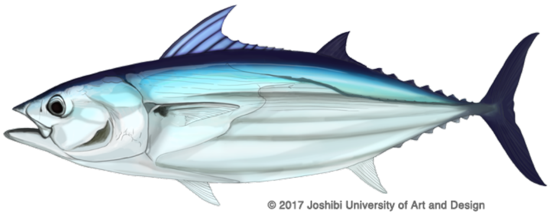

SH"U"N PROJECT ASSESSMENT REPORT

Skipjack Tuna - Western and Central Pacific

Ver 1.0.0e

Japan Fisheries Research and Education Agency

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Introduction

Species Characteristics

[Classification and form]

Skipjack tuna belong to the order *Perciformes,* suborder *Scombridei,* family *Scombridae,* and genus*Katsuwonus.* Its scientific name is *Katsuwonus pelamis.* The body is spindle-shaped and its cross-section is round. They have teeth on both upper and lower jaws. The two dorsal fins are slightly separated, and scales locate at the backs of the eyes, corselet, and lateral lines. The dorsal side is bluish purple in color and silvery white on the belly, and there are four to six vertical black stripes on the flanks.

[Distribution]

The distribution of skipjack tuna is wider from south to north in the western Pacific and narrower in the east, in line with the species' preferred temperature range.

[Ecology]

This species spawns widely in the area where surface temperatures are above 24°C and specially year-round in tropical seas. The approximate fork length of this species is reported up to 44 cm at one year old, and 62 cm at two. It is reported that their body length reaches 100 cm in adulthood. Total life-span is estimated to be six years or more. This species preys mostly on fish, crustaceans and cephalopods. Their natural predators include tuna, marlin, Spanish mackerel, sharks, and seabirds.

[Fisheries]

According to the breakdown of catches by fishing method in 2017, amount of catch by purse seine was 1,280 thousand tons, or 79 % of the total; by pole-and-line 120 thousand tons, or 8% of the total, and by "Other" commercial methods 220 thousand tons, or 13 % of the total.

By country, the USA, Korea, Taiwan, and Japan, accounted for 50 to 60% of total purse seine catches in recent years. Other major contributors were Papua New Guinea, Indonesia, and Philippines. In regard to pole ana line, although Japan had occupied about 60% of catches until 2005, catches by this method gradually decreased and Indonesia took the lead from 2006. In recent years, catches by Japan amount to around 40 to 50% of the total.

[Application]

In addition to their use in canned and dried foods, skipjack tuna is eaten fresh as sashimi or lightly roasted (tataki).

Stock Status

Skipjack tuna are one of the most important fishery resources. Its population size are estimated by catch, fishing effort, body length composition, and mark recapture method data by Multifan-CL model every three years. The data necessary for these analyses are surveyed and updated annually by the Japan Fisheries Research and Education Agency and relevant prefectures as a government-commissioned project. The spawning stock biomass of skipjack tuna has not been overfished and fishing has not exceeded overfishing level since 2010. The Western and Central Pacific Fisheries Commission (WCPFC) has implemented conservation and management measures based on the results of stock assessments carried out by the Pacific Community (SPC).

Marine Environment and Ecosystems

Regarding data on ecosystem impacts and feasibility of monitoring, ecosystem and bycatch issues, ecosystem model analyses, and bycatch data from longline fishery in the western and central Pacific Ocean are available. Research on larvae and juveniles of tropical tuna and skipjack tuna, zooplankton, and marine environments are conducted on an irregular basis. Owing to the scientific observer program, which was established in 2008, collection of information about fish catches in purse seine has been partially enabled.

Regarding the impact of fishing for target fish on other species, skipjack, one of usable bycatch species, there is a negligible impact on its stock status. Unusable bycatch species included rainbow runners (*Elagatis bipinnulata*), silky sharks, ocean triggerfish (*Canthidermis Maculata*), mackerel scads (*Decapterus macarellus*), mahi mahi (*Coryphaena hippurus*), and others. Assessments of the Productivity and Susceptibility Analyses (PSA) in the eastern Pacific revealed that impact risks were minor, except for silky sharks which were judged to be at moderate risk. Among the endangered species designated by the Ministry of the Environment, the risks were evaluated as moderate among loggerhead turtles (*Caretta caretta*), green turtles (*Chelonia mydas*), and hawksbill turtles (*Eretmochelys imbricata*).

Subsequently, the indirect impact of skipjack tuna fishing on the food web and the impact of fisheries on the environment will be discussed. Among predators of skipjack tuna are swordfish, Indo-Pacific blue marlin (*Makaira mazara*), Striped marlin (*Kajikia audax*), mako sharks (*Isurus oxyrinchus*), blue sharks (*Prionace glauca*), silky sharks, Oceanic whitetip sharks (*Carcharhinus longimanus*), and larger bigeye and yellowfin tuna. According to the mixed trophic impact of Ecopath (an ecosystem model for the western and central Pacific surface), while negative impacts to marlin and sharks are insignificant, moderate impacts to yellowfin and skipjack tuna themselves have been detected. Carnivorous skipjack tuna, which have limited selectivity, are regarded as more opportunistic in their feeding habits. The analysis with the above ecosystem model shows that the negative impact on bait organisms, fish, crustaceans and cephalopods, is insignificant. Analyses of predatory fish with roughly the same trophic level by the above ecosystem model showed negative impacts on yellowfin tuna. Since the mean trophic level of catch (MTLc) has been increasing since around 1980 with existing stock numbers and diversity declining, there are concerns over partial changes in the characteristics of the ecosystem.

This project found no reports of pollution or waste dumping violations caused by Japanese fishing vessels within the WCPFC convention area. Emissions (t-CO_2/t) required for catch per unit effort were relatively low with medium- and large-scale purse seiners for *Thunnus* including skipjack among fishing vessels in Japan, so their effect on the atmospheric environment is regarded to be insignificant.

Fisheries Management

The stock assessments implemented by SPC are not in agreement in WCPFC. Medium- and large-scale purse seine and pelagic and offshore skipjack tuna fishing by pole-and-line requires official permits from the minister of Japan's Ministry of Agriculture, Forestry and Fisheries , and coastal pole and line fishing of skipjack tuna requires the approval of the Wide Sea-area Fisheries Adjustment Commission. Output controls are not implemented. Since the stock assessment results are not agreed, it is not possible to conclude whether the input controls were successful with regard to fishing pressures. As for the technical control, while the installation of fish aggregating devices (FADs) is regulated, prohibition period was shortened. Catching silky and oceanic white tip sharks using pelagic and longline methods for skipjack and other tuna are prohibited. Medium- and large-scale purse seine operations near whale shark are also prohibited. There were no particular problems regarding abandoned fishing gear for pole-and-line fishing. Tuna Fisheries Office of International Affairs Division o of Japan's Fisheries Agency is cooperating with the WCPFC and the SPC. Medium- and large-scale purse seine that fish skipjack tunas are managed and supervised by the Tuna Fisheries Office of the International Affairs Division and the Fisheries and Resources Management Division of Fisheries Agency, and pole-and-line fishing is managed and supervised by the Tuna Fisheries Office of the International Affairs Division. Coastal pole-and-line fishing of skipjack tuna is subject to the approval by the Wide Sea-area Fisheries Adjustment Commission due to relation to the management of bluefin tuna. The management system is established and functioning. In medium- and large-scale purse seine and pelagic and coastal longline fishing, any vessel must have appropriate observers on board , when ordered by the Minister of Agriculture, Forestry and Fisheries. In Japan, procedures for prior confirmation of imported fish (which require certificates and related documents ensuring that they were caught by fishing vessels on the Positive List), have been compiled at the Fisheries Agency. Projects for strengthening tuna stock management skills under the international agreement at the WCPFC are being conducted as well. To revise domestic ministerial ordinances, reviewing resource management policies, according to management objectives, results of the stock assessments, and other management measures by the administration authority are evaluated to be measures equivalent to adaptable management. Under resource management policies, fishermen implement suspension of fishing on a voluntary basis. The Japan Far Seas Purse Seine Fishing Association, etc. are actively planning for the realization of effective control measures. Fishermen's' organizations are leading the reform plan and verification project. Coastal Fishery Cooperatives are promoting sales by establishing a skipjack tuna brand. Stakeholders participate in the Resource Management Subcommittee of the Fisheries Policy Council and NGOs participate in the WCPFC annual meetings and the Scientific Committee.

Regional Sustainability

Most skipjack tuna in the western and central Pacific Ocean are caught by medium- and large-scale pelagic tuna purse seines using one vessel (Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, and Nagasaki), medium- and large-scale offshore tuna purse seine using one vessel (Shizuoka), pole-and-line pelagic skipjack tuna fishing (Miyagi, Shizuoka, Mie), pole-and-line offshore skipjack tuna fishing (Miyazaki), and pole-and-line coastal skipjack tuna fishing (Kochi). Fishing income has trended at the medium level. Profitability is low and assets related to fishery are at a medium level. Management stability is medium in terms of both income and stability of catches. Financial reports are not published by most of fishermen's organizations. Operational safety is high, and contributions to regional employment are high. As for labor conditions, there was no significant problems in fisheries. Most skipjack tuna is landed on the base market and the number of buyers is proportional to the quantity of the catches in each market, and the principle of competitive bidding at auction is mostly working. Hygiene management is thoroughly managed along with the wholesale market development project. The product goes to the medium-to-luxury consumer market. There were no labor issues at the processing or distribution stages. Sustainability in the processing and distribution industry can be evaluated as high. The introduction and propagation of advanced technologies are accomplished through a well-prepared logistical system. Income levels of people working in the fishery industry are relatively high. Both pole-and-line and purse seine fishery are based on traditional methods, and while traditional processing and distribution technology are maintained, new usages are also being developed.

Health, Safety, and Security

Skipjack tuna contains various functional nutrients, such as niacin (the coenzyme of redox enzymes in the body), vitamin B1 (a contributor to cell metabolism), vitamin D (which promotes absorption of calcium and phosphates and is a principal component of bones), serene (which has antioxidative properties), selenoneine (reputed to provide various benefits, including detoxication of methylmercury), taurine (which has functions including prevention of arteriosclerosis and heart disease). Skipjack tuna fat is rich in both EPA, which prevents thrombus, etc. and DHA, which promotes brain development and prevents dementia, etc. Additionally, this species has high protein and the red muscle is rich in iron. The best time for harvesting is from spring to autumn. Spring skipjack tuna are called "*hatsu-gatsuo*" ("first skipjack"), which are good for eating and low in fat. Autumn skipjacks are called "*modori-gatsuo*" ("returning skipjack"), which are rich in fat and delicious. Care should be taken to avoid histamine poisoning and anisakis parasites when eating them raw. Histamine poisoning is caused by increases in histamine that are produced when bacteria break down histidine an amino acid which is contained in abundance in skipjack muscles. It is important that the fish be maintained at low temperatures while handling and processing and these low temperatures maintained even after thawing. Since anisakis parasites, live in the internal organs and invade the muscles after the death, they can be avoided if the fish is eaten while fresh or just after thawing and by never eating raw internal organs.

1. Stock Status

Overview

Biological Research and Monitoring of the Target Species (section 1.1)

Skipjack tuna are important as a commercial species. Research about both stock and ecosystems have been actively conducted. So far, academic papers and reports have discussed on their distribution and migration, age, growth, and lifespan, as well as maturity and spawning of this species, and available as basic information for stock assessment. The catch and fishing effort data collection, scientific research in a regular basis, and monitoring of catch statuses are conducted on a regular basis annually. Stock assessment by Multifan-CL using these catch, fishing effort, body length constitution data and mark and recapture data has been executed every three years.

Stock Abundance and Trends (section 1.2)

The spawning biomass of the stock, which shows increasing tendency since 2010, was evaluated as high stock level, but its trend continues to be evaluated.

Impact of Fisheries on the Target Species (section 1.3)

The assessment showed that catches did not exceed overfishing level and the target stock was not overfished. The WCPCF is implementing conservation and management measures for skipjack tuna based on the results of stock assessments carried out by the Pacific Community (SPC).

Outline

(1) Identification of target species' fishing and localities

Skipjack tuna, a target species in this assessment report, inhabits the western and central Pacific Ocean areas.

(2) Collection statistics for the target species

The Pacific Community (SPC) collects statistical data on catches in various countries.

(3) Collection of stock assessment data for target species

Since the fishing year 1972, the SPC has been collecting data on catches, effort, body length frequency, and mark recapture.

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

Collect publications and reports on monitoring research conducted for target species.

(5) Collection of information on physiological and ecological research conducted on 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 regarding target fish species, including life history and ecology, is indispensable for fisheries management and research (Tanaka 1998). Items 1.1.1.1-3 cover physiological and ecological information that should be analyzed first to determine whether enough data are available to prepare a sufficient stock assessment for the target species to be discussed in section 1.2 and subsequent sections. The information to be evaluated includes (1) Distribution and migration, (2) age, growth, and lifespan, and (3) maturation and spawning. A simple average of these scores is used as the overall score.

1.1.1.1 Distribution and Migration

The range of skipjack tuna distribution in the Pacific Ocean is wider from south to north in the western area and narrower in the east, according to the species' preferred ocean temperatures. As they grow, the species tends to inhabit exclusively tropical areas, while smaller specimens are distributed widely from south to north. Therefore, while skipjacks of all sizes, from larvae to adult fish over 60 cm exist in tropical waters, migrating feeding groups of 1-year-old fish are seasonally distributed through peripheral temperate waters areas. From recent mark recapture research, three migration routes going up north towards Japan's adjacent waters have been discovered (Kiyofuji, 2014). 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

Skipjack tuna are around 2.6 mm immediately after hatching and growth rate increases markedly after that. The body length exceeds 10 cm after 1.5 months and reaches 30 cm in 6 months. After that, the approximate fork length of this species is 44 cm at 1 year-old and 62 cm at 2 years old (Tanabe et al. 2003, Kayama et al., 2003). It is said that a few large specimens exceeding 80 cm are caught by longline, with the largest reaching 100 cm. These big fish are estimated to be 6 years old or over. Consequently, a score of 3 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 Maturation and Spawning

Body length at first maturation is 40.0 cm for females, and 35.5 cm for males, showing that males reach sexual maturity earlier (Ashida, 2010). Spawning areas are formed where surface water temperature is 24°C or higher and no specific spawning area is observed. Spawning is assumed to occur year-round in tropical areas. Since some larvae have been found around Okinawa, Izu Islands, and roughly latitude 35°N in northern Japanese waters, it is suggested that small scale spawning also occurs (Ueyanagi, et al., 1973). Consequently, a score of 3 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

1.1.2 Monitoring Systems

Fisheries research that collects biological data on marine resources can provide a great deal of valuable information about target fish species and implementation of fisheries management. Items 1.1.2.1-4 evaluate whether the information required for the stock assessment is in order. The items to be evaluated include: (1) scientific research, (2) surveys on catch data, (3) surveys on fishing operations, and (4) biological investigations of landed fish. A simple average of these scores is used as the overall score. Long- or short-term specifications here are reached by the age of five years, or three generations (IUCN 2014) required for determination of trends.

1.1.2.1 Scientific Research

Distribution and ecology of larvae and juveniles and mark-release research are implemented by research vessels (Kiyofuji, 2014, Kiyofuji et. al., 2019). Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No surveys	Available past survey data in habitat range of target species	Irregular surveys are conducted in habitat range of target species	Regular surveys are conducted in habitat range of target species, with data available on changes over years in some stock items	Regular surveys are conducted in habitat range of target species, with data available on changes over years in many stock items

1.1.2.2 Survey of Catch Data

According to the statistics of skipjack catches by fishing method in 2017, 1,280 thousand tons or 79% were caught by purse seine, 120 thousand tons or 8% were caught by pole-and-line, 220 thousand tons or 13% were caught by "Other” methods. Fifty to 60% of catches by purse seine were by pelagic fishery countries such as USA, Korea, Taiwan, and Japan. Apart from them, Papua New Guinea, Indonesia, and The Philippines also accounted for a large portion of the total. In 2017, Papua New

Guinea, Korea, the USA and Japan were responsible for an especially large quantity, at 189 thousand tons, 183 thousand tons, 130 thousand tons, and 128 thousand tons, respectively (WCPFC 2018a). As for pole-and-line fishing, Japan constituted about 60% of catches until 2005 (when catches started declining), and Indonesia claiming the largest share since 2006, with Japan constituting about 40 to 50% (Figure 1.1.2.2). Consequently, a score of 4 points is given.

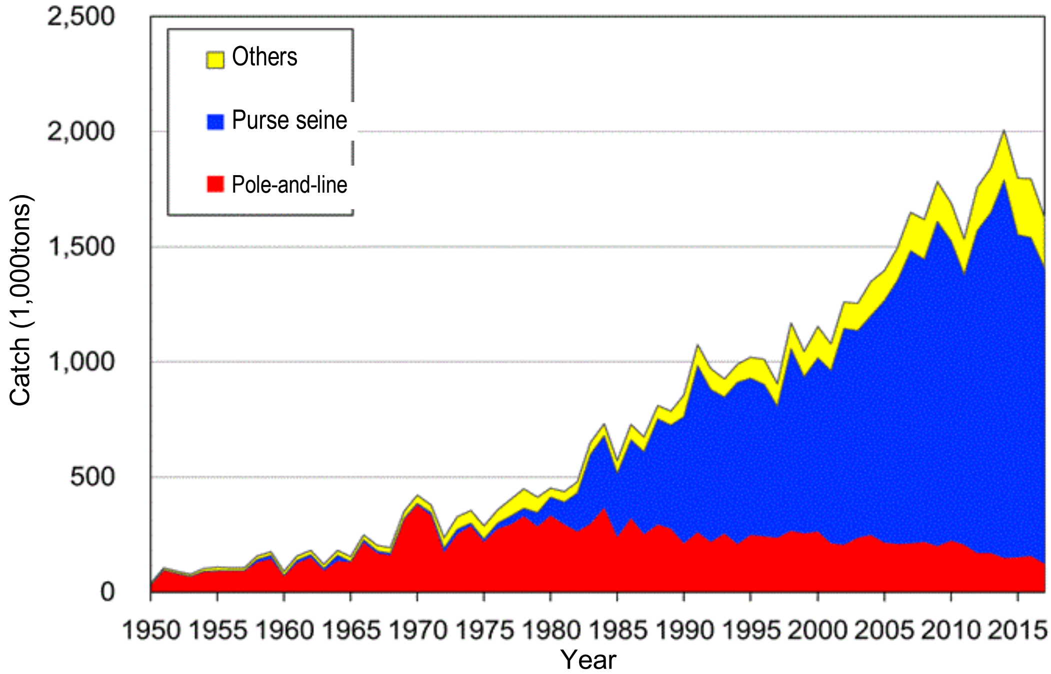

Figure 1.1.2.2: Annual change of catch of skipjack tuna in the western and central Pacific Ocean by fishing method (aggregated from WCPFC 2018a)

1 Point	2 Point	3 Point	4 Point	5 Point
Catch is unknown	Some of the catch is known to be short-term	Some of the catch is known to be long-term but the total catch is unknown	Total catch is known to be short-term	Total catch is known to be long-term

1.1.2.3 Survey of Fishing Operations

Fishing operations in Japan are surveyed and updated every year by the Japan Fisheries Research and Education Agency and the relevant prefectures as a government-commissioned project (Kiyofuji, 2019). Information about other countries is available at the Pacific Community (SPC) and the Western and Central Pacific Fisheries Commission (WCPFC) (Williams and Reid 2018). Consequently, a score of 3 points is given.

1 Point	2 Point	3 Point	4 Point	5 Point
No information 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 Survey of Landed Catches

Biological surveys are conducted every year by the Japan Fisheries Research and Education

Agency and the relevant prefectures as a government-commissioned project (Kiyofuji 2019). The information about other countries is available at the Pacific Community (SPC) and the Western and Central Pacific Fisheries Commission (WCPFC) (Williams and Reid 2018). Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information 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

1.1.3 Stock Assessment Methods and Objectivity of Assessment

Stock assessment is the analysis of collected catch statistics and various types of survey data to understand how marine resources have been changed due to the impacts of fishing, and to predict future trends. This assessment is vital for resource (fishery) management (Matsumiya 1996). The stock assessment methods and objectivity of the results are evaluated in items 1.1.3.1-2.

1.1.3.1 Stock Assessment Methods

The latest stock assessment of skipjack tuna in the western and central Pacific Ocean was implemented by a group of experts from the SPC in 2016 (McKechine et al. 2016). The integrated model of Multifan-CL was used in the analysis. The evaluation period was from 1972 to 2015 and catch, effort, body length composition, and mark recapture data were input. These data were integrated based on 5 sea areas and 23 fishery definitions. Consequently, a score of 5 points is given based on the assessment method ① below.

Assessment method	1 Point	2 Point	3 Point	4 Point	5 Point
①			.	Assessment based on simple annual change of biomass	Assessment based on detailed analysis of annual changes
②	.	.	Assessment based on simple analysis of CPUE annual changes	Assessment based on detailed analysis of CPUE annual changes	.
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	Assessment based on accurate scientific survey data
⑤	No stock assessment	.	.	.	.

1.1.3.2 Objectivity of the Stock Assessment

Stock assessments are conducted by a scientific expert group of the Pacific Community (SPC), which is independent of the management agency, i.e., the Western and Central Pacific Fisheries Commission (WCPFC). The resulting assessment shall be reviewed and approved by the WCPFC Scientific Committee. Consequently, a score of 3 points is given.

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

1.2 Target Species Abundance and Trends

1.2.1 Target Species Abundance and Trends

Stock levels and trends obtained from stock assessments are important in that they are directly linked to society, economy and to biological aspects of target species. For this reason, these matters are evaluated as a single item. Japan has established basic fishery management rules for calculating the allowable biological catch (ABC) and has carried out stock assessments that combine resource abundance levels and trends (Fisheries Agency and FRA 2016). This assessment reviews the stock status from the combination of abundance levels and trends of the target species according to specified rules. Here, the stock abundance level is classified in three stages "high, medium, and low" based on changes in stock (catch) over the past 20 years. The trend is similarly classified in three stages "increasing, flat, and decreasing" based on changes in trends and stock (abundance index and catch) in the past 5 years.

Overall Spawning stock biomass in the western and central Pacific Ocean shows an increase since 2010 (Figure 1.2.1). At present (2015), spawning stock biomass is 58% of the value estimated on the assumption that there was no fishing. Although the stock level was evaluated as high, the trend was evaluated as pending (Kiyofuji 2019). Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Low and decreasing Low and flat Indeterminable or unknown	Low and increasing Medium and decreasing	Medium and flat	High and decreasing Medium and increasing	High and increasing High and flat

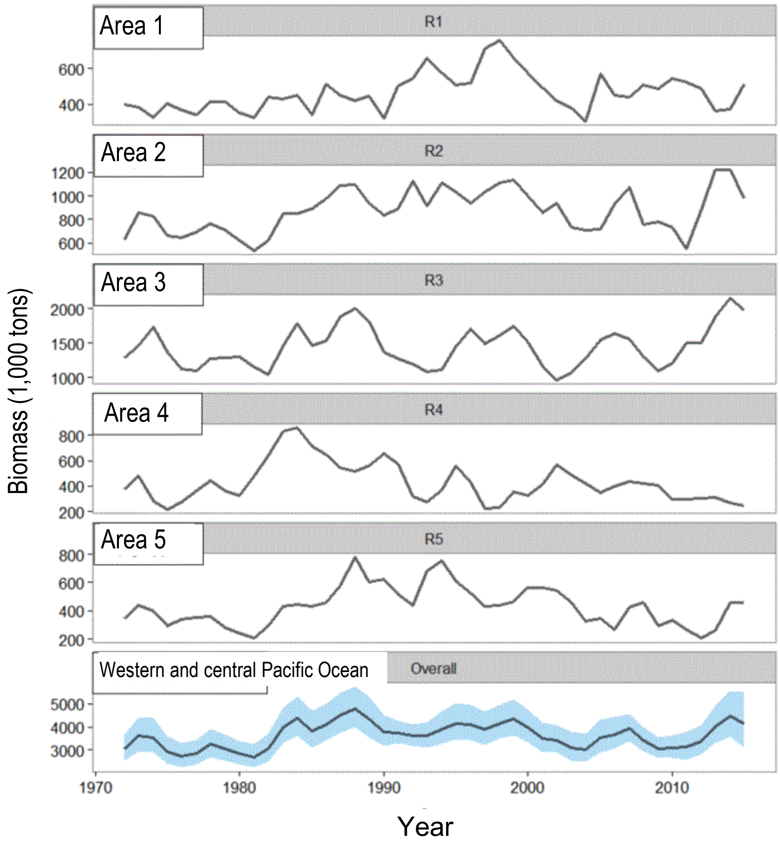

Figure 1.2.1: Annual change in the estimated stock in each sea area and western and central Pacific Ocean (WCPO) (McKechnie et al. 2016)

1.3 Impacts of Fisheries on Target Species

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

Fishing pressure during 2011-2014 was under FMSY (Frecent/FMSY: 0.45), and spawning stock biomass (SSB) was over the MSY level (SBrecent/SBMSY: 2.31). Based on these, the opinion that the resource was unlikely to be overfished or caught recklessly was supported by Science Subcommittee of the WCPFC. On the other hand, it was pointed out that some results were under the tentative target reference points (50 % of the estimated current stock on the assumption that there was no fishing) (Kiyofuji 2019). Consequently, a score of 5 points is given based on the assessment method ① below.

Assessment Method	1 Point	2 Points	3 Points	4 Points	5 Points
①	Bcur ≦ Blimit Fcur ＞ Flimit	.	Bcur ＞ Blimit Fcur ＞ Flimit, or Bcur ≦ Blimit Fcur ≦ Flimit	.	Bcur ＞ Blimit Fcur ≦ Flimit
②	Ccur ＞ ABC	.	.	Ccur ≦ ABC	.
③	Major impact on fisheries	.	Minor impact on fisheries	.	.
④	Unknown or indeterminable	.	.	.	.

1.3.2 Stock Depletion Risk at Current Fishery Pressure

Since the fishery pressure during 2011-2014 was under FMSY, it was thought that the risk of depletion of resources was nonexistent (Kiyofuji 2019). Consequently, a score of 5 points is given based on the assessment method ① below.

Assessment 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 is not an end in itself, but a part of way to increase information available for stock and fisheries management (Matsumiya 1996). This section evaluates the influence of stock assessment results on the formulation of fishery management measures in terms of rules and procedures.

1.3.3.1 Presence of Fisheries Management Measures

The WCPFC has implemented conservation and management measures based on the results of stock assessments by the SPC Scientific Evaluation Group (WCPFC 2018b). Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No harvest control rules	Harvest control rules exist but are not reflected in fisheries management	.	.	Harvest control rules exist and the results of stock assessments are reflected in the fisheries management

1.3.3.2 Presence of Precautionary Measures

It can be concluded that precautionary measures have been taken since multiple stock assessment scenarios and management objectives are being examined to account for disparities, (Kiyofuji, 2019). Consequently, a score of 5 points 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

1.3.3.3 Considering Impacts of Climate Change

Although it is not currently considered, it is recognized that climate change has an impact (Kiyofuji, 2014). Consequently, a score of 3 points 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 exist but are not considered at all	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 Fisheries Management Measures

The WCPFC is introducing (1) a gradual tightening of regulations on FADs operations, (2) limitations on the number of boats held by members (except those of island countries) to purse seine fishing in tropical areas as conservation and management measures for skipjack tuna (WCPFC 2018b). Consequently, a score of 4 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 in consideration of internal stakeholders	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 for Recreational, Foreign Commercial, and IUU Fishing for Fisheries Management Procedures

The WCPFC IUU Vessel List is available on the WCPFC website (WCPFC 2019). 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 IUUs' catches are not considered	Efforts are being made to propose management measures considering recreational fishing, foreign fishing vessels, and IUUs	Management measures are proposed, in partial consideration of capture by recreational fishing, foreign fishing vessels, and IUUs	Management measures are proposed, in close consideration of recreational fishing, foreign fishing vessels, and IUUs	Management measures are proposed, In full consideration of recreational fishing, foreign fishing vessels, and IUUs

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2. Marine Environment and Ecosystems

Overview

Ecosystem Data and Monitoring (section 2.1)

Ecosystem and the problem of bycatches, analysis of ecosystem model, and bycatch information in longline fishery were summarized (3 points for item 2.1.1). Research on larvae and juveniles of tropical tunas and skipjack tuna, zooplankton, and marine environments are conducted on an irregular basis (3 points for item 2.1.2). Since 2008, when the scientific observer program was established, a system for obtaining information of bycatches in longline and purse seine fishing has been developed, and to make partial collection of information has been possible (3 points for item 2.1.3).

Bycatch (section 2.2)

Yellowfin tuna, one of the usable bycatches, are of no concern with stock status (5 points for item 2.2.1). Unusable bycatches are rainbow runners (*Elagatis bipinnulata*), silky sharks, ocean triggerfish (*Canthidermis Maculata*), mackerel scads (*Decapterus macarellus*), mahi mahi (*Coryphaena hippurus*), and other species. Risks to these species are reported as insignificant, with the exception of silky sharks, which were judged to be at moderate risk in the PSA evaluation in the eastern Pacific Ocean (4 points for item 2.2.2). Among the endangered species specified by the Ministry of the Environment, loggerhead turtles (*Caretta caretta*), green turtles (*Chelonia mydas*), and hawksbill turtles (*Eretmochelys imbricata*) were evaluated to be at moderate risk in the PSA evaluation (3 points for item 2.2.3).

Ecosystems and Environments (section 2.3)

Skipjack predators include swordfish (*Xiphias gladius*), Indo-Pacific blue marlin, striped marlin (*Kajikia audax*), mako sharks (*Isurus oxyrinchus*), blue sharks (*Prionace glauca*), silky sharks (*Carcharhinus falciformis*), oceanic whitetip sharks (*Carcharhinus longimanus*), and larger bigeye and yellowfin tunas. According to the mixed trophic impact matrix using the Ecopath with Ecosim model at western and central Pacific surface, which was structured by Allain et al. (2007), the negative impact on marlin and sharks is deemed minor, but moderate impacts on yellowfin tuna and the skipjack tuna themselves have been detected (3 points for item 2.3.1.1). Bait organisms of skipjack tuna, which have weak selectivity, are fish, crustaceans, and cephalopods. They are regarded to be opportunistic feeders. The analysis with the above ecosystem model shows that the negative impact on bait organisms, fish, crustaceans, and cephalopods, is minor (5 points for item 2.3.1.2). The analysis of predatory fish with roughly the same trophic level, including yellowfin tuna, genus Alepisaurus, Bramidae, Carangidae (*Carangids nei*), Coryphaena, *Gempylidae*, Wahoo (*Acanthocybium solandri*), moonfish, and *Scombridae*, by the above ecosystem model showed negative impact on yellowfin tuna (3 points for item 2.3.1.3).

The mean trophic level of catch (MTLc) has been increasing since around 1980 with existing stock abundance and diversity declining. Although the impact of fisheries is insignificant according to SICA evaluation, the tendency of the MTLc implies a concern over partial changes in the characteristics of the ecosystem (3 points for item 2.3.2).

There were no reports of illegal marine pollution or waste dumping by Japanese fishing vessels in in the WCPFC convention area (4 points for item 2.3.4). As for emissions per catch (t-CO_2/t), since medium- and large-scale purse seine fishery using one vessel has comparatively low CO_2 emissions, its impact on the atmospheric environment is regarded as insignificant (4 points for item 2.3.5).

Outline

① Identification of target fisheries

The total catch of skipjack tuna in the western and central Pacific Ocean in 2017 was 1,628 thousand tons. The breakdown by fishing method is, 1,283 thousand tons, or 79% by purse seine, 123 thousand tons, or 8% by pole-and-line, 218 thousand tons or 13 % by other methods. Consequently, the method to be evaluated is purse seine (Kiyofuji, 2019a).

② Identification of target region

The western and central Pacific Ocean, where purse seine fishers, constituting 78% of the total catch, is the target area.

③ Collection and description of data on target fishery type and ecosystems

1) Fishing gear and methods

Purse seine fisheries operating in the target area, western and central Pacific Ocean, are evaluated.

The Japanese bag net used overseas has a total length of 810 fathoms (approximately 1,500 m) reaches depths of 78 fathoms (approximately 140 m) (Kaneda 2005). Initially, purse seiners targeted free schools and natural driftwood swarming fish schools, but since the 1990s, the use of fish aggregating devices (FADs) has supplanted these operations (Sato 2019a).

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

The number of vessels using purse seine in 2014 was 142 (accounting for a gross tonnage of 200 or more) from Japan, Korea, Taiwan, and the USA, 95 from Pacific Island countries and 65 from China, Ecuador, El Salvador, New Zealand, and Spain, for a total of 302 vessels (Sato 2016).

3) Annual catch of major fish species

Below is the average of major fish species catches in the FAO Area 71 – Pacific, Western Central – (roughly bounded by longitude 175° W, latitudes 20° N and 25°S, the Australian continent, the Greater Sunda Islands, and the Lesser Sunda Islands) over five years (2012 through 2016). This area is at the center of the distributional range of skipjack tuna and the fishing grounds formed (FAO 2018).

English name	Japanese name	Scientific name	Average catch (1,000 tons)
Skipjack tuna	Katsuo	*Katsuwonus pelamis*	3,057
Yellowfin tuna	Kihada	*Thunnus albacares*	1,529
Indian mackerel	Guru kuma	*Rastrelliger kanagurta*	764
Bigeye tuna	Mebachi	*Thunnus obesus*	557
Short mackerel		*Rastrelliger brachysoma*	219
Narrow-barred Spanish mackerel	Yokoshima sawara	*Scomberomorus commerson*	387
Kawakawa	Suma	*Euthynnus affinis*	207
Bigeye scad	Me aji	*Selar crumenophthalmus*	181
Goldstripe sardinella		*Sardinella gibbosa*	141
Frigate tuna	Hira soda	*Auxis thazard*	121
Yellowstripe scad	Hoso hira aji	*Selaroides leptolepis*	116

4) Operating range

Most of skipjack tuna in the western and central Pacific Ocean are caught in tropical areas with most of the rest caught in the waters around Japan in some seasons. In western tropical area, majority of the catch are occupied by offshore fisheries of Indonesia and Philippines. In the central tropical area, purse seine fisheries by pelagic fisheries countries and island countries are distinguished.

5) Spatio-temporal distribution of operations

Fishing grounds for skipjack tuna are as shown in Figure 1. Information about fishing seasons were not obtained.

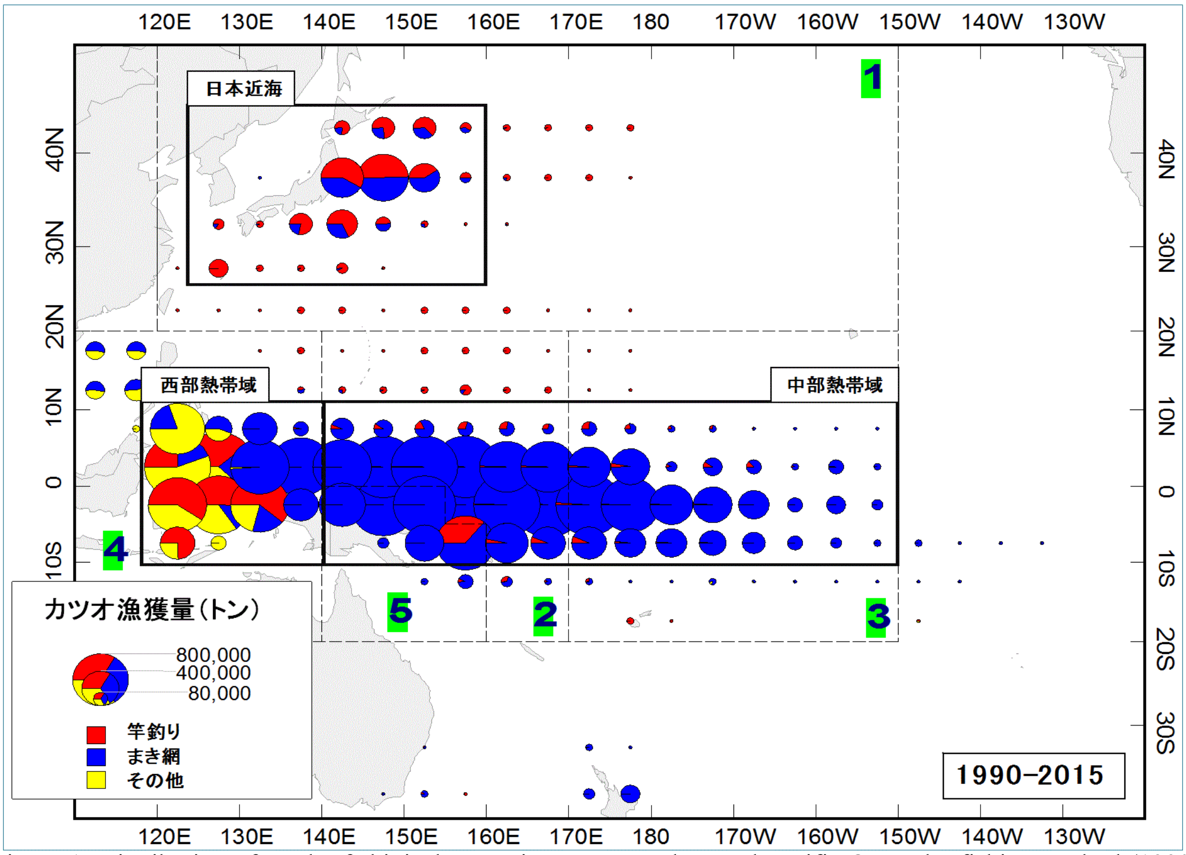


Figure 1: Distribution of catch of skipjack tunas in western and central Pacific Ocean by fishing method (1990-2015) Red: Pole-and-line fishing, Blue: Purse seine fishery, Yellow: Other

6) Bycatch:

Usable species:

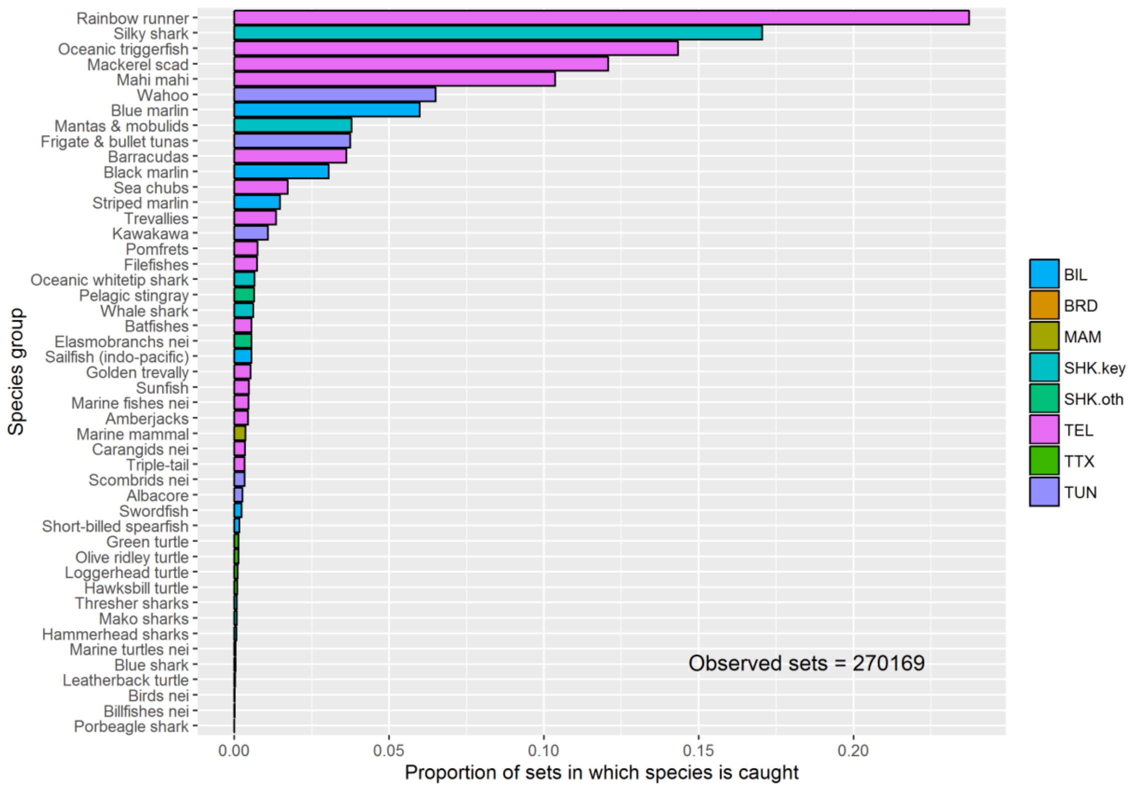
Several types of purse seine nets are used for tuna species (including skipjack) i.e., targeting schools of fish, using floating objects and FADs. The use of FADs results in catching the most bycatch species (Hall and Roman 2013).

Annual catches by Japanese vessels in 2017, obtained from purse seine fishing in the western and central Pacific, are shown below (WCPFC 2018). Of these (excluding skipjack) yellowfin alone accounted for more than 75% of total catches and therefore the species was determined to be a usable bycatch by this method.

Species	Catch (tons)	Percentage (%)
Skipjack tuna	128,266	73.88
Yellowfin tuna	34,410	19.82
Pacific bluefin tuna	4,540	2.62
Albacore	3,679	2.12
Bigeye tuna	2,644	1.52
Indo-Pacific blue marlin	59	0.03
Black marlin	7	0.00

Unusable (non-commercial) bycatch species:

Purse seine bycatch species comprising the highest proportion of unusable stock in the western and central Pacific Ocean in 2017 were rainbow runners, silky sharks, oceanic triggerfish, mackerel scads, and mahi mahi (Peatman et al. 2017, see below).



7) Rare (endangered or threatened) species:

Among the species listed in the 2019 Red Data Book compiled by Japan's Ministry of the Environment, animals that inhabit the western and central Pacific Ocean are as follows (Ministry of the Environment 2019).

Reptiles

Loggerhead turtles (EN), green turtles (VU) and hawksbill turtles (EN)

Birds

Ancient murrelets (CR), laysan albatrosses (EN), red-footed boobies (EN), short-tailed albatrosses (VU), Swinhoe's petrels (VU), greater crested terns (VU), roseate terns (VU), and black-naped terns (VU)

Freshwater and brackish water fish species were excluded because skipjack tuna operations have been conducted at sea.

2.1 Environment and Ecosystem Data, Research, and Monitoring on the Target Sea Area

2.1.1 Overview of Basic Information

Some ecosystem-bycatch issues, ecosystem model-based analyses, and bycatch data from longline fishing in the western and central Pacific Ocean are summarized, and available (MRAG 2002, Allain et al. 2015, Clarke et al. 2014, Hall and Roman 2013). Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No information available		Partially complete information is 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 Research

In the western and central Pacific Ocean, surveys were conducted on larval and juvenile of tropical tuna, including skipjacks on an irregular basis from a research vessel. In addition, zooplankton samples and marine environments are surveyed, and therefore a score of 3 points is given (Uosaki et al. 2016).

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 Fishery Activities

Some information on catch and bycatch composition can obtain since 2008, due to a scientific observer program in the western and central Pacific Ocean was established and a system which obtains information (actual catch and size) on catch and bycatch composition by purse seines has been in place (WCPFC 2007). Consequently, a score of 3 points is given.

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 Usable (Commercial) Bycatch Species

Results of stock status of yellowfin tuna, caught with skipjack tuna are shown in the table below.

Target fishery	Purse seine
Target sea area	Central and western area of the North Pacific Ocean
Target fish	Skipjack tuna

species		
Survey section No.	2.2.1.1	
Survey item	Usable bycatch species	
Survey Target	Abundance	5
	Reproduction capacity	
	Age and size composition	
	Distribution area	
	Other:	
Overview of survey rationale	Stock assessment results show that yellowfin tuna is not concerning , and therefore a score of 5 point is given.	
Details	Yellowfin tuna in the western and central Pacific Ocean treated as one of the usable bycatch species are shown below. Yellowfin tuna in the western and central Pacific Ocean: The stock level is medium-low and the trend is flat. The average SSB level for 2012-2015 ($SB_{2012-2015}/SB_{F=0}$) was 0.33, well over the limit reference point ($SB/SB_{F=0}$ = 0.20). Average fishing coefficient for 2012-2015 was below Fmsy ($F_{2012-2015}/F_{MSY}$=0.74). Consequently, the resource is quite unlikely to be in overfished and fishing pressure is unlikely to be excessive (Sato 2019a). As described above, the usable bycatch species of the purse seine is not concerning with regard to stock status, and therefore a score of 5 points is given.	

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	Many usable bycatch species are in poor stock status or have high risks of adverse bycatch impacts	Stock status of a small number of usable bycatch 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 usable bycatch species are in bad stock status; No species are at significant risks of adverse bycatch impacts	Individual stock assessment results indicate that usable bycatch species are considered in healthy stock status, and judged to be at sustainable levels

2.2.2 Unusable (Non-commercial) Bycatch Species

Unusable bycatches in purse seine in the western and central Pacific Ocean include rainbow runners, silky sharks, Ocean triggerfish, Mackerel scads, and mahi mahi, etc., however, information necessary to evaluate stock statuses of all but silky sharks are not available. Productivity Sustainability Analyses (PSAs) for bycatches of purse seine fishing were implemented in the IATTC (2018) for the eastern Pacific Ocean, where similar bycatches to those of the western and central Pacific Ocean. This analysis reported that impacts on these species were minor except in the case of silky sharks (short fin mako sharks), to which the impact was evaluated as medium. Consequently, a score of 4 points is given.

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

Table 2.2.2 Result of PSA on unusable bycatch species (reproduced from IATTC 2018)

TABLE L-1. Productivity (*p*) and susceptibility (*s*) scores used to compute the overall vulnerability measure *v* for the tuna purse-seine fishery of large vessels in the eastern Pacific Ocean. Susceptibility (*s*) scores are shown for each fishery (dolphin (DEL), unassociated (NOA), floating object (OBJ)) and as a weighted combination of the individual fishery values. Vulnerability scores rated as low (green), medium (yellow), and high (red).
TABLA L-1. Puntuaciones de productividad (*p*) y susceptibilidad (*s*) usadas para computar la medida general de vulnerabilidad *v*. D. Se señalan las puntuaciones de susceptibilidad para cada pesquería (DEL: delfín; NOA: no asociada; OBJ: objeto flotante) y como combinación ponderada de los valores de las pesquerías individuales. Puntuaciones de vulnerabilidad clasificadas de baja (verde), mediana (amarillo), y alta (rojo).

Group	Scientific name	Common name	Nombre común	Code	*s* by fishery / *s* por pesquería			*p*	*s*	*v*
Grupo	Nombre científico			Código	DEL	NOA	OBJ			
Tunas Atunes	*Thunnus albacares*	Yellowfin tuna	Atún aleta amarilla	YFT	2.38	2.38	2.38	2.78	2.38	1.4
	Thunnus obesus	Bigeye tuna	Atún patudo	BET	1	2.23	2.38	2.33	1.7	0.97
	Katsuwonus pelamis	Skipjack tuna	Atún barrilete	SKJ	1	2.38	2.38	2.78	1.73	0.76
Billfishes Peces picudos	*Makaira nigricans*	Blue marlin	Marlín azul	BUM	2.23	2.23	2.69	2	2.39	1.71
	Istiompax indica	Black marlin	Marlín negro	BLM	2.23	2.23	2.69	2	2.39	1.71
	Kajikia audax	Striped marlin	Marlín rayado	MLS	2.54	2.54	2.54	2.33	2.54	1.68
	Istiophorus platypterus	Indo-Pacific sailfish	Pez vela indopacífico	SFA	2.54	2.54	2.54	2.44	2.54	1.64
Dolphins Delfines	*Stenella longirostris*	Unidentified spinner dolphin	Delfín tornillo no identificado	DSI	1.77	1	1	1.22	1.36	1.82
	Stenella attenuata	Unidentified spotted dolphin	Delfín manchado no identificado	DPN	1.77	1	1	1.33	1.36	1.71
	Delphinus delphis	Common dolphin	Delfín común	DCO	1.62	1	1	1.33	1.29	1.7
Large fishes Peces grandes	*Coryphaena hippurus*	Common dolphinfish	Dorado	DOL	1	2	2.31	2.78	1.64	0.68
	Coryphaena equiselis	Pompano dolphinfish	Dorado pompano	CFW	1	1	2.38	2.89	1.48	0.5
	Acanthocybium solandri	Wahoo	Peto	WAH	1	1	2.62	2.67	1.57	0.66
	Elagatis bipinnulata	Rainbow runner	Salmón	RRU	1	1	2.31	2.78	1.46	0.51
	Mola mola	Ocean sunfish, Mola	Pez luna	MOX	1	1.92	1.92	1.78	1.49	1.31
	Caranx sexfasciatus	Bigeye trevally	Jurel voráz	CXS	1	2.38	1	2.56	1.25	0.51
	Seriola lalandi	Yellowtail amberjack	Medregal rabo amarillo	YTC	1	2.08	1.85	2.44	1.49	0.75
Rays Rayas	*Manta birostris*	Giant manta	Mantarraya gigante	RMB	1.92	2.08	1.77	1.22	1.9	1.99
	Mobula japanica	Spinetail manta		RMJ	1.92	2.08	1.77	1.78	1.9	1.51
	Mobula thurstoni	Smoothtail manta		RMO	1.92	2.08	1.77	1.67	1.9	1.6
Sharks Tiburones	*Carcharhinus falciformis*	Silky shark	Tiburón sedoso	FAL	2.08	2.08	2.15	1.44	2.1	1.91
	Carcharhinus longimanus	Oceanic whitetip shark	Tiburón oceánico punta blanca	OCS	1.69	1	2.08	1.67	1.7	1.5
	Sphyrna zygaena	Smooth hammerhead shark	Cornuda común	SPZ	1.77	1.92	2.08	1.33	1.91	1.9
	Sphyrna lewini	Scalloped hammerhead shark	Cornuda gigante	SPL	1.77	1.92	2.08	1.33	1.91	1.9
	Sphyrna mokarran	Great hammerhead shark	Cornuda cruz	SPK	2.08	1.77	1.92	1.33	1.97	1.93
	Alopias pelagicus	Pelagic thresher shark	Tiburón zorro pelágico	PTH	1.92	1.92	1.77	1.22	1.87	1.98
	Alopias superciliosus	Bigeye thresher shark	Tiburón zorro ojón	BTH	1.77	2.08	1.46	1.11	1.72	2.02
	Alopias vulpinus	Common thresher shark	Tiburón zorro	ALV	1.92	1.92	1.77	1.67	1.87	1.59

Group	Scientific name	Common name	Nombre común	Code	*s* by fishery / *s* por pesquería			*p*	*s*	*v*
Grupo	Nombre científico			Código	DEL	NOA	OBJ			
	Isurus oxyrinchus	Short fin mako shark	Tiburón marrajo dientuso	SMA	2.23	2.23	1.92	1.22	2.12	2.1
Small fishes Peces pequeños	*Canthidermis maculatus*	Ocean triggerfish	Pez ballesta oceánico	CNT	1	1	2	2.33	1.35	0.76
	Sectator ocyurus	Bluestriped chub	Chopa	ECO	1	1	2.08	2.22	1.38	0.87
Turtles-Tortugas	*Lepidochelys olivacea*	Olive ridley turtle	Tortuga golfina	LKV	1.62	2.23	1.62	1.89	1.73	1.33

2.2.3 Rare, Endangered or Threatened Species

Among the endangered species designated by Japan's Ministry of the Environment, whose distribution areas overlap with the target waters include loggerhead turtles, green turtles, hawksbill turtles, ancient murrelets, laysan albatrosses, red-footed boobies, short-tailed albatrosses, Swinhoe's petrels, greater crested terns, roseate terns, black-naped terns.

Results of the risk assessments with the PSA on these species is shown in the Table 2.2.3a and biological parameters, etc. are shown in Table 2.2.3b. Excluding loggerhead turtles, green turtles, and hawksbill turtles whose risk was evaluated as moderate, the general impact of purse seine fishing is evaluated as small. Consequently, a score of 3 points is given.

Table 2.2.3a Assessments based on the PSA of endangered species

	Catch (tons)		Productivity (P) score									Susceptibility (S) score					PSA result	
Item	Common name	Vertebrate or invertebrate	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 score	Risk category
2.2.3	Loggerhead turtle	Vertebrate	3	3	2	2	2	2	3		2.43	2	3	2	2	2.21	3.29	High
2.2.3	Green turtle	Vertebrate	2	3	2	2	2	2	3		2.29	2	3	2	2	2.21	3.18	High
2.2.3	Hawksbill turtle	Vertebrate	3	3	2	2	2	2	3		2.43	2	3	2	2	2.21	3.29	High
2.2.3	Ancient murrelet	Vertebrate	1	1	3	1	1	2	3		1.71	1	1	1	2	1.19	2.09	Low
2.2.3	Laysan albatross	Vertebrate	2	3	3	1	2	2	3		2.29	1	1	1	2	1.19	2.58	Low
2.2.3	Red-footed booby	Vertebrate	1	2	3	1	2	2	3		2.00	1	2	1	2	1.41	2.45	Low
2.2.3	Short-tailed	Vertebrate	2	2	3	1	2	2	3		2.14	1	1	1	2	1.19	2.45	Low
2.2.3	Swinhoe's petrel	Vertebrate	1	1	3	1	1	2	3		1.71	2	1	1	2	1.41	2.22	Low
2.2.3	Greater crested tern	Vertebrate	1	1	3	3	1	2	3		2.00	1	1	1	2	1.19	2.33	Low
2.2.3	Roseate tern	Vertebrate	Unknown	2	3	1	1	2	Unknown		1.80	1	1	1	2	1.19	2.16	Low
2.2.3	Black-naped tern	Vertebrate	Unknown	2	3	1	1	2	Unknown		1.80	1	1	1	2	1.19	2.16	Low
Target method	Purse seine	T Vertebrate	Western and central Pacific											Overall PSA score			2.56	Low

Table 2.2.3b Biological parameters related to productivity of endangered 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	Minami and Suganuma (2017), Ishihara (2012), Nel & Casale (2015)
Green turtle	19	70～80	400	100	92	2.1	Minami and Suganuma (2017), Ishihara (2012), Seminoff (2004)
Hawksbill turtle	30-50	20-40	96-200	80	60	2.1	Minami and Suganuma (2017), Ishihara (2012), UMMZ (2019)
Ancient murrelet	2	7	2	26	24	3.8	Kano 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)
Short-tailed albatross	5	25+	1	94	84	4+	Hasegawa (1998)
Swinhoe's petrel	2	6	1	20	19	3.6	Hamaguchi, et al. (1985), Klimkiewicz et al. (1983)
Greater crested tern	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)

HAGR: Human Aging Genomic Resources
UMMZ: University of Michigan Museum of Zoology

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 indicates 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 indicates 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 indicates an overall low risk of bycatch impacts, with no species adversely impacted	Based on individual assessments of rare species, it is determined that the target fisheries do not threaten the survival of rare species

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	10-25 years	> 25 years
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		

2.3 Ecosystems and Environments

2.3.1 Indirect Impacts through the Food Web

2.3.1.1 Predators

Predators of skipjack tuna are swordfish of the billfish category (Indo-Pacific blue marlin, striped marlin), shortfin mako sharks, blue sharks, silky sharks, Oceanic whitetip sharks, and bigeye tuna and yellowfin tuna. According to the mixed trophic impact matrix using the Ecopath with Ecosim model for the western and central Pacific surface stratum, which was structured by Allain et al. (2007), negative impacts on marlin and sharks are minor. On the other hand, a medium-negative impact was detected on yellowfin and the skipjack tunas themselves. Consequently, a score of 3 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	Some predator species demonstrate directional changes and/or increased fluctuation	CA does not detect any significant impacts on predators caused by catch/bycatch of the target fishery	Ecosystem model-based assessments indicate that indirect impacts of catch/bycatch in the target fishery on predators through the food web are at sustainable levels

2.3.1.2 Preys

Skipjack tuna prey upon fish, crustaceans, and cephalopods. The skipjack's diet selectivity with regard to prey is weak so they are regarded as opportunistic feeders, eating whatever are most abundant or easy to catch. (Kiyofuji 2019a). According to the mixed trophic impact of the ecosystem model Ecopath structured by Allain et al. (2007) (Figure 2.3.1.2), negative impacts to prey species (fish, crustaceans and cephalopods), are minor. Consequently, a score of 5 points is given.

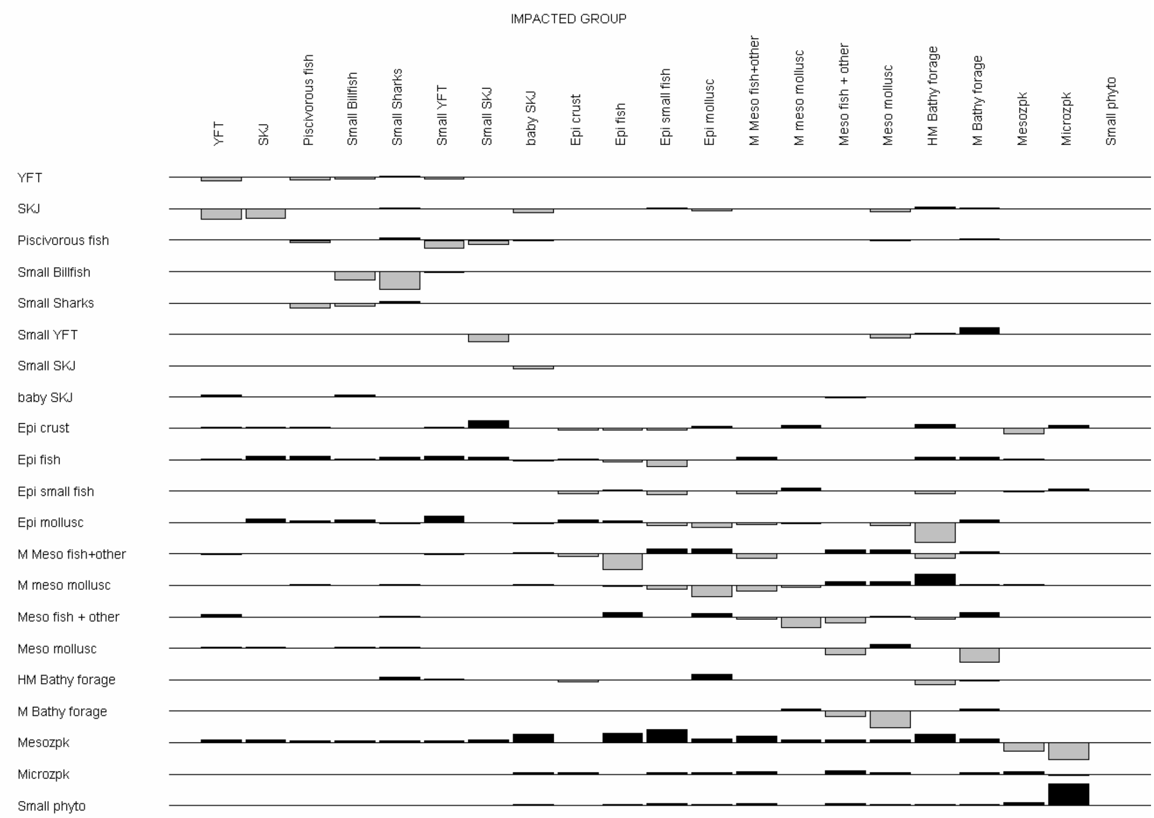


Figure 2. Mixed trophic impact matrix of selected components of the ecosystem. ***Impacting groups on the left, impacted groups on top; grey box below the line represents a negative impact, black box above the line represents a positive impact.***

Figure 2.3.1.2 Results of the mixed trophic impact matrix using the Ecopath with Ecosim model. Impacting groups on the left, impacted groups on top; gray box below the line represents a negative impact, black box above the line represents a positive impact (cited from Allain et al. 2015).

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

2.3.1.3 Competitors

Fish species positioned similarly to skipjack tuna on the food chain are likely to be competitors. The trophic level of skipjack tuna estimated with the ecosystem model Ecopath in the surface depths of the western and central Pacific Ocean structured by Allain et al. (2007) is 4.92 (Table 2.3.1.3), to which predatory fish, including yellowfin tuna (4.88), genuses *Alepisaurus, Bramidae, Carangidae, Coryphaena, Gempylidae*, Wahoo, opah, and *Scombridae*, are known to belong. Negative impacts on yellowfin tuna are detected according to the Mixed trophic impact of Ecopath (Figure 2.3.1.2). Consequently, a score of 3 points is given.

Table 2.3.1.3 Tropic level estimated using the ecosystem-based Ecopath with Ecosim model for the western and central Pacific Ocean (cited from Allain et al 2007)

Group name	Trophic level	Biomass (t/km²)	Prod./ biom. (/year)	Cons./ biom. (/year)	Ecotrophic efficiency	Production / consumption
Swordfish	5.24	0.0036	0.4	5	0.05	0.08
Other Billfish	5.58	0.0052	0.6	5	0.075	0.12
Blue Shark	5.35	0.016	0.3	3	0.031	0.1
Other Sharks	5.57	0.0012	0.3	3	0.356	0.1
BET	5.41	0.00162	0.95	15	0.777	0.063
YFT	4.88	0.00799	1.537	16.14	0.56	0.095
SKJ	4.92	0.0842	2.046	25	0.347	0.082
Piscivorous fish	4.93	0.025	1.5	10	0.946	0.15
Small Billfish	5.22	0.0106	1	10	0.114	0.1
Small Sharks	5.27	0.0118	0.5	5	0.043	0.1
Small BET	4.51	0.00241	0.834	26.159	0.644	0.032
Small YFT	4.89	0.0128	1.983	33.964	0.849	0.058
Small SKJ	4.33	0.0194	2.539	50.698	0.927	0.05
baby SKJ	3.88	0.00659	25	191.81	0.776	0.13
Epi crust	2.64	4.515	8	30	0.98	0.267
Epi fish	3.54	2.127	3	15	0.95	0.2
Epi small fish	3.24	0.785	10	60	0.98	0.167
Epi mollusc	4.3	0.384	7	20	0.95	0.35
Epi small mollusc	3.2	0.955	15	100	0.98	0.15
M Meso fish+other	3.57	3.404	2.2	10	0.95	0.22
M meso mollusc	4.25	1.484	3	10	0.95	0.3
Meso fish + other	4.21	0.634	2.5	10	0.95	0.25
Meso mollusc	4.74	0.201	3	10	0.95	0.3
HM Bathy forage	3.38	1.803	1.189	8	0.95	0.149
M Bathy forage	4.7	0.282	1.338	8	0.95	0.167
Bathy forage	3.64	0.0698	0.845	8	0.95	0.106
Mesozpk	2.2	4.4	50	230	0.995	0.217
Microzpk	2	2	120	382	0.992	0.314
Large phyto	1	1.849	120.3	-	0.829	-
Small phyto	1	8	109.44	-	0.756	-
Detritus	1	100	-	-	0.791	-

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

2.3.2 Whole Ecosystem

In the western and central Pacific and northern Pacific Oceans, stock assessments have been conducted for 12 species, i.e., Pacific bluefin tuna, albacore, yellowfin tuna, bigeye tuna, swordfish, striped marlin, Indo-Pacific blue marlin, skipjack tuna, blue sharks, shortfin mako sharks, silky sharks, and oceanic whitetip sharks. Among these, the stock levels judged to be medium or more accounted for seven species at 58% and non-decreasing levels accounted for 67% (eight species) (Nakatsuka et al. 2019; Kiyofuji 2019a; Sato 2019a and 2019b; Ijima 2019a, 2019b, 2019c; Kai and Fujinami 2019, Semba 2019, Semba and Kai 2019, Semba and Kurashima 2019, Clarke et al., 2014). In addition, Allain et al. (2015) reported that the average trophic level of the catch showed an increasing trend from 1980 to 2000 before flattening out (Figure 2.3.2a). On the other hand, the diversity and biomass of species with high trophic levels (small and large fish) were said to have increased or decreased with significant changes in 2000 and later. From the above, some ecological changes are concerning even though the impact of the target fishing method is not serious, and therefore a score of 3 points is given.

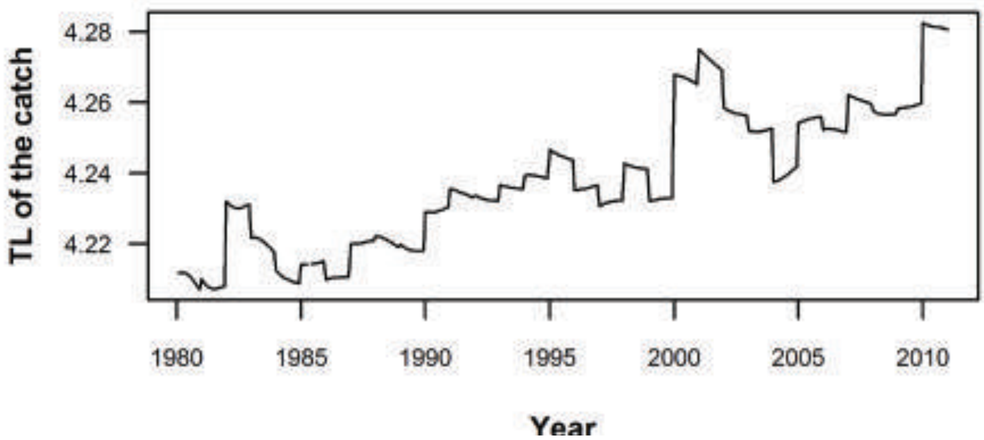


Figure 2.3.2a Average trophic levels of the catch (cited from Allain et al. 2015)

The result of evaluating the impacts of purse seine fishing on the whole ecosystem in the western and central Pacific Ocean with SICA is as shown in Table 2.3.2a.

Table 2.3.2a Result of SICA evaluation for impacts on whole ecosystem

Target fishery	Purse seine
Target sea area	Western and central Pacific Ocean
Survey section No.	2.3.2
Survey item	Impact on the overall ecosystem
Spatial scale score	0.5
Outline of the basis of evaluating the spatial score	The size of the area of one purse seine fishing operation since the length of medium- and large-scale purse seine nets is 1,500 m, 179,000 m^2, the size of the circle with that circumference. The number of purse seine net boats operating in the western and central Pacific Ocean is 302. The number of operation days of Japanese purse seine net tuna fishing is, according to Fishery Census 2013 (MAFF 2015), 252 days per year for Japanese tuna fishers. Actual operation days are assumed 150, excluding the time to travel between fishing grounds. Since it is necessary to consider the impact of using FADs, that are more efficient than normal operations, the efficiency of fishing using FADs is assumed to be 1.8 times higher, because success rates of catching fish schools normally, the rate is more than 90% if FAD is used (Fonteneau et al. 2000). While there are some prohibited periods in FAD operations (Sato 2019a), any breakdown of the 150 days by type of operation (whether to use FAD) is not known. In the western Pacific Ocean, FAD operations constitute 25% of all operations (Hall and Roman 2013). From

	the above information, the maximum area to which skipjack tuna (and other kinds of tuna) fishery can affect is computed as 179×1,000 m^2×302(boats)×150(days)×(0.25×1.8 ＋0.75×1)＝9.73×10^3 km^2. On the other hand, areas of the ground of purse seine fishery in the central and western Pacific is defined as approximately latitude 10°N-10°S, longitude 120 E-150 W from Figure 3 by Sato (2019a) and estimated 2.2×10^7 km^2. The range which purse seine net fishery influences is computed 0.07% by arithmetic division. This value is evaluated as strength 0.5 (<15%), according to the procedure.
Time scale score	1.5
Outline of the basis of evaluating time scale	Here the period for which Japanese purse seine net offshore tuna fisheries are operated is assumed to be 150 days. If purse seine net fishing boats from all countries operate for the same period simultaneously, the time scale of purse seine fishery is computed as 150/365＝41％, giving strength 1.5(30％～45％).
Strength of the influence score	0.87
Outline of the basis of evaluating strength of the influence	The impact of medium- and large-scale purse seine net fishing is computed as SQRT(0.5×1.5)＝0.87, according to the procedure.

Consequence	Constitution of the species	
(Result) Score	Constitution of the functional group	
	Distribution of the crowd	
	Constitution of the trophic level	2
	Size constitution	
Outline of the reason for the evaluation result	According to Allain et al. (2015), the mean trophic level of the catch (MTLc) has tended to increase since around 1980 (Allain et al. 2015, Figure 2.3.2a). Additionally, it was pointed out that both residue quantity and diversity of organisms of high trophic level are declining. Consequently, a score of 2 points is given.	
Total evaluation	Score	3
Outline of the reason for the total evaluation	The strength of influence by fishing is as low as 0.87 (SI＜1). Additionally, since bycatch quantities are low in purse seine fishing (Fonteneau et al. 2000, Hall and Roman 2013), impacts to bycatches are assumed to be minor. However, considering the trend of MTLc, it is concerning that characteristics of the ecosystem are varying or that the variance is increasing (C=3). Consequently, a score of 3 points is given.	

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	There is a serious concern about the impacts of the target fishery, prolonged directional changes or intensification of fluctuations are occurring	Although the impact of the target fishery is not serious, there is a concern about some directional ecological changes or intensification of fluctuations	SICA shows the impact of the target 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 Benthic Ocean Environment

No bottom fishing gear is used in purse seines, and therefore 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 of concern	Impacts of fisheries on the benthic environment are not considered serious, but changes in some fishing grounds are of 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 target fishery

2.3.4 Water Quality of the Environment

As per the regulations in the Western and Central Pacific Fisheries Commission (WCPFC) and the Secretariat of the Pacific Regional Environment Programme (SPREP), scientific observers have been aboard vessels operating in the target seas to record the presence or absence of pollution and waste dumping. However, nationalities of vessels cannot be identified. Impacts of Japanese fishing vessels on the marine environment are unknown.

Oceanic pollution and waste dumping from Japanese fishing vessels are regulated by the Japan's Law Relating to the Prevention of Marine Pollution and Maritime Disaster. Under this law, Japanese vessels with gross tonnages of 100 tons or more are required to be equipped with an oily water separator, with specified effluent concentrations and methods and locations in which it is allowed. There were no reports of pollution and waste dumping violations by Japanese fishing vessels in the WCPFC convention area, and therefore it was judged that their operations were conducted in compliance with Japanese domestic regulations. Consequently, a score of 4 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Assessment cannot be conducted	For many substances, there are concerns that effluent from the target fishery will negatively impact water quality	There are concerns that some effluent from the target fishery will negatively impact water quality	Effluent from the target fishery is properly managed and the impacts on water quality are judged to be minimal	Effluent from the target fishery is properly managed, with impact on water quality judged to be insignificant, combined with efforts made to reduce the impact on water quality by the target fishery

2.3.5 Atmospheric Environment

According to Hasegawa (2010), the amount of CO2 emission per unit of catch (t-CO2/t) is by fishing method in Japan are as follows:

Small-scale bottom trawl, or the like	1.407
Offshore bottom trawl by one vessel	0.924
Boat seine	2.130
Small- and medium-scale purse net	0.553
Medium- and large-scale purse seine using one vessel	0.648
Medium- and large-scale purse seine for tuna including skipjack using one vessel	1.632
Saury stick-held dip net	0.714
Coastal tuna longline	4.835
Offshore tuna longline	3.872
Distant water 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

CO_2 emissions of medium- and large-scale tuna purse seine fisheries using one vessel is 1.6, which is comparatively low among Japanese fishing vessels. Therefore, the impact of the exhaust gases emitted by target fisheries is considered low. Consequently, a score of 4 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 the target fishery will have negative impacts on the atmospheric environment	For some substances, there are concerns that the emissions from the target fishery will have negative impacts on the atmospheric environment	Emissions from the target fishery are properly managed and the impacts on the atmospheric environment judged to be minimal	Efforts have been made to reduce the impacts of the target fishery on the atmospheric environment, and it has been confirmed that there are no negative impacts

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3. Fisheries Management

Overview

Details of Management Measures (section 3.1)

The stock assessment by the SPC is not in agreement in WCPFC. Japanese medium- and large-scale purse seine and pelagic and offshore pole-and-line fishing in the central and western Pacific targeting skipjack tuna must be operated under ministry license and no output controls are implemented . Under the condition that stock assessment results are not agreed, it cannot be concluded that input controls sufficiently affect fishery pressure (4 points for item 3.1.1). As for technical controls, although regulations for installing fish aggregating devices (FADs) have been implemented, they are not sufficiently implemented, for prohibition periods of FADs were shortened in the management measures (4 points for item 3.1.2). In pelagic and offshore tuna fishing, catches of silky sharks and oceanic white tip sharks, etc. are prohibited. Additionally, operation of medium- and large-scale purse seines are prohibited near whale shark (5 points for item 3.1.3.1). Use of low sulfur fuel, efforts to reduce fuel oils and prohibitions on ocean waste disposals are thoroughly implemented. There are no issues of abandoned fishing gear from pole-and-line fishing (5 points for item 3.1.3.2).

Enforcement System (section 3.2)

The International Affairs Division of the Fisheries Agency is cooperating with the WCPFC and the SPC, with a majority role taken the by Tuna Fisheries Office. Large-scale purse seine fisheries licensed by the minister of MAFF for skipjack tuna are guided and supervised by Tuna Fisheries Office of International Affairs Division and the Fisheries and Resources Management Division of Fisheries Agency. Pole-and-line fisheries are guided and supervised by Tuna Fisheries Office of International Affairs Division. Pole-and-line coastal tuna fisheries are basically required to have the approval of the Wide Sea-area Fisheries Adjustment Commission. The management system is established and functioning (5 points for item 3.2.1.1). If the Minister of Agriculture, Forestry, and Fisheries ordered, vessels engaged in medium- and large-scale purse seine and pelagic or offshore tuna fishing must have observers on board. Responsibility of confirming with certifications that catches came from vessels on the positive list has been integrated into the Fisheries Agency. Japan operates the support and projects related to strengthening tuna stock management skills under the international agreement at the WCPFC, with sufficient management systems implemented (4 points for item 3.2.1.2). Those who violate laws or ministerial ordinances related to fishing shall be subject to revocation of licenses or approvals, fines, or both (5 points for item 3.2.1.3). According to management objectives, stock assessments, and management measures under the WCPFC and the SPC, resource management policy has been reviewed and the Ministerial Order on the Permission, Regulation, Etc. of Designated Fisheries revised, pursuant to the adaptive management (4 points for item 3.2.2).

Co-Management Initiatives (section 3.3)

All fishermen involved in fishing skipjack tuna in the central and western Pacific can be officially identified (5 points for item 3.3.1.1). Fishermen belong to fisheries cooperatives and other associations based on type fishing or Coastal Fishery Cooperatives (5 points for item 3.3.1.2). In Japan, under the domestic guidelines for the management of marine living resources in Japan, fishermen are employing voluntary programs such as suspension fishing operations: the Japan Far Seas Purse Seine Fishing Association and other organizations themselves have been making efforts to realize effective management measures (4 points for item 3.3.1.3). These organizations are also taking initiatives to reform plans and demonstration projects through the Comprehensive Project for Japan's Fisheries Structural Reform. Sales of skipjack tuna are being promoted through the establishment of quality brands from Coastal Fishery Cooperatives (united cooperatives) (5 points for item 3.3.1.4). Active participation in voluntary and public control is also progressing (4 points for item 3.3.2.1, 5 points for item 3.3.2.2). Stakeholders participate in the Resource Management Subcommittee of the Fisheries Policy Council and NGOs participate in conferences such as WCPFC annual meetings and Scientific Committee (5 points for item 3.3.2.3).

Outline

(1) Identification of target fisheries

Although it is necessary to identify major fisheries catching skipjack tuna in the central and western Pacific Ocean, catches (MAFF 2018a) of skipjack tuna (including those of the eastern Pacific, Indian, and Atlantic Oceans) in 2017 are used to determine target fishing methods, for it is not possible at this time. In late years, it can be said that most skipjack fishing is comprised of central and western Pacific tuna. The species is caught mostly by medium- and large-scale purse seine pelagic fishing using one vessel, medium- and large-scale purse seine offshore fishing, pole-and-line pelagic fishing, offshore pole-and-line offshore fishing, and pole-and-line coastal fishing. Therefore, these methods are defined as the target.

(2) Identification of target prefectures

Catches from Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, and Nagasaki Prefectures constitute the majority of medium- and large-scale purse seine pelagic tuna fishing using one vessel. Catches from Shizuoka Prefecture comprise the majority of medium- and large-scale purse seine offshore fishing using one vessel, while Miyagi, Shizuoka, and Mie Prefectures comprise the majority of pole-and-line pelagic fishing. Miyazaki Prefecture comprises the majority of pole-and-line offshore fishing, and Kochi Prefecture comprises the majority of coastal pole-and-line fishing. These prefectures are identified the targets. The total harvest described above constitutes 79% of the total Japanese haul of skipjack tunas in 2017.

(3) Collection and description of information on target fishery type

The following information on target fisheries in each prefecture will be collected:

1) Fishing permits/licenses and details of various types of management

2) Implementation systems including monitoring systems, penalties, and adaptive management initiatives

3) Co-management initiatives for identification and organization of stakeholders, and their participation in decision making

4) Ecosystem conservation activities by stakeholders

3.1 Details of Management Measures

3.1.1 Input and Output Control

Regarding the long-term management objective, it has been agreed that (1) 50% of the current spawning stock biomass (SSB) estimated on the assumption that there was no fishing shall be the tentative target, (2) This management objective shall be revised in 2019 at the latest and further revised as necessary, (3) recommendations on the migration situation to Japan, etc. by the Scientific Committee shall be considered, in the 12th Annual Meeting of Western and Central Pacific Fisheries Commission (WCFPC) in 2015. State of the stock has not yet been agreed upon (Kiyofuji 2019). Stock assessment by Secretary of Pacific Community (SPC), which shows that stock is not subject to over-fishing, and not over-fished, stock state has recovered and fishing pressure is decreasing is not approved by WCPFC, because some countries including Japan claimed that there were problems in defining the assessment model and that the assessment result is quite different from what fishermen observe (Fisheries Agency, 2018a). Medium- and large-scale purse seine pelagic tuna method using one vessel for catching skipjack tuna in the central and western Pacific is the medium- and large-scale purse seine fishery method for harvesting all tunas in central area of Pacific Ocean. This requires license from the Minister of Agriculture, Forestry, and Fisheries. Medium- and large-scale purse seine offshore fishing is the method used for catching tunas in the remaining waters around Japan and also requires license from the Minister of Agriculture, Forestry, and Fisheries. Pole-and-line pelagic tuna fishing is defined as pelagic tuna fishery and requires license from the Minister of Agriculture, Forestry, and Fisheries. Pole-and-line offshore tuna fishing is defined as offshore tuna fishery and requires license from Minister of Agriculture, Forestry, and Fisheries. Pole-and-line coastal tuna fishing is a method other than pelagic and offshore tuna methods. Those who caught bluefin tuna even just a little must be approved by Wide Sea-area Fisheries Adjustment Commission. Fishery suspension days are defined in the resource management policy in Kochi (Kochi 2018). From the above information, input controls are implemented but output control is not. While stock assessment results are not yet agreed upon, it cannot be concluded that input control is sufficiently affecting fishery pressure. Consequently, a score of 4 points is given.

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

3.1.2 Technical Control

Fisheries licensed by the Minister of Agriculture, Forestry, and Fisheries are designated fisheries whose areas of operation and quantity in tons are notified publicly and licenses are issued for fishermen who have applied for the notification. As for medium- and large-scale purse seine fisheries, operating is restricted in the EEZs of the Pacific island countries (MAFF, 2018c). The WCPFC decreed that conservation and management measures for bigeye, yellowfin, and skipjack tunas should be in effect from 2019 to 2020, with a closed period for use of Fish Aggregating Devices (FAD) in EEZ and high seas lasting 3 months and 5 months, respectably. Furthermore, the number of these devices is limited to 350 or fewer per boat at all times (Kiyofuji 2019, Fisheries Agency 2018b). In Japanese purse seine fisheries overseas, operations not using FADs even outside the closed period are increasing. Regulations on operating of medium- and large-scale purse seine fisheries between latitude 20 S. and 20 N. were revised (when operating within 1 sea mile from the FAD is defined) in order to properly follow conservation and management measures (CMM2017-1) of the WCPFC under domestic laws. Additionally, in paragraphs regarding pelagic and offshore tuna fishing (limited to pole-and-line fishing) of the Ministerial Ordinance on the Permission, Regulation, Etc. of Designated Fisheries, a provision prohibiting the fishery during the period specified by Minister of Agriculture, Forestry, and Fisheries (Fisheries Agency 2018c) is included. Although regulations on installing FADs, etc. are implemented in technical controls, the closed period specified in 2018 was shortened. Consequently, it cannot be said that it is sufficiently implemented. Consequently, a score of 4 points is given. 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 Ecosystem Conservation

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

In the Ministerial Ordinance on the Permission, Regulation, Etc. of Designated Fisheries on pelagic and offshore tuna fishing (limited to catching by pole and line), paragraphs included prohibiting fisheries of yellowfin and bigeye tuna in the central and western Pacific during the period specified by Minister of Agriculture, Forestry, and Fisheries. In pelagic and offshore tuna fishery, taking silky sharks, oceanic whitetip sharks, etc. (Ministerial Ordinance on the Permission, Regulation, Etc. of Designated Fisheries). In the target area of Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, if a whale shark is sited before casting, the fishery shall not operate within 1 sea mile from where the animal was sited (MAFF 2018c) and the WCPFC has adopted guidelines for fishermen to free live whale sharks should they somehow become trapped in nets (WCPFC 2012). Consequently, fishers are directed to live-release whale sharks if caught in nets for some reason. 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	Sufficient and effective regulations are being implemented

3.1.3.2 Ecosystem Conservation and Restoration Activities

In medium- and large-scale purse seine pelagic tuna fisheries using one vessel, lower sulfur contents in fuel by installing fuel coolers (to mitigate deterioration of lubricity) as a countermeasure for international air pollution (Japan Far Seas Purse Seine Fishing Association 2018). In medium- and large-scale purse seine fisheries using one vessel, fuel consumption is reduced by using energy-efficient vessels as one measure to rationalize the group sizes (Shizuoka Purse Seine Fisheries Association 2009). Brochures, etc. have been created by the Offshore Tuna Fishing Problem Investigative Commission of Japan Offshore Tuna Fishing Association calling for a complete prohibition on waste disposal in an attempt to spread the word among fishers, etc. Pole-and-line fishing does not contribute to the problem of abandoned gear (Japan Fisheries Resource Conservation Association 2010a). The Pelagic Pole-and-Line Tuna Fishing Council on the problem recognized by the Japan Tuna Fisheries Co-operative Association, is taking measures to prohibit waste disposal leading to marine pollution, and to share knowledge with the relevant fishermen. Pole-and-line fishing does not have any problem of abandoned gears (Japan Fisheries Resource Conservation Association 2010b). 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	.	Ecosystem conservation or restoration activities are being actively conducted

3.2 Enforcement System

3.2.1 Management Enforcement

3.2.1.1 Jurisdiction

Most skipjack tuna in the central and western Pacific are caught in tropical areas with most of the rest caught seasonally in the waters around Japan. Stock assessments of skipjack tuna in these areas are performed by a group of experts from the Secretariat of Pacific Committee (SPC) while conservation and management measures of skipjack tunas are discussed at the WCPFC (Kiyofuji 2019). Cooperation with these regional fisheries management organization is maintained by the International Affairs Division of the Fisheries Agency, mainly led by the Tuna Fisheries Office. Japan, Korea, Indonesia, and Papua New Guinea, etc. are catching skipjacks using pole-and-line, purse seines, etc. Medium- and large-scale purse seine pelagic and offshore tuna fisheries using one vessel are directed and managed by the Tuna Fisheries Office of the International Affairs Division, the Fisheries Agency and the Fisheries and Resources Management Division, as ministry-licensed medium- and large-scale purse seine fisheries. Pelagic and offshore skipjack pole-and-line fisheries are directed and controlled by the Tuna Fisheries Pelagic Tuna Fisheries Office of International Affairs Division as ministry-licensed medium- and large-scale tuna fishery. Coastal skipjack pole-and-line fishery is virtually approved by Wide Sea-area Fisheries Adjustment Commission. Organizations of these fishing types include the Japan Far Seas

Purse Seine Fishing Association and Northern Pacific Purse Seine Fishing Association, etc. for medium- and large-scale purse seine fishery, and the Japan Pelagic Tuna Fishing Association, Japan Tuna Fisheries Co-operative Association, Japan Offshore Tuna Fishery Association, and Coastal Fishery Cooperatives of each district are active. As shown above, the management system is well-established. 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 Monitoring System

Japan's Fisheries Agency established the Fisheries Enforcement Headquarters in 2018 to strengthen the control system for appropriate resource management and maintenance of fisheries (Fisheries Agency, 2018a), and cited issues such as prevention of illegal operations in cooperation with international organizations as measures to regulate fisheries (Fisheries Enforcement Headquarters of Fisheries Agency 2019). For the purpose of monitoring international fisheries in the pelagic sea area, vessels Syoyo Maru, Toko Maru, and Hakuryu Maru, of the Fisheries Agency, are mostly deployed there. The installation and constant operation of a vessel monitoring system, which had been mandatory only for fishing vessels engaged in high seas tuna-related operations, is now mandatory for all ministry licensed fishing vessels upon the last simultaneous renewal of the license in 2017 (Fisheries Agency 2017b). Medium- and large-scale purse seiners and offshore and pelagic tuna vessels have the WCPFC observers to be on board as deemed necessary by the Minister of Japan's MAFF to follow the WCPFC conventions (MAFF 2018c). One hundred percent of overseas purse seine fishery boats are required to have observers on board (Nakamae 2013), and so arrangements for recruiting them is among major duties of corresponding fishing organizations (Japan Far Seas Purse Seine Fishing Association, 2019). Fishing results report is 100% submitted. Coastal pole-and-line skipjack tuna fishery requires approval by the Wide Sea-area Fisheries Adjustment Commission making it possible to investigate the number of days of operation as necessary. Procedures of prior confirmation that fish had been caught from vessels included in the positive list (based on the Article 10 of Act on the Special Measures for the Enhancement of Conservation and Management of Tuna Resources, Act No. 101 of June 21, 1996), which were enacted in as measures for preserving tuna resources, strengthening management and consequently contributing to the sustainable development of tuna fishing, stabilizing supply of tunas, importing frozen tuna, etc. have been integrated into the Fisheries Agency since April 1, 2018 (International Affairs Division, Fisheries Agency, 2019). Additionally, as a port nation for foreign fishing boats, Japan is expanding port inspections, exchanging information and cooperating with the Food and Agriculture Organization (FAO) of The United Nations member countries to participate in the enforcement of illegal fisheries. Through effective measures taken by port nations, the Agreement on

Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (PSMA) to prevent, inhibit, and exclude IUU (Illegal, Unreported and Unregulated) fisheries is operating effectively in Japan (Fisheries Agency 2017b). While the monitoring system is sufficient as described above, Japan has been supporting the smooth and reliable implementation of fishery management measures by training human resources and improving systems in Pacific Island countries (especially PNA countries) through the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC), which is part of projects for capacity enhancement of tuna fishery management in developing countries (MAFF 2018b). Under the current situation, it is not possible to determine whether the surveillance system is functioning effectively enough within the WCPFC scope, and therefore a score of 4 points is given instead of the highest score.

1 Point	2 Points	3 Points	4 Points	5 Points
No monitoring activity	Limited monitoring activity around major fishing ports	.	There is a considerable 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, commercial fishing license and permits are revoked and/or a prison term, penalty, or cumulative impositions imposed. This is thought to be an effective penal provision. If the laws are violated in foreign waters, the offenders will be inspected or arrested. 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

In accordance with the management objectives, resource assessment and management measures based on the WCPFC and the SPC, the Ministerial Ordinance on the Permission, Regulation, Etc. of Designated Fisheries have been revised. For highly migratory fish stock and living marine resources in high seas, stock management objectives are set and resource management policies according to fishery type for each species are defined in the control guidelines of the government. It is further defined that optimum stock control be realized by revising the measures based on the stock status and state of fisheries at least once per year. (Fisheries Agency 2018a). In accordance with the management objectives, stock assessment and management measures based on management and related organizations, each resource management policy has been reviewed and the Ministerial Ordinance on the Permission, Regulation, Etc. of Designated Fisheries revised. These activities are evaluated as measures equivalent to adaptive management, and 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 Identifying Resource Users

Since medium- and large-scale purse seine using one vessel pelagic fisheries, medium- and large-scale offshore purse seine using one vessel fisheries, pelagic and offshore tuna pole-and-line fisheries, offshore tuna pole-and-line fishing are specified as ministry licensed fisheries, it is possible to identify fishers engaged in these methods. Since coastal skipjack pole-and-line fishery requires the notification to the minister, it is possible to identify fisheries engaged in it. 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 Fishing Organizations

Medium- and large-scale purse seine pelagic fisheries using one vessel belong to the Japan Far Seas Purse Seine Fishing Association, and medium- and large-scale purse seine offshore fisheries using one vessel mainly belong to the Northern Pacific Purse Seine Fishery Cooperatives. Both are subordinate organizations to the Japan Purse Seine Fisheries Association. Pole-and-line pelagic tuna fisheries belong to the organizations in each prefecture, such as Eastern or Northern Miyagi Tuna Fisheries Co-operative Association. They also belong to Japan Pelagic Tuna Fishers Association and Japan Tuna Fisheries Co-operative Association. Miyazaki offshore pole-and-line fishers belong to Miyazaki Tuna Fishers Association, Federations of Coastal Fishery Cooperative, Japan and Japan Offshore Tuna Fishers Association. Kochi Coastal pole-and-line fisheries belong to the local Coastal Fishery Cooperative. All fisheries operating targeted fisheries belong to fishers Associations. 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

It is specified in resource management policy enacted by the Japanese government that the effort towards the appropriate stock management measures of tunas in the central and western Pacific region approved in WCPFC be continued so that fishing pressure may not be increased. Therefore, it is claimed that fishermen catching them, namely overseas purse seine fishery, large- and medium-scale purse seine fishery, pelagic pole-and-line tuna fishery, and offshore pole-and-line fishery, should comply not only to the public measures such as conservation and management measures by regional fisheries management organization, etc., but also voluntary measures, such as suspending the fishery. (Fisheries Agency 2018a). It is actually implemented in stock management plan of each fishery (Fisheries Agency 2014). The resource management policy of Kochi specifies that it is necessary to endeavor to decide fishing suspension days as a voluntary measure to reduce catching fishing effort of coastal pole-and-line tuna fishing (Kochi 2018). Stock management plan along that was formulated and implemented by boats registered to branches of Kochi Fishery Cooperatives. The fishery management activities of fishing organizations have a certain degree of influence, and the fisheries cooperatives themselves organize their own activities to realize effective management measures (Organization for the Promotion of Responsible Tuna Fisheries (OPRT) 2018a, 2018b). Judging from the above, a score of 4 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 influence 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

With regard to the medium- and large-scale purse seine pelagic fisheries using one boat, Japan Far Seas Purse Seine Fishing Association (2018) has led the demonstration projects of planned and efficient implementation of stock management type fishing boats with the labor environment improved as Far Seas Fishing Regional Project III. Japan Far Seas Purse Seine Fishing Association (2016) has led the demonstration project of recovering profitability by effective utilization of existing fishing vessels as Far Seas Fishing Regional Project II. Japan Far Seas Purse Seine Fishing Association (2013) has led a reformed fishing vessel plan as Far Seas Fishing Regional Project. In all of the above projects, landing in Makurazaki, Yamakawa, Yaizu ports and stabilization of the supply are planned. Japan Far Seas Purse Seine Fishing Association (2012) has led a demonstration project of the joint venture with Micronesia as Makurazaki Regional Project for Skipjack Tuna. Japan Far Seas Purse Seine Fishing Association (2009) has led a demonstration project of the joint venture with Papua New Guinea. As for medium- and large-scale single boat purse seine offshore fisheries, Shizuoka Purse Seine Fishing Association (2009) has led the project mainly constituted by improving profitability to enable stable management and restructuring the system to distribute the landed fish as Shizuoka Purse Seine Fisheries Cooperative Regional Project. Japan Tuna Fisheries Co-operative Association (2017) has led the demonstration project of implementing reformed fishing vessels as Pelagic Skipjack Pole-and-line Fishery Project (Reformed fishing vessels (Shiogama)). As for pelagic pole-and-line tuna fishery, Japan Tuna Fisheries Co-operative Association (2016a) has led the demonstration project of reformed fishing vessels as Pelagic Skipjack Pole-and-line Fishery Project (Reformed fishing vessels (Yaizu ③)). Japan Tuna Fisheries Co-operative Association (2016b) has led the demonstration project of improving profitability by implementing innovative fishery boats as Pelagic Skipjack Pole-and-line Fishery Project (Reformed fishing vessels (Owase)). As for offshore pole-and-line fishery, Japan Nearshore Tuna Fishing Association (2015) has led the demonstration project as an Nearshore Tuna Regional Project Reform Plan (Nichinan/Nangou Area Local Subcommittee: Offshore Skipjack Tuna Pole-and-Line Fishery ②).

Miyazaki has registered *Nichinan Katsuo*, skipjack tunas caught in offshore by pole-and-line fishery (National Pride-Fish Miyazaki 2019), and Kochi has registered *Tosa Saga Himodori Katsuo* (fresh skipjack tunas caught on the day in Tosa Saga) (National Pride-Fish Kochi 2019) to Pride Fish, operated by Japan Federations of Fishery Cooperatives and federation of prefectural fisheries cooperative associations, to promote their sales. Japan Tuna Fisheries Cooperative Association has organized Japan Tuna Fisheries Corporation to sell the seafoods they caught and manages the selling business in order to maintain suitable price (Japan Tuna Fisheries Corporation 2019). Although the achievement may not be sufficient, activities could be highly evaluated. Since, as described above, fishers' organizations are performing all activities of management and selling, Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No activity by fishing organizations	.	Some activities 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 of tuna fishing organizations have attended meetings such as the WCPFC annual meetings and the SPC meetings. They have also attended the consultations with WCPFC-related Island countries: Japan-Kiribati Fisheries Consultations, Japan-Solomon Fisheries Consultations, Japan-Papua New Guinea Fisheries Consultations, and Japan-Micronesia Fisheries Consultations. Not all relevant fishing organizations attend all meetings, but several organizations were in attendance, i.e., the Japan Far Seas Purse Seine Fishing Association, All Japan Offshore Tuna Fisheries Association, the Japan Pelagic Tuna Fisheries Co-operative Association, and the Japan Tuna Fisheries Co-operative Association. The annual meetings of the regional fishery management organizations have a term of around five days, and the inter-country meetings have a term of about two or three days. Each organization has its own board of directors and holds general meetings to discuss fishery management issues and related topics. In addition, they hold meetings with like organizations. Related organizations (Japan Tuna Fisheries Co-operative Association, Japan Far Seas Purse Seine Fishing Association, Japan Federation of Northern Pacific Purse Seine Fishery Cooperatives, Japan Offshore Tuna Fisheries Co-operative Association, and Japan Federations of Fishery Cooperatives) participate in International Research & Development about Aquatic Resource Promotion Meeting held by National Research Institute of Far Seas Fisheries of Japan Fisheries Research and Education Agency, where research & development about tuna resource and where current situation of cooperation, situation of tuna resource, and needs of research are explained and discussed. They present the report of related matters and request, and exchange opinions there. In addition, they hold meetings with like organizations, and it is thought that there are meetings of 12 days or more but less than 24 days per 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 Stakeholders in Public Management

Prefectures where offshore and coastal pole-and-line fishing is operated have representatives, who are elected from among their members, to participate in Pacific Ocean Wide Sea-area Fisheries Adjustment Commission (Fisheries Agency, 2019a). Fishers of Tottori and Nagasaki operating medium- and large-scale single boat purse seine pelagic and offshore tuna fishery participate in Sea of Japan / Western Kyushu Wide Sea-area Fisheries Adjustment Commission (Fisheries Agency 2019b). For Resource Management Subcommittee of the Fisheries Policy Council, a director is selected from Japan Federations of Fishery Cooperatives, which is the superstructure of Coastal Fishery Cooperatives which coastal and offshore skipjack pole-and-line fishers belong to and medium- and large-scale single boat purse seine pelagic tuna fishers are selected in Tokyo. Both of them attend at the subcommittee, the former as a committee member and the latter as a special member. Since it is evaluated that they are appropriately participating (Fisheries Agency 2019c), Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Near no participation	.	Formal or limitedparticipation	.	Proper participation

3.3.2.3 Widespread Stakeholder Involvement

Although the species is not subject to total allowable catch (TAC), it is managed as highly migrating species by regional fisheries management organization. It is often discussed about the species as the one of fish to be specified in the resource management policy in Resource Management Subcommittee of the Fisheries Policy Council these days, and representatives of labor unions organized by crews of fishery boats and dock workers, anglers' organization, distributors, and WWF Japan participate in the Resource Management Subcommittee as members or extraordinary members. (Fisheries Agency 2019c). Annual meetings of WCPFC and its Science Committee also have representative of NGOs. It is concluded that almost all major stakeholders are effectively involved. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Near no involvement	.	Partial or limited involvement	.	Nearly all key stakeholders are effectively involved

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4. Regional Sustainability

Overview

Status of Fisheries Production (section 4.1)

Most skipjack tuna caught in the central and western Pacific Ocean are fished by medium- and large-scale single-vessel purse seine pelagic methods (Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, Nagasaki), medium- and large-scale single-vessel purse seine offshore method (Shizuoka), pole-and-line pelagic method (Miyagi, Shizuoka, Mie), pole-and-line offshore method (Miyazaki), pole-and-line coastal method (Kochi). Fishery income trended at medium level (3 points for item 4.1.1.1). Profitability trends and fishery assets are obtained from national averages for company organization, resulting that the score for 4.1.1.2 is as low as 1 point and the score for 4.1.1.3 is medium at 3 points. As for stability of the operation, both the stability of income and of catch earned 3 points (medium level). Financial statuses of fishing organizations scored 2 points due to so few of them disclosing financial statements. Stability of operations had scores as high as 4. Contribution to local employment is evaluated as high (5 points for item 4.1.3.2). For fairness of working conditions, there were no problems reported (3 points for item 4.1.3.3).

Status of Processing and Distribution (section 4.2)

While there were numerous small-scale markets in the prefectures evaluated, most skipjack tuna landed in base markets where the number of buyers are proportional to the volume (5 points for item 4.2.1.1). So, in general, the principle of competition is working in both bidding and tender (4 points for item 4.2.1.2). While tariff rate is basically 5%, it is 3.5% for WTO and ASEAN, and 0 or 1.8 to 2 % for several countries with special tariff preferences or EPA (4 points for item 4.2.1.3). Sanitation is thoroughly managed according to the wholesale market development project (5 points for item 4.2.2.1). Sales included a variety of customers, including purchasing for both luxurious and casual purposes (4 points for item 4.2.2.2). There was no significant problem in the fairness of labor condition (5 points for item 4.2.3.3). From the above information, sustainability of processing and distribution industry in these areas can be evaluated as high.

Regional Status (section 4.3)

Both implementation and spread of advanced technologies are ongoing (5 points for item 4.3.1.2), and logistics systems were also well developed. (5 points for item 4.3.1.3). Financial statuses of prefectural governments are 3 points on average (4.3.2.1). Income levels of people involved in fisheries are at a high standard (5 points for 4.3.2.2). Both pole-and-line and purse seine fisheries are using traditional gears and methods (5 points for item 4.3.3.1). While traditional processing and distribution technologies are well maintained, new usages are also being developed (5 points for item 4.3.3.2).

Outline

(1) Identification of target fisheries

Medium- and large-scale single boat purse seine pelagic tuna fisheries (Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, Nagasaki), medium- and large-scale single vessel offshore tuna fisheries (Shizuoka), pole-and-line pelagic tuna fisheries (Miyagi, Shizuoka, Mie), offshore skipjack pole-and-line fisheries (Miyazaki), coastal skipjack pole-and-line fisheries (Kochi)

(2) Identification of target prefectures

Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, Kochi, Nagasaki and Miyazaki

(3) Collection and description of information on target fishing methods

Below items and other information added in each section are to be collected on the fisheries and related industries in each target prefecture.

1) Basic information on fishing methods, limitations, etc.
2) Annual landing volumes and values for the past 11 years
3) Fisheries-related assets
4) Return-on-investment ratio
5) Annual average income of those involved in fisheries compared to regional average income
6) Financial indicator of each local government

4.1 Status of Fisheries Production

4.1.1 Fisheries-related assets

4.1.1.1 Fishery Income Trends

For trends of fisheries income, fisheries amount of money of skipjack tuna calculated in 4.1.2.1 are used. The ratio of fisheries income in the last year to the average of the highest three years in the past 10 years for each prefecture was calculated. The simple average is about 0.77. Consequently, a score of 3 points is given (Miyagi: 3 points, Kanagawa: NA, Tokyo: NA, Niigata: NA, Shizuoka: 3 points, Mie: NA, Tottori: NA, Kochi: 3 points, Nagasaki: NA, Miyazaki: 3 points).

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 there are no data sorted by fishery type and prefecture at the same time in the fishery management surveys (Ministry of Agriculture, Forestry, and Fisheries: "Research of Fishery Management"), analyses are performed with data sorted by fishery type. Among target fisheries, data on medium- and large-scale purse seine fisheries (200-500 tons), medium- and large-scale purse fisheries (500 tons or above), and pelagic and offshore skipjack pole-and-line fisheries (100-200 tons) are used in the analysis. The average of (Profit of Fishing / Capital Employed in Fishery) for years 2013-2017 is, for medium- and large-scale purse seines (200-500 tons), -0.11, with negative profit in four out of five years (Value was not obtained in one year). Consequently, a score of 1 point is given. For medium- and large-scale purse seine fisheries (500 tons+), the score is 1 point because negative profits had been recorded for five years. For pelagic and offshore skipjack pole-and-line fisheries (100-200 tons), the score is 1 point, because there were no profitable years. Consequently, a score of 1 point is given.

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 no data were compiled by fishery type and prefecture at the same time in the fishery management surveys years 2008-2017 (MAFF "Fishery Management Research"), analysis is performed using data compiled by fishery type. Among target fisheries, medium- and large-scale purse seine fisheries (200-500 tons), medium- and large-scale (500+ tons), and pelagic and offshore skipjack pole-and-line fisheries (100-200 tons) operated in company organizations are used in the analysis. Regarding the report of company organization: there are data for only four years regarding medium- and large-scale purse seine fisheries (200-500 tons). The three years with the biggest total investment are 2014, 2016, and 2017. Since the latest value, in 2017, is 86% of the average for the three years, Consequently, a score of 4 points is given. As for medium- and large-scale purse seine fisheries (500+tons), the three years with the largest total investment are 2014, 2015, and 2016. Since the latest value in 2017 are 94% of the average for the three years, a score of 4 points is given. As for medium- and large-scale purse seine fisheries (500+ tons), the three years with the biggest total investment are 2014, 2015, and 2016. Since the latest value, in 2017, is 94 % of the average for these years, Consequently, a score of 4 points is given. As for pelagic and offshore skipjack pole-and-line fisheries, the three years with the largest total investment are 2008, 2009, and 2011. Since the latest value, in 2017, are 35% of the average for these three years, a score of 1 point is given. As score of 3 points (the average of the three) are given.

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 cash amounts of catches by fishery type are not published in the Annual Statistical Report of Fisheries and Aquaculture Production published by MAFF, the ratio of the caught by the target fishery to the total catch of skipjack tuna of the prefecture is computed annually (MAFF “Annual Statistical Report of Fisheries and Aquaculture Production”) and then the amount of cash taken for skipjack tuna by fishery type is computed in each prefecture by the total amount of cash multiplying the ratio of fishery production by fishery type in total amount in each prefecture (MAFF, “Fishery Production by Kind of Fish”). The stability of the catch income of skipjack tuna for each fishery for the past 10 years (2006-2015) is evaluated. The ratio of the average of catch income to the standard deviation for the 10 years is computed, then the simple average is 0.22 is taken. Consequently, a score of 3 points is given (Miyagi: 3 points, Kanagawa: 3 points, Tokyo: NA, Niigata: NA, Shizuoka: 3 points, Mie: NA, Tottori: NA, Kochi: 3 points, Nagasaki: NA, Miyazaki: 5 points).

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

MAFF’s Annual Statistical Report of Fisheries and Aquaculture Production are referred to evaluate the stability of skipjack tuna fishery during the past 10 years (2006-2015) (MAFF, “Annual Statistical Report of Fisheries and Aquaculture Production”). The ratio of average annual catch for the past 10 years to its standard deviation is about 0.23. Consequently, a score of 3 points is given. (Miyagi: 3 points, Kanagawa: 3 points, Tokyo: NA, Niigata: NA, Shizuoka: 3 points, Mie: 4 points, Tottori: NA, Kochi: 3 points, Nagasaki: NA, Miyazaki: 3 points).

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 Financial Status of Commercial Fishing Organizations

The managing bodies of medium- and large-scale purse seine fisheries in Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, and Nagasaki Prefectures belong to the Northern Pacific Ocean Federation of Purse Seine Fishery Cooperatives, Japan Far Seas Purse Seine Fishing Association, Shizuoka Purse Seine Fishers' Association, Aichi-Mie Medium- and large-scale Purse Seine Fishers' Association, Northern Sea of Japan Purse Seine Fishers' Association, San-in Purse Seine Fisheries Cooperative Association, and Japan Pelagic Purse Seine Fisheries Cooperative Association, etc. Financial data for these organization were not published. The managing bodies of Miyagi, Shizuoka, and Mie Prefectures belong to the Japan Tuna Fisheries Co-operative Association, etc., with financial data not published. The managing bodies of offshore and coastal skipjack pole-and-line fishing in Miyazaki and Kochi Prefectures belong to the Coastal Fisheries Cooperative Association. Normal profits for both prefectures (by prefecture) are positive (MAFF 2018).

Consequently, the scores are as follows: medium- and large-scale single vessel purse seine pelagic fisheries (Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, Nagasaki)×1 point＋Medium- and large-scale single boat purse seine offshore fisheries (Shizuoka)×1 point＋pelagic skipjack pole-and-line fishing (Miyagi, Shizuoka, Mie)×1 point + offshore skipjack pole-and-line fishing (Miyazaki)×5 points + coastal skipjack pole-and-line fishing (Kochi)×5 points. Then the average value is to 1.57. Consequently, a score of 2 points (the rounded value), is given

1 Point	2 Points	3 Points	4 Points	5 Points
Ordinary profits are in the red or no information	.	.	.	Ordinary profits are in the black

4.1.3 Working Status

4.1.3.1 Operational Safety

The number of fatalities due to occupational and marine accidents in the fishery industries in each prefecture in 2017 are, 3 in Miyagi, 0 in Tokyo, 2 in Kanagawa, 0 in Niigata, 0 in Shizuoka, 2 in Mie, 1 in Tottori, 0 in Kochi, 1 in Nagasaki, 1 in Miyazaki (Miyagi LBMHLW 2018, Tokyo LBMHLW 2018, Kanagawa LBMHLW 2018, Niigata LBMHLW 2018, Shizuoka LBMHLW 2018, Mie LBMHLW 2018, Tottori LBMHLW 2018, Kouchi LBMHLW 2018, Nagasaki LBMHLW 2018, Miyazaki LBMHLW 2018, Japan Transport Safety Board 2019). Although most fatalities were identified as irrelevant to the target fisheries, fishery type could not be identified in the case of Mie Prefecture. Since the possibility that the accident occurred in target fisheries could not be ruled out, safety is evaluated on the assumption that the accident occurred in the target fishery. Since the number of fishermen by fishery type is not available, and the number of workers in the fishing industry by prefecture is available, safety is evaluated with data from the number of workers by prefecture. The number of fishermen working on the sea are, according to the latest available data (2013), 7,791 in Mie (MAFF 2015). Therefore, the annual number of fatalities per 1,000 people is 0 in Miyagi, 0 in Tokyo, 0 in Kanagawa, 0 in Niigata, 0 in Shizuoka, 0 in Mie, 0.1284, 0 in Tottori, 0 in Kochi, 0 in Nagasaki, and 0 in Miyazaki. The average is 0.0128.

Consequently, a score of 5 points is given. Additionally, the scores for by prefecture are, 5 points for Miyagi, 5 points for Tokyo, 5 points for Kanagawa, 5 points for Niigata, 5 points for Shizuoka, 5 points for Mie, 5 points for Tottori, 5 points for Kochi, 5 points for Nagasaki, and 5 points for Miyazaki.

1 Point	2 Points	3 Points	4 Points	5 Points
More than 1.0 fatal accidents per 1,000 fishermen per fishing season	0.75-less than 1.0	0.5-less than 0.75	0.25-less than 0.5	Less than 0.25 fatal accidents per 1,000 fishermen per fishing season

4.1.3.2 Contributions to Local Employment

According to each plan of the Comprehensive Project for Japan's Fisheries Structural Reform (Fishing Industry/Communities Promotion Organization 2019), although the proportion of foreign workers in fisheries catching skipjack tuna varies widely, the number itself is not low. However, since it has been established that the number of apprentices shall not exceed the number of other crew members in fisheries operated at sea, this rule also applies to foreign workers engaged in technical intern training programs (Japan International Cooperation Organization 2019), the number shall not exceed 50%. Additionally, it has been established that fisheries cooperatives shall provide an address where fisheries are operated (Article 1, Chapter 5 of the Fishery Cooperatives Act) and their members are housed (paragraph 18, Article 4, Chapter 2 of the above act). The federations of fisheries cooperatives shall also provide addresses in their areas (Article 88, Chapter 4 of the above act). Consequently, virtually all fishers including foreign workers shall live or work within these areas and it can be concluded that they contribute to local economies. 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 January 4, 2019, the number of published cases of Labor Standards Act violations sent to prosecutors were 4 in Miyagi, 23 in Tokyo, 17 in Kanagawa, 15 in Shizuoka, 10 in Mie, 13 in Niigata, 0 in Tottori, 5 in Shimane, 9 in Kochi, 5 in Nagasaki, 9 in Oita, 3 in Miyazaki, 6 in Kagoshima, 13 in Okinawa (Self Career Design Association 2019). While cases such as failure to pay wages, paying wages less than the minimum, and forcing illegal overtime work to foreign technical interns in other industries also exist, labor conditions in skipjack tuna fisheries can be regarded substantially fair. Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Aside from skill-based pay differences and commission systems, treatment is extremely bad for some employees	.	Aside from skill-based pay differences and commission systems, treatment is not extremely different among employees	.	Aside from skill-based pay differences and commission systems, treatment is fair among employees

4.2 Processing and Distribution Status

Situations of the target prefectures where central and western Pacific Ocean skipjack tuna are landed are analyzed in this section.

4.2.1 Market Pricing

Here, the status of price formation at each landing port (landing market) is evaluated.

4.2.1.1 Buyers

Ten landing ports have fish markets in Miyagi Prefecture. While there is one market with an annual volume of less than 100 tons, there are two markets with annual volumes of 100-500 tons, and five base markets with 10,000+ tons, which constitutes 50 % of all. Taking the number of buyers into account, the number of markets with 50 or more buyers registered is seven, markets with 20- less than 50 is one, markets with 10-less than 20 is one. There is only one market with fewer than five buyers. The number of buyers of small volumes is reasonable for the trade volume of the market. Principles of competition are generally working in biddings and auction trading (The 2013 Census of Fisheries, MAFF 2015).

Eight landing ports have fish markets in Tokyo. While there are three markets with annual volumes of 100 to 500 tons among them, two are medium-scale market with annual volume of 500 to 1,000+ tons, and two are with 1 to 30,000 tons. Taking the number of buyers into account, the number of markets with 50+ buyers is one, one market has 20-50 buyers, six markets have 20-50 buyers, and four markets have 10-20 buyers. There is one market with fewer than 10 buyers. Principles of competition are generally working in biddings and auction trading (The 2013 Census of Fisheries, MAFF 2015).

Fourteen landing ports have fish markets in Kanagawa. While there are two markets with annual volumes fewer than 100 tons, six markets are of medium scale, with the annual volume of 1,000-5,000 tons, and six are of 1-100 thousand tons. Taking the number of buyers into account, the number of markets with 50+ buyers is seven, four markets have 20-50 buyers, and three have 10-20 buyers. On the other hand, there are no markets with fewer than 10 buyers. The number of buyers small-volume is reasonable for the trade volume of the market. Principles of competition are generally working in biddings and auction trading (The 2013 Census of Fisheries, MAFF 2015).

Thirty-one landing ports have fish markets in Shizuoka Prefecture. While there are 15 market with annual volumes of 100-500 tons, 10 markets are medium-scale with annual volumes of 500-5,000 tons, and seven markets have 5000 tons or above. Noticing the number of buyers, there are nine markets with 50 buyers or more registered, 12 markets have 20-50 buyers, and three markets have 10-20 buyers. On the other hand, there are small markets with fewer than five buyers. Since there are cases in which brokers do not participate in biddings or auctions in small-scale markets (depending on characteristics of seafoods), there are some cases in which the principles competition in biddings and auction trading do not work (The 2013 Census of Fisheries, MAFF 2015).

Fifty-two landing ports have fish markets in Mie Prefecture. There are 13 markets with annual volumes of less than 100 tons, 17 markets with 100-500 tons. Taking the number of buyers into account, there are six markets with 50 or more buyers registered, 16 markets with 20-50 buyers, 21 markets with 10-

20 registered buyers. On the other hand, there are three markets with fewer than five buyers. Since there are cases in which brokers do not participate in biddings or auctions in small-scale markets (depending on characteristics of seafoods), there are some cases in which the principles competition in biddings and auction trading do not work (The 2013 Census of Fisheries, MAFF 2015).

Eighteen landing ports have fish markets in Niigata Prefecture. While there are six markets with annual volumes of 100-500 tons, there are six medium-scale markets with annual volumes of 500-5,000 tons, there are six markets with 5000 tons or more. Taking the number of buyers into account, while there are 14 markets with 50 or more buyers registered, three with 20-50 buyers, one with 10-20, there are no small-scale markets with fewer than 10 buyers. The number of buyers of small volumes is reasonable for the trade volume of the market. Principles of competition are generally working in biddings and auction trading (The 2013 Census of Fisheries, MAFF 2015).

Eight landing ports have fish markets in Tottori Prefecture. There are two markets with annual volumes of 500 tons or less, and five markets with annual volumes of 1000-5000 tons. Taking the number of buyers into account, there are three markets with 50 or more buyers registered, two markets with 20-50 buyers, three markets with 10-20 buyers, with many buyers participating in bidding and auctions (The 2013 Census of Fisheries, MAFF 2015).

Forty-one landing ports have fish markets in Kochi Prefecture. Among them, while there are 26 markets with annual volumes of less than 500 tons, 13 markets are medium-scale with annual volumes of 500-5,000 tons, two markets have a million tons or above. Taking the number of buyers into account, there are six markets with 50 or more buyers registered, eight markets with 20-50 buyers, and 13 markets with 10-20 registered buyers. On the other hand, there are seven small-scale markets with fewer than five buyers. Since there are cases in which brokers do not participate in biddings or auctions in small-scale markets (depending on characteristics of seafoods), there are some cases in which the principles competition in biddings and auction trading do not work (The 2013 Census of Fisheries, MAFF 2015).

Twenty-six landing ports have fish markets in Nagasaki Prefecture. While there are 16 markets with annual volumes fewer than 500 tons, six markets are medium-scale with annual volumes of 500-3,000 tons, four markets have 5,000 tons or more. Taking the number of buyers into account, there are two markets with 50 or more buyers registered, 11 markets have 20-50, and five have 10-20 buyers. On the other hand, there are two small markets with buyers of fewer than five. Since there are cases in which brokers do not participate in biddings or auctions in small-scale markets (depending on characteristics of seafoods), there are some cases in which the principles competition in biddings and auction trading do not work (The 2013 Census of Fisheries, MAFF 2015).

Eighteen landing ports have fish markets in Miyazaki. There are two markets with annual volumes less than 100 tons, three markets have 100-500 tons. Taking the number of buyers into account, four markets have 50 or more buyers registered, 10 markets have 20-50 buyers. Since there are cases in which brokers do not participate in biddings or auctions in small-scale markets (depending on characteristics of seafoods), there are some cases in which the principles competition in biddings and auction trading do not work (The 2013 Census of Fisheries, MAFF 2015).

There are numerous buyers registered to resident markets in Miyagi, Tokyo, Kanagawa, Niigata, and Tottori Prefectures. Consequently, it can be concluded that market competition principles are working and fair pricing is executed. On the other hand, Shizuoka, Mie, Kochi, Nagasaki, and Miyazaki Prefectures have many small-scale markets. There are few numbers port landings and therefore buyers are few. Since there are cases in which brokers do not participate in biddings or auctions in such small-scale markets (depending on characteristics of seafoods), there are some cases in which the principles competition in biddings and auction trading do not work. Scores for each prefecture are, 5 points for Miyagi, 5 points for Tokyo, 5 points for Kanagawa, 5 points for Niigata, 5 points for Tottori, 4.5 points for Shizuoka, 4.5 points for Mie, 4.5 points for Kochi, 4.5 points for Nagasaki, 4.5 points for Miyazaki. The overall score is 4.8. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
No informationavailable	.	There are few buyers	.	There are many buyers

4.2.1.2 Availability of Market Information

Guarantees of fairness in trading and principles of competition as well as the development of facilities, guarantees of safety, and allocations of personnel are described in the wholesale market development projects prepared by each prefecture. Information about landings, deliveries, starting times for biddings and auctions, locations of the market, etc. are also posted in the public places, sent to brokers via phone, FAX, etc. The information is thus fairly provided to brokers (Miyagi 2016, Tokyo 2017, Kanagawa 2017, Shizuoka 2016, Mie 2016, Niigata 2017, Tottori 2002, Kochi 2017, Nagasaki 2017, Miyazaki 2016). Because of these, principle of competition is working in bidding and auction to form the price fairly. 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

Current effective import tariff rate for raw and frozen skipjack tuna is basically 5%, but are 3.5% for WTO and ASEAN, and none or 1.8-2% for several countries with special preference or EPA (Japan Customs, 2019). Additionally, there are no nontariff barriers, such as import quotas (METI, 2017). Evaluations are calculated by averaging the tariff (3 points) and nontariff barriers (5 points) Consequently, a score of 4 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 Creating Added Value

The circumstances in which value is added to landed seafood by processing and distribution industries are evaluated here.

4.2.2.1 Hygiene Management

In Miyagi Prefecture, resident wholesale markets and small-scale markets are managed according to sanitary standards enacted by the prefecture and municipalities in accordance with the 10th Miyagi Wholesale Market Development Project (Miyagi 2016). Additionally, the Miyagi Food Hygiene Meister System is established to thoroughly manage hygiene (Miyagi 2017). Additionally, the Sendai City Food Hygiene Self-Management and Evaluation System was enacted in Sendai City (Sendai HACCP) to thoroughly manage hygiene (Sendai City 2019).

In Tokyo, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by the prefecture and municipalities in accordance with the 10th Tokyo Wholesale Market Development Project (Tokyo 2017). Additionally, the Tokyo Food Hygiene Self-Management and Evaluation System (established in August 2004) was enacted to thoroughly manage hygiene (Tokyo 2003).

In Kanagawa Prefecture, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by the prefecture and municipalities in accordance with the 10th Kanagawa Wholesale Market Development Project (Kanagawa 2017). Additionally, the Kanagawa Food Safety and Security Assurance Regulations (established in July 2004) was enacted to thoroughly manage hygiene (Kanagawa 2009).

In Shizuoka Prefecture, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by the prefecture and municipalities in accordance with the 10th Shizuoka Wholesale Market Development Project (Shizuoka 2016).

In Mie Prefecture, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by the prefecture and municipalities in accordance with the 10th Mie Wholesale Market Development Project (Mie 2016). Additionally, Mie Food Hygiene Self-Management and Evaluation System was enacted to thoroughly manage hygiene (Mie 2019). Also, the Toushi Intensive Local Wholesale Market of the Toba Isobe Fishery Cooperative in Mie is qualified as a resident market executing advanced quality and hygiene management (Fishing Boat and System Engineering Association 2018).

In Niigata Prefecture, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by prefecture and municipalities in accordance with the 10th Niigata Wholesale Market Development Project (Niigata 2017). Additionally, the Niigata Food Safety and Security Assurance Regulation was enacted to thoroughly manage hygiene (Niigata 2005).

In Tottori Prefecture, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by prefecture and municipalities in accordance with the 7th Tottori Wholesale Market Development Project (Tottori 2002). Additionally, the Tottori HACCP-

Compliant Facility Certification System was enacted to thoroughly manage hygiene (Tottori 2019).
In Kochi Prefecture, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by prefecture and municipalities in accordance with the 9th Kochi Wholesale Market Development Project (Kochi 2017). Additionally, the Kochi Food Comprehensive Sanitation Management and Certification System was enacted to thoroughly manage hygiene (Kochi 2019).
In Nagasaki Prefecture, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by prefecture and municipalities in accordance with the 10th Nagasaki Wholesale Market Development Project" (Nagasaki 2017). Additionally, the Nagasaki Food Hygiene Self-Management and Evaluation System was enacted (Nagasaki HACCP) to thoroughly manage hygiene (Nagasaki 2014).
In Miyazaki Prefecture, resident wholesale and small-scale markets in the prefecture are managed according to sanitary standards enacted by prefecture and municipalities in accordance with the 10th Miyazaki Wholesale Market Development Project (Miyazaki 2016). Additionally, thorough hygiene management is attempted with the Food Hygiene Monitoring and Direction Plan (Miyazaki 2019).

As described above, all prefectures manage resident wholesale and small-scale markets are managed according to sanitary standards enacted by prefectures and municipalities in accordance with wholesale market development projects that are revised every five years. Additionally, all prefectures have enacted self-management and qualification systems to secure food safety, thoroughly managing hygiene together with strict management in accordance with local sanitary standards. Consequently, a score of 5 points is given.

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 Pattern

Skipjack tuna caught by pole-and-line are used for high-quality consumption such as *sashimi* and *tataki*, while those caught by purse seine are used for casual consumer products, such as dried bonito (for which most of them are used), and processed *tataki* (frozen), with overall consumption fringing from luxury and casual use (Baba 2011). Therefore, medium- and large-scale purse seine using one vessel pelagic fisheries (Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, Nagasaki)×3 points＋medium- and large-scale purse seine using one vessel offshore fisheries (Shizuoka)×3 points ＋pelagic skipjack pole-and-line fishery (Miyagi, Shizuoka, Mie)×5 points＋offshore skipjack pole-and-line fishery(Miyazaki) × 5 points ＋ coastal skipjack pole-and-line fishery (Kochi) × 5 points arithmetically averaged to obtain 3.71. Consequently, a score of 4 points is given (rounded value).

1 Point	2 Points	3 Points	4 Points	5 Points
Fish meal, animal feed, prey, or unused	.	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 Status

4.2.3.1 Labor Safety

The number of fatalities in food manufacturing in each prefecture in 2017 was, 0 in Miyagi, 0 in Tokyo, 2 in Kanagawa, 1 in Niigata, and 5 in Shizuoka (since three of these cases were obviously of the result of other industries than seafood processing, the number shall be 2), 0 in Mie, 0 in Tottori, 0 in Kochi, 0 in Nagasaki, 0 in Miyazaki (Miyagi LBMHLW 2018, Tokyo LBMHLW 2018, Kanagawa LBMHLW 2018, Niigata LBMHLW 2018, Shizuoka LBMHLW 2018, Mie LBMHLW 2018, Tottori LBMHLW 2018, Kouchi LBMHLW 2018, Nagasaki LBMHLW 2018, Miyazaki LBMHLW 2018). The number of workers engaged in food manufacturing is, according to the latest available data (2017), 49,353 in Kanagawa, 34,046 in Niigata, Shizuoka 46,248 (METI 2018). Therefore, annual fatalities per thousand people is, 0 in Miyagi, 0 in Tokyo, 0.0405 in Kanagawa, 0.0294 in Niigata, 0.0432 in Shizuoka, 0 in Mie, 0 in Tottori, 0 in Kochi, 0 in Nagasaki, and 0 in Miyazaki. The average is 0.011. Consequently, a score of 5 points is given. Additionally, the evaluations of each prefecture are, 5 points to Miyagi, 5 points to Tokyo, 5 points to Kanagawa, 5 points to Niigata, 5 points to Shizuoka, 5 points to Mie, 5 points to Tottori, 5 points to Kochi, 5 points to Nagasaki, and 5 points to Miyazaki.

1 Point	2 Points	3 Points	4 Points	5 Points
More than 1 fatal accidents per 1,000 workers annually	0.6 or more but less than 1	0.3 or more but less than 0.6	0.1 or more but less than 0.3	Less than 0.1 fatal accidents per 1,000 fishermen per fishing season

4.2.3.2 Contributions to Local Employment

According to the Fisheries Processing Industry Management Survey (Fisheries Agency 2017), a simple average of the number of seafood processing companies in prefectures catching skipjack tunas is 1.65 times the national average. Consequently, a score of 4 points is given. (Miyagi: 5 points, Kanagawa: 4 points, Tokyo: 4 points, Niigata: 3 points, Shizuoka: 5 points, Mie: 3 points, Tottori: 2 points, Kochi: 3 points, Nagasaki: 4 points, Miyazaki: 3 points).

1 Point	2 Points	3 Points	4 Points	5 Points
Under 0.3	0.3 or more but less than 0.5	0.5 or more but less than 1.0	1.0 or more but less than 2.0	Over 2

4.2.3.3 Fairness of Working Conditions

As of January 4, 2019, the number of published cases of Labor Standards Act violations sent to prosecutors was 4 in Miyagi, 23 in Tokyo, 17 in Kanagawa, 15 in Shizuoka, 10 in Mie, 13 in Niigata, 0 in Tottori, 9 in Kochi, 5 in Nagasaki, 3 in Miyazaki (Self Career Design Association 2019). While there were cases such as failure to pay wages, paying less than minimum wages, and forcing illegal overtime work on foreign technical interns in other industries, labor conditions in skipjack tuna processing and distribution can be regarded substantially fair. Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Aside from skill-based pay differences and commission systems, 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

The number of refrigerating plants in Miyagi Prefecture is 183, with cold storage capacity at 494,183 tons (2.761 tons per plant with refrigerating capacities), the daily freezing capacity is 6,551 tons (52 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Tokyo Metropolitan is 137, with cold storage capacity at 1,390,484 tons (10,300 tons per plant with refrigerating capacities), the daily freezing capacity is 2,641 tons (53 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Kanagawa Prefecture is 120, with cold storage capacity at 853,565 tons (7,295 tons per plant with refrigerating capacities), the daily freezing capacity is 2,662 tons (44 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Shizuoka Prefecture is 314, with cold storage capacity at 605,426 tons (1,972 tons per plant with refrigerating capacities), the daily freezing capacity is 17,4 tons (96 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Mie Prefecture is 182, with cold storage capacity at 103,484 tons (569 tons per plant with refrigerating capacities), the daily freezing capacity is 3,600 tons (20 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Niigata Prefecture is 123, with cold storage capacity at 97,107 ton (830 tons per plant with refrigerating capacities), the daily freezing capacity is 7,908 tons (111 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Tottori Prefecture is 65, with cold storage capacity at 122,982 tons

(1,921.6 tons per plant with refrigerating capacities), the daily freezing capacity is 2,240 tons (35 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Kochi Prefecture is 92, with cold storage capacity at 33,618 ton (378 tons per plant with refrigerating capacities), the daily freezing capacity is 3,213 tons (55 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Nagasaki Prefecture is 239, with cold storage capacity at 205,222 tons (908 tons per plant with refrigerating capacities), the daily freezing capacity is 4,367 tons (24 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

The number of refrigerating plants in Miyazaki Prefecture is 104, with cold storage capacity at 63,705 tons (613 tons per plant with refrigerating capacities), the daily freezing capacity is 2,221 tons (21 tons per plant with freezing capacities), providing sufficient capacity for the daily catches (The 2013 Census of Fisheries, MAFF 2015).

Despite an occasional imbalance between demand and supply in all prefectures, balance among districts is kept through commercial transactions. Freezing and cold storage capacity satisfy the requirements for the catch. All 10 prefectures earned 5 points and earning a cumulative score of 5 points.

1 Point	2 Points	3 Points	4 Points	5 Points
The amount of ice is very limited	Ice is available, but supply is limited and often used or reused in a thawed state	Ice is available in limited form 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

In medium- and large-scale tuna purse seine fisheries, advanced technologies such as ship innovations, fleet downsizing, catch preservation improvements, joint use of cargo ships, and effective catch utilization, are introduced (Ishinomaki Regional Project Conference 2008, Pelagic Purse Seine Fishery Cooperative Association Regional Project 2013, 2014a, 2014b, 2015, 2016a, 2016b, 2018a, 2018b, 2018c, Pelagic Purse Seine Fishery Cooperative Association Regional Project 2008, Shizuoka Purse Seine Fisheries Cooperative Regional Project 2010, Hachinohe Regional Project Conference 2007, 2010, Northern Pacific Medium- and Large-scale Purse Seine Fishery Regional Project 2012, 2018a, 2018b, Northern Pacific Medium- and Large-scale Purse Seine Fishery Regional Project Conference 2008a, 2008b, 2009a, 2009b, Mie Outer Bay Regional Project 2016).

In pelagic skipjack pole-and-line fisheries, advanced technologies such as innovative energy-saving fishing vessels, and stable live sardine supplies as bait are introduced (Pelagic Skipjack Pole-and-line Fishery Project Conference 2011, 2012, 2013, 2015, 2016a, 2016b, 2017, Makurazaki Regional Project 2012, 2016). Technologies developed and verified in research projects on oceanic fisheries resources (optimization of water temperature of fish tanks for growing live baits for energy saving, etc.) are also implemented in some of the newer fishing boats.

In offshore pelagic pole-and-line fisheries, advanced technologies such as seawater ice makers and low-temperature feeders, etc. are introduced (Nearshore Tuna Regional Project 2015a, 2015b). Technologies developed and verified in research projects on oceanic fisheries resources (reduction of costs and efficient operation by downsizing vessels, and freshness preserving technology, etc.) are implemented in some of the newer fishing boats.

In coastal pelagic pole-and-line fisheries, advanced technologies such as fleet downsizing , cost-savings by through new energy-saving fishing vessels, etc. (Nearshore Tuna Fisheries Regional Project, 2011, Nase Coastal Tuna Pole-and-Line Fishery Regional Project 2015) are implemented. 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 onlybeing partially introduced and spread	.	New technologies are being spread and advanced technologies introduced

4.3.1.3 Logistics System

Scanning on Google Maps for the time to carry fish from ports where central and western Pacific groups of skipjack tuna are landed at distribution bases such as local and central wholesale markets, trade ports, and airports, it is found that it takes about 150 minutes at maximum capacity from multiple major ports to central wholesale markets via arterial roads. In most cases, it is possible to go from fishing ports to local wholesale markets in about 60 minutes. Since it is possible to go to airports or trading ports in 2 hours at the maximum, it is also possible to choose foreign trade as a corporate strategy. Although this is not the case at remote islands, fishery boats considering foreign trade by entering trade ports, the evaluation is unchanged. 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 nearby	.	Both a trading port and an airport are nearby, or a highway to reach either one nearby

4.3.2 Living Conditions

4.3.2.1 Financial Status of Local Governments

The financial capability index, which indicates a local public service level, was obtained by dividing the amount of revenue of each related prefecture by the amount of money each local government needs to maintain services. The index was, 0.6144 for Miyagi, 1.1013 for Tokyo, 0.9083 for Kanagawa, 0.7195 for Shizuoka, 0.5855 for Mie, 0.4511 for Niigata, 0.2655 for Tottori, 0.2582 for Kochi, 0.3261 for Nagasaki, and 0.3328 for Miyazaki. Average is 0.5563 (Ministry of Internal Affairs and Communications 2018). Consequently, a score of 3 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
Financial capability index is 0.2 or less	Financial capability index is over 0.2 but 0.4 or less	Financial capability index is over 0.4 but 0.6 or less	Financial capability index is over 0.6 but 0.8 or less	Financial capability index is over 0.8

4.3.2.2 Income Levels of Fishery Workers

Since no data are available about medium- and large-scale purse seine using one vessel pelagic and offshore tuna fisheries, targeting the central and western Pacific species (Miyagi, Tokyo, Kanagawa, Shizuoka, Mie, Niigata, Tottori, Nagasaki), the data for medium- and large-scale purse seines in each prefecture is used instead. Monthly salaries are, 617,758 yen in Miyagi (5 points), 530,888 yen in Tokyo (4 points), 618,649 yen in Kanagawa (5 points), 886,635 yen in Niigata (5 points), 983,379 yen in Shizuoka (5 points), 618,649 yen in Mie (5 points), 684,215 yen in Tottori (5 points), 401,135 yen in Nagasaki (5 points). Since there were no data for Kanagawa and Mie, the national average data were used instead. Additionally, there were only data for income standards of skipjack pole-and-line fishers for pelagic skipjack pole-and-line fishing (Miyagi, Shizuoka, Mie) and offshore skipjack pole-and-line fishing (Miyazaki), and coastal skipjack pole-and-line fishing (Kochi). So gross data were used instead. Monthly salaries of pole-and-line fishermen are 479,445 yen in Miyagi (5 points), 409,463 yen in Shizuoka (4 points), 522,155 yen in Mie (5 points), 286,888 yen in Kochi (3 points), 373,412 yen in Miyazaki (5 points) (Ministry of Land、Infrastructure and Transport 2018). According to the Basic Survey on Wage Structure, average salary of men working in manufacturing companies of 10-99 employees in the five prefectures are, 267,500 yen in Miyagi, 275,799 yen in Niigata, 377,500 yen in Tokyo, 341,500 yen in Kanagawa, 314,100 yen in Shizuoka, 321,800 yen in Mie, 236,500 yen in Tottori, 265,200 yen in Kochi, 260,400 yen in Nagasaki, 242,800 yen in Miyazaki (Ministry of Health, Labour and Welfare 2018). On the other hand, according to Table 7 The Number of Workers and Wage (executives) by Wage Grade in the result of Statics of Wage Status in Private Sector 2017 (National Tax Agency 2018), the national average salary of executives of companies with capital less than 20 million yen is 473,167 yen and ratio of executive salary to fishermen's salary (*mochisirosuu*) is 1.23. So, the monthly salary is 759,842 yen in Miyagi (5 points), 652,992 yen in Tokyo (4 points), 760,938 yen in Kanagawa (5 points), 1,063,962 yen in Niigata (5 points), 1,209,556 yen in Shizuoka (5 points), 760,938 yen in Mie (5 points), 841,584 yen in Tottori (5 points), 493,396 yen in Nagasaki (3 points). Additionally, *mochisirosuu* of executives of pole-and-line skipjack tuna fishery companies is 1.47, monthly salary is 704,784 yen in Miyagi (5 points), 601,910 yen in Shizuoka (4 points), 767,567 yen in Mie (5 points), 421,725 yen in Kochi (3 points), 548,915 yen in Miyazaki (4 points), showing that pay is higher than the national average in the manufacturing industry with some exceptions. Therefore, it is shown that the skipjack tuna industry is competitive to the level of executives of small and medium sized enterprises or local manufacturing. Consequently, a score of 5 points is given (the average for the prefectures, rounded off).

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

4.3.3 Inheritance of Regional Culture

4.3.3.1 Inheritance of Local Cultural Fishing Methods

Skipjack tuna in the central and western Pacific Ocean are caught mostly by pole-and-line and purse seines. Skipjack tuna pole-and-line fishing is mostly operated to catch skipjacks ranging from the sea near Japan to tropical Pacific regions. Gear used consists of poles mostly made of glass or carbon fiber and line made of nylon line slightly shorter than the pole. Bait used in this method are barbless lures (Ogawa & Kurosaka 2004). The fishing itself is done in the following way: When schools of fish are discovered by sight or sonar, live anchovies are casted and seawater is sprinkled from the side of the vessel for attracting schools of skipjack nearside of the vessel, and the skipjack are caught one by one with poles (Ogawa, Kurosaka 2004). In Okinawa, tuna fishing with *sone* or payao, utilizing the tunas' swarming behavior around floating materials, is done (Yoshimura 2016). In this way, traditional and simple methods and fishing gear are passed down. On the other hand, advanced technologies and devices are applied to equipment made of advanced material, fish detection, etc. Efforts to keep fishing traditions into as well as passing down traditional methods and gears will continue (Kimura, et al. 2018).

Purse sein skipjack fisheries target the central and western Pacific Ocean, especially the tropical Pacific. Historically, the methods used goes back to Meiji and Taisho eras, when American technology was introduced, according to existing records. It is in 1969 that the industry gathered momentum, when *Dai-san* Hayabusa-maru developed the epoch-making technology of catching schools of skipjack gathered around floating wood (Miwa 1991). Then Marine Fisheries Research and Development Center successfully expanded overseas with purse seines on a commercial basis in 1971 (Japan Marine Fishery Resource Research Center 2001 , Miwa 1991). Afterwards, the latest electronics technology and hydraulic machinery were introduced and labor and energy-saving developments continue (Miwa 1991). In this way, both fishery types operate based on traditional methods and equipment while steadily supplying food materials necessary for continuing local culture. From the above information, continuity of local culture in fishing methodology and gear is identified and consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
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

Skipjack tuna are eaten raw in most districts of Japan as *noborigatsuo* (bonito of the first season), and returning bonito, which return southward from the north in autumn (Wakabayashi 2004). As read in *senryu* verse that “eat the bonito in first season even by borrowing money on the security of your own wife,” in the Edo era, first bonito was loved by Tokyoites, who make much of foods caught early in the season. Soon, the custom of eating skipjack tuna raw spread all over Kanto area around Edo (Tokyo) (Nihira 2009, Wakabayashi 2009). In Tago, Nishiizu Town, Shizuoka, which used to be among the major fishing ports where skipjack tuna fishing boats, skipjack have been lucky charms and offerings to the gods in fishermen’s families. Salted skipjack (as preserved food) still used in the present as traditional foods (Nishiizu Salted Skipjack Tunas Workshop 2019). The trend of celebrating skipjack tuna as the fish of the season continues with *tataki* (lightly roasted bonito) and returning bonito (*modorigatsuo*) are consumed widely throughout Japan.

Although the most popular way of eating skipjack tuna is raw, the fish quickly loses its freshness, so most skipjack tuna caught are processed into dried bonito. This dried bonito is often described in literature since the Muromachi era, as the product has been historically used as stock to extract broth. Since the Edo era it has been known as *honkarebushi*, which is matured by fermentation. After that, production of dried bonito increased nationwide. It had already become an ubiquitous food for Japanese by the Meiji era. (Oumi 2000, Nihira 2009). Further improvements were made in the form of *arabushi*, which is dried in the excellent traditional *baikan* way of processing by smoking with oak wood, sawtooth oak, or cherry wood and *honkarebushi*, which is fermented. The unique *umami* (flavor) and flavor, which are generated by amino acids through time and effort, of these kinds of traditional preserving methods is deeply rooted in Japanese food culture (Takeuchi-shouten 2019, Fushitaka 2019, Kanesa Katsubushi Shouten 2019). Currently, the main producing center is in Yamagawa Town, Makurazaki City, Kagoshima where the product is made from imported skipjacks or those caught overseas (Shintani 2005). Yaizu City, Shizuoka, is also a major center of production. Since dried bonito are rich in inosinic acid (an *umami* element), flavorful broth is extracted from them. They are among Japan’s most familiar processed seasoning (Kohno, et al. 2000).

On the other hand, with the Westernization of Japanese eating habits and spread of chemically processed cheap and convenient (i.e., instant bouillon), households that shave off portions of dried bonito, or even the ones who cook by boiling ingredients to extract bouillon are becoming rarer. For the above reason, skipjacks are processed into dried bonito, shaved dried bonito, half-dried bonito, reduced in soy sauce, *furikake* (seasoned powder for sprinkling over rice), or seasoning (instant bouillon). Also, they are added to various processed food as bonito extract. Additionally, it is difficult to make the product profitable due to the many steps and length of time to produce a quality product. It is extremely difficult to find successors in the industry. For example, in Tago, Nishiizu Town, out of the 40 manufacturers of dried bonito that existed in early 1930s who, as few as four still follow the traditional process called *Tebiyama-shiki* (handling fire to roast and dry the portion of bonito) (Ida, et al. 2004).

While the classic skipjack tuna dish is <*tataki*>, a fillet of the raw fish lightly roasted, the fish is also commonly eaten as *sashimi* accompanied by spices such as ginger, *wasabi*, garlic, etc. Besides *tataki* or *sashimi*, or *teriyaki* (broiled with soy sauce), boiled dishes, boiled cubed, stew cuts, skipjack rice (*sashimi* seasoned with vinegar and soy sauce are mixed with *sushi* rice), and *namerou* (minced sashimi mixed with spring onions and *miso*, then mashed) are well known. In Kochi, Kagoshima, Shizuoka, the guts, which are removed in large quantity in the production of *namaribushi* (lightly simmered fillets), are processed by salting (*shutou*) and eaten by fishermen and producers. The skipjack's guts are washed thoroughly, soaked in around 30% saltwater and fermented for about six to more than twelve months, and then shipped. The guts are digested and fermented by their own digestive enzymes. Highly fermented samples served on rice are mostly dissolved when hot tea is added (*chazuke*). It is said that *shutou* was named by Toyosuke Yamauchi, the 12th feudal lord of Tosa (Kitamura 2005).

Among traditional cooking methods handed down in various districts of Japan, in the Tohoku (northern) region, *sashimi* of skipjack tuna caught off the Sanriku coast are eaten with spicy grated daikon in Iwate (Ohmori 1984). Miyagi Prefecture, also in the Tohoku region, has *dabu-dhuke* (salted) (Haga 1990) *namaribushi* and vinegared *wakame* seaweed, which is regarded as a traditional southern dish, are eaten in Fukushima (Yoshijima 1987), dried bonito, and *amawata* (salted skipjack guts) as a by-product are produced in coastal Iwaki (Suzuki 1987).

In the Chubu district, there are various traditional skipjack tuna cuisines such as "grandchild tea," a kind of *chazuke* (steamed rice with tea added), salted skipjack tuna, dried bonito, salted and grilled skipjack heart and *haramo* (belly meat), *shikidhuri* (made with *haramo*), hung skipjack bones, vinegared raw skipjack, grandchild tea, etc. are made in coastal Shizuoka. Here, the guts are also salted to make *shiokara* (preserved food) (Makita 1986). In the Yaizu region, the skipjack are processed in various ways. Red muscle meat is eaten boiled together with the bones, the heart is commonly eaten fried, or stewed in *oden*. Additionally, *katsuo-meshi* (skipjack tuna rice), which is not a sushi of rice and sliced fillet combination, but rice boiled with crumbled fish meat, is a local soul food. In the Omaezaki region, a cold soup which fishermen have eaten on vessels since long ago, called *gawa,* prepared by mixing minced skipjack with ice, vegetable, and miso has become their local soul food. In the Maisaka region, fresh skipjack tuna, before becoming stiff, caught that day (*himodori katsuo*, skipjack tuna brought back that day) are called *mochi-gatsuo* and are highly valued as a feature of the season when *noborikatsuo* are landed in the district (Hamamatsu City 2019). Additionally, *arajiru*, which is prepared by boiling guts with onion and tofu, and cooking in miso sauce, is also introduced. In Mie, *watajokara* (salted skipjack guts) and *tekonezushi* (hand-formed sushi) are introduced (Tokui 1987) in the Shima coastal region. In the Himi region of Toyama Prefecture, it has been recorded that skipjack are eaten as soup, salt-grilled, or simmered in miso, and when they caught in large quantities made into dried bonito (Takahashi 1989).

While raw (*sashimi*) and lightly roasted fillet (*tataki*) are well known in Kochi Prefecture, the preparation of *tataki* varies among districts and there are four varieties of sauce (*tare*). In addition to *katsuo-meshi* (skipjack tuna rice) and dried-bonito shavings *chazuke* with tuna topping (*katsuo chazuke*), boiled bones (*arani*), salt-grilled heart, and heart boiled in ginger sauce are also traditionally eaten (Kochi Prefectural Museum of History, 2008).

In Kyushu, a cooking method of topping soy marinated skipjack tuna on hot steamed rice and adding hot tea is introduced in the Miyazaki Plain (Yamauchi, 1991). It is also reported that dried bonito shavings are eaten at the northern foot of Mt. Kirishima, where fish are not often available (Higo, 1991). In the Nichinan district, a procedure of laying tuna fillets on spread bamboo leaves and boiling for about 10 minutes is reported as a method of making boiled and half-dried bonito (*namaribushi*) (Matsumoto, 1991). In the Nakagami region of Okinawa, scenes of peddlers selling half-grilled *namari*, dried bonito, and raw skipjack tunas is introduced as a feature of summer (Asato 1988). In the Yaeyama region, boiling skulls and bones of tunas in salted water (*maasu-ni*) and eating them with potatoes is introduced as a way of eating (Sakiyama, Uezu, 1988). In the Goto Island region of Nagasaki, the cooking method of mincing skulls and bones of the tuna with a cooking knife into a paste and then mixing with miso and green perill, further mincing, then adding vinegar is introduced (Kuriki, 1985).

As a comparatively new processed food, skipjack are used for canned tuna (light tuna, light meal). Also, there is a report that boiled tuna cubes were developed as a method of processing tuna landed in large quantities in Yaizu, Shizuoka in 1931 (Hasegawa, 2005). From the above information, it is evaluated that, while traditional processing and distribution technology is maintained, new ways of use are also developed. Consequently, a score of 5 points is given.

1 Point	2 Points	3 Points	4 Points	5 Points
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 Nutrition Function

5.1.1 Nutritional Components

The Nutritional composition of skipjack tuna (spring) is as shown in the table below (Ministry of Education, Culture, Sports, Science and Technology, 2016).

Energy		Water	Protein	Calculated as the sum of amino acid residues	Lipid,	Fatty acids, expressed intriacyl-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
114	477	72.2	25.8	20.1	0.5	0.3	0.12	0.07	0.14	60	0.1	-	(0)	1.4

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
43	430	11	42	280	1.9	0.8	0.11	0.01	-	-	-	-

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
5	0	0	0	0	5	4.0	0.3	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
0.13	0.17	19	0.76	8.4	6	0.7	-	Tr	0.1

5.1.2 Functional Components

5.1.2.1 EPA and DHA

Fat from skipjack tuna contains EPA and DHA, both of which are higher unsaturated fatty acids. They are contained especially in skipjack tuna caught in the autumn (returned bonito). The EPA content of skipjack tuna (in autumn) is 400mg/100g, while the DHA content is 970mg/100g. EPA has benefits including prevention of thrombus, anti-inflammatory properties, and prevention of hypertension. DHA has benefits including promotion of brain growth, prevention of dementia, prevention of eyesight loss, prevention and improvement of arteriosclerosis, and anticancer effects, etc. (Fisheries Agency 2014, MEXT, 2015).

5.1.2.2 Vitamins

Skipjack tuna is rich in niacin, vitamin B1, and vitamin D. Niacin acts as a cofactor for oxidoreductase in human bodies. Vitamin B1 contributes to cell metabolism while vitamin D contributes to the absorption of Calcium and phosphorus, main components of bones (Japan Fisheries Association 1999).

5.1.2.3 Minerals

Selenium red muscle (which has antioxidative effect) contains a large amount of iron, a major constituent of blood (Japan Fisheries Association 1999).

5.1.2.4 Selenoneine

Selenoneine is a selenium-containing imidazole compound. This compound is thought to repair DNA damage and prevent various lifestyle-related diseases, such as cancers, heart disease, cranial nerve damage, immune deficiency, type 2 diabetes, and aging. Additionally, animal studies have shown detoxification of methylmercury, suggesting the possibility of similar effects on humans (Yamashita 2012, Yamashita et al. 2013).

5.1.2.5 Taurine

This is an amino acid found at high levels in skipjack tuna. This component is effective for prevention of arteriosclerosis, heart disease, gallstones, anemia, liver detoxification, recovery of vision, etc. (Japan Fisheries Association 1999, Fisheries Agency 2014).

5.1.2.6 Proteins

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

5.1.3 Season and Expert Advice

5.1.3.1 Best season

Skipjack tuna season is from spring to autumn. Those caught in spring are called *hatsugatsuo* (first skipjack tuna), which do not have much fat but are tasty. Those caught autumn are called *modorigatsuo* (returning skipjack tuna) which have rich fat and are delicious (Fujiwara 2011).

5.1.3.2 Expert Advice

Fresh fish have the following characteristics, which are the points for deciding.

(1) The body should have good gloss, with clear markings on the skin. (2) Eyes should be clear. (3) Gills are vivid red in color. (4) The smell should not be strong, (5) The abdomen should be hard and firm, with no guts extruded (Suyama, Kounosu 1987).

5.2 Inspection System

5.2.1 Important Points When Serving as Food

5.2.1.1 Infection to Anisakis in Eating them Raw

Infections to larval *anisakis* caused by eating skipjack tunas have increased in recent years (Asahi Shinbun, Digital Edition 2019). Anisakis larvae can enter the skipjack's body through bait, etc., where it moves from the alimentary tract to abdominal cavity and on to the surfaces of organs. After the death of the host fish, they move on to and infest muscle tissue. If larval anisakis enter a human body when raw fish such as sashimi are eaten, they invade the digestive tract. Although occurrences are rare, anisakiasis, acute or chronic stomachache, vomiting, or diarrhea, etc. may result .

For prevention, suggestions include (1) use of a fresh fish, (2) quick removal of the internal organs, (3) visual check for and removal of larval anisakis, (4) avoidance of serving raw internal organs, (5) use of proper heat (the parasites perish at the temperatures of 70°C or above), freezing (parasites degrade after freezing for 24 hours at -20°C) (Ministry of Health, Labour and Welfare 2019).

5.2.1.2 Histamine Poisoning

Skipjack tunas carry high levels of histidine in muscle tissue, and are likely to cause histamine poisoning. Histamine poisoning, which is also called allergy-like food poisoning, carries symptoms of blushing, headache, urticaria, or fever after eating. Histamine is generated from histidine by decarboxylase of bacteria. While its major causative agent is histamine, it should be precisely understood that histamine poisoning is a bacterial food poisoning with the same preventative measures. As for prevention, thorough handling under low temperatures is effective. Unless the fish is fresh, it should not be consumed raw. Frozen tuna should be thawed in refrigerator, not room temperature. Repeated freeze-thaw cycles must be avoided. Additionally, it should be noted that it is impossible to break down histamine with heat, once created (Fujii 2010, Tokyo Metropolitan Government Bureau of Social Welfare and Public Health 2019).

5.2.2 Hygiene Inspections for Distribution and the 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 and Measures to Prevent Food Poisoning

There are no tests specifically targeting on this species.

5.2.4 Treatments and Responses in the Case of a Positive Test Result

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 Infection with Anisakis

Fresh seafoods should be chosen and their internal organs removed immediately. Internal organs must not be eaten raw. A visual check for larval anisakis should be done and any that are found removed (Ministry of Health, Labour and Welfare, 2019)。

5.2.5.2 Prevention of Histamine Poisoning

The fish should be managed only at low temperature. Frozen fish should be thawed in refrigerators not at room temperature. Fish should be consumed soon after the thawing. Repeated freeze-thaw cycles should be avoided. For symptoms felt after consuming fish, histamine poisoning may be suspected. In these cases, fish should be disposed of and not consumed (Fujii 2010, Tokyo Metropolitan Government Bureau of Social Welfare and Public Health, 2019).

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SH"U"Nのおさかな推奨指標のまとめ

系群・地域　カツオ中西部太平洋　　参考値

漁業　まき網漁業　　4.1

年

資源の状態

大項目	中項目	中項目_評価点	中項目_重み	大項目_重み	大項目_評価点	評価軸_総合点
対象種の資源生物研究・モニタリング・評価手法	生物学的情報の把握	3.0	1.0	1.0	3.4	4.4
	モニタリングの実施体制	3.3	1.0			
	資源評価の方法と評価の客観性	4.0	1.0			
対象種の資源水準と資源動向	対象種の資源水準と資源動向	5.0	1.0	1.0	5.0	
対象種に対する漁業の影響評価	現状の漁獲圧が対象種資源の持続的生産に及ぼす影響	5.0	1.0	1.0	4.7	
	現状漁獲圧での資源枯渇リスク	5.0	1.0			
	資源評価結果の漁業管理への反映	4.0	1.0			

生態系・環境への配慮

大項目	中項目	中項目_評価点	中項目_重み	大項目_重み	大項目_評価点	評価軸_総合点
操業域の環境・生態系情報、科学調査、モニタリング	基盤情報の蓄積	3.0	1.0	1.0	3.0	3.6
	科学調査の実施	3.0	1.0			
	漁業活動を通じたモニタリング	3.0	1.0			
同時漁獲種	混獲利用種	5.0	1.0	1.0	4.0	
	混獲非利用種	4.0	1.0			
	基盤情報の蓄積	3.0	1.0			
生態系・環境	食物網を通じた間接作用	3.7	1.0	1.0	3.7	
	生態系全体	3.0	1.0			
	海底環境（着底漁具を用いる漁業）	5.0	1.0			
	水質環境	4.0	1.0			
	大気環境	3.0	1.0			

漁業の管理

大項目	中項目	中項目_評価点	中項目_重み	大項目_重み	大項目_評価点	評価軸_総合点
管理施策の内容	インプット・コントロール又はアウトプット・コントロール	4.0	1.0	1.0	4.3	4.5
	テクニカル・コントロール	4.0	1.0			
	生態系の保全施策	5.0	1.0			
執行の体制	管理の執行	4.7	1.0	1.0	4.3	
	順応的管理	4.0	1.0			
共同管理の取り組み	集団行動	4.8	1.0	1.0	4.9	
	関係者の関与	5.0	1.0			

地域の持続性

大項目	中項目	中項目_評価点	中項目_重み	大項目_重み	大項目_評価点	評価軸_総合点
漁業生産の状況	漁業関係資産	2.3	1.0	1.0	3.1	4.1
	経営の安定性	2.7	1.0			
	就労状況	4.3	1.0			
加工・流通の状況	市場の価格形成	4.7	1.0	1.0	4.4	
	付加価値の創出	4.5	1.0			
	就労状況	4.0	1.0			
地域の状況	水産インフラストラクチャ	5.0	1.0	1.0	4.7	
	生活環境	4.0	1.0			
	地域文化の継承	5.0	1.0			

資源の状態

大項目	中項目	小項目	漁業　スコア　漁業別重み*	スコア	小項目_重み	中項目_評価点
対象種の資源生物研究・モニタリング	生物学的情報の把握	分布と回遊		3	1.0	3.0
		年齢・成長・寿命		3	1.0	
		成熟と産卵		3	1.0	
	モニタリングの実施体制	科学的調査		3	1.0	3.3
		漁獲量の把握		4	1.0	
		漁獲実態調査		3	1.0	
		水揚物の生物調査		3	1.0	
	資源評価の方法と評価の客観性	資源評価の方法		5	1.0	4.0
		資源評価の客観性		3	1.0	
対象種の資源水準と資源動向	対象種の資源水準と資源動向	対象種の資源水準と資源動向		5	1.0	5.0
対象種に対する漁業の影響評価	現状の漁獲圧が対象種資源の持続的生産に及ぼす影響	現状の漁獲圧が対象種資源の持続的生産に及ぼす影響		5	1.0	5.0
	現状漁獲圧での資源枯渇リスク	現状漁獲圧での資源枯渇リスク		5	1.0	5.0
	資源評価結果の漁業管理への反映	漁業管理方策の有無		5	1.0	4.0
		予防的措置の有無		5	1.0	
		環境変化が及ぼす影響の考慮		3	1.0	
		漁業管理方策の策定		4	1.0	
		漁業管理方策への遊漁、外国漁船、IUU漁業などの考慮		3	1.0	

生態系・環境への配慮

大項目	中項目	小項目	漁業　スコア　漁業別重み*	スコア	小項目_重み	中項目_評価点
操業域の環境・生態系情報、科学調査、モニタリング	基盤情報の蓄積	基盤情報の蓄積		3	1.0	3.0
	科学調査の実施	科学調査の実施		3	1.0	3.0
	漁業活動を通じたモニタリング	漁業活動を通じたモニタリング		3	1.0	3.0
同時漁獲種	混獲利用種	混獲利用種		5	1.0	5.0
	混獲非利用種	混獲非利用種		4	1.0	4.0
	希少種	希少種		3	1.0	3.0
生態系・環境	食物網を通じた間接作用	捕食者		3	1.0	3.7
		餌生物		5	1.0	
		競争者		3	1.0	
	生態系全体	生態系全体		3	1.0	3.0
	海底環境（着底漁具を用いる漁業）	海底環境（着底漁具を用いる漁業）		5	1.0	5.0
	水質環境	水質環境		4	1.0	4.0
	大気環境	大気環境		3	1.0	3.0

漁業の管理

大項目	中項目	小項目	漁業　スコア	漁業別重み*	スコア	小項目_重み	中項目_評価点
管理施策の内容	インプット・コントロール又はアウトプット・コントロール	インプット・コントロール又はアウトプット・コントロール			4	1.0	4.0
	テクニカル・コントロール	テクニカル・コントロール			4	1.0	4.0
	生態系の保全施策	環境や生態系への漁具による影響を制御するための規制			5	1.0	5.0
		生態系の保全修復活動			5	1.0	
執行の体制	管理の執行	管轄範囲			5	1.0	4.7
		監視体制			4	1.0	
		罰則・制裁			5	1.0	
	順応的管理	順応的管理			4	1.0	4.0
共同管理の取り組み	集団行動	資源利用者の特定			5	1.0	4.8
		漁業者組織への所属割合			5	1.0	
		漁業者組織の管理に対する影響力			4	1.0	
		漁業者組織の経営や販売に関する活動			5	1.0	
	関係者の関与	自主的管理への漁業関係者の主体的参画			4	1.0	5.0
		公的管理への漁業関係者の主体的参画			5	1.0	
		幅広い利害関係者の参画			5	1.0	

地域の持続性

指標	中項目	小項目	漁業　スコア	漁業別重み*	スコア	小項目_重み	中項目_評価点
漁業生産の状況	漁業関係資産	漁業収入のトレンド			3	1.0	2.3
		収益率のトレンド			1	1.0	
		漁業関係資産のトレンド			3	1.0	
	経営の安定性	収入の安定性			3	1.0	2.7
		漁獲量の安定性			3	1.0	
		漁業者団体の財政状況			2	1.0	
	就労状況	操業の安全性			5	1.0	4.3
		地域雇用への貢献			5	1.0	
		労働条件の公平性			3	1.0	
加工・流通の状況	市場の価格形成	買受人の数			5	1.0	4.7
		市場情報の入手可能性			5	1.0	
		貿易の機会			4	1.0	
	付加価値の創出	衛生管理			5	1.0	4.5
		利用形態			4	1.0	
	就労状況	労働の安全性			5	1.0	4.0
		地域雇用への貢献			4	1.0	
		労働条件の公平性			3	1.0	
地域の状況	水産インフラストラクチャ	製氷施設、冷凍・冷蔵施設の整備状況			5	1.0	5.0
		先進技術導入と普及指導活動			5	1.0	
		物流システム			5	1.0	
	生活環境	自治体の財政状況			3	1.0	4.0
		水産業関係者の所得水準			5	1.0	
	地域文化の継承	漁具漁法における地域文化の継続性			5	1.0	5.0
		加工流通技術における地域文化の継続性			5	1.0	