.2). The impact on the water quality environment was determined to be minor (4 points for item 2.3.5). The CO2 emissions of longline vessels were relatively high, and there was concern about the impact on the atmospheric environment (3 points for item 2.3.6).

Outline

① Identification of target fisheries

The blue shark is basically a bycatch species of the tuna longline fishery (Kai and Fujinami 2020). The volume of blue sharks landed in Japan in 2018 was 7,660 tons (Senba 2020), but longline accounted for 86% by fishing method (according to the JFREA), so the target fisheries are longline (tuna longline). Of the tuna longline fisheries, the pelagic tuna longline fisheries are conducted outside the target sea area, so the target fisheries are offshore and coastal tuna longline fisheries. In terms of catch, tuna longline accounts for majority (Kai and Fujinami 2020).

② Identification of target sea area

Blue sharks in the Pacific Ocean have a high distribution abundance in the temperate zones, and considered to be a different stock from those in the North and South Pacific (Kai and Fujinami 2020). The target sea area is the North Pacific, but the main fishing grounds for offshore tuna longlines is in the midwestern part of the North Pacific (National Fishery Workers Securing and Training Center 2018), so the target sea area are further limited to the midwestern part of the North Pacific.

③ Summarization and description of information on target fisheries and ecosystems

1) Fishing gear and methods

In the case of Japan's offshore tuna longline, about 3,000 branch ropes are attached to a trunk rope with a length of 120 km or more.

2) Vessel size and the number of vessels engaged in the target fisheries

The number of longline vessels in operation is 278 Japanese vessels under 200 tons, 83 Japanese vessels over 200 tons, 112 South Korean medium and large vessels, 73 Taiwanese large vessels, 1,275 Taiwanese small vessels under 100 tons, and 245 Chinese ice storage vessels and 108 Chinese rapid freezing vessels, totaling 2,174 vessels (Sato 2016).

3) Annual catch of major fish species

The following table (FAO 2020) shows the volume of major catches in the central western Pacific (FAO fishing Area 71), which includes the waters south of the midwestern part of the North Pacific, in 2018.

English name	Japanese name	Scientific name	1,000 tons
Skipjack tuna	Katsuo	*Katsuwonus pelamis*	1849.9
Yellowfin tuna	Kihada	*Thunnus albacares*	560.1
Short mackerel		*Rastrelliger brachysoma*	230.4
Bigeye tuna scad	Mebachi	*Selar crumenophthalmus*	172.6
Indian mackerel	Guru kuma	*Rastrelliger kanagurta*	172
Kawakawa	Suma	*Euthynnus affinis*	148
Narrow-barred Spanish mackerel	Yokoshima sawara	*Scomberomorus commerson*	147.6
Frigate tuna	Hira soda	*Auxis thazard*	115.7
Bigeye tuna	Mebachi	*Thunnus obesus*	83.9
Yellowstripe scad	Hoso hira aji	*Selaroides leptolepis*	78.7
Albacore	Bin naga	*Thunnus alalunga*	47.6

4) Operating range

The following map is a fishing ground for the tuna longline fisheries that catches blue sharks.

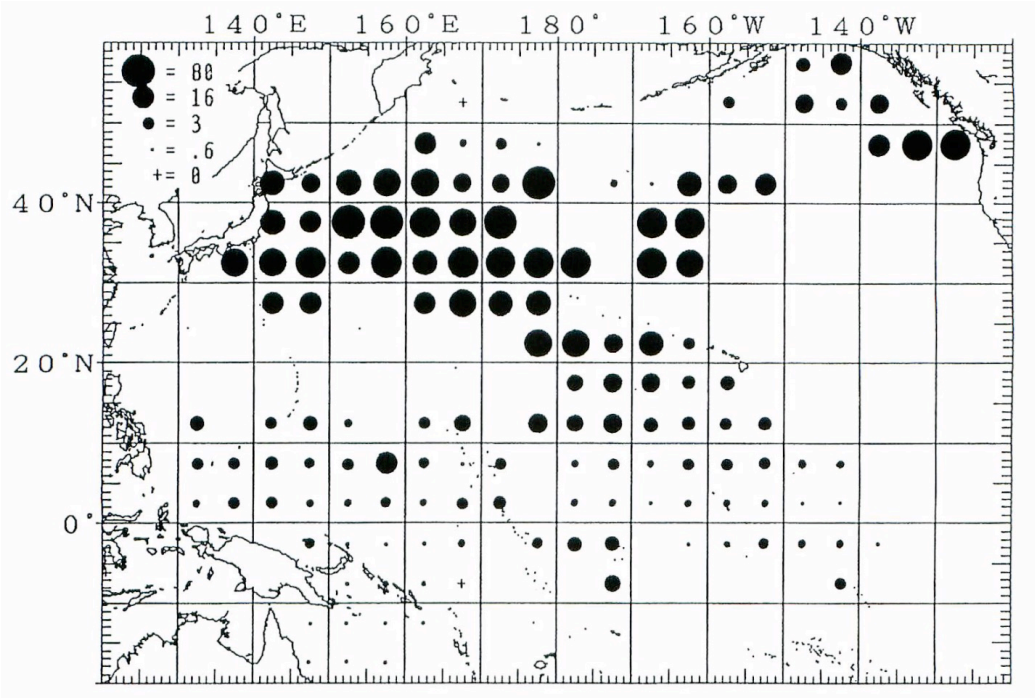


Fig. Blue shark fishing ground map and Catch Per Unit Effort (CPUE: catch in numbers / 1000 hooks) for longline (cited from Nakano 1994)

5) Spatio-temporal distribution of operations

The spatial distribution is as shown in the above figure. Seasonally, fishing grounds with high CPUE move to around 35-45 °N in September, when the water temperature is the highest, and to 30-36 °N in March, when the water temperature is the lowest (Nakano 1994).

6) Bycatch species

Usable species: The following table shows catches from offshore and coastal tuna longline by fish species according to the 2018 Agriculture, Forestry and Fisheries Statistics (the Ministry of Agriculture, Forestry and Fisheries 2019).

	Offshore	Costal	Total	Rate (%)
Albacore	11,959	889	12,848	30.0
Sharks	10,279	571	10,850	25.3
Bigeye tuna	6,924	298	7,222	16.9
Yellowfin tuna	4,876	1,611	6,487	15.1
Swordfish	2,381	69	2,450	5.7
Blue marlin	804	83	887	2.1
Marlin	640	240	880	2.1
Bluefin tuna	201	483	684	1.6
Total	38,426	4,427	42,853	100

Since the catch by fishing type of sharks are unknown, the number of sharks investigated by Clarke et al. (2014) was used. More specifically, the catch by shark type was calculated by apportioning the number of sharks (average in 2000 to 2009) caught by tuna longline in the Western and Central Pacific as shown below:

Fish species	Number of fish caught	Estimated catch (ton)	Rate (%) in 2018
Blue shark	793	7,411	17.3
Silky shark	144	1,346	3.1
Oceanic whitetip shark	89	832	1.9
Thresher shark	71	664	1.5
Shortfin mako shark	64	598	1.4

Unusable species:

The following bycatch species by longline in the Western and Central Pacific are considered to be unusable species (Clarke et al. 2014).

Sea turtles: Green turtles, loggerhead turtles, hawksbill turtles, leatherback turtles, olive ridley turtles. Among them, the loggerhead turtles have a specifically high bycatch of more than 0.01 per 1,000 hooks used in longlines in the North and South Pacific.

Seabirds: Albatrosses, such as Black-footed Albatross and Laysan albatross, and Procellaria birds, such as Macronectes, Pterodroma and Procellaria genera are candidates for bycatch. However, since bycatch of sea birds is rare in the Tropical Zone, their habitats are considered not to overlap with the longline fishing grounds of Yellowfin tuna.

Marine mammals: False killer whales are said to have a large impact according to data off the coast of Hawaii.

Teleosts: 4 - 18% of dolphinfish, 3 - 50% of lampris guttatus, 23 - 73% of oilfish, and 48 - 98% of sunfish are dumped.

7) Endangered species:

The species listed in the Red Data Book published by the Ministry of the Environment (2019) whose habitats are in the western and central Pacific are as follows:

Reptiles: Loggerhead turtle (EN), Green turtle (VU), Hawksbill turtle (EN)

Birds: Ancient Murrelet (CR), Laysan albatross (EN), Red-footed booby (EN), Albatross (VU), Swinhoe's storm petrel (VU), Greater crested tern (VU), Roseate tern (VU), Eligro hydrangea (VU)

Since the tuna longline fishery is carried out in the ocean, freshwater and brackish water fish are excluded.

2.1 Environment and Ecosystem Data, Research, and Monitoring in the Focal Sea Area

2.1.1 Accumulation of Basic Information on Regional Environment and Ecosystems

Ecosystem and bycatch issues in the Western and central Pacific waters, ecosystem model analysis, and information on bycatch from longline and purse seine are summarized as needed (MRAG Americas Inc. 2002, Allain et al. 2015, Clarke et al. 2014, Hall and Roman, 2013). Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information available		Fragmental information available	Information is available for a risk-based assessment	Sufficient information is available for evaluations based on chronological data and ecosystem models based on field observations

2.1.2 Implementation of Scientific Surveys

Research vessels surveys are conducted irregularly on the larvae and juveniles of tropical tunas and skipjack tuna in the western and central Pacific. Zooplankton collection and marine environment surveys are also conducted in this survey (Uosaki et al. 2016). Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No research has been conducted		Partial and irregular surveys have been conducted on the marine environment and ecosystem	A series of surveys are regularly conducted on the marine environment and ecosystem	Regular surveys fully applicable for monitoring marine environment and modeling ecosystems are ongoing

2.1.3 Monitoring through Commercial Fisheries Activity

A scientific observer program was introduced in the western and central Pacific in 2008, and a system has been established to acquire records of catch and bycatch by longlines and purse seine and size information, allowing information on bycatch and catch composition to be partially collected. Consequently, a score of 3 points is given. (WCPFC 2007).

1 Point	2 Points	3 Points	4 Points	5 Points
No information is collected from fisheries		Partial data on catch and bycatch composition can be collected	Representative information on catch and bycatch composition can be collected	A fishery-based system is in place that can monitor the marine environment and ecosystem status applicable for adaptive management

2.2 Bycatch

2.2.1 Commercial Bycatch Species

The species that exceeded 5% of the total catch in the offshore and coastal tuna longline were albacore, blue shark, bigeye tuna, yellowfin tuna, and swordfish. As a result of conducting an assessment based on the stock status, a score of 4 points is given.

CA assessment results of usable bycatch species by tuna longline

Target fishery	Tuna longline	
Target water	Western and central Pacific	
Target fish species	Albacore, bigeye tuna, yellowfin tuna, swordfish	
Item no.	2.2.1.	
Assessment item	Usable bycatch species	
Assessed element	Abundance	4
	Reproduction capacity	
	Age and size composition	
	Distribution area	
	Other	
Overview of assessment rationale	The stock status of albacore, bigeye tuna, yellowfin tuna, and swordfish are not concerns. Consequently, a score of 4 points is given.	
Assessment rationale	The stock status of albacore (North Pacific), bigeye tuna (western and central Pacific), yellowfin tuna (western and central Pacific), and swordfish (North Pacific) are as follows: ・Albacore in the North Pacific: The stock level and trend are medium and flat. Since SSBMSY (female only) is estimated to be 24,000 tons, while SSB_{2015} (female only) is estimated to be 80,000 tons and $F_{2012\text{-}2014}/F_{MSY}$ is 0.61, the stock is considered not to be overfished and the fishing pressure is not excessive (Kiyofuji 2020). ・ Bigeye tuna in the western and central Pacific: The stock level and trend are medium and flat. The average spawning stock level $SB_{2012\text{-}2015}/SB_{F=0}$ from 2012 to 2015 is 0.36, which exceeds the limit reference point ((SBlimit)) ($SB/SB_{F=0} = 0.20$). Given that $F_{2012\text{-}2015}/F_{MSY} = 0.77$, it is highly likely that the fishing pressure is not excessive (Sato 2020a). ・ Yellowfin tuna in the western and central Pacific: The stock level is medium to low, and the trend is flat. The average spawning level from 2012 to 2015 ($SB_{2012\text{-}2015}/S_{BF=0}$) is 0.33, which is higher than the limit reference point ($SB/SB_{F=0} = 0.20$). The average fishing coefficient for 2012-2015 was below F_{msy} ($F_{2012\text{-}2015}/F_{MSY} = 0.74$). In other words, the stock is unlikely to be overfished and the fishing pressure is unlikely to be excessive (Sato 2020b). ・ Swordfish (North Pacific): Regarding the swordfish stock in the midwestern part of the North Pacific, the stock level and trend are high and increasing. The current stock is not overfished and the catch is not in a state beyond a permitted level (Ijima 2020). As mentioned above, the stock status of albacore, bigeye tuna, and swordfish is not a concern, and the stock of yellowfin tuna, which may be in a low state, is not overfished and the fishing pressure is not excessive. Consequently, a score of 4 points is given.	

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	Many bycatch species are in poor stock status or have high risks of adverse bycatch impacts	Stock status of a small number of species may be adversely impacted by bycatch; In CA or PSA the risks of adverse bycatch impacts are generally low but some species may be adversely affected	No bycatch species are in bad stock status; No species are at significant risks of adverse bycatch impacts	Individual stock assessment results indicate that bycatch species are considered to be in healthy stock status and do not have significant adverse impacts by bycatch

2.2.2 Non-commercial Bycatch Species

Among marine reptiles, green turtles, loggerhead turtles, hawksbill turtles, leatherback turtles, olive ridley turtles, etc. are bycaught and dumped. These species lacking quantitative stock information have been evaluated by Kirby and Hobday (2007) based on PSA. As a result, the potential risk from longline

fishing is high for green turtles, loggerhead turtles, hawksbill turtles, and olive ridley turtles. Leatherback turtles are determined to be at moderate risk near the surface and low risk at lower depths, but at a high risk overall. Kirby and Hobday (2007) determine the degree of risk as follows: moonfish are at moderate risk, sunfish at moderate risk in lower depths and a low risk near the surface, mahi mahi are at medium risk, and oilfish at low risk. According to Kelleher (2005), the dumping rate of the longline vessels of tuna and highly migratory fish is 28.5%, but the breakdown is unknown. In the central western Pacific, the most bycatch of teleost fish are moonfish, sunfish, mahi mahi, and oilfish, but stock trends are unknown because there are no catch statistics other than those of mahi mahi. As shown in Figure 2.2.2, the catch of mahi mahi in the western and central Pacific has been increasing significantly since the 2000s.

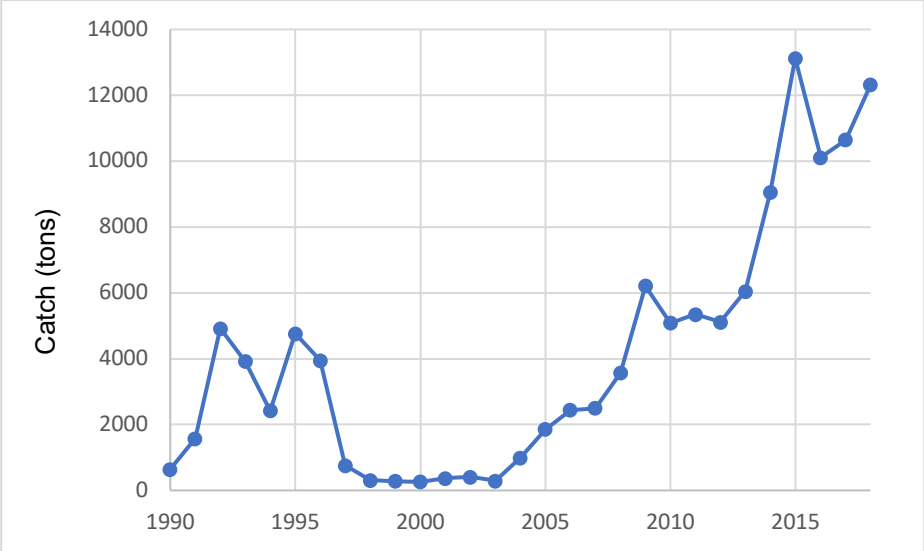


Fig. 2.2.2 mahi mahi catch in the western and central Pacific (FAO 2020)

Among marine mammals, false killer whales (Clarke et al. 2014), which are said to be impacted by longline fishing, are also considered to be at moderate risk based on PSA conducted by Kirby and Hobday (2007).

As mentioned above, some bycatch species are determined to be at moderate to high potential risk from of longline fishery bycatches. Consequently, a score 2 points is given as an overall score.

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	Many non-commercial bycatch species are in poor stock status; PSA shows overall high risks of bycatch impacts with some species that may have significant adverse impacts	A small number of non-commercial bycatch species are in poor stock status; PSA shows overall low risks of bycatch impacts with a small number of species that may have significant adverse impacts	No non-commercial bycatch species are in poor stock status; PSA shows overall low risks of bycatch impacts with no species that are supposed to be adversely impacted	Individual stock assessments of non-commercial bycatch mortalities are at sustainable levels with no adverse impacts expected

2.2.3 Rare (Endangered or Threatened) Species

The endangered species designated by the Ministry of the Environment with habitats overlapping target

water regions are loggerhead turtles, green turtles, hawksbill turtles, ancient murrelets, laysan albatrosses, red-footed boobies, swinhoe's storm petrels, sterna bergii, roseate terns, and black-naped terns.

These species were risk-assessed (see Table 2.2.3c) based on PSA and summarized in Table 2.2.3a. Table 2.2.3b summarizes their biological characteristic values. The risk was determined to be low on the overall average, but the risk of sea turtles was determined to be high. Consequently, a score of 3 points is given.

Table 2.2.3a PSA assessment results for rare species (longlines)

評価対象生物			P（生産性、Productivity）スコア									S（感受性、Susceptibility）スコア					PSA評価結果	
Item	Catch (tons) Common name	Vertebrate or invertebrate	Productivity (P) score Age at first maturity	Maximum age	Fecundity	Maximum size (cm)	Size at maturity (cm)	Reproductive strategy	Trophic level	Density dependence	Overall P score (arithmetic mean)	Horizontal distribution overlap	Vertical distribution overlap	Fishing gear selectivity	Post-release mortality	Overall S score (geometric mean)	PSA result PSA score	Risk category
2.2.3	Loggerhead turtle	Vertebrate	3	3	2	2	2	2	3		2.43	2	3	1	2	1.86	3.06	Medium
2.2.3	Green turtle	Vertebrate	2	3	2	2	2	2	3		2.29	2	3	1	2	1.86	2.95	Medium
2.2.3	Hawksbill turtle	Vertebrate	3	3	2	2	2	2	3		2.43	2	3	1	2	1.86	3.06	Medium
2.2.3	Ancient murrelet	Vertebrate	1	1	3	1	1	2	3		1.71	1	1	1	1	1.00	1.98	Low
2.2.3	Laysan albatross	Vertebrate	2	3	3	1	2	2	3		2.29	1	1	1	1	1.00	2.49	Low
2.2.3	Red-footed booby	Vertebrate	1	2	3	1	2	2	3		2.00	1	2	1	1	1.19	2.33	Low
2.2.3	Short-tailed	Vertebrate	2	2	3	1	2	2	3		2.14	1	1	1	1	1.00	2.36	Low
2.2.3	Swinhoe's petrel	Vertebrate	1	1	3	1	1	2	3		1.71	2	1	1	1	1.19	2.09	Low
2.2.3	Greater crested tern	Vertebrate	1	1	3	3	1	2	3		2.00	1	2	1	1	1.19	2.33	Low
2.2.3	Roseate tern	Vertebrate	Unknown	2	3	1	1	2	Unknown		1.80	1	2	1	1	1.19	2.16	Low
2.2.3	Black-naped tern	Vertebrate	Unknown	2	3	1	1	2	Unknown		1.80	1	2	1	1	1.19	2.16	Low
Target fishery	Longline	Target area	Western and central Pacific											Overall PSA score			2.45	Low

Table 2.2.3b. Biological characteristic values for the productivity of rare species

Target species	Age at first maturity (year)	Max age (year)	Fecundity	Max size (cm)	Size at maturity (cm)	Trophic level	Source
Loggerhead turtle	35	70～80	400	110	80	4	Okamoto et al. (2020), Ishihara (2012), IUCN (2017)
Green turtle	19	70～80	400	100	92	2.1	Okamoto et al. (2020), Ishihara (2012), Seminoff (2004)
Hawksbill turtle	30-50	20-40	96-200	80	60	2.1	Okamoto et al. (2020), Ishihara (2012), UMMZ (2020)
Ancient murrelet	2	7	2	26	24	3.8	Kanouchi et al. (1998), Preikshot (2005), HAGR (2017)
Laysan albatross	8	55	1	81	79	4+	Hamaguchi et al. (1985), Gales (1993)
Red-footed booby	2	20+	1	80	70	4+	Takano (1981)
Albatross	5	25+	1	94	84	4+	Hasegawa (1998)
Swinhoe's storm petrel	2	6	1	20	19	3.6	Hamaguchi et al. (1985), Klimkiewicz et al. (1983)
Sterna bergii	3	21	1.5	53	43	3.8	Hamaguchi et al. (1985), Milessi et al. (2010)
Roseate tern	Unknown	23	1–3	76	67	Unknown	Yamashina Institute for Ornithology (2017)
Black-naped tern	Unknown	23	2	76	67	Unknown	Yamashina Institute for Ornithology (2017)

UMMZ: University of Michigan, Museum of Zoology
HAGR: Human Ageing Genomic Resources

Table 2.2.3c PSA scoring guideline

	Productivity score (P)	High (1)	Medium (2)	Low (3)
P1	Age at first maturity	<5 years	5 - 15 years	> 15 years
P2	Maximum age (avg.)	<10 years old	10 - 25 years old	> 25 years old
P3	Fecundity	> 20,000/year	100-20,000/year	< 100/year
P4	Maximum size (avg.)	< 100 cm	100-300 cm	> 300 cm
P5	Size at maturity (avg.)	< 40 cm	40-200 cm	> 200 cm
P6	Spawning method	Bathypelagic egg release (drifting eggs)	Demersal egg release (adhesive eggs)	Embryonic; viviparity (live birth), or ovoviviparity (fertilized egg laying)
P7	Trophic level	< 2.75	2.75-3.25	> 3.25
P8	Density dependence (invertebrates only)	Compensation at low density is observed.	No density compensation effects	Reverse compensation at low density (Ally effect) is observed.
P	Overall P score	Calculated arithmetically		= (P1+P2+…Pn)/n
	Susceptibility score (S)	1 (Low)	2 (Medium)	3 (High)
S1	Vertical distribution overlap	< 10%	10-30%	> 30%
S2	Horizontal distribution overlap	Low chance of encounter with fishing gear	Medium probability of encounter with fishing gear	High chance of encounter with fishing gear
S3	Fishing gear selectivity	Young immature fish are less likely to be caught	Young immature fish are commonly caught	Young immature fish are frequently caught
S4	Post-release mortality	There is evidence that many fish released after catch survive	There is evidence that some fish released after catch survive	Retained after catch or most do not survive if released after
S	Overall S score	Calculated by geometric average		'=(S1*S2*...Sn)^(1/n)
	PSA score	If < 2.64, low	If 2.64-3.18, medium	If> 3.18, high
	Overall PSA score	The Euclidean distance between zero and point (P, S) is calculated		=SQRT(P^2 +S^2)
	Overall assessment	To evaluate based on the overall PSA score and presence of high-risk species		

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	Rare species in poor stock status may be negatively impacted by the fishery; PSA or CA indicated an overall high risk of bycatch, with some species that may have significant adverse impacts	A small number of rare species are in poor stock status; PSA or CA indicated an overall low risk of bycatch impacts, with a small number of species that may be adversely impacted	No rare species have poor stock status; PSA or CA indicated an overall low risk of bycatch impacts, with no species adversely impacted	Based on individual assessments of rare species, it is determined that the focal fisheries do not threaten the survival of rare species

2.3 Ecosystems and Environments

2.3.1 Indirect Impacts through the Food Web

2.3.1.1 Predators

Blue sharks can be prey to larger sharks and marine mammals as juveniles, but no such information is available for adult sharks (Nakano and Seki 2003). As adults, blue sharks, which are near the top of the food chain, are unlikely to be preyed upon. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	Many predator species demonstrate directional changes and/or increased fluctuation of the indicator element possibly due to catch/bycatch in focal fisheries	Some predator species demonstrate directional changes and/or increased fluctuation of the indicator element	CA does not detect any significant impacts on predators caused by catch/bycatch of the focal fisheries	Ecosystem model-based assessments indicate that indirect impacts of catch/bycatch in the focal fisheries on predators through the food web are at sustainable levels

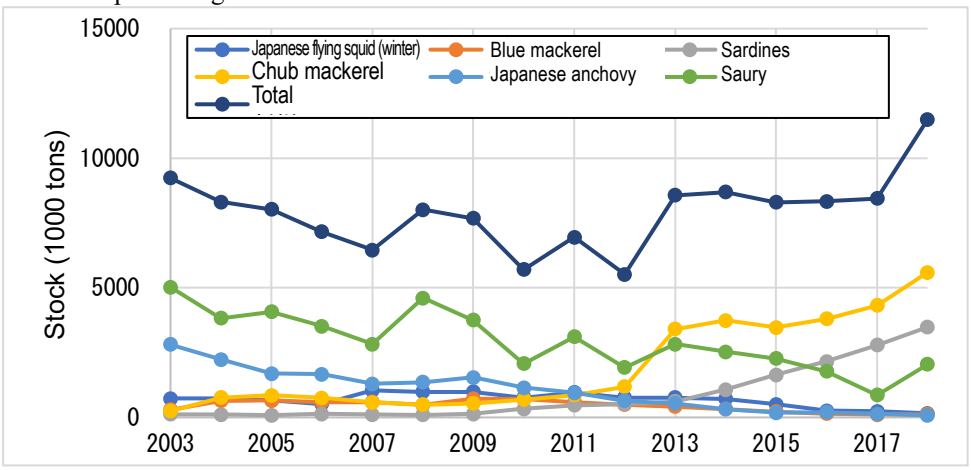
2.3.1.2 Prey

The main prey of blue sharks in the northwestern Pacific is the Japanese anchovy, lanternfish, and open-eyed cephalopods, which are distributed from the coastal areas to the mesopelagic zone (Fujinami et al. 2018). However, blue sharks are said to exhibit opportunistic rather than selective feeding habits (Kai and Fujinami 2020). Accordingly, the abundance of prey species is evaluated not based on the abundance of specific species, but on the total abundance of high-catch small pelagic fish, such as sardines, Japanese anchovy, chub mackerel, blue mackerel, saury, and Japanese flying squid in the northwestern Pacific. As a result, the stock of these high-catch small pelagic fish as a whole tends to be flat. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	Many prey species demonstrate directional changes and/or increased fluctuation of the indicator elements possibly due to catch/bycatch or stock enhancement in focal fisheries	Some prey species demonstrate directional changes and/or increased fluctuation of the indicator element	CA does not detect any significant impacts on prey species by catch/bycatch or stock enhancement in the focal fisheries	Ecosystem model-based assessments indicate that indirect impacts of catch/bycatch on prey through the food web in the focal fisheries are at sustainable levels

Assessment results of prey organisms for blue shark

Target fishery	Longline	
Target sea area	Midwestern part of the North Pacific	
Target fish species	Sardines, Japanese anchovy, chub mackerel, blue mackerel, saury, Japanese flying squid	
Item No.	2.3.1.2	
Survey item	Prey organisms	
Survey Target	Abundance	4
	Reproduction capacity	
	Age and size composition	
	Distribution area	
	Other	
Overview of survey rationale	Among the high-catch small pelagic fish, the stock status of Japanese anchovy and Japanese flying squid is of concern, but the total stock of the entire high-catch small pelagic fish is flat. Consequently, a score of 4 points is given.	
Details	The stock assessment results of high-catch small pelagic fish, which are considered to be prey organisms for blue sharks, are as follows: ・ Pacific sardine stock: Medium level/increasing (Furuichi et al. 2020) ・ Pacific Japanese anchovy stock: Low level/decreasing (Kamimura et al. 2020) ・ Pacific chub mackerel stock: The amount of parent fish is above the proposed SB limit and below the target reference point (SBmsy), and the trend is increasing (Yukami et al. 2020a).	

	・ Pacific blue mackerel stock: The amount of parent fish is above the proposed SB limit and below the target reference point (SBmsy), and the trend is declining (Yukami et al. 2020b). ・ Saury (North Pacific): Medium level/decreasing (Suyama et al. 2020) ・Japanese flying squid (winter-spawning stock): Low level/decreasing (Kaga et al. 2020). As shown in Figure 2.3.1.2, the stocks of Japanese anchovy, saury, Japanese flying squid, and blue mackerel are trending downward, but those of sardines and chub mackerel are trending upward, and the stocks of high-catch small pelagic fish are flat. Consequently, a score of 4 points is given.  Fig. 2.3.1.2 Pacific side, stock of high-catch small pelagic fish

2.3.1.3 Competitors

Albacore, bigeye tuna, yellowfin tuna, and swordfish, which are taken largely as bycatch species of tuna longlines and have strong fish-eating preference like the blue shark, are considered to be competitors. These four species are usable bycatch species assessed in 2.2.1, and none of their stocks is a concern. Since the score in 2.2.1 was 4 points, this item is also given a score of 4 points.

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	Many competitor species demonstrate directional changes and/or increased fluctuation of the indicator element due to catch/bycatch or stock enhancement in focal fisheries	Some competitor species demonstrate directional changes and/or increased fluctuation of the indicator element	CA does not detect any significant impacts on competitors by catch/bycatch or stock enhancement in the focal fisheries	Ecosystem model-based assessments indicate that indirect impacts of catch/bycatch on competitors through the food web in the focal fisheries are at sustainable levels

2.3.2 Whole Ecosystem

According to the Sea Fishery Production Statistics in 2018, the catch compositions of the top 10 fish species in the catches in the Pacific Ocean (middle and southern regions), are shown in Figure 2.3.2a. The trophic level (TL) compositions of the catches in the assessment waters are shown in Figure 2.3.2b, indicate that the TL 3.5-4.0 and TL 2.0-2.5 mostly occupy the middle Pacific while catches increase as the TL increases in the southern Pacific. There was a significant decreasing trend in the total catch with changes in the MTLc over time in the southern Pacific (Figure 2.3.2c). Here, the total catch decreased

due to a decrease in fish species catches comprising TL 3.5 or more, including blue sharks. The MTLc decreased with increases in the number of Japanese sardines *Sardinops melanostictus* comprising TL 2.0-2.5, which suggests an orthogenetic change in the ecosystem. Consequently, a score of 3 points is given.

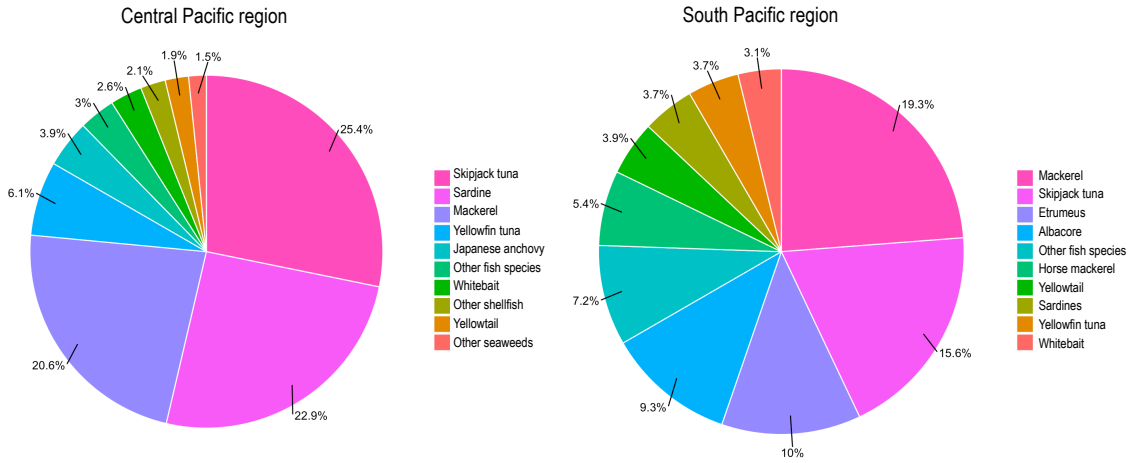


Figure 2.3.2a Composition of catches in target sea area based on the 2018 Sea Fishery Production Statistics

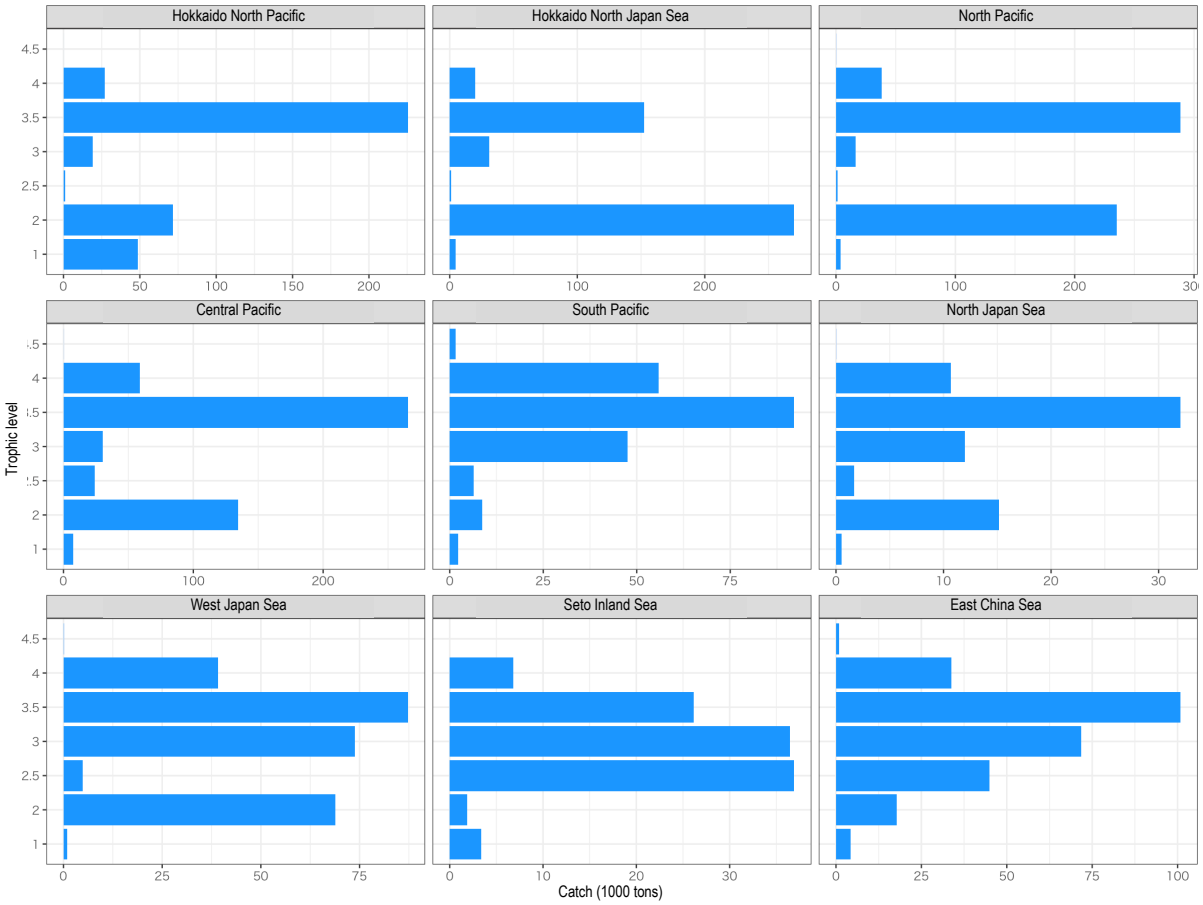


Figure 2.3.2b Trophic level composition of catches by water around Japan, as determined based on the 2018 Sea Fishery Production Statistics

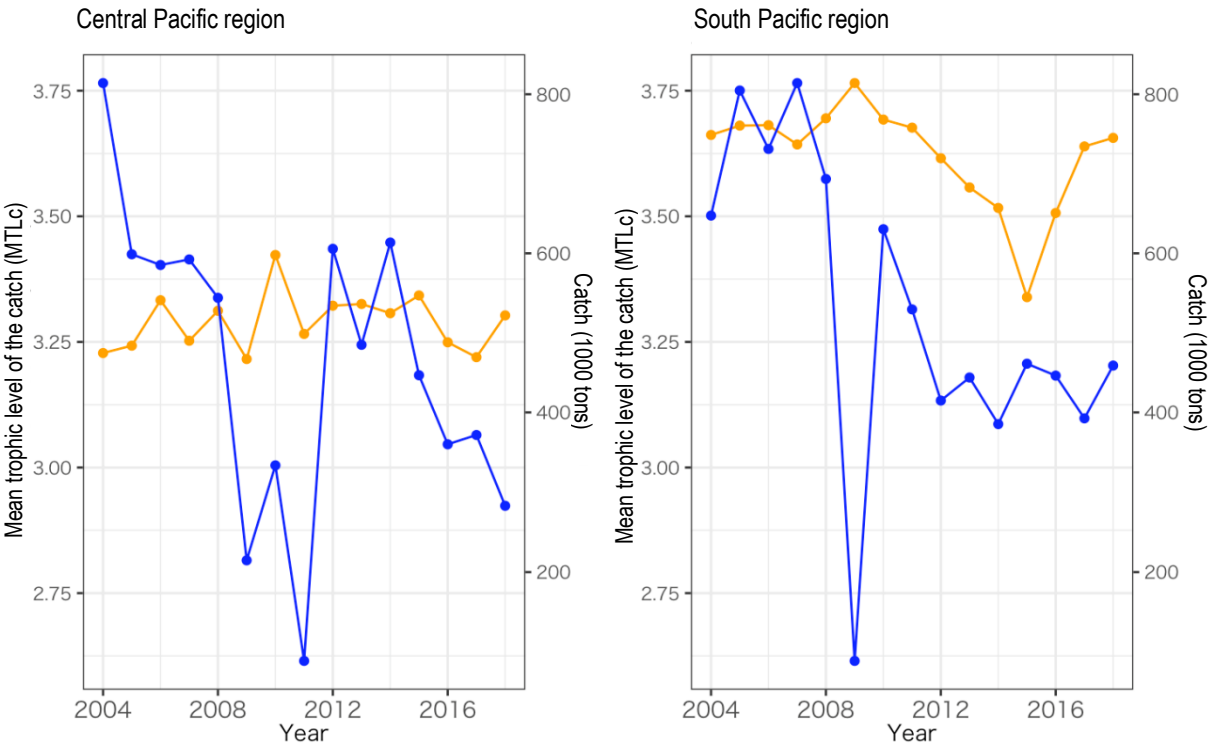


Figure 2.3.2c Mean trophic level of catch (orange) and total catch (blue) in the target waters, as determined based on the Sea Fishery Production Statistics (provisional values).

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	There is a serious concern about the impacts of the focal fishery, prolonged directional changes or intensification of fluctuations are occurring	Although the impact of the focal fishery is not serious, there is a concern about some directional ecological changes or intensification of fluctuations	SICA shows the impact of the focal fishery is not severe and that no irreversible changes have occurred in the ecosystem	Assessments based on time-series data demonstrate that irreversible changes have not occurred in the ecosystem

2.3.3 Effects of Stock Enhancement on Ecosystem

This item is not assessed because no juvenile release is conducted for this species.

2.3.4 Benthic Ocean Environment

Since tuna longlines do not use bottom fishing gear, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	Impacts of fisheries on the benthic environment are severe, and changes over a wide range of fishing grounds are a concern	Impacts of fisheries on the benthic environment are not considered serious, but changes in some fishing grounds are a concern	SICA shows the impacts of the fisheries on the benthic environment and changes in the environment are not serious	Seafloor environmental impact assessments based on spatio-temporal information indicate there are no serious impacts due to the focal fisheries

2.3.5 Water Quality of the Environment

According to the provisions of the Western & Central Pacific Fisheries Commission (WCPFC) and the Secretariat of the Pacific Regional Environment Programme (SPREP), fishing vessels operating in target sea areas must be boarded by scientific observers to record pollution or waste dumping violations. However, no information is available regarding pollution and waste dumping by ship registry and the impact of Japanese fishing vessels on the water quality environment is unknown.

Pollution and/or waste dumping into the ocean by Japanese fishing vessels are regulated by the Act for the Prevention of Marine Pollution and Maritime Disasters and the Enforcement Ordinance of the Law Concerning the Prevention of Marine Pollution, etc. and Maritime Disasters. These laws require vessels with a gross tonnage of 100 tons or more to install oil-water separators and are limited to waters where discharge is allowed, discharge concentrations, and discharge methods. No violations were found regarding pollution and/or waste dumping to the ocean by Japanese fishing vessels in WCPFC waters, and thus the vessels can be considered to be equipped with necessary equipment and operate in compliance with domestic regulations. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
For many substances, there are concerns that the effluent from fisheries or stock enhancement facilities will negatively impact water quality, or the status of efforts cannot be evaluated due to lack of information		There are concerns that some substances from fisheries or stock enhancement facilities will negatively impact water quality	Effluent from fisheries and hatcheries are properly managed, and the impacts on water quality are judged to be minimal	Effluent from fisheries and hatcheries are properly controlled, and not only is the impact on water quality judged to be insignificant, but efforts are also being made to reduce the impacts on water quality by fisheries or hatcheries

2.3.6 Atmospheric Environment

According to Hasegawa (2010), the emissions per unit catch (t-CO_2/t) for each type of fishery in Japan are as follows.

Small-scale bottom trawlers, or the like	1.407
Offshore bottom trawlers by one vessel	0.924
Boat seine	2.130
Small- and medium-scale purse net	0.553
Medium- and large-scale purse seine by one vessel	0.648
Medium- and large-scale round haul net fishing by one vessel for tuna and skipjack tuna	1.632
Saury stick-held dip net	0.714
Coastal tuna longline	4.835
Offshore tuna longline	3.872
Pelagic tuna longline	8.744
Coastal skipjack pole-and-line	1.448
Offshore skipjack pole-and-line	1.541
Pelagic skipjack pole-and-line	1.686
Coastal squid jigging	7.144
Offshore squid jigging	2.373
Pelagic squid jigging	1.510

Tuna longliners emit much CO_2 ranging from 3.9 to 8.7, which is the highest rate of emissions in Japan's fishing industry. There is a concern about an adverse impact of engine exhaust from the target fishery on the atmospheric environment for some substances. Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	For many substances, there are concerns that the emissions from fisheries will have negative impacts on the atmospheric environment	For some substances, there are concerns that the emissions from fisheries will have negative impacts on the atmospheric environment	Emissions from fisheries are properly managed and the impacts on the atmospheric environment are judged to be minimal	Efforts have been made to reduce the impacts of fisheries on the atmospheric environment, and it has been confirmed that there are no negative impacts

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3. Fishery Management

Overview

Details of Management Measures (section 3.1)

The offshore tuna longline fishing (offshore skipjack and tuna fishery) is a designated fishery licensed by the Minister of Agriculture, Forestry and Fisheries. According to the conservation and management measures of the Western & Central Pacific Fisheries Commission (WCPFC), a longline fishery management plan for sharks has been created for tuna longline fishing vessels based in Kesennuma, with the upper limit for annual landing amount set at 7,000 tons. Input and output are controlled, and the fishing pressure can be effectively controlled (5 points for item 3.1.1). The tonnage of fishing vessels in the target offshore tuna longline fisheries is limited to less than 120 tons. The use of shark lines is prohibited in the longline fishery management plan, and it is also stipulated that fins shall not be cut from bodies until landing (4 points for item 3.1.2). There are restrictions on fishing gear as conservation and management measures for sea turtles and seabirds, and the catching of silky sharks and oceanic whitetip sharks is prohibited. A scientific observer research and analysis project is being implemented (5 points for item 3.1.4.1). A related fishermen's group participates in the Kesennuma City Marine Plastics Countermeasures Promotion Council, and an action plan are being implemented. A fuel reduction plan has been implemented, and further efforts are being made to successfully reduce the fuel by 10% from the current state (5 points for item 3.1.4.2).

Enforcement System (section 3.2)

Blue sharks are widely distributed in waters from the Black Stream-Oyashio Current transition zone to the Emperor Seamounts Chain and move from east to west seasonally. Offshore tuna longline fishing is under the jurisdiction of Skipjack and Tuna Fisheries Office, International Affairs Division, the Fisheries Agency. Offshore tuna longline fishermen belong to fishing method specific unions, and a management system covering the habitat has been established and is functioning (5 points for item 3.2.1.1). If an inspector from a contracted country of the WCPFC, etc. requests boarding and agrees to inspections on the open sea, and a fishery supervisor instructs the inspector to board a fishing vessel, the inspection cannot be refused. Additionally, an observer must be on board when deemed necessary by the Minister of Agriculture, Forestry and Fisheries. The monitoring system and penalties mentioned above are working effectively (5 points for item 3.2.1.2 and 5 points for item 3.2.1.3). The introduction of these management measures in Japan based on recent discussions on stock assessment and conservation measures at the WCPFC, etc. were evaluated as equivalent to adaptive management (4 points for item 3.2.2).

Co-management Initiatives (section 3.3)

Offshore longline fishing in the North Pacific included in offshore skipjack and tuna fishing, which is designated fishery licensed by the Minister. The offshore longline fishermen operating in the North Pacific can be all identified and belong to fishing method specific fishery cooperatives (5 points for item

3.3.1.1 and 5 points for 3.3.1.2). In recent years, fishermen have been controlling to catch blue sharks in birth season, as well as implementing the longline fishery management plan (5 points for item 3.3.1.3). The Kesennuma Fisheries Cooperative took the lead in implementing the Kesennuma Regional Fisheries Restoration Project (a restoration plan for the offshore tuna longline fishery and two plans for utilizing existing ships) and established a cooperative corporation. Furthermore, the National Nearshore Skipjack and Tuna Fisheries Association takes the lead in demonstrating a planned and efficient introduction of stock management and fishing vessels for improving working environment (5 points for item 3.3.1.4). Active participation in voluntary and public managements is performed properly (4 points for item 3.3.2.1 and 5 points for item 3.3.2.2). Efforts to tackle issues, such as sustainable use of sharks and higher added value, are being considered to revitalize the industry of Kesennuma City. Processing and distribution companies played a central role in founding a Council for Promoting the Concept of Shark Town Kesennuma. Special commissioners from various fields participate in the Stock Management Subcommittee of the Fisheries Policy Council (5 points for item 3.3.2.3). The North Pacific Tuna International Scientific Subcommittee (ISC) conducted stock assessments based on fishery information, etc., and the WCPFC, attended by stakeholders, considered conservation and management measures. Based on these conservation and management measures, the Japanese government formulated and implemented a longline fishery management plan for sharks (4 points for item 3.3.2.4).

Outline

① Identification of target fisheries

North Pacific blue shark stock is caught mainly by offshore tuna longline fishing. The offshore skipjack and tuna fisheries, which is a designated fishery licensed by the Minister, is a fishery targeting skipjack and tunas, marlins or sharks by pelagic longlines or pole-and-lines (Cabinet Office 1963). Offshore tuna longline fisheries is a part of it. The so-called Kesennuma fleet that catches the North Pacific blue shark stock include the offshore tuna longline fishing vessels, which are assessment targets, and pelagic tuna longline fishing vessels, which are not assessment targets.

② Identification of target prefectures

Most blue sharks are caught by offshore tuna longline fishing in Miyagi Prefecture (Kesennuma). The offshore tuna longline fishery in Miyagi Prefecture (Kesennuma) is designated as an assessment target.

③ Summarization and description of information on target fisheries

The following information is summarized for the target fishery in the target prefecture:

1) Permit and the contents of various management measures

2) Enforcement systems, such as monitoring, penalties, adaptive management efforts, etc.

3) Identification and organization of related parties, participation in decision-making, and co-management initiatives

4) Ecosystem conservation activities by related parties

3.1 Details of Management Measures

3.1.1 Input Control and Output Control

The offshore tuna longline fishery (offshore skipjack and tuna fishery) is a designated fishery that is licensed by the Minister of Agriculture, Forestry and Fisheries. Fishermen submit applications for fishing operations in accordance with a public notice that indicates the area of operation and the number of vessels and receive permits before fishing operations begin. This means that input control is established. The latest stock assessment conducted by the ISC in 2017 and accepted by the WCPFC shows That the stock level is medium to high, and the trend is flat. The amount of stock in 2015 is above the MSY level and the fishing mortality coefficient from 2012 to 2014 is below the MSY level. Future forecast shows that the median future stock is unlikely to fall below MSY levels in scenarios with a different fishing mortality coefficient (Kai and Fujinami 2020). In Japan, the Kesennuma-based tuna longline fleet alone operates seasonally mainly for sharks. A longline fishery management plan for sharks has been prepared and implemented since January 2016 based on the conservation and management measures (WCPFC 2014) of the WCPFC, which has jurisdiction over the operating waters. In this plan, the upper annual limit landing amount is set at 7,000 tons (Fisheries Agency 2016, Kai and Fujinami 2020). All of this indicates that output control is introduced. Both of input and output controls are implemented and the fishing pressure is effectively controlled. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Neither input control nor output control are included in management, and catch pressure is significantly above target		Input control or output control are implemented in management		Input control or output control are implemented appropriately in management, and fishing pressure is effectively controlled

3.1.2 Technical Control

Fishing vessels in offshore tuna longline fisheries are limited to less than 120 tons in tonnage. Regarding longline fishing targeting tunas and marlins, it was agreed at the WCPFC that either wire leaders (wire branch ropes and beams) or shark lines (branch ropes connected to floating balls or ropes) (WCPFC 2014, Ministry of Agriculture, Forestry and Fisheries 2015) should not be used. The above-mentioned longline fishery management plan prohibits the use of shark lines. It is also agreed that the fins shall not be cut from the bodies until landing (Fisheries Agency 2016, Kai and Fujinami 2020). All of this indicates that technical controls have been introduced. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No technical control measures are implemented		Some technical control measures are implemented		Technical controls are sufficiently implemented

3.1.3 Improving Efficiency of Stock Enhancement

This item is not assessed because no juvenile release is conducted for this species.

1 Point	2 Points	3 Points	4 Points	5 Points
No measures are being taken to enhance the effects of stocking		Some measures are being taken to enhance the effects of stocking		Sufficient measures are being taken to enhance the effects of stocking

3.1.4 Ecosystem Conservation

3.1.4.1 Regulations on Fishing Gear to Control Impacts on Ecosystems and Environments

Fishing gear is a pelagic longline and does not affect the seafloor environment. Japan imposes mandatory restrictions on fishing gear in order to implement the fishing treaties and other international commitments that Japan has concluded. More specifically, the Minister of Agriculture, Forestry and Fisheries separately stipulates and communicates allowed fishing gear and prohibits operations that violate the rules. For example, restrictions on fishing gear have been announced as conservation and management measures for sea turtles and seabirds (Ministry of Agriculture, Forestry and Fisheries 2015, it applies mutatis mutandis to offshore skipjack and tuna fishery), which are also applicable to offshore skipjack and tuna fishery. The capture of silky sharks and oceanic whitetip sharks in the Western and Central Pacific Ocean Convention Area is prohibited (Ministry of Agriculture, Forestry and Fisheries 2018). Mainly to respond to recommendations and decisions that were made by regional fishery management organizations for tuna, such as the WCPFC, the Fisheries Agency formulates and evaluates a scientific observer program, establishes a committee, trains and secures the observers, and has them board fishing vessels in collaboration with fishmen's organizations. The Fisheries Agency also manages and analyzes fishery information to demonstrate how tuna longline fishing vessels use bycatch avoidance fishing gear, and is conducting a project to analyze the results of surveys conducted by scientific observers under these collaborations. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No regulations are being implemented and impacts on environments and ecosystems can be seen	Regulations are partially implemented, but are not sufficient		Considerable regulations are being implemented	The fishery to be evaluated is not considered to have any direct impacts on the ecosystem, or sufficient and effective regulations are being implemented

3.1.4.2 Ecosystem Conservation and Restoration Activities

The Kesennuma City Marine Plastics Countermeasures Promotion Council is attended by officers of the Kesennuma Fisheries Cooperative, Kesennuma Pelagic Fisheries Cooperative, etc. as members. An action plan for offshore bottom trawling by one vessel and pelagic fishery stipulates appropriate management of garbage, including on board and taking back. The plan also stipulates the promotion of technological developments to reduce both the volume and weight of garbage, the promotion and

introduction of equipment and systems, etc., proper use and management of fishing gear to minimize loss during operations outflow of floats, etc. and encouraging inspections before and after operations (Kesennuma City Marine Plastics Countermeasures Promotion Council 2019). In the Kesennuma Regional Fisheries Restoration Project (a restoration plan for the offshore tuna longline fishery and two plans for utilizing existing ships) led by the Kesennuma Fisheries Cooperative, efforts were made to reduce the weight of cargo, slow down the speed of round-trip voyages, and reduce fuel consumption by reducing the voyage periods (Kesennuma Fisheries Cooperative 2013, 2015). An Offshore Skipjack and Tuna Regional Project (Kesennuma district) led by the National Nearshore Skipjack and Tuna Fisheries Association is working to reduce fuel consumption by 10% through the adoption of a buttock flow-type with a knuckle valve, introduction of a high-efficiency SG propeller and improved bearing equipment, changing lights to LEDs, installation of all-electric kitchens, and energy-saving operations (National Nearshore Skipjack and Tuna Fisheries Association 2018). Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No ecosystem conservation or restoration activities are being conducted		Some ecosystem conservation or restoration activities are being conducted		The target ecosystem is not considered to be affected by fishery activities, or ecosystem conservation and restoration activities are being actively conducted

3.2 Enforcement System

3.2.1 Management Enforcement

3.2.1.1 Jurisdiction

Blue sharks are widely distributed in waters from the Black Stream-Oyashio Current transition zone to the Emperor Seamounts Chain and move seasonally from east to west (Kai et al. 2017). The stock is assessed by the ISC and approved by the WCPFC. The Inter-American Tropical Tuna Commission (IATTC), a regional fishery management organization, also handles this stock. The Skipjack and Tuna Fisheries Office, International Affairs Division, the Fisheries Agency plays a central role in coordinating with these regional fisheries management organizations. Kesennuma's offshore tuna longline fishermen belong to the Kesennuma Fisheries Cooperative, an fishing method specific association, and a wholesaler of the Kesennuma City Fish Market, and to the Kesennuma Pelagic Fisheries Cooperative, an fishing method specific association. The national version of both organizations is the National Federation of Fisheries Cooperatives. Furthermore, Kesennuma Regional Skipjack and Tuna Fishery Association and Miyagi Prefecture Skipjack and Tuna Fisheries Association are organized. The national version of the latter organization is the National Nearshore Skipjack and Tuna Fisheries Association. All fishermen belong to fishermen’s organizations. The detailed distribution of 0-year-old fish to elderly fish is said to be unclear, but a management system that covers the habitats is established and functioning. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Habitats of target species are not covered		There is a system covering the habitats of target species, but with insufficient functions		A management system covering the habitat is established and functioning

3.2.1.2 Surveillance System

To properly manage stocks and maintain the fishery order, the Fisheries Agency established the Fisheries Enforcement Headquarters in 2018 to strengthen the fishery control system (Fisheries Agency 2018). Specific measures for cracking down on violating operations include preventing unsanctioned operations in collaboration with international organizations. The Fisheries Agency's Shoyo Maru, Toko Maru, and Hakuryu Maru are dispatched mainly to surveil international fisheries. Installing a vessel monitoring system and keeping it always active was required only for tuna fishing vessels operating on the high seas, but also became required for all minister-licensed fishing vessels at the time of the previous simultaneous renewal in 2017 (Fisheries Agency 2017a). If a legitimately authorized inspector of a contracting country of the WCPFC, etc. requests boarding and acceptance of inspections on the high seas, and the fishery supervisor instructs the inspector to be on board, the requested vessel must allow the inspector to be on board according to instructions and cannot refuse inspection (Fisheries Agency 2017b). The inspection includes the vessel, fishing gear, equipment, facilities, catches (and their products), permits, other relevant documents, etc. If the Minister of Agriculture, Forestry and Fisheries finds it necessary to carry out inspections by the WCPFC, the fishing vessel must have observers on board (Ministry of Agriculture, Forestry and Fisheries 2018). This surveillance system is functioning. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No monitoring activity	Limited monitoring activity around major fishing ports		There is a consider monitoring system, but it is not perfect	An adequate monitoring system is functioning effectively

3.2.1.3 Penalties and Sanctions

In cases of violations of Japan’s Fisheries Act and related laws, or ministerial ordinances, the violator is subject to license or permit revocations, imprisonment, fines or all three. The penal provisions are considered effective. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No penalties or sanctions		Penalties and sanctions exist but with insufficient function		Effective penalties and sanctions are in place

3.2.2 Adaptive Management

Domestic management measures have been established and operated based on stock assessments and decisions on management measures by the ISC, WCPFC, and IATTC. The results of management will be reflected in the next stock assessment, and management measures will be revised if necessary.

Adaptive management is thought to encourage the improvement of stock assessment and fishery management methods. Recently, regional fishery management organizations and related organizations assessed stocks and discussed management measures, and the Japanese government introduced management measures based on them. This effort is evaluated to be equivalent to adaptive management. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
There is no system to implement changes in management based on surveillance of the fishery		Adaptive management is partially implemented		Adaptive management is well implemented

3.3 Co-management Initiatives

3.3.1 Collective Action

3.3.1.1 Identification of Resource Users

Offshore skipjack and tunas fishing are designated fisheries licensed by the Minister, operate with permits issued, and include offshore tuna longline fisheries operating in the North Pacific. All offshore tuna longline fishers engaged in it can be identified. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Near 0%	5-35%	35-70%	70-95%	Near 100%

3.3.1.2 Ratio of Fishermen Belonging to Fishermen's Organizations

Kesennuma's offshore tuna longline fishermen belong to the Kesennuma Fisheries Cooperative, an fishing method specific association and a wholesaler of the Kesennuma City Fish Market, and to the Kesennuma Pelagic Fisheries Cooperative, an fishing method specific association. The national version of both organizations is the National Federation of Fisheries Cooperatives. Furthermore, Kesennuma Regional Skipjack and Tuna Fishery Association and Miyagi Prefecture Skipjack and Tuna Fisheries Association are organized. The national version of the latter organization is the National Nearshore Skipjack and Tuna Fisheries Association. All fishermen belong to fishermen's organizations. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Near 0%	5-35%	35-70%	70-95%	Near 100%

3.3.1.3 Influence of Fishing Organizations on Management

Offshore tuna longline fisheries are required to comply with public measures, such as the conservation and management measures of regional fishery management organizations, and to focus on suspension of fishing as voluntary measures (Fisheries Agency 2020a). The National Nearshore Skipjack and Tuna Fisheries Association has implemented a stock management plan for bigeye, yellowfin, bluefin tuna and swordfish, in offshore tuna longline fisheries, sets upper limits on catches

and issues suspensions (Fisheries Agency 2020b). Regarding blue sharks, a longline fishery management plan for sharks has been implemented in the restoration plan for offshore tuna longline fisheries led by fishermen's group. In the demonstration plan for the planned and efficient introduction of stock management and fishing vessels to improve working conditions (which is continuously implemented), fishermen's organizations are working to control catches during the blue shark birthing period, as well as to implement the longline fishery management plan (National Nearshore Skipjack and Tuna Fisheries Association 2018). Fishermen's organizations were evaluated to have a strong influence on management. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No fishing organizations exist or no management activity		Fishing organizations have some impact on management activities		Fishing organizations have a strong influence on management activities

3.3.1.4 Activities of Fishing Organizations Related to Management and Economics

In comprehensive measures to reform the fishing structure, the Kesennuma Regional Fisheries Restoration Project led by the Kesennuma Fisheries Cooperative was implemented. The Restoration Project includes a restoration plan for offshore tuna longline fisheries and two plans for utilizing existing vessels for 2012-2015 and 2016-2019 (Kesennuma Fisheries Cooperative 2013, 2015). In the Restoration Project, collective operations were carried out and a cooperative corporation was established (Norinchukin Bank 2019). Led by the National Nearshore Skipjack and Tuna Fisheries Association, an Offshore Skipjack and Tuna Regional Project was planned in the Kesennuma district to demonstrate a planned and efficient introduction of stock management and fishing vessels for improving working environment (National Nearshore Skipjack and Tuna Fisheries Association 2018). The Kesennuma Fisheries Cooperative, a wholesaler of the Kesennuma City Fish Market, ships fish and shellfish fresh, processes them at a plant in the hinterland and supplies them nationwide (Kesennuma City Fish Market 2020). A “Group Promoting Kesennuma Fish for School Lunches” was established for the purpose of promoting local production for local consumption through food education activities, while also contributing to the restoration of Kesennuma's fish food culture and the regions key fishery industry. The Group Promoting Kesennuma Fish for School Lunch’s membership includes fishermen and fishermen's groups, and is active alongside prefectural and municipal governments and distribution processors (Group Promoting Kesennuma Fish for School Lunch 2017). As shown above, fishermen's organizations are fully active. Consequently, a score of 5 points is given. Furthermore, support is also provided from research fields to improve management, etc. from the perspective of market value or through profit analysis (Ishimura and Bailey 2013, Tsuru 2018).

1 Point	2 Points	3 Points	4 Points	5 Points
No activity by fishing organizations		Some activity by fishing organizations		Full operation of fishing organizations

3.3.2 Involvement of Fishery Related Parties

3.3.2.1 Involvement of Fishery Related Parties in Voluntary Management

Representatives from skipjack and tuna fishermen's organizations, such as the National Nearshore Skipjack and Tuna Fisheries Association, attend the WCPFC's annual meetings, ISC, IATTC and other meetings. Although not all related fishermen's groups attend these meetings, several groups belonging to the National Nearshore Skipjack and Tuna Fisheries Association do. The annual meeting of a regional fishery management organization lasts for about 5 days. The National Nearshore Skipjack and Tuna Fisheries Association, Kesennuma Pelagic Fisheries Cooperative, Kesennuma Regional Skipjack and Tuna Fishery Association, etc. also have meetings concerning fishery management. So, fishery related parties participate in voluntary management meetings at least 12 days a year. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
0	1-5 days	6-11 days	12-24 days	Over 24 days per year

3.3.2.2 Involvement of Fishery Related Parties in Public Management

The Stock Management Subcommittee of the Fisheries Policy Council deliberate on national stock management guidelines including the offshore tuna longline fishery. Representative directors of companies belonging to related fishermen's organizations in Kesennuma and directors from the National Federation of Fisheries Cooperatives, which is a superordinate organization of offshore fishery cooperatives to which offshore tuna longline fishermen belong have attended The Stock Management Subcommittee (Fisheries Agency 2020c). The active involvement in public management was thus ascertained. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No substantial participation	.	Formal or limited participation	.	Proper participation

3.3.2.3 Widespread Stakeholder Involvement

No recreational fishing takes place. Efforts to tackle issues, such as sustainable uses for sharks as well as added value, are considered to revitalize Kesennuma's industry. Processing and distribution companies played a central role in founding a "Council for Promoting the Concept of Shark Town Kesennuma" (Council for Promoting the Concept of Shark Town Kesennuma 2016).

In order to consider a plan for the Offshore Skipjack and Tuna Regional Project (stock management and fishing vessels for improving working environments) led by the National Nearshore Skipjack and Tuna Fisheries Association, a Kesennuma District Working Group is formed. The Kesennuma District Working Group is attended by people involved in fishing, finance/management, research, and local governments, as well as people involved in distribution and processing (National Nearshore Skipjack and Tuna Fisheries Association 2018). In addition, efforts have been made, including by those involved

in academic fields, for longline fleet that target blue sharks to acquire international fishing certifications (Ishimura 2015). The offshore tuna longline fishery, which is the main method for catching blue sharks, is covered by the national stock management guidelines (Fisheries 2020a). The Stock Management Subcommittee of the Fisheries Policy Council, which deliberates on these guidelines, is attended by labor unions organized by seafarers working in the marine products and/or port maritime industries, consultants for the sustainable use of marine products, organizations that promote the spread and development of sound fishing, university researchers, etc. as special commissioners (Fisheries Agency 2020c). The materials of the Fisheries Policy Council are open to the public (Fisheries Agency 2020d). An appropriate participation of stakeholders was thus ascertained. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Near no involvement by stakeholders other than fisherman		Key stakeholders have partial or limited involvement		Nearly all key stakeholders are effectively involved or no stakeholders other than fishermen exist

3.3.2.4 Decision Making for Management

Stock assessments are conducted at the ISC based on fishery information, etc., and conservation and management measures are considered at the WCPFC, which is attended by stakeholders. Based on the conservation and management measures that were decided, domestic management measures are determined, and a longline fishery management plan for sharks is implemented. This longline fishery management plan covers 2016 - 2020. An annual report on the plan has been made to the WCPFC (Japan 2019), but there is still no about whether the plan was reviewed at the WCPFC in the final year. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No decision-making system, and no discussion regarding management measures	There is a decision-making system including specific stakeholders as members, but there is not enough consultation	There is a decision-making system including specific stakeholders as members where management measures are determined and goals are reviewed	There is a decision-making system including stakeholders as members, but there are areas where discussions are not sufficient	There is a decision-making system including stakeholders as members, and policies and targets have been sufficiently reviewed

3.3.2.5 Understanding the Cost of Stock Enhancement

This item is not assessed because no juvenile release is conducted for this species.

1 Point	2 Points	3 Points	4 Points	5 Points
Cost transparency is low and the results on the beneficiaries are not examined		The results on the beneficiaries are examined, and some are paying		Cost transparency is high and beneficiaries are paying fairly

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4. Regional Sustainability

Overview

Status of Fisheries Production (Section 4.1)

The Pacific blue sharks landed in Japan are mostly caught by the offshore tuna longline fisheries in Miyagi Prefecture. The trend for fishery income is low (1 point for item 4.1.1.1). The trend of the earning rate and fishery-related assets, which was investigated using the national average data of company management entities, is a slightly low at 2 points for items 4.1.1.2 and 4.1.1.3. Regarding the stability of management, the stability of income was a slightly low at 2 points, and the stability of catch was moderate at 3 points. The overall financial situation of fishermen's organizations was higher at 4 points. Operational safety was rated as high as 5 points. Contributions to local employment were determined to be high (5 points for item 4.1.3.2). Regarding the fairness of working conditions, no problems were found within the fishing industry (3 points for item 4.1.3.3).

Processing and Distribution Status (section 4.2)

Although there are many small markets in the target prefecture, the Kesennuma market has a large volume of blue shark landings, and the number of buyers in each market varies depending on volume, and the principle of competition is generally working through auction or bidding transactions (5 points for item 4.2.1.1). The fairness of transactions is ensured (5 points for item 4.2.1.2). The tariff is basically 5% while it is set to 2.5% in the WTO agreement or with ASEAN (3 points for item 4.2.1.3). Hygiene management is thoroughly implemented in accordance with a wholesale market development project (5 points for item 4.2.2.1). Fish meat is used for processing, while shark fin is ranked as a high-end food item (4 points for item 4.2.2.2). There was no problem with fairness in working conditions (3 points for item 4.2.3.3). Although the safety of the fishery processing industry was as low as 1 point, no fatal accidents occurred. Consequently, the processing and distribution industry in this region can be evaluated to be highly sustainable.

Regional Status (section 4.3)

Advanced technologies are introduced, disseminated and instructed (5 points for item 4.3.1.2). There is a well-organized distribution system (5 points for item 4.3.1.3). Quality of life in this area was evaluated at 3 points (item 4.3.2.1). The income level of fishery workers is relatively high (4 points for item 4.3.2.2).

Outline

① Identification of target fisheries

Offshore tuna longline fishery in Miyagi Prefecture

② Identification of target prefectures

Miyagi Prefecture

③ Summarization and description of information on target fisheries

The following information and other points will be summarized later for fishery and related industries in the target prefecture:

1) Basic information on fishery types, restrictions, etc.
2) Volume and amounts of annual landings for the past 11 years
3) Fishery-related assets
4) Rate of return on capital
5) Annual income of fishery-related workers compared to the regional average
6) Ease of living in the area

4.1 Status of Fisheries Production

4.1.1 Fisheries Assets

4.1.1.1 Fishery Income Trends

To understand trends in fishery income, data on the amount income of blue shark calculated in 4.1.2.1 were used. Within the past nine years, the average of fishery income from Miyagi offshore tuna longline fishing for top three years were used. The ratio of this average to the amount of fishery income in the most recent reference year (2015) was calculated to be 0.45. Consequently, a score of 1 point is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Under 50%	50-70%	70-85%	85-95%	Over 95%

4.1.1.2 Rate of Return Trends

Since the fishery management survey report does not contain data by fishery type for each prefecture, data by fishery type were used to conduct the analysis. The target fisheries include pelagic nearshore and offshore tuna longline fisheries (vessel tonnage class 10 to 20 tons and 100 to 200 tons) conducted by company management entities, and the pelagic nearshore and offshore tuna longline fisheries (10 to 20 tons) conducted by individual management entities. The data from these two different types of management entity are used for analysis. The average (fishing profit) / (total capital invested) in pelagic and offshore tuna longline fisheries from 2014 to 2018 are -8% and -62%, respectively, for company management entities (1 point for each tonnage level) and 195% for individual management entities (5 points). The points are averaged to obtain a score of 2 points.

1 Point	2 Points	3 Points	4 Points	5 Points
Under 0.1	0.1-0.13	0.13-0.2	0.2-0.4	Over 0.4

4.1.1.3 Fishery Asset Trends

Since the fishery management survey report (2008-2017) (Ministry of Agriculture, Forestry and Fisheries 2009-2018) does not contain data by fishery for each prefecture, data by fishery type were used to conduct this analysis. The target fisheries include the pelagic and offshore tuna longline fisheries (vessel tonnage class 10 to 20 tons and 100 to 200 tons) conducted by company management entities and the pelagic and offshore tuna longline fisheries (10 to 20 tons) conducted by individual management entities. The data from the different types of management entity are used for this analysis. For pelagic and offshore tuna longline fisheries, the average over the three years with the highest total fixed capital invested in the fisheries in the past 10 years was used. The ratio of the latest 2017 value to this average is 55% (2 points) for the 10 to 20 tons class, and 78% (3 points) for the 100 to 200 tons class for the company management entities, and 19% (1 point) for individual management entities. The points are averaged to obtain a score of 2 points.

1 Point	2 Points	3 Points	4 Points	5 Points
Under 50%	50-70%	70-85%	85-95%	Over 95%

4.1.2 Management Stability

4.1.2.1 Income Stability

Since the amount income of catches for each type of fishery has not been publicized, the total amount income of catch of blue shark in all the nine markets in Miyagi Prefecture publicized in the Prefectural Fish Market Landing Summary issued by Miyagi Prefecture (Miyagi Prefecture 2020) were used. The stability of the amount income of blue shark caught in the Miyagi offshore tuna longline fisheries over the past nine years from 2006 to 2015 was evaluated using the data of that period, excluding 2006 because of missing data. The ratio of the average amount income of catches from fisheries over the nine years to its standard deviation was calculated to be about 0.61. Consequently, a score of 2 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Over 1	0.40-1	0.22-0.40	0.15-0.22	Under 0.15

4.1.2.2 Catch Stability

Similarly to 4.1.2.1, the stability of the volume of blue shark caught in the Miyagi offshore tuna longline fisheries over the past nine years from 2006 to 2015 was evaluated using the data of that period, excluding 2006 because of missing data with reference to the Prefectural Fish Market Landing Summary issued by Miyagi Prefecture (Miyagi Prefecture 2020). The ratio of the average catch volume from the fisheries over the nine years to its standard deviation was calculated to be about 0.34. Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Over 1	0.40-1	0.22-0.40	0.15-0.22	Under 0.15

4.1.2.3 Economic Status of Commercial Fishing Organizations

The management entities in the Miyagi offshore tuna longline fisheries mainly belong to the National Nearshore Skipjack and Tuna Fisheries Association and the Kesennuma Pelagic Fisheries Cooperative. The former had a normal loss but a positive net asset balance at end of period. It has reduction in net asset relative to total business costs by 2% (National Nearshore Skipjack and Tuna Fisheries Association 2019). On the other hand., the latter managed a normal profit (Kesennuma Pelagic Fisheries Cooperative 2018, 2019). The management and balance of current account of the former is determined to be stable (sustainable) and a score of 3 points is given. A score of 5 points is given to the latter. A total score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Current account is in the red or information is not available to make determination		Current account is nearly balanced		Ordinary profits are in the black

4.1.3 Working Status

4.1.3.1 Operational Safety

Of the number of fatalities due to occupational and marine accidents in the fishery industry in 2019, the number of fatalities determined to have been or likely caused by accidents in the target fisheries are 0 (Miyagi Labor Bureau, Ministry of Health, Labour and Welfare 2020, Japan Transport Safety Board 2020). So, the annual death toll per 1,000 people is zero. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
More than 1.0 fatalities in accidents per 1,000 people during the fishing season	0.75-1.0 people	0.5-0.75 people	0.25-0.5 people	Less than 0.25 fatal accidents per 1,000 fishermen per fishing season

4.1.3.2 Contribution to Local Employment

A fishery cooperative is legally obligated to have an address at the location of the fishery (Chapter 1, Article 5 of the Fisheries Cooperative Associations Act), and its members must also reside in the area (Chapter 2, Article 18 of the same act). A federation of fishery production associations must also have residence in the area (Chapter 4, Article 88 of the same act). The Ministry of Justice and other ministries and agencies (2017) stipulates that when foreign workers who utilize the technical intern training system are engaged in onboard fishing, the number of foreign workers must not exceed the number of crew members excluding them. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Near 0%	5-35%	35-70%	70-95%	95-100%

4.1.3.3 Fairness of Working Conditions

As of June 5, 2020, there were five cases sent to prosecutors in Miyagi Prefecture for violations of labor standards-related laws and regulations, all of which were in other industries (Self-Career Design Association 2020). Although there have been cases of non-payment of wages in other industries, fairness of working conditions in blue shark fisheries is considered to be relatively high. Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Reports of poor treatment or problems for some employees exist		Aside from skill-based pay differences and commission systems, treatment is not extremely different among employees and no problems have been reported		Treatment is fair

4.2 Processing and Distribution Status

4.2.1 Market Pricing

This subsection evaluates the state of price formation at each landing port (markets in the production area).

4.2.1.1 Buyers

There are 10 fish markets in Miyagi Prefecture. Of these, five have annual handling volumes of 10,000 tons or more, accounting for 50% of the total. Four markets have annual handling volumes of less than 1,000 tons, accounting for 40% of the total. Regarding numbers of buyers, there are six markets with 50 or more buyers registered, two with 20 to less than 50 registered, and one with 10 to less than 20 registered. There is only one small market with less than 10 buyers registered. The principle of competition is working in auction and bidding transactions, and fair prices are formed (the Ministry of Agriculture, Forestry and Fisheries 2020a). Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information is available		There are few buyers		There are many buyers

4.2.1.2 Market Information Availability

A wholesale market improvement plan prepared by Miyagi Prefecture includes ensuring fairness and competitiveness of transactions, in addition to facilities maintenance, safety and recruitment of personnel. Landing information, arrival information, auction/bidding start times, and sales floor information are posted in public and conveyed to buyer's offices by telephone or fax. Market information is thus fairly communicated to buyers (Miyagi Prefecture 2016). This allows the principle of competition to work in auction transactions and bidding transactions, resulting in formation of fair prices. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information available		Reliable pricing and quantity information is reported and available before the market opens		Accurate pricing and quantity information available real time

4.2.1.3 Trade Opportunities

The effective import tariff rate for blue sharks as of April 1, 2020, is basically 5%. The tariff rate is set to 2.5% for items covered by the WTO Agreement. The tariff rate is set to zero or 0.2% with countries with which Japan has an economic partnership agreement (Japan Customs 2020). Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No trade opportunities	.	Not fair competition due to some regulations in place	.	Virtually unrestricted entry into globally competitive markets

4.2.2 Creation of Added Value

This subsection assesses how the landed catches are value-added by the processing and distribution industries.

4.2.2.1 Sanitary Management

Miyagi Prefecture manages the hygiene status of the wholesale and small-scale markets in the prefecture in accordance with the "10th Miyagi Wholesale Market Development Project" (July 2016) and in light of the hygiene standards set by the prefectural and municipal governments (Miyagi Prefecture 2016). Miyagi Prefecture has established a certification system for voluntary management of Miyagi food sanitation to ensure thorough hygiene management (Miyagi Prefecture 2017). The evaluation score is 5 points. On June 13, 2018, the Food Sanitation Act, etc. was partially amended to require all food business operators to work on hygiene management in accordance with the Hazard Analysis and Critical Control Point (HACCP). In the future, the handling of the certification system for voluntary management may be changed.

1 Point	2 Points	3 Points	4 Points	5 Points
Inadequate hygiene and frequent problems	.	Japanese hygiene standards are met	.	Advanced hygiene management

4.2.2.2 Usage Form

Blue shark fins are used for the high-end cuisine as "Fuka-hire (dried shark fins)", meat is used for "Surimi" as grounded into paste products (raw materials for *hanpen*), cartilage is used as a material for *oden* (suji) and functional foods. Skin of Blue shark is used for leather products and for the materials of functional foods. Blue sharks with poor freshness are used as a raw material for fish meal (Miyata et al. 2012). In this way, blue sharks are used for high- and middle-end foods for consumption and fish meal, etc. However, their main use is in dried shark fins and paste products. Consequently, a score of 4 points, between 3 and 5 points, is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Fish meal / Animal Feed / Feed	.	Standard-grade seafood for human consumption (frozen, mass processed products)	.	High-grade seafood human consumption (live fish, fresh fish, high-end processed products)

4.2.3 Working State

4.2.3.1 Labor Safety

The number of fatalities due to accidents in the fishery food manufacturing industry in Miyagi Prefecture in 2018 was 67 (the Ministry of Health, Labour and Welfare 2019b). The number of fishery-related food manufacturing workers in Miyagi Prefecture was 9,138 according to the latest data available (2018) (the Ministry of Economy, Trade and Industry 2019). The annual number of fatalities per 1,000 people is 7.33. Consequently, a score of 1 point is given.

1 Point	2 Points	3 Points	4 Points	5 Points
More than 7 injuries or fatalities per 1,000 person-years	6-7	4-6	3-4	Less than 3 injuries or fatalitie per 1,000 person-years

4.2.3.2 Contribution to Local Employment

According to the 2018 Fisheries Census, the number of fishery processing companies in Miyagi Prefecture that process blue sharks was about 1.88 times the national average (the Ministry of Agriculture, Forestry and Fisheries 2020b). This number indicates that the number of fishery processing companies in the region is much higher than the average number of processing companies in all the prefectures. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Under 0.3	0.3-0.5	0.5-1	1-2	Over 2

4.2.3.3 Fairness of Working Conditions

As of June 5, 2020, there were five cases sent to prosecutors in Miyagi Prefecture for violations of labor standards-related laws and regulations, all of which were in other industries (Self-Career Design Association 2020). Although there have been cases of non-payment of wages in other industries, the fairness of working conditions in the blue shark fishery is considered relatively high. Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Reports of poor treatment or problems for some employees exist	.	Aside from skill-based pay differences and commission systems, treatment is not extremely different among employees and no problems have been reported	.	Treatment is fair

4.3 Regional Status

4.3.1 Fisheries Infrastructure

4.3.1.1 Maintenance of Ice-making, Freezing, and Refrigeration Facilities

In the municipalities in Miyagi Prefecture that catch blue sharks, there are 201 factories equipped with freezing and refrigerating warehouses. They have a refrigerating capacity of 503,434 tons (2,504 tons per factory with refrigerating capacity) and a daily freezing capacity of 10,409 tons. Each factory with freezing capacity can freeze 72.8 tons per day (the Ministry of Agriculture, Forestry and Fisheries 2020b). Imbalances in supply and demand between districts sometimes occur due to good or bad catches, but supply and demand are adjusted between them through commercial activities. The freezing and refrigerating capacity in the region is considered to meet the volume requirement for the landed volume. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
The amount of ice is very limited	Ice is available, but the supply is limited and often reused or used in a melted state	Ice is available in limited form and quantity and supplies only the most expensive catches	Ice is available in a variety of forms, and can supply coverage for all catches that need it	Ice can be used in various forms at fishing ports, and refrigeration facilities are also in place

4.3.1.2 Introduction and Spread of Advanced Technology

The Kesennuma District Fishery Reconstruction Project is working to shorten the number of voyaging days and improve the freshness of catches by switching from single-ship operations to group operations in the offshore tuna longline fisheries (Kesennuma District Fishery Reconstruction Project 2013, 2015). In addition, the Offshore Skipjack and Tuna Regional Project is working to build an intranet between ships and land and introduce an "automatic transmission system for fishing grounds and catch data" for the purpose of strengthening stock management and improving ship safety. The district project is also working on increasing the sizes of hulls (119 tons type -> 149 tons type) to improve working conditions (National Coastal Skipjack and Tuna Fisheries Association 2018). Active introduction and dissemination activities of advanced technology are being carried out. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No spread of new technology	.	New technologies are only being partially introduced and spread	.	New technologies are being spread

4.3.1.3 Logistics System

The time required from a fishing port in Miyagi Prefecture where blue sharks are mainly landed to points such as a local or central wholesale market, trading port, or airport was assessed using Google Maps. If an arterial road is used, the time required from multiple major fishing ports to the central wholesale market is around two and a half hours. The time required from most fishing ports to local wholesale markets is about one hour. The time required from these fishing ports to the airport or trading port is two hours at most. Traders can also choose their own trade option as a business strategy. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No access to major logistics hubs	.	There is either a trading port or an airport nearby, or a highway to reach it	.	Both the trading port and the airport are nearby, or the highway leading to them is nearby

4.3.2 Living Conditions

4.3.2.1 Livability in Local Regions

In reference to the comprehensive evaluation deviation scores indicating "ease of living ranking" (Toyo Keizai Inc. 2019), which is an index of ease of living in each region, the average of the related coastal cities in Miyagi Prefecture was 49.75. So, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Livability Ranking less than 47	Livability Ranking of 47 − 49	Livability Ranking of 49 − 51	Livability Ranking of 51 − 53	Livability Ranking over 53

4.3.2.2 Income Levels of Fishery Workers

Regarding the income levels of the offshore tuna longline fisheries (Miyagi Prefecture) that catches the North Pacific blue shark stock, only the data of the tuna longline fisheries are available, so aggregated values had to be used. The monthly salary of a worker engaged in the tuna longline fishery was 386,173 yen (4 points) in Miyagi Prefecture (the Ministry of Land, Infrastructure, Transport and Tourism 2019). According to the Basic Statistics Survey on Wage Structure, the average monthly salary of men engaged in the manufacturing industry in Miyagi Prefecture with a company size of 10 to 99 is 337,975 yen (the Ministry of Health, Labour and Welfare 2019a). According to Table 7 "Number of Salary Earners (Officers) and Salary Amount by Company Size and by Salary Class" of "Results of FY2018 Statistics Survey on Private Business Salary" conducted by the National Tax Agency, the average monthly salary of the officers of corporations nationwide with capital of less than 20 million yen is 504,167 yen. Based on this figure and the national average fishing ability index for tuna longline fishery officers, which is 1.51, the monthly salary of tuna longline fishery officers in Miyagi Prefecture was calculated to be 583,121 yen (4 points) (National Tax Agency 2019). This indicates that the tuna longline fishing industry is competitive, compared with SME officers and the manufacturing industry in the region. These scores are averaged and rounded off to obtain a score of 4 points.

1 Point	2 Points	3 Points	4 Points	5 Points
Income is less than 50% of regional average	Income is 50-90% of regional average	Income within ±10% of the regional average	Income exceeds regional average by 10-50%	Income exceeds regional average by more than 50%

4.3.3 Inheritance of Local Culture

4.3.3.1 Inheritance of Local Cultural Fishing Methods

The tuna longline fishing industry is said to have started at Fura Port (now in Tateyama City) by fishermen who moved from the Kii Peninsula to the southern tip of the Boso Peninsula during the Edo era (the middle of the 18th century). After the World War II, the MacArthur Line restricted fishing vessels from operating in high seas, but restrictions were gradually loosened then completely lifted in 1952. Since then, pelagic longline fishing vessels have expanded their ranges of operation to oceans all over the world's while steadily modernizing main engines, refrigerators, fishing and electronic equipment. In due course, Kesennuma Port was designated as a fishing port of specified type 3 in 1969. Since then, it has become a base for the skipjack and tuna fishing industry.

In the 1960s, emerging countries in Africa and Latin America began to claim their territorial waters and exclusive economic zones. In response to this trend, the Third United Nations Maritime Law Conference started in 1973. It took 10 years to form consensus among countries and finally the United Nations Convention on the Law of the Sea was adopted in 1982. As a result, 200 nautical miles have been set for each country. Catch restrictions, fees, bycatch problems, and protection of rare marine organisms have become issues. Drift nets on the high seas and commercial whaling have been banned. Since the treaty came into force, operations and catches have been restricted in all waters, and Japanese fishing

vessels have withdrawn from high seas and been reduced in number.

This trend has also greatly impacted longline fisheries. Currently, the Kesennuma offshore longline fleet has only 13 tuna longline fishing vessels operating in the high seas targeting blue sharks and swordfish (Kesennuma Fishing Communication Association, 2016). Offshore tuna longline fishing in the Kesennuma district is carried out on vessels in the 119- and 150-ton class. These vessels conduct voyages of around 30 days in the northwestern Pacific Ocean about 9 to 10 times a year. They mainly catch bigeye tuna, swordfish and blue sharks, store them in ice and land them at the Kesennuma Fish Market. Kesennuma offshore longline fisheries generally catch sharks from May to September, and swordfish and other sharks from October to April of the following year (Kesennuma Pelagic Fisheries Cooperative 2018, 2019).

The above history indicates that the fishing industry in this region has developed while inheriting the traditional fishing gear and methods. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Point
No local traditional fishing gear or methods	.	Local traditional fishing gear and methods have already disappeared, but efforts are being made to revive and preserve them	.	Local traditional fishing gear and methods are still being used

4.3.3.2 Inheritance of Local Cultural Processing and Distribution Techniques

Blue sharks account for about 70 - 80% of the sharks landed in Kesennuma, Miyagi Prefecture, and Kesennuma sharks represent an overwhelming share (about 90%) of the national shark market (Fishery Department of Kesennuma Regional Promotion Office 2020). Given this fact, the use of sharks in Kesennuma is noteworthy. In Kesennuma, shark meat is processed into paste products, such as *kamaboko* and *hanpen* (types of fishcake) or *satsuma-age* (deep-fried minced shark meat and vegetables). The fins are used in high-end cuisine, the skin is processed into bags and wallets as sharkskin, and cartilage is used as raw material for chondroitin sulfate. The remaining parts are processed into fish meal. Sharks are mostly completely utilized with virtually nothing going to waste (Kono et al. 1999a). In addition to paste products, there are increasing efforts to cook and otherwise prepare fresh shark meat as is (Secretariat of Council for Promoting the Concept of Shark Town Kesennuma 2016a).

It is relatively recently that “shark fins” that are traded at high prices have been published. The term is said to have first appeared in the <shark> section of <<Honso-koumoku (1596)>> written in the Ming Dynasty era (1368–1644). In western Japan, sharks were called *fuka*. When “Nagasaki bales” were exported to China in the modern age, only sea cucumbers and abalone were exported from Nagasaki, and shark fins were not (Kawashima 2012). It is said that the production of shark fins began in Kesennuma at around the end of the Edo era (Secretariat of Council for Promoting the Concept of Shark Town Kesennuma 2016b). Originally, shark fins were never used in home cooking or traditional foods. Today, Kesennuma is a main production area of shark fins, which are processed into shark fin products.

The main species used for this purpose is blue shark (Fujiwara 2005). Shark fin, which has been regarded as a high-end food item, is now a more familiar local gourmet specialty in dishes such as “shark fin ramen,” “shark fin bowl (Kesennuma shark fin bowl),” “shark fin sushi,” “steamed egg hotchpotch with shark fin,” and “pan-fried noodles with shark fin,” “rice bowl topped with grilled shark fin,” “fried rice with shark fin topped with a starchy sauce,” “shark fin soft cream” and so on (FROM TO JAPAN 2020).
In 1882, the nationally famous *chikuwa* was invented as a paste product. The spiny dogfish and blue shark, which no one had paid attention to until then, were caught by bottom gill nets, sent to the Tokyo area by mail and sold under the “Chikuwa Kamaboko” name. The Kesennuma Port played a major role in establishing “Chikuwa” as an independent industry. Businesses that started as incidental to the chikuwa manufacturing industry were shark oil, fish fertilizer, castella kamaboko (fish cake) using shark eggs, and dried shark fins (Kawashima 2012).
Chiba (1990) introduces a story about the situation in the early Showa period. “In the foothills of Funagata, Miyagi Prefecture, people cut shark meat into several fillets and soak them in *sanbaizu*, a mixture of vinegar, soy sauce, sake, etc. During the winter, when food is naturally preserved, they put shark fat on a sieve basket with a saucer under it, and put them in a sunny place for about a month. Fat gradually accumulates on the saucer. This fat is mainly used for tempura. They buy a big piece of shark to get oil. The shark contains tufts of eggs in the body that are about the size of chicken egg yolk. They crush these eggs, salt them, apply oil to the surface of a square iron pan, pour the egg liquid into the pan, and bake it. It's the best snack for children (castella cake-like omelet made of shark eggs).”
The blue shark is generally not well known because it is not available as a fresh fish. However, in conjunction with National School Lunch Week (January 24 to 30) conducted by the Ministry of Education, Culture, Sports, Science and Technology, efforts are made to provide students with an opportunity to learn about local food culture (Secretariat of Council for Promoting the Concept of Shark Town Kesennuma 2016c). For example, “shark nuggets” made from shark meat that is locally produced in Miyagi Prefecture and “shark fin soup” are offered on school lunch menus.
In Tokyo, star-spotted sharks, blue sharks, shortfin mako sharks, etc. have been used as raw material fish for floating *hanpen* (fish cake) since the Edo period. In Tokyo, sharks from Kesennuma, such as blue sharks, are used most at present. They are received in refrigerated blocks (Noda 2005). In the Kanto region, hanpen and *suji* are familiar as the standard contents of oden (suji kamaboko is made by connecting muscles, cartilage, etc. that were removed in the process of making hanpen with starch and boiling them). Products processed by mixing blue shark cartilage and fins with plum meat are distributed in bottles under the name of *ume-suisho*, a high-end delicacy eaten with sake.

Uses for shark other than food include high-quality wasabi graters made from “shark skin” (Kono et al. 1999b). The skin peeled from shark's body is processed into shark leather products. Sharks are thus considered to be an attractive fish species with no parts going to waste (Secretariat of Council for Promoting the Concept of Shark Town Kesennuma 2016a). As described above, traditional processing and cooking methods have been handed down for generations. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Point
No local traditional processing or distribution methods	.	Local traditional processing and distribution methods have already disappeared, but efforts are being made to revive and preserve them	.	Local traditional processing and distribution methods are still being used

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5. Health, Safety and Security

5.1 Nutritional Function

5.1.1 Nutritional Components

The following table shows the nutritional components of blue shark (the Ministry of Education, Culture, Sports, Science and Technology 2016)

Energy		Water	Protein	Calculated as the sum of amino acid residues	Lipid,	Fatty acids, expressed intriacy1-glycerol equivalents	Fatty acid			Cholesterol	Carbohydrates,	Carbohydrate, available; expressed in mono-saccharide equivalents	Dietary fiber, total,	Ash
							Saturated	Monounsaturated	Polyunsaturated					
kcal	kJ	g	g	g	g	g	g	g	g	mg	g	g	g	g
85	356	79.2	18.9	9.2	0.6	0.2	0.07	0.05	0.10	54	Tr	-	(0)	1.3

Mineral												
Sodium	Potassium	Calcium	Magnesium	Phosphoros	Iron	Zinc	Copper	Manganese	Iodine	Selenium	Chromium	Molybdenum
mg	mg	mg	mg	mg	mg	mg	mg	mg	μg	μg	μg	μg
210	290	5	19	150	0.4	0.5	0.06	-	-	-	-	-

Vitamin (fat-soluble)											
A						D	E				K
Niacin	Carotene		β-carotene	β-carotene equivalents	Retinol activity equivalents		Tocopherol				
	α	β					α	β	γ	δ	
μg	μg	μg	μg	μg	μg	μg	mg	mg	mg	mg	μg
9	-	-	-	(0)	9	0	0.9	0	0	0	(0)

Vitamins (water-soluble)									
B1	B2	Niacin	B6	B12	Folic acid	Pantothenic acid	Biotin	C	NaCl equivalent
mg	mg	mg	mg	mg	μg	mg	μg	mg	g
0.11	0.11	0.9	0.24	0.3	4	0.49	-	Tr	0.5

5.1.2 Functional Components

5.1.2.1 EPA and DHA

Blue shark oil contains highly unsaturated fatty acids EPA and DHA. The EPA content of the blue shark lipid is 6 mg/100 g, and the DHA content is 51 mg/100 g (the Ministry of Education, Culture, Sports, Science and Technology 2018). EPA has the effect of preventing blood clots and hypertension, and also acts as an anti-inflammatory. DHA has effect of promoting brain development, preventing dementia and vision loss, while preventing and treating arteriosclerosis and fighting various forms of cancer (Fisheries Agency 2014, Ministry of Education, Culture, Sports, Science and Technology 2015).

5.1.2.2 Protein

Protein is one of the most important nutrients for muscle, other tissues and enzymes. Blue shark contains comparatively high levels of protein among fish and shellfish (Japan Fisheries Association 1999).

5.1.2.3 Chondroitin Sulfate

Chondroitin sulfate is a type of acidic mucopolysaccharides that is abundant in cartilage. It has water retention, lubrication, and anti-inflammatory properties, and used in injectables for arthropathy, eye drops and ointments for skin diseases, cosmetics, etc. (Matahira 2012).

5.1.3 Seasonal and Expert Advice

5.1.3.1 Season

Since blue sharks distributed in the markets are those mainly bycaught by tuna longline fishery (Nomura 2016), seasonality is unknown.

5.1.3.2 Expert Advice

Blue sharks exude a stronger ammonia odor as their freshness degrades, so those with more subdued odors are better quality.

5.2 Inspection System

5.2.1 Important Points When Serving as Food

5.2.1.1 Generation of Odor Due to Decreased Freshness

The blue shark contains a large amount of urea and trimethylamine oxide in its meat, and these components are break down into ammonia and trimethylamine as freshness degrades and a fishy odor ensues. Fresh blue shark should be selected and cooked as soon as possible.

5.2.2 Sanitary Inspection in Distribution and Related Laws and Regulations

Article 11 of the Food Sanitation Law stipulates that the most probable number of Vibrio parahaemolyticus in fresh fish and shellfish for raw consumption should be 100/g or less.

5.2.3 Inspections for Specific Seafood Products

There are no tests specifically targeted at this species.

5.2.4 Treatments and Responses In the Case of a Positive Test

If the number of shellfish poisonings or most probable number of Vibrio parahaemolyticus cases in seafood products distributed in the markets exceeds the standard value, this constitutes a violation of Article 6 of the Food Sanitation Law (July 1, 1980, The Ministerial Ordinance Regarding the Ingredient Standard etc. of Milk and Dairy Products No. 29).

5.2.5 Important Points When Cooking at Home

5.2.5.1 Prevention of Odor Generation

Odor is generated due to degradation of freshness, so fresh specimens should be chosen and consumed as soon as possible.

5.2.5.2 Precautions for Ingestion by Pregnant Women

Blue sharks may accumulate more mercury (methylmercury) than other fish species. A recent research report has shown that low levels of mercury intake can affect fetuses. The Ministry of Health, Labour and Welfare has published precautions regarding the ingestion of fish and shellfish during pregnancy (the Ministry of Health, Labour and Welfare 2010). For the blue shark, up to 160 g per week (two slices of fillet) does not affect human fetuses. If a pregnant woman also consumes fish other than blue sharks it is likely that a large amount of mercury can accumulate over a week and she should try to reduce the consumption of blue shark to the recommended intake amount (the Ministry of Health, Labour and Welfare 2010).

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6. Assessment Point Table

Stock, locality	Blue Shark – North Pacific	Score
Fisheries	Long-line	4.1
year		

Resource Status

Major category	Sub-item	score of Sub-item	weight	weight	score of Major category	score of Principle
Biological Research and Monitoring of Target Species	Overview of Biological Information	4.0	1.0	1.0	4.4	4.4
	Monitoring Implementation System	4.8	1.0			
	Stock Assessment Methods and Objectivity of Assessment	4.5	1.0			
	Effects of Stock Enhancement*					
Target Species Abundance and Trend	Target Species Abundance and Trend	5.0	1.0	1.0	5.0	
Impacts of Fisheries on Target Species	Impacts of Current Fishery Pressures on Sustainable Production of Target Species	5.0	1.0	1.0	3.7	
	Stock Depletion Risk at Current Fishery Pressure	4.0	1.0			
	Influence of Stock Assessment on Fisheries Management	2.2	1.0			

Marine Environment and Ecosystems

Major category	Sub-item	score of Sub-item	weight	weight	score of Major category	score of Principle
Environment and Ecosystem Data, Research, and Monitoring on the Target Sea Area	Overview of Basic Information	5.0	1.0	1.0	3.7	3.5
	Implementation of Scientific Research	3.0	1.0			
	Monitoring through Fishery Activity	3.0	1.0			
Bycatch	Usable Bycatch Species	4.0	1.0	1.0	3.0	
	Unusable Bycatch Species	2.0	1.0			
	Rare (Endangered or Threatened) Species	3.0	1.0			
Ecosystems and Environments	Indirect Impacts through the Food Web	4.3	1.0	1.0	3.9	
	Whole Ecosystem	3.0	1.0			
	Effects of Stock Enhancement on Ecosystem*					
	Benthic Ocean Environment	5.0	1.0			
	Water Quality of the Environment	4.0	1.0			
	Atmospheric Environment	3.0	1.0			

Fisheries Management

Major category	Sub-item	score of Sub-item	weight	weight	score of Major category	score of Principle
Details of Management Measures	Input Control and Output Control	5.0	1.0	1.0	4.7	4.6
	Technical Control	4.0	1.0			
	Improving Efficiency of Stock Enhancement*					
	Ecosystem Conservation	5.0	1.0			
Enforcement System	Management Enforcement	5.0	1.0	1.0	4.5	
	Adaptive Management	4.0	1.0			
Co-Management Initiatives	Collective Action	5.0	1.0	1.0	4.8	
	Involvement of Fishery Related Parties	4.5	1.0			

Regional Sustainability

Major category	Sub-item	score of Sub-item	weight	weight	score of Major category	score of Principle
Status of Fisheries Production	Fisheries Assets	1.7	1.0	1.0	3.0	3.8
	Management Stability	3.0	1.0			
	Working Status	4.3	1.0			
Processing and Distribution Status	Market Pricing	4.3	1.0	1.0	3.8	
	Creating Added Value	4.5	1.0			
	Working Status	2.7	1.0			
Regional Status	Fisheries Infrastructure	5.0	1.0	1.0	4.5	
	Living Environment	3.5	1.0			
	Inheritance of Regional Culture	5.0	1.0			

* Regarding Stock Enhanced Species

Resource Status

Major category	Sub-item	Smaller item	Fisheries	score	weight	score	weight of smaller item	Score of sub-item
Biological Research and Monitoring of Target Species	Overview of Biological Information	Distributions and Migration				3	1.0	4.0
		Age, Growth, and Life-Span				4	1.0	
		Maturation and Spawning				5	1.0	
		Stock Enhancement*						
	Monitoring Implementation System	Scientific Research				4	1.0	4.8
		Survey of Catch Data				5	1.0	
		Survey of Fishing Operations				5	1.0	
		Biological Investigations on Landed Fish				5	1.0	
		Stock Enhancement Performance*						
		Identification of Naturally and Artificially Spawned Fishes*						
	Stock Assessment Methods and Objectivity of Assessment	Stock Assessment Methods				5	1.0	4.5
		Objectivity of Stock Assessment				4	1.0	
	Effects of Stock Enhancement*	Effects on Fisheries Production*						
		Effects of Stock Enhancement*						
		Impacts on Natural Stocks*						
Target Species Abundance and Trend	Target Species Abundance and Trend	Target Species Abundance and Trend				5	1.0	5.0
Impacts of Fisheries on Target Species	Impacts of Current Fishery Pressures on Sustainable Production of Target Species	Impacts of Current Fishery Pressures on Sustainable Production of Target Species				5	1.0	5.0
	Stock Depletion Risk at Current Fishery Pressure	Stock Depletion Risk at Current Fishery Pressure				4	1.0	4.0
	Influence of Stock Assessment on Fisheries Management	Presence of Fisheries Management Measures				1	1.0	2.2
		Presence of Precautionary Measures				1	1.0	
		Considering Impacts of Climate Change				1	1.0	
		Formulation of Fisheries Management Measures				5	1.0	
		Considerations of Recreational, Foreign Commercial, and IUU Fishing for Fisheries Management Procedure				3	1.0	

* Regarding Stock Enhanced Species

Marine Environment and Ecosystems

Major category	Sub-item	Smaller item	Fisheries	Score	weight	score	weight of smaller item	Score of sub-item
Environment and Ecosystem Data, Research, and Monitoring on the Target Sea Area	Overview of Basic Information	Overview of Basic Information				5	1.0	5.0
	Implementation of Scientific Research	Implementation of Scientific Research				3	1.0	3.0
	Monitoring through Fishery Activity	Monitoring through Fishery Activity				3	1.0	3.0
Bycatch	Usable Bycatch Species	Usable Bycatch Species				4	1.0	4.0
	Unusable Bycatch Species	Unusable Bycatch Species				2	1.0	2.0
	Rare (Endangered or Threatened) Species	Rare (Endangered or Threatened) Species				3	1.0	3.0
Ecosystems and Environments	Indirect Impacts through the Food Web	Predators				5	1.0	4.3
		Prey				4	1.0	
		Competitors				4	1.0	
	Whole Ecosystem	Whole Ecosystem				3	1.0	3.0
	Effects of Stock Enhancement on Ecosystem*	Securing the Quantity of Bloodstock for Genetically Healthy Seedlings*						
		Avoiding Gene Disruption*						
		Preventing Spread of Disease to Wild Stocks*						
	Benthic Ocean Environment	Benthic Ocean Environment				5	1.0	5.0
	Water Quality of the Environment	Water Quality of the Environment				4	1.0	4.0
	Atmospheric Environment	Atmospheric Environment				3	1.0	3.0

* Regarding Stock Enhanced Species

Fisheries Management

Major category	Sub-item	Smaller item	Fisheries Score weight	score	weight of smaller item	Score of sub-item
Details of Management Measures	Input Control and Output Control	Input Control and Output Control		5	1.0	5.0
	Technical Control	Technical Control		4	1.0	4.0
	Improving Efficiency of Stock Enhancement*	Improving Efficiency of Stock Enhancement*				
	Ecosystem Conservation	Regulations on Fishing Gear to Control Impacts on Ecosystems and Environments		5	1.0	5.0
		Ecosystem Conservation and Restoration Activities		5	1.0	
Enforcement System	Management Enforcement	Jurisdiction		5	1.0	5.0
		Surveillance System		5	1.0	
		Penalties and Sanctions		5	1.0	
	Adaptive Management	Adaptive Management		4	1.0	4.0
Co-Management Initiatives	Collective Action	Identifying Resource Users		5	1.0	5.0
		Ratio of Fishermen Belonging to Fishing Organizations		5	1.0	
		Influence of Fishing Organizations on Management		5	1.0	
		Activities of Fishing Organizations Related to Management and Economics		5	1.0	
	Involvement of Fishery Related Parties	Involvement of Fishery Related Parties in Voluntary Management		4	1.0	4.5
		Involvement of Fishery Related Parties in Public Management		5	1.0	
		Widespread Stakeholder Involvement		5	1.0	
		Decision Making for Management		4	1.0	
		Understanding the Cost of Stock Enhancement*				

* Regarding Stock Enhanced Species

Regional Sustainability

Major category	Sub-item	Smaller item	Fisheries Score weight	score	weight of smaller item	Score of sub-item
Status of Fisheries Production	Fisheries Assets	Fishery Income Trends		1	1.0	1.7
		Rate of Return Trends		2	1.0	
		Fishery Asset Trends		2	1.0	
	Management Stability	Income Stability		2	1.0	3.0
		Catch Stability		3	1.0	
		Economic Status of Commercial Fishing Organizations		4	1.0	
	Working Status	Operational Safety		5	1.0	4.3
		Contributions to Local Employment		5	1.0	
		Fairness of Working Conditions		3	1.0	
Processing and Distribution Status	Market Pricing	Buyers		5	1.0	4.3
		Market Information Availability		5	1.0	
		Trade Opportunities		3	1.0	
	Creating Added Value	Sanitary Management		5	1.0	4.5
		Use Form		4	1.0	
	Working Status	Labor safety		1	1.0	2.7
		Contributions to Local Employment		4	1.0	
		Fairness of Working Conditions		3	1.0	
Regional Status	Fisheries Infrastructure	Maintenance of Ice-making, Freezing, and Refrigeration Facilities		5	1.0	5.0
		Introduction of Advanced Technology and Dissemination Guidance Activities		5	1.0	
		Logistics System		5	1.0	
	Living Environment	Livability in Local Regions		3	1.0	3.5
		Income Levels of Fishery Workers		4	1.0	
	Inheritance of Regional Culture	Inheritance of Local Cultural Fishing Methods		5	1.0	5.0
		Inheritance of Local Cultural Processing and Distribution Techniques		5	1.0	