Sustainable, **H**ealthy, and “**U**mai” Japanese Seafood

(サスティナブルでヘルシーなうまい日本の魚)

SH“U”N PROJECT ASSESSMENT GUIDELINE

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Introduction

Background and Overview

The population of the world is increasing day by day. According to the United Nations World Population Estimate, the world population is at 7.71 billion as of 2019; showing a more than 2.1 times increase in the last 50 years since 1969 (UN DESAPD 2019). Meanwhile, around 820 million people, or one in nine, suffer from malnourishment worldwide; two-thirds of which are in Asia (FAO et al. 2015). The demand for marine resources as a source of protein for these people has never been higher.

In recent decades, the world's fisheries have been modernized, particularly in small-scale fisheries in Asia and Africa, and catches have increased dramatically (Mathew 2003). Looking at the state of global fisheries resource use as of 2016, approximately 60% are fully developed, 33% are over-fished, and those that have not been fully developed have fallen to just 7% (FAO 2018). A serious problem here is the fact that the rate of overfishing is still increasing.

At the United Nations Conference on Environment and Development (also known as the Earth Summit) held in Rio de Janeiro in 1992, the “Rio Declaration” and its action plan “Agenda 21” which aim for sustainable development, were agreed upon. Afterwards, in the fishing industry, the United Nations Food and Agriculture Organization (UN FAO) published the Code of Conduct for Responsible Fisheries in 1995, setting out guidelines for sustainable fisheries development. At the United Nations Millennium Summit held at the UN headquarters in New York in 2000, eight international goals, titled the Millennium Development Goals (MDGs), were agreed upon and set to be achieved by 2015. The first goal is the “Eradication of extreme poverty and hunger,” and the seventh is “Ensuring environmental sustainability.” Then in 2015 an additional set of objectives, the Sustainable Development Goals (SDGs) were created based on the MDGs. Among these, the second goal is addressing hunger and food security, and the fourteenth is the sustainable use of marine resources.

In order to meet the global demand for seafood and eradicate poverty and hunger in a sustainable manner, it is important to properly manage and recover the over-fished 33% of the stock, while continuing to use the remaining 67% in a sustainable manner. As the center of the world’s fisheries, Asian waters account for 85% of the world's 59.6 million fishermen, 75% of the world's 4.6 million fishing vessels, and 50% of the world's 79 million tonnes of fish (FAO 2018). Japan, as a developed Asian fish-eating nation, has a crucial international responsibility for achieving the sustainable development of fisheries in Asia.

The Fisheries Research and Education Agency (hereafter referred to as the FRA) has been estimating the resources of many fish species found around Japan and the surrounding seas for many years, and has been publishing the results (Domestic Resources: Fisheries Agency, Fisheries Research Agency 2016a,

International Resources: Fisheries Agency, Fisheries Research Agency 2016b). As a result, for over 20 years the government has been using these data to set the Total Allowable Catch (TAC) and establish a set of governance rules for fisheries management. They have also been used to assist in the sustainable development of fisheries through cooperative efforts with the commercial fisheries industry. Additionally, the FRA has been promoting cultivation efforts that release artificially grown fish and shellfish into the wild to maintain and recover marine resources (known as stock enhancement). However, today the sustainable development of fisheries requires not only management and policy making by governments and international organizations, but also a deeper understanding of marine resources by the actual consumers of seafood. By utilizing the results of this previously administrative-based research to influence the diets and decisions of these seafood consumers, we believe Japan will be able to make a greater contribution to the sustainable development of the fishing industry in Asia moving into the future. For this reason, in order to support activities to ensure the sustainability of resources at the consumer level, the SH“U”N Project has been established to provide scientific information from government and industry data to consumers in an easy-to-understand manner. The acronym「SH“U”N」used here stands for Sustainable, Healthy, and “Umai” Nippon seafood.

Through the SH“U”N Project, the state of fisheries resources and fisheries management, the nutrition and safety of seafood, and other important pieces of information, are compiled in an easy-to-understand manner, and published via our website for consumer use. By referring to this information when purchasing seafood products, consumers can deepen their understanding of the sustainability of marine resources and have confidence in purchasing sustainable Japanese seafood products. Our goal is to support sustainable production by actively encouraging consumers to purchase seafood products after providing them with the basic knowledge of sustainability.

The SH“U”N Project will publish all of these compiled results, evaluation criteria, and data on which the evaluation is based. In ensuring transparency, the SH“U”N Project will be available to many stakeholders, including local fishing associations, processing and distribution companies, retailers, certification organizations, consumer organizations, environmental NGOs, and educational institutions. Utilizing the results of this compilation with many groups of people to further promote activities such as next-generation dietary education, the “sixth industrialization[1]” (vertical integration of industries), regional revitalization, and export expansion are some of the main goals of the SH“U”N Project.

In other words, along with these kinds of lifestyle changing activities spread over a wide range of people, the greatest aim of the SH“U”N project is restoring the lost connection between the dining table and the sea, and encouraging consumers to think and support sustainable marine resources. We hope that in the

[1] “sixth industrialization” means combining the functions of the primary industry (fisheries), secondary industry (farm products processing), and tertiary industry (distribution and sales).

future, we can report the knowledge and information obtained from the SH“U”N project around the world, so that other fisherman in Asia and elsewhere may utilize the various fishing methods and gear employed by Japan to make use of the gifts of the sea. With this, consumers around the world who eat seafood will be able to think about the sustainability of fishery resources.

Concept

In everyday life when most people think of “fishery resources” they think of the *fish* in the seas, rivers, and lakes. However, that is just one aspect of a “fishery resource.” In fact, no matter how many *fish* we find in nature, they do not make up a “fishery resource” on their own. It is only when our society recognizes the value of these “fish” and establishes a mechanism to use them effectively, do these “fish” become a “fishery resource.”

According to EW Zimmermann (1888-1961), "resources are not, they become", and he emphasized the importance of the synthetic assessment of the human, cultural, and natural factors that determine resource availability (Zimmermann 1933). In order to protect and sustainably maintain our resources for future generations, it is important that we protect nature, mankind, and culture, and make the interactions between them strong, harmonious, and smooth.

Fig. 1, compiled in 2009 by the Fisheries Research Agency (the predecessor of the Fisheries Research and Education Agency), shows this concept in the scope of marine resources based on the results of an assessment of the "Comprehensive management of fishery resources and fisheries in Japan." This schematic shows how fish are born and grow in the sea, are caught by fishermen in each region, are given value through land-based processing and distribution, and are later enjoyed at the homes of consumers. We call this flow of fish through nature and society the Fisheries System (Fisheries Research Agency 2009). We believe that strengthening, and smoothing this flow will lead to the sustainable protection of marine resources.

Of course, without fish in the seas none of this is obtainable. Without fisheries, processing, distribution, or retailing, fish cannot be delivered to the dinner table. Furthermore, without the consumers who have inherited our fish-eating culture to enjoy these fish, the value is lost. If any part of this Fisheries System is removed, the term “fishery resource” does not hold.

The SH“U”N project evaluates the entire Fisheries System (shown in Fig. 1) by considering the four assessment Factors; Resource Status, Marine Environment and Ecosystems, Fisheries Management, and Regional Sustainability. With these we have developed an itemized visualization of the related health, safety, and security of the Fisheries System (Fig. 2). As a comprehensive research institute, the FRA has accumulated research in various academic fields covering these four factors and one additional

consideration (totaling 5 factors) over the course of many years. Starting with the results of our research, and including all the relevant information available, we have comprehensively assessed the sustainability of fisheries resources in Japan. Below, we will explain the concept of evaluation for each of these 5 items.

Fig. 1 Fisheries system (from birth of fish until they reach the dining table, modified from the Fisheries Research Agency 2009)

Principle 1 (Resource Status) First of all, living fish in the sea is the most basic condition for the sustainable use of marine resources. According to the United Nations Convention on the Law of the Sea enacted in 1994, coastal marine resources are to be properly managed by the coastal nations, and it is the responsibility of the coastal nations to understand the state of the resources, to manage those resources, and to use them sustainably. At present, there is concern worldwide whether we can continue to catch fish in the future (Worm et al. 2009). The state of fish in the sea can be known by comprehensively analyzing biological information, fisheries information, and various other factors, in what we call a stock assessment. For over 20 years the FRA has been using these stock assessment data to set the Total Allowable Catch (TAC) and for setting rules with international organizations. In the SH“U”N project, first we assess factors such as whether the fish species being evaluated have been adequately researched, how many of them are present in the sea, whether they are increasing or decreasing, whether a transparent and appropriate

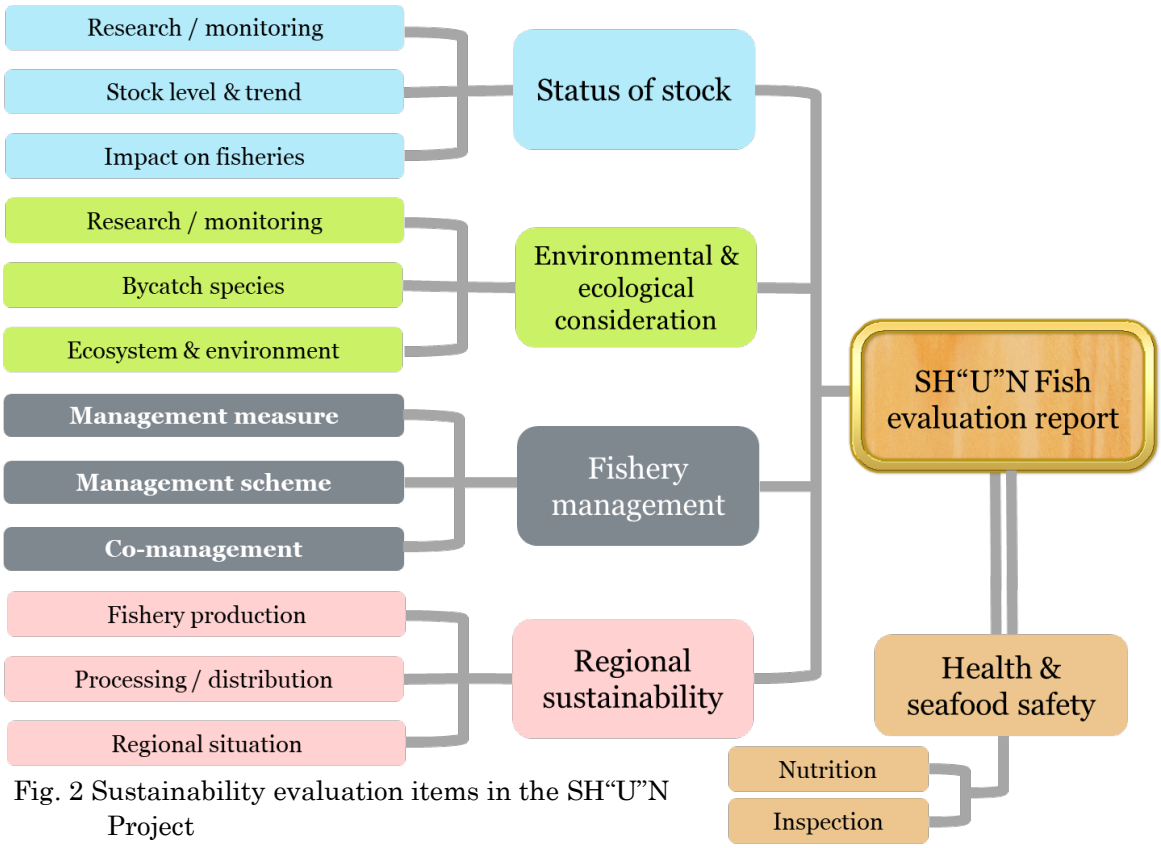

Fig. 2 Sustainability evaluation items in the SH"U"N Project

assessment system has been established for sustainable use, and if the target resources are subject to a cultivation fishery, whether it's effects have been implemented in a verifiable manner.

Principle 2 (Marine Environment and Ecosystems) In order for these fish to be born, mature, and reproduce in the sea, it is important not only to protect the individual target fish species, but also to conserve their prey, habitat, and relationships with other organisms. In order for these fish to obtain sufficient food from the sea, it is important to have a functioning food web, which extends from primary production by phytoplankton and algae through photosynthesis, to zooplankton, fish, and fish-eating animals, and facilitates material circulation including the decomposition of organic matter. In terms of habitats, it is necessary to provide an appropriate environment for each life stage of the target fish species. This includes access to spawning grounds, nurseries, feeding grounds, etc., where organisms have complex interrelationships and form diverse ecosystems (Convention on Biological Diversity). Conserving the structure and function of marine ecosystems in a balanced manner is fundamental to the sustainable use of individual resources, however it can be very difficult to assess whether the entire ecosystem is in healthy and resilient condition. In order to conserve the entire ecosystem it is also necessary to pay attention to the protection of organisms not being used by humans including endangered or threatened species. Depending on the spatial capacity, productivity and property of species interactions, there is an upper limit to the amount of living organisms that can survive in any ecosystem. This is known as Carrying Capacity. Because the abundance of an individual species varies in a complex manner through

environmental fluctuations and interactions with other organisms, it is not possible to manipulate the abundance of one particular species independently. Even if we attempt to increase the abundance of species useful and convenient for humans, it will not lead to healthy ecosystems. For this reason, it is necessary to assess the impacts of human activities on natural ecosystems. In the seas around Japan, the alternation of the abundance of small pelagic fish species such as the Japanese sardine, Japanese anchovy, and Mackerel, known as fish species alternation phenomenon (Takasuka et al. 2008) has been studied extensively. Recent studies have analyzed the structure of the food webs in the Seto Inland Sea and off Sanriku and evaluated the impacts of commercial fisheries (Watari 2015, Yonezaki et al. 2016). Through this research on the response of marine ecosystems to environmental fluctuations and fishery impacts, as well as other studies on water pollution and coastal construction, we are beginning to understand the mechanisms of marine ecosystems that encompass the individual fish species. However, as the results of such studies are limited, it is difficult to assess the changes in ecosystem structure and function for all fish species. With the SH“U”N project, based on the existing information and knowledge, we aim to evaluate the entire marine ecosystem, including the impacts of commercial fisheries and aquaculture, taking into account the complex ecosystem structure and function in the possible range.

Principle 3 (Fisheries Management) The third point of concern is the Fishery itself. The Japanese fishery, unlike the fisheries of developed countries in Europe and the United States, includes a large number of small fishing boats that use a variety of fishing gear and methods to capture resources as food for the domestic population. This is a characteristic that is common in Asian countries (Makino and Masuda 2011). Generally in such a fishery, limiting management to government enacted top-down regulations for fisherman to follow does not seem to be very effective. Rather, it is more effective to clarify the rights and responsibilities of the local fishermen, and to have the government and fisherman work together (Gutierrez et al. 2011). This management method is called "Fisheries Co-Management" and has recently become highly valued internationally as an efficient management method. In Japan, various approaches to the sustainable use of resources have been voluntarily carried out by fishermen in many places for many generations. The main conclusion of the Fisheries Agency's “Resource Management Study Group” is that only “Advancement of public management through government and local authorities along with voluntary and co-management by fisherman” will be effective (Fisheries Agency 2014). Japan, as a fish-eating nation located in the Asia-Pacific region, is committed to enhancing public management through government and co-management by fishermen, and we believe has an international responsibility for transmitting the wisdom and experience gained to neighboring countries. With this belief, the SH“U”N Project assesses the initiatives for the cooperation and management of fisherman and the contents of that management, and if stock enhancement is carried out, we also assess whether it is promoted rationally and with a broad enough understanding, as a strategy for resource management.

Principle 4 (Regional Sustainability) In realizing the sustainable use of fisheries resources, creating a comparative view of the importance of local fishing economies and cultures, we assess the current situation in Japan based on Fishery Performance Indicators (Anderson et al. 2016). In recent years, cultural diversity has been emphasized alongside natural biodiversity, and it is said that the collection of culture and knowledge generated by the activities of human society is as valuable and should be protected as much as the biodiversity of the natural world (Convention on the protection and promotion of the diversity of cultural expressions). In Japan, the fishing industry has created a lot of employment and has supported the local economy in regions that are said to be disadvantaged, such as the remote islands and the tips of peninsulas. Because there are people engaged in fisheries, fishery processing and distribution, and retail in all parts of Japan, various fish from each region can be delivered to consumers' dining tables. In recent years where the problems of depopulation and aging in many local areas have become apparent, the creation of communities through attractive and demanded fisheries is expected to play a greater social role (Masuda 2014). In addition, the knowledge and wisdom of the sea that fishermen from different regions have accumulated over generations are widely used for voluntary management. The functions of the middlemen in charge of the "judgement" and "information processing" who efficiently distribute to the appropriate destinations, as well as the functions of local processing companies who store fish and maintain prices are also important assets to consider. In other words, sustainability of the local communities means that this diverse knowledge, wisdom, and experience will be passed on to the next generation. The Japanese archipelago that we have lived on and consumed fish on for over 10,000 years, is a long archipelago extending from north to south. From the subarctic sea of Hokkaido to the tropical sea of Yaeyama, various cultures and traditions have been nurtured utilizing the gifts of the diverse ecosystems found in each region. In particular, the seafood culture and traditional dishes found all over the country are part of a valuable and indispensable cultural heritage enjoying the gifts of the sea that once lost, can never be restored. With the SH"U"N Project, we believe that the sustainability of the local communities around Japan is the basis for protecting and carrying on this diverse culture.

Additional Principle 5 (Health, Safety, and Security) Finally, we consider the safety and security of these resources as food. In the 1960's an epidemiological study on Greenlandic Inuits began to draw attention to the health-related functionality of components in seafood (Dyerberg et al. 1975, Bang et al. 1976). The health benefits of omega-3 polyunsaturated fatty acids such as EPA and DHA which are contained in seafood started to become clear. In addition to the functionality of single components such as EPA and DHA, the functionality of multiple components such as the anti-thrombotic effect due to the synergistic effect of fish protein and fish oil, and the enhanced neutral fat suppression effect of the combination of fish and seaweed were also found (Murata et al. 2002, 2004, Fisheries Agency 2015). The Japanese food culture, starting with seafood, was registered as a UNESCO Intangible Cultural Heritage in 2013, and now more than ever fish-based diets are gaining international interest as a secret

to the healthy longevity of Japanese people. However, in order for consumers to enjoy seafood culture with peace of mind and live healthy lives, it is a required prerequisite that this food is safe. Natural dangers such as pufferfish and shellfish poisons, parasites, food poisoning, as well as chemical pollutants from human activities are all safety concerns and require continuous monitoring. Currently, marine products distributed in the Japanese market are subject to strict safety standards set by the government and inspections are being done, but it is not known in detail what kind of inspection system is in place. So that consumers may purchase marine products with even greater security, in addition to the requirements on the labeling of origin specified in the JAS Law, the SH“U”N Project will compile and publish information on a scientific basis for food inspection and its system in an easy-to-understand manner.

There is always a certain degree of "uncertainty" in scientific evaluation. To begin, the marine environment naturally fluctuates in the first place, and there are many natural mechanisms that we have not yet fully understood. There are also errors in the data obtained from surveys and experiments, and limitations inherent in the hypotheses and theories used in the analyses. For this reason, accepting the presence of some uncertainty, it is important to always learn while monitoring the assessments and be

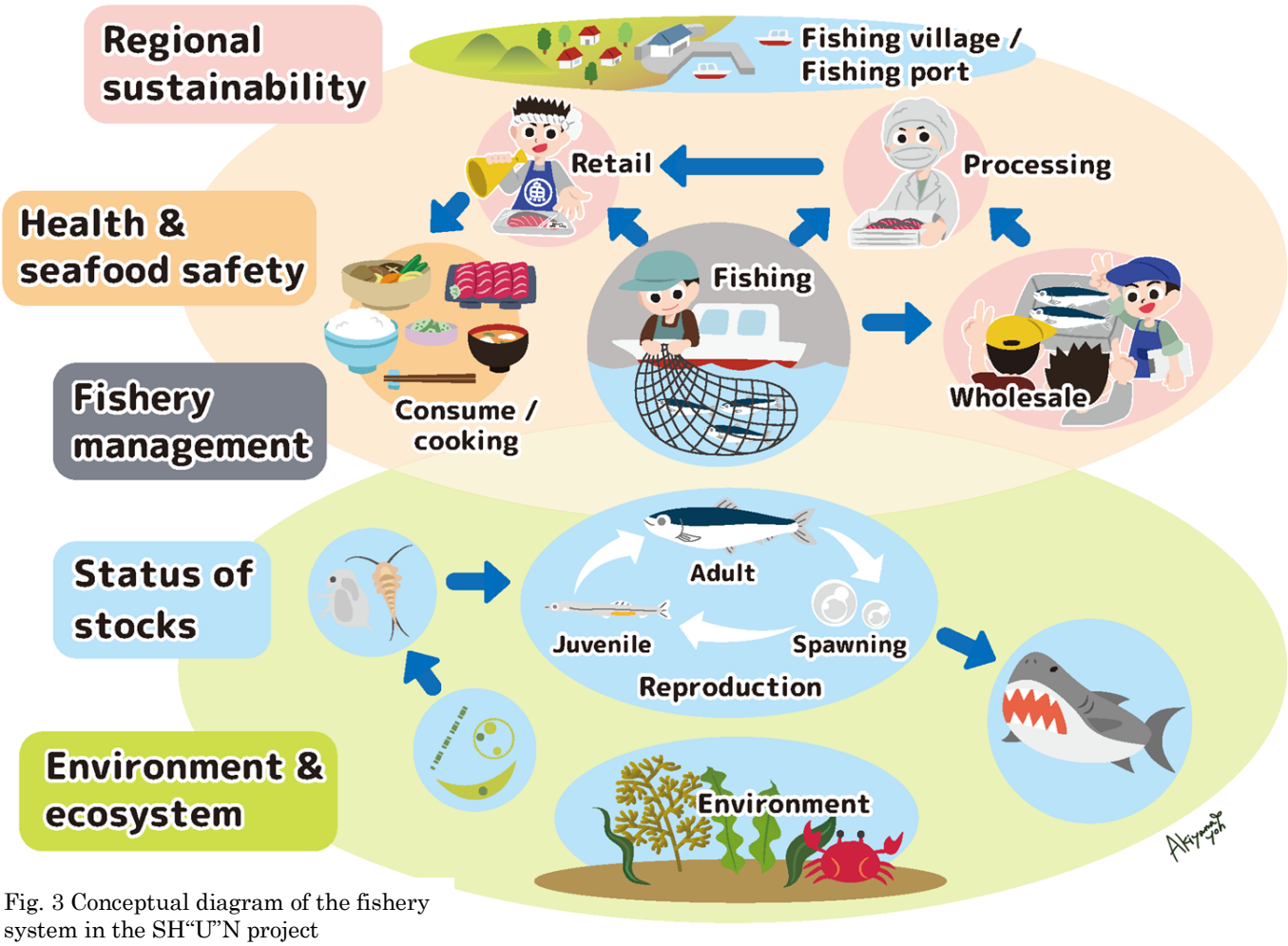

Fig. 3 Conceptual diagram of the fishery system in the SH“U”N project

flexible in adjusting management plans according to the results observed [Adaptive management (Walters and Hilborn1976, Fisheries Research Agency 2009)]. In The 4th Mid/Long Term Plan, of the Japan Fisheries Research and Education Agency started this year, we aim to push three main pillars of research and development; [Pillar #1: Research and development for the sustainable use of fisheries resources], [Pillar #2: Research and development for the sound growth of the fishing industry and the stable supply of safe marine products], [Pillar #3: Marine and ecosystem monitoring and basic research for the next generation of fisheries], and one pillar of education; [Pillar #4. Human resource development for the fisheries industry]. The assessment results of the SH“U”N Project performed under the proposed four criteria are not set in stone but are flexible, and we believe will be improved by considering the latest research by the FRA and any observed updates in the ecosystems and status of resources. The subjects “Advanced resource management methods” and “Development of resource management measures considering the impacts of marine ecosystems and socio-economic conditions” implemented under Pillar #1 are expected to contribute to more accurate analyses and evaluation of fisheries resources in the first principle (Resource status), advanced assessment of impacts on ecosystems in the second principle (Marine environment and ecosystems), and appropriate and advanced management in the third principle (Management of fisheries). “Research and development for the safety and security of marine products” conducted under Pillar #2 is an issue that is directly linked to “health, safety, and security.” “Marine ecosystem monitoring, and advancement of the collection and storage of fishery products” conducted under Pillar #3 is based on the first principle (Resource Status) and the second principle (Marine Environment and Ecosystems), and will contribute to faster evaluation and decision making. In addition, for the smooth operation of this project in the future, we will need researchers with a broad perspective on fisheries resources and ecosystems, commercial and rural fisheries, as well as marine products themselves and their consumption and distribution. The FRA will also actively engage in the development of human resources, and develop activities as a research institution that connect resources and consumers. These results will be reflected in the SH“U”N Project.

As mentioned earlier, if any one of these five aspects of Japan's fishery system (resources, ecosystems, fisheries, land-based communities, or the health, safety, and security of seafood) are missed, the sustainability of fishery resources cannot be guaranteed. The complex organic relationships covered by the five major items in the SH“U”N Project are expressed in Fig.3.

However, one could argue there are many ways to consider which aspects of the fishery system are most important (of course taking all legal considerations into account). The one point we feel is inarguable is the importance of safety and security. In the past the Japanese fishing industry has experienced tragedies related to the safety and security of seafood; such as pollution from Minamata disease and radioactive contamination from the Fukushima Daiichi disaster. We believe that ensuring these types of events are

not repeated is an absolute necessity for the sustainability and development of the Japanese fishing industry for future generations. However, considering the other four principles, deciding which are important and to what extent depends on individual personal values. For some, the state of resources may be particularly important. Others may think the impact on ecosystems is most important. Yet, some people may place special emphasis on regional sustainability. It may even be that you think that all four factors are equally important. There is no one "correct answer" that we can derive scientifically. Every consumer, and ultimately every society, must decide for themselves. Therefore with the SH"U"N Project, all the scientific information from the four principles that makes up the basis of the assessment is made public, and a system that allows the user to freely select the relative weighting can be used, while the overall score is not displayed. We assume that the weighting will be adjusted as appropriate according to each user's values and point of view, and that a sustainability assessment based on their own opinions will be linked to purchasing behavior.

We hope that the information in the SH"U"N Project will help consumers deepen their understanding of the sustainability of marine resources and lead to a society where Japanese marine products can be eaten with peace of mind.

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*: title translated by SH”U”N Project Office

Target Species and Assessment Procedures

This section covers the implementation system and report preparation procedures required for the advancement of the SH“U”N Project.

Project Implementation System

This project is implemented in cooperation with the FRA researchers under the leadership of the SH“U”N Project Office of the FRA. In the case where there is no resident expert on the target fish species or fishing method, part of the assessment may be analyzed by researchers from external organizations.

The project office handles the assessment procedure decision making, associated office work and meetings, editing, and the updates of the website and smartphone application.

Independently of the project office, an external review committee consisting of external industry experts, specialists on the fisheries system, and general consumers among others is also established in order to provide multiple points of view on the project. The results of the diverse set of opinions and viewpoints are also reflected in the implementation of the project.

Target Fish Species

Regarding the fish species covered in the assessment, the order is determined by the analyzing the following factors.

1) 1) The following 6 criteria are considered in selecting fish species for the assessment.
   - Needs for a Stable Supply of Resources

     Seafood that demands a steady supply at reasonable prices

     Ex. Over 10,000 tons distributed

     Over 10 billion yen of value created
   - Universal Consumption

     Seafood that consumers are likely to purchase

     Ex. Included in the Communications Household Survey of Ministry of Internal Affairs or published on Cookpad
   - Gross Catch

     Fisheries accounting for a large proportion of fishery production desired by consumers

     Ex. Over 20,000 tons of fishery and aquaculture production
   - Social Interest

     Ex. Japanese version of a search engine that ranks Google pages based on their popularity. (https://www.google.co.jp/#hl=ja&gws_rd=cr)
   - Regional Food Cultures and Traditions

     Regional special fish species or traditional local seafood

     Ex. Listed in the 100 Best Local Cuisines of Ministry of Agriculture, Forestry, and Fisheries' or “Pride Fish” of the National Federation of Fisheries Cooperatives

- Urgent need for protection

  Marine resources that are shown to be depleted in surveys

  Ex. Listed in the Red databook of Japan's Ministry of Environment, Fisheries Agency's "Data book on rare wild aquatic organisms in Japan," or Prefectural Red List.

2) Regarding any emergency protection actions required, the Project Management Office will determine the priority based on social needs, regardless of the other rankings.

Relationships: Focal Areas and Principles

Selection of the target species, sea area, and prefectures for the assessment report are treated as follows.

1) The project office determines the target fish species and candidate areas for the assessment based on sea area, and selects the staff in charge of drafting the principles 1-4 (Fig. 1). Each responsible staff wrote a report for principles 1-4.

2) For the 2nd principle, after collecting citation materials and statistical reports, we selected the fisheries where summed catch exceeds 75% of total catch. The comprehensive score of each term is achieved by averaging each fisheries score weighted by respective catch weight.

3) For the 3rd and 4th principles, we selected the fisheries and prefectures with over 75% of total catch (in order from the largest gross catch). (Fig. 2)

4) To calculate the total score for Principles 3 and 4, a) the assessment results by fishery type and prefecture are weighted and averaged by catch, giving an assessment by fishery type or prefecture, and then items are further weighted by catch to develop a comprehensive assessment, and b) the efforts by prefecture and the evaluation results of the industrial structure for a comprehensive assessment are averaged, and used according to the statistical values (Fig. 2).

Fig. 1 Sea Area Classifications

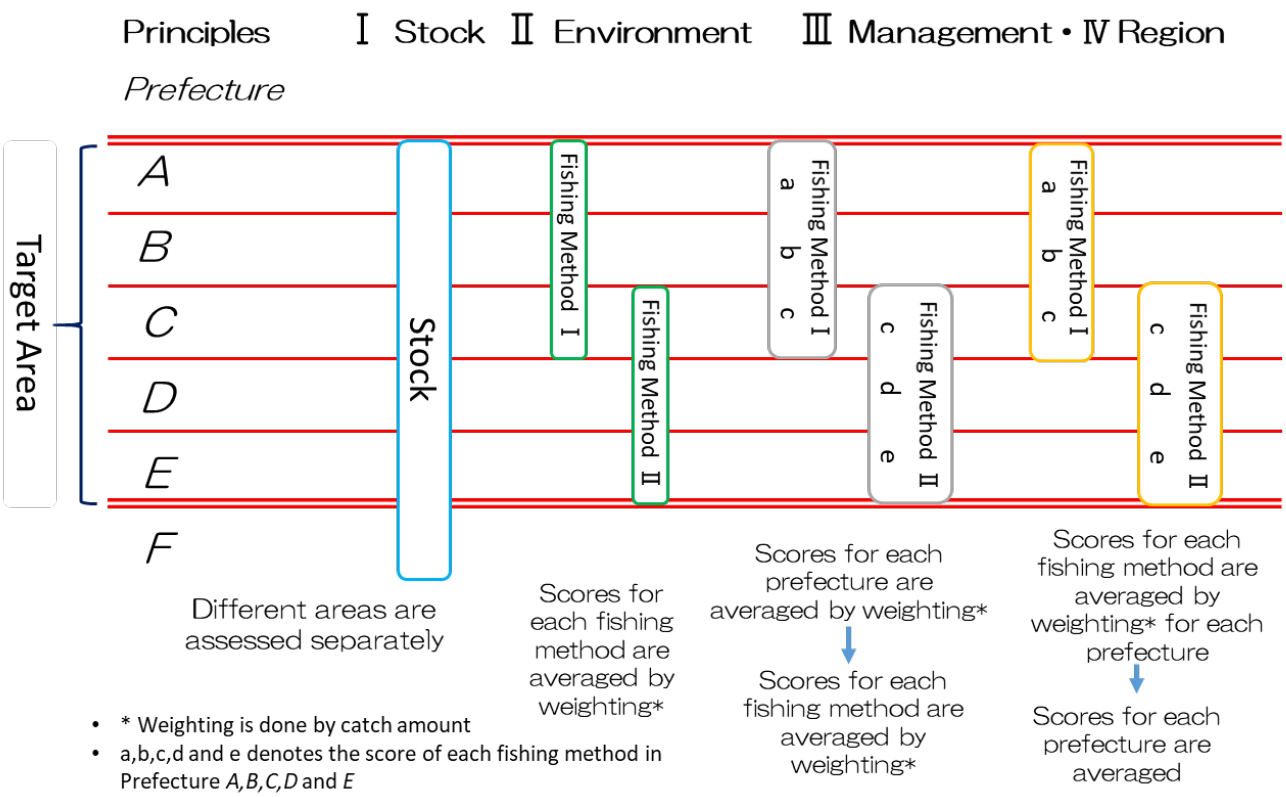


Fig. 2 Basic concept for calculating the comprehensive score for each evaluation factor

Assessment Procedures

1) The assessment guideline will be re-examined and revised according to changing conditions such as: A) expansion of the evaluation target species, B) changes in the legal system, or C) other external inputs.
2) In the case of any revision work, the revised items will be confirmed and organized by both the Project Office and the FRA, and a revised draft will be prepared.
3) Revised drafts will be subjected to peer review by a number of external experts before being considered complete.
4) Details regarding the progress of the work will be reported to the external review committee, and any comments received will be used to implement necessary improvements.

Assessment Report

In this section we have included the report format and necessary conditions for preparing the assessment. The project office uses these conditions for creating the report as well as for any revisions or editing of the report.

Contents

The assessment is compiled based on each individual stock (items of consideration are shown below). The Overview (1) goes over the principles 1-4 and each item concerning health, safety, and security. A summary of each principle (2-6) involves an outline of sets of the three main items ranked under each principle.

1) Overview
2) Resource Status
   - Overview and scope of evaluation
   - Results of each item
   - References
3) Marine Environment and Ecosystems
   - Overview and scope of evaluation
   - Results of each item
   - References
4) Fisheries Management
   - Overview and scope of evaluation
   - Results of each item
   - References
5) Regional Sustainability
   - Overview and scope of evaluation
   - Results of each item
   - References
6) Health, Safety, and Security
   - References

Results and references Excel Sheet

Structure of Assessment and Scoring Methods

Each assessment factor is broken down into three major categories, and each of these 3 categories are further discussed in terms one or more sub-items. Furthermore, each sub-item is subdivided into one or more smaller items in a hierarchical design where the importance of the metric and content are considered to determine their relative significance. For each standard metric, 1 to 5 points are evaluated according to the standard evaluation table defined in the assessment guideline.

1) The total score for each factor is calculated by averaging from the smallest-items. In general, each score is averaged at the smallest item level, then these aggregate points are averaged at the sub-item level, and the resultant score is calculated with the average number of points in the 3 categories. This average of the 3 categories becomes the score for each factor.
2) If the evaluation result is thought to be located at the midpoint, the midpoint is labeled with a reason why this is assumed.
3) When multiple regions and fishing methods are evaluated together, the calculation methods are described before they are averaged. The average score is then rounded off and used as the assessment score for that item.

Assessment Report Drafting and Peer Review

The assessment report draft and public comments are carried out as follows.

1) For each stock assessment, the target fish species and focal areas are decided on, and after reviewing and collecting the literature for each of the 4 principles, an assessment report describing the evaluation of each item is drafted.

2) For each assessment report, two internal representatives are nominated from within the the FRA to conduct overall internal peer reviews of the work. This includes formatting and checking for the omission of referenced materials.

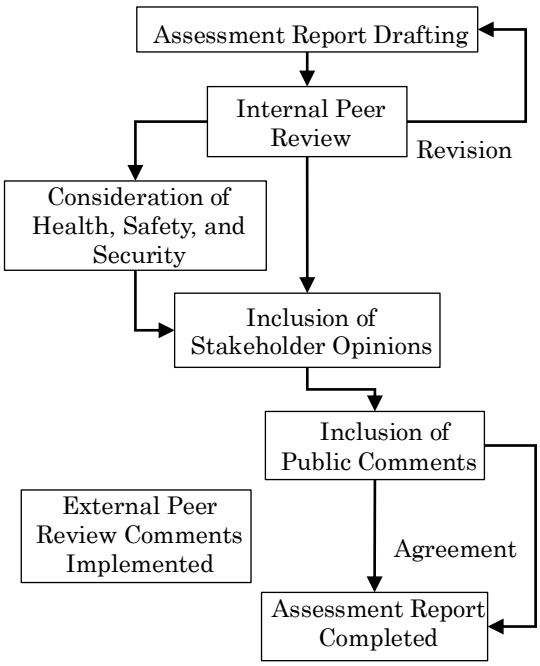
3) After adding considerations for each item's health, safety, and security to the internally peer reviewed assessment report, stakeholder consultations are conducted. As a result of stakeholder consultation, the results of correcting or adjusting any deficiencies, misunderstandings, as well as the differences in views of the information are included as public comments.

4) Public comments are gathered by posting the report draft on the website of the FRA for at least two weeks where the public may view and interject.

5) The results of the assessments are finalized after making necessary revisions and organizing the response plans based on the public comments received.

6) The details are reported to an external peer review committee, and any comments received are used to make necessary revisions.

7) The announcements of the final assessment report are posted on the website and smartphone application.



*The term “stakeholder” generally refers to the people or groups of people (organizations) who use, manage, survey, research, or are in anyway connected to the resources or assessments. However due to the limitations of clerical work and the implementation of individual public comments, the scope of inquiries during the hearing of stakeholders is limited to relevant prefectural fisheries administrations, fisheries research institutes, fishery associations, and other similar formal organizations.

Report Format

The format of the assessment report is as follows.

- The main text is 11 point MS Mincho typeface, 36 lines per page, grid alignment, 0.5 line break after paragraph.
- The charts are 10 point MS Mincho typeface and one line between sections.
- Japanese citations are 11 point MS Mincho, 3 space indent for each document, no grid spacing, 1 line between lines, 0.5 line break after paragraph.
- English citations are 11 point Times New Roman, 3 characters indented for each document, no line spacing, 1 line, 0.5 line after paragraph.
- For headings, the rules below formatting is used (bold underlined items are content labels).

Table 1 (Cover) Illustration, species to be evaluated, sea area, version number, evaluation standard, creation date

Table 2 (Rear Cover) List of authors, version update overview

Table of Contents (Table of Contents is broken into 4 levels, bold underlined items are content labels, using Microsoft Word)

Overview	(MS Gothic 16 Point)
Fish Species Characteristics	(MS Gothic 11 Point)
〔Classification・Form〕 〔Distribution〕	(MS Mincho 11 Point)
Resource Status, Marine Environment and Ecosystems --	
(Overview of each assessment factor)	(MS Mincho 11 point)
1. Resource Status	(Arial, MS Gothic 16 Point)
Overview	(MS Gothic 14 Point)
Research on Biological Resources and Monitoring (1.1)	(MS Mincho 11 Point)
Assessment Range	(MS Gothic 14 Point)
1.1 Biological Research...	(Arial, MS Gothic 14 Point)
1.1.1 Overview of Biological Information	(Arial, MS Gothic 12 Point)
1.1.1.1 Distributions and Migration Patterns	(Arial, MS Gothic 11 Point)
References	(MS Gothic 14 Point)

- - - Same formatting applies below

Version Management

The version number of the Assessment Guideline is “0.1.0” at the time of the internal review version, and a revision number shall be assigned as necessary until it reaches "1.0.0" at the time of completion.

When there is a revision for an error due to a simple typographical error or mistake, the last number is updated, and when there is a change in the content such as an update to reference data, the first number is updated.

Procedure for Assessment Report Revisions

Regarding post-publication feedback of the evaluation report, simple typographical errors and other small mistakes will be corrected as appropriate. Feedback related to contents will be considered and scrutinized about once a year except in the case of urgent matters, and revised if necessary.

Evaluation Contents and Criteria

In this section, we discuss how the researchers use the points system to assign value to each factor and item that is discussed.

１． Resource Status

Overview

As fisheries resources have the ability to reproduce and proliferate on their own, if the reproductive capacity is known and they are fished within the allowable range they can be used sustainably. This is unlike other natural resources such as minerals which are not reproductive. In order to use resources in a sustainable manner, it is necessary to understand the current status of each resource as well as the reproductive ability, and use this knowledge for managing catch to avoid overfishing.

Therefore, with the SH“U”N Project, research and surveys on distribution areas and reproductive characteristics, monitoring systems for catches, age composition statistics, and other factors necessary for an accurate and effective stock assessment are discussed in Section 1.1. After analyzing how these factors have been implemented together, we will evaluate the methods and accuracy of the project and whether the assessment is being performed objectively and transparently. Sections 1.2 and 1.3 assess the status of the stock; such as whether maximum sustainable production (MSY) can be realized (high level or low level), current population levels, increasing or decreasing trends, and the current state of the fishery including relevant fishing pressure. We then evaluate whether appropriate management measures have been established or not.

Outline

① Identification of target species’ fishery and local sea area

Set sea area and fishery for target species

② Collection of catch data for target species

Collect fishery statistics and other data from the selected areas of interest for target species

③ Collection of stock assessment data for target species

Collect research on international resources, resources around Japan, research on factors in resource fluctuations, prefectural assessments, and the results of other past research.

④ Collection of data on the research and monitoring activities for target species.

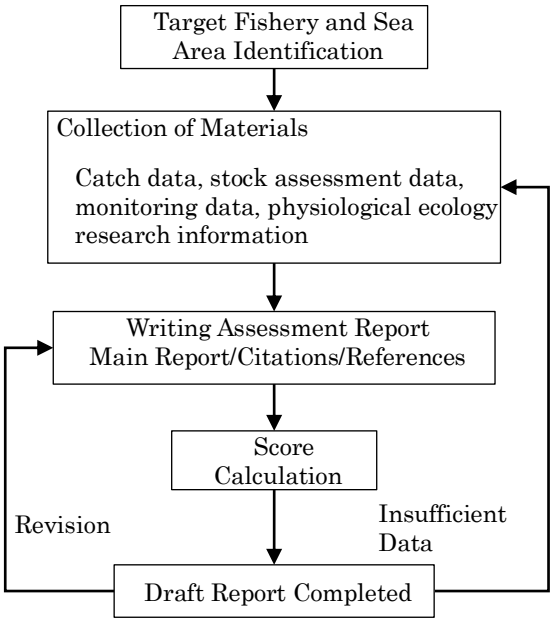
Collect publications and reports on monitoring research conducted on target species.

⑤ Collection of information on physiological ecology of target species.

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

⑥ Check whether there is a stock enhancement program or not for target species.

Check is made based on the collection of data on the presence or absence of a stock enhancement project for the target species. Experimental scale stock enhancement activities by research institutions are not taken into account.



1.1 Biological Research and Monitoring of Target Species

1.1.1 Overview of Biological Information

Base level information on the target fish species, such as life history and ecology, is indispensable for fisheries management and research (Tanaka 1998). Items 1.1.1.1-4 cover the physiological and ecological information are first analyzed to determine whether enough data are available to prepare a sufficient stock assessment for the target species. The information to be analyzed includes (1) Distribution and Migration, (2) Age, Growth, and Life-span, and (3) Maturity and Spawning. For fish species undergoing stock enhancement, (4) basic information necessary for stock enhancement is also included. A simple average of each individual score is used to calculate the overall score.

1.1.1.1 Distributions and Migration

Understanding migration patterns is not only necessary for assessing stocks, but also essential for tracking the life histories of each population, assessing the impacts of fishing, and considering resource management strategies (Tanaka 1998). Here, we evaluate the availability and content of information on distributions and migrations after referencing and describing the literature.

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, has minimum required for stock assessment	Detailed information on some stages of life history including data due to 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 Life-Span

Understanding the age, growth and longevity of an organism plays an important role in resource management. Even in a stock assessment, the age range, growth curve, mortality coefficient, and other variables related to the dynamic characteristics of the target species cannot be discussed without knowing the age of the organism (Tanaka 1998). Here, we evaluate the availability and content of information on age, growth, and life-span after referencing and describing the literature.

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

1.1.1.3 Maturation and Spawning

Fisheries resources are self-regulating renewable resources, and knowing their reproductive ecology is essential for understanding them. Fluctuations in recruitment due to environmental fluctuations affect the overall trends in resources and are important considerations for predicting and managing resources. It is necessary to study biological recruitment from the maturation of the spawning adult stock to the survival of eggs and larvae (Tanaka 1998). Here, we evaluate the availability and content of information on age of maturation, spawning seasons, and spawning grounds after referencing and describing the literature.

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

1.1.1.4 Stock Enhancement (Only Regarding Stock Enhanced Species)

In order to efficiently enhance stocks and improve the survival rate post-release, we need to evaluate whether the appropriate stocking numbers, suitable stocking locations, sizes at release, and other factors are understood through surveys and research.

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

1.1.2 Monitoring Implementation System

Fisheries research that collects biological data on marine resources can provide a great deal of neccesary information for understanding target fish species and implementing fisheries management. Items 1.1.2.1-6 evaluate whether the information for conducting a stock assessment with survey data is available. 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. For fish species undergoing stock enhancement, (5) grasping the results of enhancement and (6) the status of discrimination between natural fish and artificially released seedlings are also covered. A simple average of each individual score is used to calculate the overall score. Long- or short-term used here is signified by 5 years, or the 3 generations (IUCN 2019) required for trend judgement.

1.1.2.1 Scientific Research

Through surveys conducted by research vessels, it is possible to obtain data on primary production, plankton densities, eggs and larvae of target species, etc. in the focal sea area broadly. Here, we evaluate the availability, content, accuracy, and time periods of scientific research necessary for an accurate stock

assessment after referencing and describing the literature.

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

1.1.2.2 Survey of Catch Data

Catch data on most target species can be obtained from available catch statistics, however the catches of species that are not surveyed need to be independently tabulated by research institutions. Recreational fishing can be disregarded in some cases, but there are instances where recreational fishing data may be comparable with professional fishing data depending on the fish species and sea area. In addition, for target species that are distributed outside of Japan's exclusive economic zone, it can be necessary to utilize the catch figures of foreign fishing vessels and IUU (Illegal, Unreported, and Unregulated) fisheries. Here we evaluate whether the total catch of the target fish species is fully grasped after referencing and describing the literature.

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

1.1.2.3 Survey of Fishing Operations

Though the total catch is covered in 1.1.2.2, a lot of additional useful information such as the relative amounts of resources, spatio-temporal distributions, and changes in catch over time can be understood by analyzing the data on the catch, effort, and location of each fishery operation. The sources of these data include catch result reports, daily logs of vessels sampled, and operational records. Surveys by “scientific observers” can also collect biological information and catch composition data for each individual fishery operation. Additionally, it is possible to obtain information on the catch and effort input by collecting the sales records (landing slips) for each fishing vessel in the market, although with this method the specific locations related to each catch may be unknown. Here, we evaluate the availability, content, accuracy, and time periods of fishery-sourced catch data necessary for an accurate stock assessment after referencing and describing the literature.

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

1.1.2.4 Biological Investigations on Landed Fish

Collecting data on body length, total weight, and gonad weight, along with conducting age assessments on landed fish can provide detailed information on target species, greatly contributing to the improvement of stock assessments and stock management. For example, if information is available on size composition such as the number of catches by size class and age class, it is possible to track the depletion of a certain age group. This can also lead to analyses considering the age structure and parent-offspring relationship dynamics. The availability, detail, and period of data from landed fish necessary for an accurate stock assessment are scored after referencing and describing the literature.

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

1.1.2.5 Stock Enhancement Performance (Only Regarding Stock Enhanced Species)

Here we evaluate whether data are recorded and managed to assess the effectiveness of stock enhancement activities and their effects on ecosystems.

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

1.1.2.6 Identification of Naturally and Artificially Spawned Fishes (Only Regarding Stock Enhanced Species)

In order to evaluate the effects of stock enhancement, it is first necessary to differentiate artificially spawned fish from naturally spawned fish through tagging or markers, and to determine whether there is a way to estimate the number of landed fish that are a product of artificial stocking.

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

1.1.3 Stock Assessment Methods and Objectivity of Assessment

A stock assessment is the collection and analysis of catch statistics and various types of survey data to understand how marine resources have changed due to the impacts of fisheries, and additionally to predict

future trends which are very important for resources (fishery) management (Matsumiya 1996). The stock assessment methods and objectivity of the assessment are evaluated in 1.1.3.1-2.

1.1.3.1 Stock Assessment Methods

There are two major method types of assessments for evaluating the status of marine resources for fisheries management: assessments based on data obtained from fisheries, and assessments based on data from fisheries independent surveys. Stock assessments are carried out using the more suitable of the two methods, depending on the biological characteristics of the target species and the types of data available. In this section, it is first decided which method is used for the stock assessment, and next the chosen method is evaluated in terms of accuracy based on the following two criteria.

When data obtained from fisheries are used for the stock assessment, there are 3 models that are considered based on the availability of data such as the age composition of the catch, the index value of the relative stock, catch per unit effort (CPUE), and total yield. The following methods are considered based on the available data while considering the accuracy of each: ① A method of estimating stocks using a population dynamics model based on information regarding catch and effort, ② a method using CPUE, and ③ methods using catches or methods based on limited information such as CA (Consequence Analysis, MSC 2014; 2.2.1 Usable bycatch species reference). ④ Fisheries independent methods include catch data of target species by recorded by scientific survey boats (area density method), egg and larval surveys (egg count method), visual surveys (visual method), acoustic surveys (fish finding method), etc. and are applied for resource assessments using fully fisheries independent information.

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

1.1.3.2 Objectivity of Stock Assessment

With stock assessments, it is important that the data and place of consideration are properly disclosed, that third parties provide appropriate advice on the assessment methods, and that there is a mechanism to reflect that, in order to ensure the transparency of the process (FAO 2009). In order to ensure the transparency of the stock assessment process, it is necessary that the data used in the assessment and the place for evaluation are properly disclosed. It is also necessary to evaluate the extent of how the data and information used in the analyses are disclosed and the opinions of third parties are considered.

In addition, the periodic review of the methods used in the stock assessment and the existence of a system that is updated and revised as needed are important concerns for ensuring the reliability of the assessment results. Here we evaluate whether appropriate corrections on the assessment results have been made after the methods and results are reviewed.

1 Point	2 Points	3 Points	4 Points	5 Points
Data and discussions are private, and no peer reviews are considered		Data and place 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 reviews are conducted on the methods and results

1.1.4 Effects of Stock Enhancement (Only Regarding Stock Enhanced Species)

According to the 7th Basic Policy on Cultivated Fisheries (Fisheries Agency 2017a), it is believed that a cultivation fishery that secures the brood stock to ensure reproduction continues and reshapes marine resources, rather than the conventional approach of continuing to release stocks on the assumption that all released seedlings are caught after growth, should be promoted to maintain and recover coastal resources. Here, the effects of conventional stock enhancement that exhaust all released stock in their own generation (1.1.4.1) and the effects of enhancement as a resource shaping strategy (1.1.4.2) are evaluated. The impacts on natural fisheries resources (Kitada 2001) will also be evaluated following (1.1.4.3).

1.1.4.1 Effects on Fisheries Production (Only Regarding Stock Enhanced Species)

Here, we evaluate whether the effects of conventional stock enhancement activities that exhaust all released stock in their own generation are understood and recognized, using mixing rate and retrieval rate as key indices.

1 Point	2 Points	3 Points	4 Points	5 Points
Mixing rate and retrieval rate have not been researched		Mixing rate or retrieve rate have been researched for a certain window of time, but no obvious effects of stock enhancement are observed		Mixing rate or retrieve rate have been investigated for a significant time period, and effects of stock enhancement are observed

1.1.4.2 Effects of Stock Enhancement (Only Regarding Stock Enhanced Species)

Here, we evaluate whether stock enhancement activities contribute to the recovery of marine resources.

1 Point	2 Points	3 Points	4 Points	5 Points
No artificially stocked matured individuals are observed in catch		Some artificially stocked matured individuals are observed in catch occasionally	Artificially stocked matured individuals are observed in catch frequently	It has been confirmed that artificially stocked fish contribute to reproduction

1.1.4.3 Impacts on Natural Stocks (Only Regarding Stock Enhanced Species)

Here, we evaluate whether there has been any replacement of natural stocks by artificially released fish, due to increased competition for food or predation (cannibalism), as a result of artificial stock enhancement. Competition among individuals for food and predation are evaluated in factor 2.

1 Point	2 Points	3 Points	4 Points	5 Points
Replacement of natural stocks by artificially released fish has not been researched	Replacement of natural stocks by artificially released fish has been researched and is suspected			Research has confirmed no occurrence of the replacement of natural stocks by artificially released fish

1.2 Target Species Abundance and Trend

Information on stock levels and trends obtained from stock assessments is important information that is directly linked to society and the economy, as well as biological aspects of the target species. Therefore, resource abundance levels and trends obtained from stock assessment results are evaluated as a single item.

1.2.1 Target Species Abundance and Trend

In Japan, we have established basic fishery management rules for calculating the Allowable Biological Catch (ABC), and have carried out stock assessments that combine resource abundance and trends (Fisheries Agency and FRA 2019). In this evaluation, the following two methods will be used in the stock assessment based on the new MSY based standard that is being introduced for some fish species. ① As the abundance level of the target species, the target reference point and the limit reference point derived from the viewpoint of sustainable use are used as the standard and divided into three stages, “above the target reference point,” “between the target reference point and limit reference point,” and “below the limit reference point,” or ② evaluate the stock status from the combination of the abundance level and trends of the target species according to the rules so far. Here, the resource abundance is classified into three levels of “high, medium, and low” based on the change in the amount of stock (or catch) over the past 20 years, and the trend is classified as “increasing, flat, or decreasing” based on the changes in amount of stock (or stock index, catch) in the past 5 years.

For species whose abundance and trend have not been determined in previous surveys or assessments, abundance and trend information is determined using the information defined above.

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

1.3 Impacts of Fisheries on Target Species

Here we evaluate whether the current catch pressure has any adverse effects on the sustainable production of the target species.

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

For stocks which have target reference points in place, ① evaluate from the relationship between the current amount of mature fish (SB_{cur}), SB_{target}, current catch coefficient (F_{cur}), and F_{msy}, and then consider that it is preferable when the abundance exceeds SB_{target} and the catch pressure is below F_{msy}. For stocks with no target reference points in place, ② evaluate from the relationship between the current stock (mature fish) amount (B_{cur}), B_{limit}, current catch coefficient (F_{cur}), and F_{limit}, and consider that it is preferable when the abundance is above the B_{limit} and catch pressure is below the F_{limit}.

If the B_{limit}, (B_{target}), and F_{limit} (F_{target}) have not been estimated, the assessment is based on ③ the relationship between the ABC and the current total catch, or ④ CA (Consequence Analysis, MSC 2014). When using method ③ for fish species for where the ABC has not been calculated, the ABC is calculated using the second standard of rules for ABC calculation (Fisheries Agency and FRA 2019).

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

1.3.2 Stock Depletion Risk at Current Fishery Pressure

Here, we evaluate the risk of stock depletion at the current fishing pressure by predicting the future of the stock assessment results and conducting simulations. The magnitude of the depletion risk is considered using 3 forecast methods; ① stochastic forecast, ② deterministic forecast, ③ extinction probability forecast considering the rarity of the species. If an extinction probability assessment is possible, it is used (Fisheries Agency 2017b).

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
② ③	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 increasing the information available for stock management and fisheries management (Matsumiya 1996). In this section, we evaluate the influence of stock assessment results in formulating fishery management measures in terms of rules and procedures.

1.3.3.1 Presence of Fisheries Management Measures

In order to understand the how the assessment results are influencing fisheries management we evaluate whether any pre-agreed catch rules (harvest control rules) are being implemented. That is, whether measures for the recovery of low fish stocks are present, whether measures for stocks that have decreased from medium to low stock are present, or whether measures to maintain the spawning stock at a certain level are present. The evaluation is conducted for cases where the harvest control rules are not considered at all from the beginning, and cases where they are considered but are not incorporated into the current fisheries management due to social and economic factors.

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

1.3.3.2 Presence of Precautionary Measures

In this section, we evaluate the presence of precautionary measures taking into account the uncertainties in resource estimation, and whether these measures are reflected in management measures. Here, the evaluation is divided into cases where no precautionary measures are considered, and cases where they are considered but are not incorporated into current policies due to social and economic factors.

1 Point	2 Points	3 Points	4 Points	5 Points
Precautionary measures are not taken into account	Precautionary measures are considered but are not reflected in fisheries management		Precautionary measures are taken into account and some are well reflected in fisheries management	Precautionary measures are taken into account and are well reflected in fisheries management

1.3.3.3 Considering Impacts of Climate Change

Catch figures and the stock status of target species are greatly affected by global climate change and the progress of global warming. In addition, it is thought that changes in habitats such as changes in the coastal environment due to factors outside of fisheries, will have a large impact on the distribution and stocks of target fish species. Here, we evaluate whether the impacts of environmental changes on stocks and catches have been identified and fully taken into account for stock management.

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

1.3.3.4 Formulation of Fisheries Management Measures

In the process of implementing the stock assessment results in fisheries management, we also evaluate whether there is a place for discussion for not only internal managers but also external experts and stakeholders. Management measures taken by each local government, independent voluntary management measures, etc. will also be evaluated.

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

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

When the target species are affected by recreational fisheries, foreign fishing activities, or IUU fishing at a level that cannot be ignored, including considerations for these activities in proposals for fishery management is also important for proper resource management. Here we evaluate whether the impacts of recreational fishing, foreign fishing vessels, and IUU (Illegal, Unreported, and Unregulated) fishing are taken into account in formulating fishery management measures. We also consider that there may be no catch or a negligible catch by recreational fishing, foreign fishing activities, or IUU fishing.

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

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*: translated by SH”U”N Project Office

２． Marine Environment and Ecosystems

Overview

Marine ecosystems are supposed to be dynamic in nature, being affected by various environmental fluctuations and anthropogenic disturbances. Fisheries unavoidably bring some changes to ecosystems by removing biological resources from the sea. It is important to avoid irreversible change of ecosystems caused by fishing (damage being so severe that an ecosystem would not recover even if the fishery was stopped for a prolonged period) and to keep the biodiversity, productivity, and resilience of the ecosystems.

Therefore, the environmental and ecosystem evaluation at the SH“U”N Project focuses on the major fisheries that harvest the target fish species. Firstly, the availability of information and research and monitoring programs necessary for evaluating the state of ecosystems and the impacts of fisheries are examined in Section 2.1. Next, the impacts of bycatch mortality on non-target species area assessed in Section 2.2; indirect effects of fishery removals on other organisms through predator-prey relationships (loss of prey or predators) and interspecific competition (increase or decrease in competitors) are assessed in Section 2.3.1; and the potential ecosystem impacts of fisheries such as environmental disturbances and altered distributions are assessed in Sections 2.3.2 and 2.3.3. Finally, the impacts of fisheries on the benthic seafloor habitats, atmospheric environment, and water quality as well as the measures to reduce them area evaluated in Sections 2.3.4 - 2.3.6.

The data available on marine environments and ecosystems are often limited. In situations where there are a lack of data, we apply a risk-based assessment that proactively assesses the risk of irreversible changes in ecosystems. If there is no information available on the marine environment or ecosystem, the lowest score of one point is given. If a risk-based assessment is performed based on limited information, the upper limit of the score is reduced to four points in consideration of the uncertainty of the information. A risk-based assessment is a method to determine the score based on changes or extent of factors (such as species abundance, reproductive potential, age, sex, size compositions, or distribution range) likely to be affected by fisheries when a direct impact assessment is not possible.

Outline

① Identification of focal fisheries

The major fisheries targeting the relevant fish species are identified. Those fisheries that in all cover 75% or more of the total annual catch for the target species are extracted for the assessment. If multiple fisheries are extracted, the scores for each fishery are first calculated, and then weighted by the catch of each fishery to provide overall scores for 2.1, 2.2, and 2.3.

② Identification of focal sea areas

The areas used by the focal fisheries are specified and expressed as the units of ocean area according to the classification by the Statistical Survey on Marine Fishery Production. In the case of assessing the impacts of small-scale fisheries on locally distributed fish species, however, a smaller spatial unit can

be used for defining the focal sea area. If the focal fishery spans multiple sea areas, the scores for each area that account for 75% or more of the total annual catch of the target species are calculated, and the average score weighted by the annual catches by area is derived.

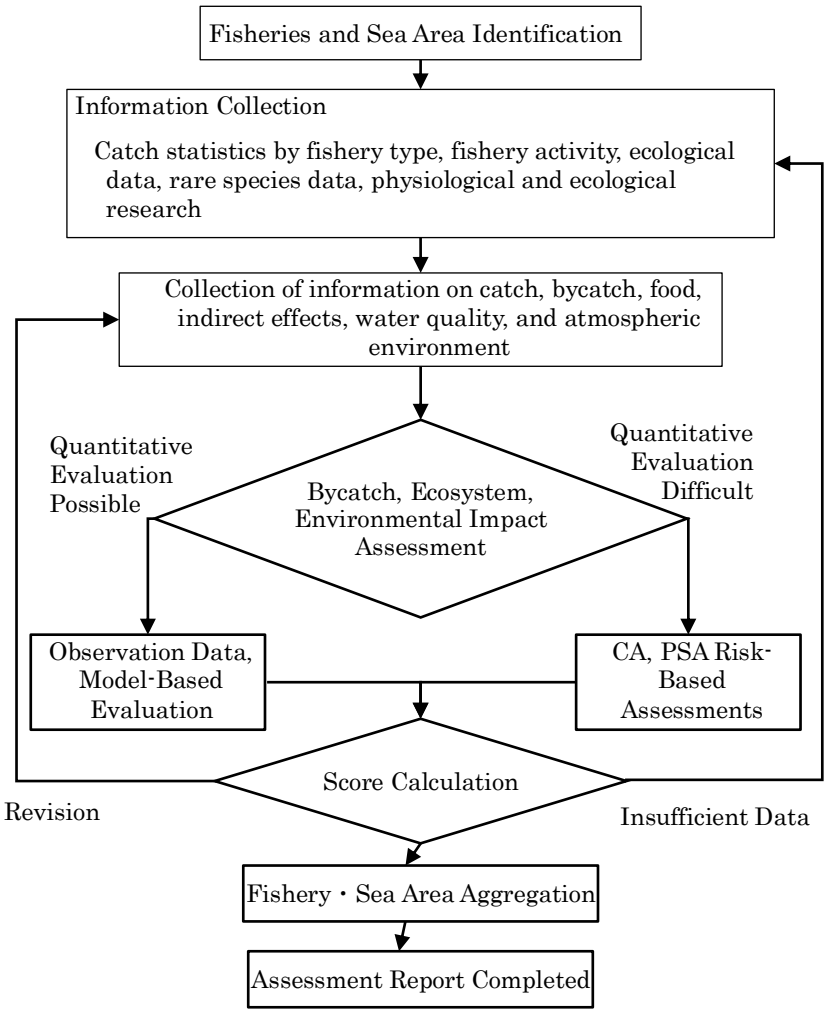
③ Collection and description of information on target fisheries and ecosystems

The characteristics of each focal fishery are clarified through the description of the following information in each sea area by the fishery:

1) Fishing gear and methods
2) Vessel size, number of operating vessels, total fishing efforts
3) Spatial range: spatial extent and depth range in focal sea areas
4) Spatio-temporal distribution of fishing operation: number of operations per month for each latitude / longitude mesh (about 30 minutes to 1 degree) in focal sea areas
5) Bycatch: list of the commercial and non-commercial species that are caught incidentally in each sea area to be assessed
6) Rare (endangered or threatened) species: the distribution ranges and seasonal occurrence of rare species that are known to occur in the focal sea areas

④ Presence/absence of stock enhancement activities

The presence or absence of a stock enhancement project for the target fish species in the focal area is determined based on the available information. It does not include experimental stock enhancement conducted by scientific research institutions.



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

2.1.1 Accumulation of Basic Information on Regional Environment and Ecosystems

Here, it is evaluated whether sufficient information has been accumulated to evaluate the impacts of fisheries on marine environments and ecosystems while considering the ecological characteristics of the focal sea area.

Necessary information includes fishing season, fishing area, fishing gear, bycatch and discard, feeding habits and trophic levels of the target species, predators and prey, seafloor environment in fishing grounds for bottom fisheries, water and atmosphere quality, etc. The availability and content of the information are described and scored after referencing the literature and other archives.

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

2.1.2 Implementation of Scientific Surveys

The extent and regularity of fisheries independent scientific surveys regarding marine environments and ecosystems are evaluated here. The assessment results are scored on the basis of the description about specific survey names, aims and subjects, and implementation structure.

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

2.1.3 Monitoring through Commercial Fisheries Activity

Here it is evaluated whether a system is in place to collect information on the marine environment and ecosystems through commercial fishing activities, using scientific observers aboard fishing vessels or port-side monitoring. This kind of information is not only useful for stock assessments, but also highly valuable for the development of voluntary adaptive management using the PDCA (Plan-Do-Check-Act) cycle to avoid irreversible adverse impacts on ecosystems. Any such information will be scored highly as it allows us to monitor the state of ecosystems real-time in active fisheries. Assessment results are scored on the basis of the description about the specific monitoring status.

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

From the following four characteristics one element that is supposed to be most susceptible to the focal fishery is selected. The current condition and any changes that have occurred for the element in the bycatch species are evaluated.

1) Abundance (catch, CPUE, other abundance indicators)
2) Reproduction ability (Change in reproductive condition caused by gear selectivity and age at first capture relative to age at maturity)
3) Size and age composition
4) Distribution area

Based on the above description, the risk of the impacts caused by the focal fishery will be assessed.

The impacts of direct mortality caused by bycatch (incidental catch) of non-target species are assessed here. Three categories of bycatch species area identified: non-target species with commercial market value that are caught and landed (commercial bycatch), non-target species without commercial market value that are caught but discarded (non-commercial bycatch), and rare (endangered or threatened) species that may be encountered during the fishing operations. Those commercial and non-commercial bycatch species whose catch is less than 5% of total catch of the focal fisheries (less than 2% for species with late maturation periods and low productivity) will not be assessed (after MSC 2018).

2.2.1 Commercial Bycatch Species

For organisms other than the target species that are caught and used by the target fishery (usable bycatch species), the socks are evaluated in the same way as previously in the evaluation of the stock abundance. As in *1. Resource Status,* the status is based on the same scales as used in *1.2.1 Target Species Levels and Trends*, *1.3.1 Effects of Current Fishery Pressures on Sustainable Production of Target Species*, and *1.3.2 Stock Depletion Risk at Current Fishery Pressure* and a score is assigned.

For species where a stock assessment cannot be performed due to deficiency of data, a Consequence Analysis (CA), a kind of risk-based assessment method is used (MSC 2014). If a stock assessment (or CA) cannot be performed for the majority of bycatch species, a Productivity-Susceptibility Analysis (PSA) is applied (Hobday et al. 2007, 2011, Patrick et al. 2009).

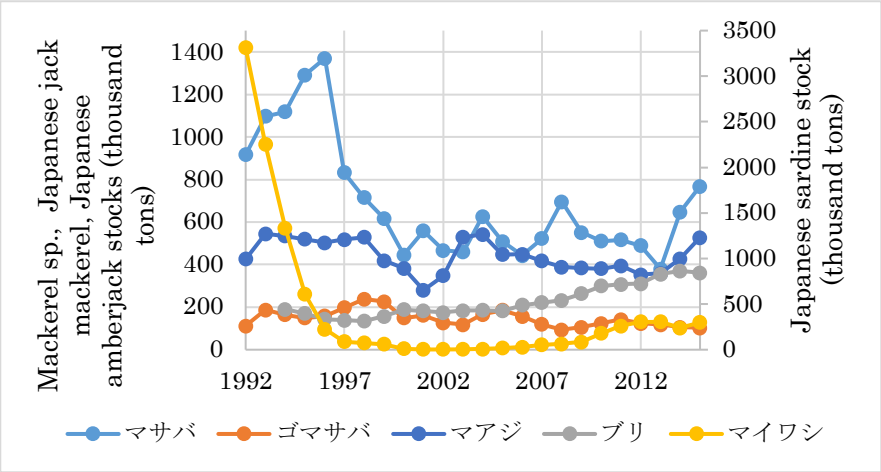
When a CA or PSA is used for the majority of bycatch species, the maximum score is limited to 4 points.

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

【Assessment method using CA: Example of commercial bycatch species】

Example of a CA evaluation sheet used in the SH“U”N Project

Focal fishery	Large and medium sized purse seines
Focal sea area	East China Sea
Target fish species	Chub mackerel (*ma-saba*)
Evaluation item number	2.2.1.1

Assessment item	Effects on bycatch species	
Evaluation focal elements	Abundance	4
	Reproductive ability	
	Age and size composition	
	Distribution area	
	Other:	
Overview of assessment basis	The stock status of spotted mackerel (*goma-saba*), Japanese jack mackerel (*ma-aji*), Japanese sardine (*ma-iwashi*), and Japanese amberjack (*buri*) are not a concern. As a result four points are given.	
Basis of assessment	Figure 2.2.1.1a shows the annual changes in resource abundances for the bycatch species, spotted mackerel (East China Sea), Japanese jack mackerel (Tsushima Current), Japanese sardine (Tsushima Current), Japanese amberjack, and Chub mackerel (Tsushima Current). The stock status of the bycatch species are shown below. ・Spotted mackerel (East China Sea): Stock abundance and trend are medium and flat, if current fishing pressures continue it is estimated that stocks will decline slightly over the next 5 years (Kuroda et al. 2018a). ・Japanese jack mackerel (Tsushima Current): Stock abundance and trend are moderate and increasing, if current fishing pressures continue it is estimated that stocks will increase over the next five years (Yoda et al. 2018). ・Japanese sardine (Tsushima Current): Stock abundance and trend are medium and flat, if current fishing pressures continue it is estimated that stocks will increase over the next five years (Yasuda et al. 2018). ・Japanese amberjack: Stock abundance and trend are high and unchanged, if the current fishing pressure continues it is estimated that the stock quantity will remain almost the same over the next 5 years (Kubota et al. 2018). As described above, the Chub mackerel is not a species whose stock status is of concern due to bycatch, so the overall score is set to 4 points.  Fig. 2.2.1.1a Annual changes in stocks of bycatch species and Mackerel	

2.2.2 Non-commercial Bycatch Species

Non-commercial bycatch species that are incidentally caught and discarded by the focal fisheries are listed, and their stock status or risks of adverse impacts are assessed. Where quantitative data are available, species that account for less than 5% of total catch of the focal fisheries, (less than 2% for species with late maturation and low productivity) are not assessed (MSC 2018). In most cases, the quantitative data available for most non-commercial bycatch species have insufficient quantitative data for stock assessment, and are assessed using CA or PSA (Hobday et al. 2007, 2011, Patrick et al. 2009). In this case, the maximum score is limited to 4 points.

If individual stock assessments of the bycatch species are available, and the assessment results indicate that bycatch mortalities are at sustainable levels, a score of 5 is given. If it is confirmed regularly that bycatch of non-commercial species is not occurring and there are no signs of negative bycatch impacts, a score of 5 points is assigned.

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

【Assessment method using PSA: non-commercial bycatch species】

1) List bycatch species in the focal fisheries.
2) If the number of bycatch species is low, perform PSA for all species. When there are many bycatch species, perform PSA for two or more species from each functional group or each taxon that are more likely to be affected by bycatch.
3) Productivity score: Scores are assigned based on age at maturation, longevity, fecundity, average length, length at maturity, spawning methods, trophic level, and density dependence.
4) Susceptibility score: Scores are assigned based on horizontal and vertical overlap in distribution with fishing operations, fishing gear selectivity, and post-release mortality rates.
5) PSA scores are assigned from the plots on the two evaluation axes, i.e., productivity and sensitivity.
6) Based on the species-specific PSA scores, the overall score is calculated.
7) Species with a score over 3.18 are judged to be of concern. Species with a score of 2.64 or less are judged to be of low concern.

PSA Scoring Guideline

	P (Productivity score)	1 (High productivity)	2 (Medium productivity)	3 (Low productivity)
P1	Maturation age	< 5 years	5-15years	> 15years
P2	Life span (ave)	< 10 years	10-25 years	> 25 years
P3	Fecundity	> 20,000 eggs/year	100-20,000 eggs/year	< 100 eggs/year
P4	Max length (ave)	< 100 cm	100-300 cm	> 300 cm
P5	Length at maturity	< 40 cm	40-200 cm	> 200 cm
P6	Spawning methods	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 effect	Reverse compensation at low density (Ally effect) is observed
P	Overall P score	Calculated arithmetically		=(P1+P2+…Pn)/n
	S (Susceptibility score)	1 (Low susceptibility)	2 (Medium susceptibility)	3 (High susceptibility)
S1	Horizontal distribution overlap	< 10 %	10-30 %	> 30%
S2	Vertical distribution overlap	Low chance of encounter with fishing gear	Medium probability of encounter with fishing gear	High probability 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 catch
S	Overall S score	Calculated by geometric average		=(S1*S2*...Sn)^(1/n)
	PSA score	< 2.64 Low	2.64-3.18 Moderate	> 3.18 High
	PSA overall score	The Euclidean distance between zero and point (P, S) is calculated		=SQRT(P^2 +S^2)
	Overall assessment	Evaluated based on the overall PSA score and presence of high-risk species		

Example of a PSA evaluation sheet used in the SH“U”N Project

	Focal species		Productivity									Susceptibiliity					PSA	
Item	English name	Vertebrate or Invertebrate	Age at maturity	Longevity	Brood size	Max imum BL	BL at maturity	Reproductive strategy	Trophic level	Density dependence	Total P score	Horizontal Overlap	Vertical Overlap	Gear Selectivity	Post-encounter mortality	Total S score	PSA Score	Risk rank
2.2.3	Loggerhead turtle	Vertebrate	3	3	2	2	2	2	1		2.14	1	1	1	1	1.00	2.36	Low
2.2.3	Tuffted puffin	Vertebrate	1	3	3	1	1	3	3		2.14	1	1	1	1	1.00	2.36	Low
2.2.3	Short-tailed albatross	Vertebrate	2	2	3	1	2	3	3		2.29	1	1	1	1	1.00	2.49	Low
2.2.3	Japanese murrelet	Vertebrate	1	1	3	1	1	3	3		1.86	1	1	1	1	1.00	2.11	Low
Fishery	Northern Purse Seine													Total PSA Score			2.33	Low
Area	Pacific North																	

2.2.3 Rare (Endangered or Threatened) Species

Those species designated as endangered or threatened species or special natural monuments acknowledged by the Red Databook of the Fisheries Agency or the Ministry of Environment of Japan which appear in the sea area where the focal fisheries operate are listed. All species for which relevant data are available are subject to the assessment. The risks of significant adverse impacts of the focal fishery on each rare species are assessed by PSA or CA. In this case, the maximum score is limited to 4 points. When the species targeted by the fishery is listed as a rare species, the assessment is determined in consideration of it’s current stock status as well as that of other rare species.

If the focal fishery is judged to have no significant adverse impacts on the basis of the stock assessment or the Population Viability Analysis (PVA) of individual rare species, a score of 5 points is assigned.

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

2.3 Ecosystems and Environments

Besides direct impacts caused by catch and bycatch as evaluated above, indirect and potential effects of focal fisheries that work through predator-prey relationships and interspecific competition are assessed here. The impacts of fisheries on water and air quality and counter measures to mitigate them are also evaluated.

2.3.1 Indirect Impacts through the Food Web

The indirect impacts of reductions in fish stocks (catch and bycatch) on ecosystems through the predator-prey relationships are evaluated here.

If an ecosystem model can be used, the impacts of catch and bycatch on low trophic producers, predators, and competitors with similar trophic niches are evaluated through the model analysis. In this case, if the catch and bycatch is judged to be at sustainable levels without any irreversible adverse impacts, a score of 5 points is assigned.

In the case where available information is limited, predators, prey, and competitors are identified based on the feeding habits and trophic level of the target species, and a risk assessment using CA is performed for each of these components. In this case, the maximum score is limited to 4 points.

2.3.1.1 Predators

Firstly, predators that feed on target and bycatch species of the focal fisheries in the focal sea area are listed. If the Ecopath with Ecosim (EwE) ecosystem model (Christensen and Walters 2004) is applicable, predators are identified by using the Predator Overlap Index from the Niche Overlap Index, and the impacts of catch are assessed by using Mixed Trophic Impact (MTI) or through the future prediction of Ecosim with the manipulation of the catch and bycatch levels.

In the case where available information is limited, changes in the most sensitive elements from among the species composition, abundance, age and size composition, distribution area, and feeding habits of the major predators over the past 10 years or more are evaluated using CA.

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

2.3.1.2 Prey

The organisms preyed on by the target species are listed, and the impacts of reduction in fish stocks on major prey species in the focal sea area are assessed here. If the EwE ecosystem model is applicable, prey species are identified by using the Prey Overlap Index from the Niche Overlap Index, and the impacts of

catch are assessed by using Mixed Trophic Impact (MTI), or through the future prediction of Ecosim with the manipulation of catch levels.

In the case where available information is limited, changes in the most sensitive elements from among the species composition, abundance, age and size composition, distribution area, and feeding habits of the major prey over the past 10 years or more are evaluated using CA.

This section also evaluates whether stock enhancement affects the ecosystem through predator and prey relationships (for example, the relationship between the Japanese Spanish mackerel and Japanese anchovy).

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

2.3.1.3 Competitors

Competing species that occupy the same feeding niche and trophic level as the target species in the focal sea area are listed, and the major competing species are subject to the assessment here. If the EwE ecosystem model is applicable, competitors are identified by using the Predator Overlap Index and Prey Overlap Index from the Niche Overlap Index, and the impacts of catch are assessed by using Mixed Trophic Impact (MTI), or through the future projections of Ecosim with the manipulation of catch levels.

In the case where available information is limited, changes in the most sensitive elements from among the species composition, abundance, age and size composition, distribution area, and feeding habits of the major competing species over the past 10 years or more are evaluated using CA.

This item also evaluates whether stock enhancement has any effect on competing species, such as increased competition for food.

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

2.3.2 Whole Ecosystem

Besides the direct impacts of catch/bycatch mortalities and indirect trophic impacts through food webs, the potential risks to the ecosystem are assessed here. First, it is determined whether there are any long-term changes in the catch of fisheries judging from the stock status and trends of the major commercial species and trophic levels of the catch in the focal sea area.

If ecosystem models or time series data of ecosystem indicators are available, comparisons with past conditions and/or other areas, and future projections are used to determine whether fisheries have caused any irreversible changes in ecosystems or if they have been operating at a sustainable levels. If EwE ecosystem models are applicable, an assessment is made by using the L-index (Liberalto et al., 2008) to analyze the impact of catch on predators, or through the future projection of Ecosim with the manipulation of catch levels. If such quantitative data and/or model analyses detect no irreversible changes in the ecosystem, a score of 5 points is assigned.

In the case where available data are limited, a risk assessment is conducted using SICA (Scale Intensity Consequence Analysis; Hobday et al. 2007, 2011). In this case, the maximum score is limited to 4 points.

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

【Assessment method using SICA: Impact on the entire ecosystem】

1) Scale Score: The spatial scale indications are calculated from the percentage of the latitudinal/longitudinal mesh of the focal sea area covered by the focal fisheries; the time scale is calculated from the time frequency of fishery operation
2) Intensity Score: Calculated from the spatial and temporal scale scores.
3) Result (Consequence) Score: The most sensitive elements of the ecosystem characteristics are selected from among species composition, functional group composition, distribution of population, trophic level, and size composition. It is then described whether directional changes or intensification of fluctuations have occurred over the past 10 years or more.
4) Based on the above description, it is determined whether any significant irreversible changes in the ecosystem have occurred.

SICA Scoring Guideline

	Scale and intensity (Score)	0.5	1	1.5	2	2.5	3
S1	Spatial scale (Spatial overlap)	< 15 %	<= 30 %	<= 45 %	<= 60 %	<= 75 %	> 75 %
S2	Time scale (Operation period)	< 15 %	<= 30 %	<= 45 %	<= 60 %	<= 75 %	> 75 %
SI	Intensity score	Scoring is based on the geometric mean of S1 and S2, taking into account the impact of fishing gear			＝SQRT(S1*S2)		
C	Consequence (Resultant change) Species composition Functional group composition	2 It is suspected that the ecosystem is undergoing		3 There is concern of some changes in ecosystems		4 No irreversible changes in ecosystem	

Community distribution Trophic level composition Size composition	irreversible changes and/or the range of fluctuation is expanding	and the expansion of fluctuations	characteristics are detected
	The element most likely to be affected by fisheries is selected from the left list, and the temporal pattern of its change is examined to detect irreversible changes or increased fluctuations		
Overall score Overall assessment	2 The impact of the assessed fishery is severe (SI> = 2), or there is concern that irreversible changes or increased fluctuations in ecosystems are occurring (C = 2)	3 Although the magnitude of the impact of the assessed fishery is not severe (SI <2), there is concern of some changes in ecosystems or the range of fluctuation is expanding (C = 3)	4 The impact of the assessed fishery is modest (SI <1) and no irreversible changes in ecosystems have occurred (C = 4)

Example of SICA evaluation sheet for ecosystem assessment used in the SH“U”N Project

Focal fishery	Northern purse seine fishery
Focal sea area	Northwestern Pacific Ocean off Tohoku Region
Item number	2.3.2
Item	Impacts on Whole Ecosystem
Spatial scale score	0.5
Spatial scale evaluation summary	A purse seine with a length of 1,800m will be 258 x 1,000 m2 when it fills and rounds out in the water when deployed. Since the annual total number of purse seines deployed in the focal sea area was 7,266 times per year on average from 2013 to 2015, the total spatial effect of the operation of purse seines can be calculated by 258 x 1,000m2 x 7,266 times = 1,875 km2. On the other hand, the distribution range of the Chub mackerel (*ma-saba*) Pacific stock is estimated to be 37,000 km2 because the distribution area of the geographic 30 degree minute square (about 3,100 km2) fishing area covers 14 fishing areas. By simply division, the spatial area the purse seine fishery covers one time will be 5.1% of the distribution area of the Chub mackerel Pacific stock. The score assigned is 0.5 (<15%) according to this calculation.
Time scale score	1.5
Time scale evaluation summary	For the Chub mackerel Pacific stock, the operating season within the distribution and migration range occurs mainly from July to January (Ebisawa 2014). There is no information on how many times a month the fishing nets are deployed during the season, but if they are deployed every day during the season, there are a total of about 210 fishing days. In reality, it is assumed there are days when operations are not possible due to stormy weather and other issues. In addition, a resource recovery plan is currently underway for the Chub mackerel Pacific stock (http://www.jfa.maff.go.jp/j/suisin/s_keikaku /pdf/masaba_taiheiyou.pdf, accessed date 2016/9/16). Since we are working to reduce the number of operating days by up to 30%, we set 210 × 0.7 = 147 days / year as the time scale of fishing activities.
Impact intensity score	0.87
Impact intensity evaluation summary	The purse seine used for fishing sardines and mackerel is intended for small pelagic fish near the trophic level of 2.5 to 3.5. Considering the selectivity of the target, it has no direct effect on smaller organisms and phytoplankton. Furthermore, no indirect effects, as discussed in 2.3.1.2, were found which impact the structure or functions of lower order ecosystems lower than Chub mackerel due to the fishery were found. Also worth mention, in the purse seine net test operations by the Japan Marine Fisheries Research and Development Center in the northern Pacific sea ward, the bycatch of Nomura’s jellyfish (*echizen kurage*) was occasionally observed (JAMARC 2011, 2012). However, since these are considered as dead migratory individuals who do not return to the East China Sea where they normally reside, there is no problem in excluding them from the study. Regarding the bycatch of large higher order predators, while Skipjack tuna (*katsuo*) and Albacore tuna (*binnaga*) are aimed at based on the Skipjack tuna and tuna

	family (*maguro*) presence cues (birds present, skipjack breaking surface), they are not recorded in the Japanese sardine and Chub mackerel presence cues (sonar sounding) (JAMARC 2011, 2012). In other words, the bycatch species found in purse seine fisheries aimed at Chub mackerel are mostly small pelagic fish, but the effects on these are based on the stock status of the bycatch species as described in sections 2.2.1, 2.2.2, 2.3.1, and 2.3.2. However, as you can see by looking at the stock status of the bycatch species, no severe or irreversible impacts were found from the spatio-temporal intensity of the purse seine operations. For lower trophic level small pelagic fish, long-term population fluctuations are observed for each species, which can be attributed to the marine environment (Kawasaki 2009). It is a self-correcting phenomenon that has been repeatedly observed in the past, and is not considered to be caused by the loss of the structure or function of the ecosystem due to the Chub mackerel fishery or bycatch of other fish species. Purse seine nets are mainly used in offshore areas less than 100m deep. Although only a part of the purse seine test operation in the northern Pacific waters carried out by the Japan Marine Fisheries Research and Development Center made contact with the sea floor, the bottom area affected by the purse seine operation was as small as 5.1% of the sea area, and as such serious impacts on the benthic ecosystem near the seabed and bottom layer are not expected.	
Consequence (result)	Species composition	4
Score	Functional group composition	
	Population distribution	
	Trophic level composition	
	Size composition	
Consequence evaluation aummary	In view of the size selectivity of the purse seine, the species composition was selected as a related item because similar trophic levels show the greatest impact on the target species. In the western part of the north Pacific pelagic ecosystem, small-sized pelagic fish such as Chub mackerel, spotted mackerel, Japanese sardine, Japanese anchovy, Pacific saury (*sanma*), Japanese jack mackerel, and Japanese flying squid (*surume-ika*) repeat long-period population fluctuations that are not considered to be solely due to fishing. These cycles last several decades. Although the population fluctuations of fish species from similar trophic levels are mutually out of phase, currently there are no fish species in this fishery that are under extreme concern regarding their stock status. Overall, the status and function of the ecosystem as a whole are being maintained.	
Comprehensive evaluation	Score	4
Comprehensive evaluation summary	The impact intensity is low at 0.87, and the impacts of purse seine fishing on the ecosystem and environment are small. No irreversible changes or increases in fluctuation in fish species composition due to purse seine fishery.	

2.3.3 Effects of Stock Enhancement on Ecosystem (Only Regarding Stock Enhanced Species)

While stock enhancement is expected to have the effect of increasing catches and recovering resources, it has also been pointed out that the release of large amounts of artificial seeds and seedlings into natural waters has an effect on the natural and marine ecosystems (Kitada 2001, Fisheries Research Agency and Fisheries Agency 2015). Here we evaluate genetic integrity (2.3.3.1), gene disruption avoidance (2.3.3.2), and the prevention of disease spread to wild stocks (2.3.3.3).

2.3.3.1 Securing the Quantity of Broodstock for Genetically Healthy Seedlings (Only Regarding Stock Enhanced Species)

Here we evaluate whether or not a sufficient number of fish are used as broodstock so the seedlings for release do not bias towards any specific gene set. According to the Fisheries Research Agency and Fisheries Agency (2015), it is recommended to regularly obtain new wild individuals to refresh the broodstock. Further, the recommended number of broodstock to reduce the risk of reduced genetic diversity is around 60. If the mixing rate of the artificially released seedlings with the naturally spawning wild stock, or the PNI used in salmon (PNI: Proportional Natural Influence, Hatchery Scientific Review Group 2014), can be estimated, the score may be determined based on that value.

1 Point	2 Points	3 Points	4 Points	5 Points
Broodstock is made up of artificially spawned fish		The broodstock is made up of naturally spawned fish obtained from the focal release sea area, or the PNI is less than 0.3	Naturally spawned fish obtained from the focal release sea area are used as broodstock, and they are replaced regularly	A group of over 60 naturally spawned fish obtained from the focal release sea area are used as broodstock, and they are replaced regularly, or the PNI is 0.5 or more

2.3.3.2 Avoiding Gene Disruption (Only Regarding Stock Enhanced Species)

Here we evaluate whether genes in geographically and reproductively isolated populations have been disrupted. Seedling escape from hatcheries and stock enhancement facilities is also covered in this item.

1 Point	2 Points	3 Points	4 Points	5 Points
Seedlings are often released into areas different from the distribution areas of the broodstock	In rare cases the release areas differ from the distribution areas of the broodstock		The stock structure is unknown, but the broodstock catch areas and seedling release areas are the same	After ascertaining the structure of the stock (or genetically uniform population), broodstock are collected from and seedlings are released within the same population

2.3.3.3 Preventing Spread of Disease to Wild Stocks (Only Regarding Stock Enhanced Species)

Here we evaluate whether there is a system (Mori 2016) to keep any disease that may occur in a hatchery facility from spreading into nature along "Measures agreed upon concerning epidemic prevention for stock enhancement (National Business Council for the Promotion of Development for Cultivation Fishery Technology)". If there are cases of disease spread in the past, the evaluation will include whether proper measures to handle them were carried out.

1 Point	2 Points	3 Points	4 Points	5 Points
Neither a system for fish disease diagnosis nor a system to prevent the spread of disease are in place				A fish disease diagnosis system is in place and there is a system to prevent spread

2.3.4 Benthic Ocean Environment

This section is applicable when the focal fishery uses bottom fishing gear. If bottom fishing gear is not used, a score of 5 is assigned.

The impacts due to bottoming fishing gear on the seafloor environment are evaluated from scientific data that are used to estimate the overall impact estimated from the intensity of fisheries, the susceptibility of the seafloor environment, the assessment guidelines for Significant Adverse Impacts in FAO's Deep Sea Fisheries Guidelines, and the response of the benthic ecosystems. The evaluation is implemented for each type of marine environment based on the type of fishery or focused sea area and the benthic environments' topography and sediment makeup. Additionally, the areas of the focused seas where no bottom fishing is taking place (protected waters not affected by fisheries) are also considered before a score is assigned.

Classification of benthic environment (= Habitat Type): The terrain (seafloor roughness, slope, irregularity) is estimated using the depth data, and the bottom of the focused sea area is classified together with the sediment (cobble, gravel, sand, mud). Seabed sensitivity (= Susceptibility): Deeper, harder, and more complex seabeds are defined as more susceptible to disturbance from fisheries, while the shallower, softer, and flatter the seabed is the more resilient it is to disturbances. The score is calculated for each habitat type. Fishery intensity (= Impact): The fishery operational frequency is calculated in the focused sea area relative to fishing method and habitat type from fishery reports, and then multiplied by the sea bottom disturbance coefficient (based on ground rope length, etc.) for each fishing method to define the overall impact of the fishery on the sea bottom. For each habitat type, the overall impacts of all fishing methods are divided into three equal parts between 0 and the upper limit, and each fishing method is scored as high (= 2), medium (= 3), or low (= 4) impact level. When there are no data on fishery operations and an evaluation is impossible a score of 1 point is assigned, and when there are no fishery operations in the focused area a score of 5 points is assigned.

Benthic ecosystem response index (= Response): Using the available scientific fixed point survey data, the changes over time of the benthic ecosystem are estimated based on the diversity and functional group composition (epifauna/infauna ratio, sessile/mobile ratio, frequency of habitat member species, rockfish/flatfish ratio, etc.), by fishing ground and habitat type for each fishing method.

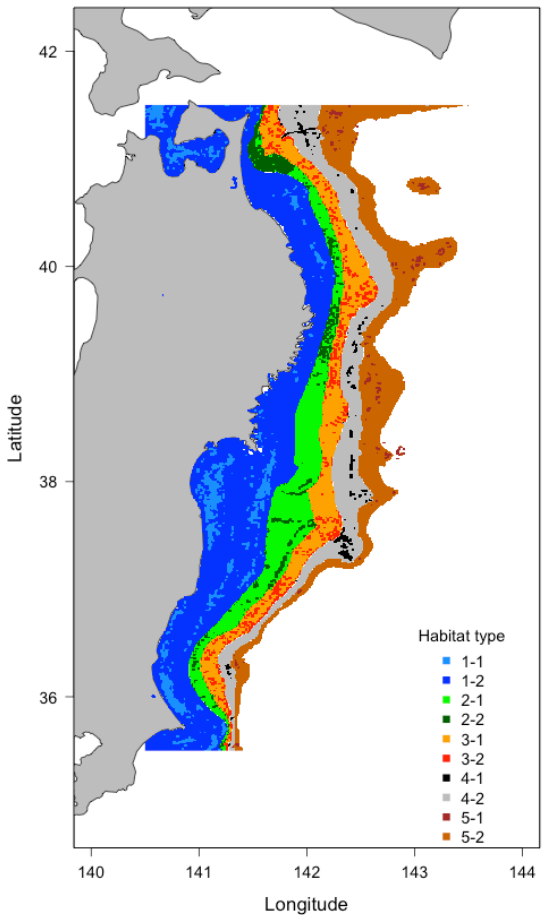


Fig.2.3.4 Habitat type classification.

If there are no survey points and response cannot be evaluated a score of 1 point is assigned. If a negative response to the ecosystem is observed in 50% or more of the survey points in the habitat type 2 points are assigned. If 20% ≤ survey points <50% it is scored as 3 points, if 0% <survey points <20% it is scored as 4 points, and if no negative response is found 5 points are assigned.

The overall score is calculated by averaging the scores of the overall impact, the response of benthic ecosystems, and the area of the restricted fishing ground, for each habitat type. The same risk classification as used for PSA is applied for the rare species assessment; an overall score of ＜2.64 is minor, 2.64-3.18 is of some concern, and ＞3.18 is judged as serious.

If the impacts of benthic disturbances cannot be assessed using the above methods, the effects of the bottom fishing gear are evaluated using SICA (Spatial Intensity and Consequence Analysis) by the scale and intensity, resilience, and consequence (Hobday et al. 2007). In this case, the maximum score is limited to 4 points.

[Evaluation procedure using SICA: Example of impact on seafloor environment]

The operating sea area of the fishery is evaluated for each habitat typed by water depth, bottom sediment, and topography. When operating in a uniform seafloor environment, one standard habitat type can be evaluated.

I. Evaluation of Scale and Intensity
- 1) Spatial overlap: Percentage of the operable area of the target sea area the target fishery operates in.
- 2) Temporal overlap: The percentage of the operating period per year.
- 3) Impact by fishing method (Gear footprint): Score the strength of impact for each fishing method.

II. Resilience Rating: Resilience to impacts based on each habitat's water depth, bottom sediment, and seafloor topography.
- 4) Water depth (0-25m; 25-200m; 200m or more)
- 5) Bottom sediment (soft sand or mud; gravel or boulders; bedrock)
- 6) Topography (flat; irregular; steep)

III. Comprehensive assessment of scale and resilience
- 7) For the scale, find the total value S as the geometric mean, and for the resilience, find the total value R as the arithmetic mean, then calculate the total score from the Euclidean distance between S and R. Evaluate the degree of impact using the same criteria as PSA.

IV. Evaluation of the result (Consequence)

Of the following characteristics, the most vulnerable factors will be evaluated for changes over the past 10 years.
- 1) 1) Benthic organism distribution area
- 2) Functional group composition of benthic communities (epifauna: infauna ratio, sessile: mobile ratio, frequency of habitat building species, rockfish: flatfish ratio, etc.)
- 3) Benthic organism size composition (community size structure, especially large upright benthic organism size composition)
- 4) Feeding ecology and trophic stage composition (filter feeder: deposit feeder ratio, predator: scavenger ratio, etc.)

V. Comprehensive evaluation

1 Point：No data for assessment

2 Points：It is judged that the S and R values are large and the impact of the fishery is large, or the deterioration of the results is obvious

3 Points：The S and R values are not large, but there is some concern of deterioration of the results

4 Points：The S and R values are small, and no deterioration of the results is observed.

The evaluation score for each habitat is weighted by the area of the habitat to obtain the average value, which is then used as the total score for each fishing method. The upper limit for SICA evaluation is 4 points. As a result of conducting an impact assessment in accordance with FAO's Deep Sea Fisheries Guidelines (FAO 2008), 5 points will be given if no serious adverse effects are observed on benthic organisms.

Seafloor environment SICA scoring guidelines

Scale and strength			1	2	3
S1	Spatial overlap	Ratio to the seabed area where the fishery can operate	< 30 %	30-60 %	> 60 %
S2	Time overlap	Ratio of annual operating days of the fishery	< 30 %	30-60 %	> 60 %
I1	Impact of fishing method	Evaluate by fishing method	Line fishing, etc.	Bottom line, bottom longline, Danish seine, etc.	Bottom trawl, dredge, etc.
S	Overall strength	Calculate as geometric mean		S=(S1*S2*I1)^(1/3)	
Resilience			1	2	3
R1	Water depth	The operating area of the fishery is evaluated by classifying it by water depth, bottom sediment, and topography. If operating in a uniform seafloor environment, you can evaluate one of the representative ones.	< 25 m	25-200 m	> 200 m
R2	Geology		Soft sand or mud	Pebbles and boulders	Bedrock
R3	Topography		Flat	Irregular	Steep
R	Total resilience	Calculate as arithmetic mean		R = (R1+R2+R3)/3	
SR Score			< 2.64 Low	2.64-3.18 Medium	> 3.18 High
		Obtained as the Euclidean distance between S and R		=SQRT(S^2 + R^2)	
Impact results (evaluate one of them)			2	3	4
Distribution area		Distribution area of major constituent species or typical benthic communities	There is concern that the ecological characteristics of benthic organisms are undergoing directed changes and widening changes	There is concern that some of the ecological characteristics of benthic organisms are undergoing directed changes or an increase in the range of changes	No irreversible changes in the ecological properties of benthic organisms
Species composition		Yearly changes of species composition based on benthic surveys			
Functional group composition		epifauna: infauna ratio, sessile: mobile ratio, frequency of habitat building species, rockfish: flatfish ratio, etc.			
Size composition		Benthic organism community size composition Especially large upright benthic organism size composition			
Feeding ecology / TL composition		filter feeder: deposit feeder ratio, predator: scavenger ratio, etc.			

Example of seafloor environment evaluation sheet used in the SH“U”N Project

			規模と強度								生態系の応答			リスク区分	
評価項目	ハビタットタイプ	漁法名	操業密度	影響度係数	漁業の強度	海底の脆弱度	総合影響度	規模と強度の評価点	非漁場の割合	非漁場の割合の評価点	多様度指数の評価点	負の応答を示した調査点数	ハビタットタイプ内の調査点数	ハビタットタイプの総合評価点	リスク区分
2.3.3	1-1	オッタートロール	12307.50	1.36	16738.20	0.51	8486.26	2	30.44	2	1	0	0	1.7	重篤
2.3.3	1-2	オッタートロール	15161.00	1.36	20619.00	0.29	5876.41	2	39.18	2	2	1	1	2.0	重篤
2.3.3	2-1	オッタートロール	15056.70	1.36	20477.10	0.34	6982.67	2	23.53	2	2	3	4	2.0	重篤
2.3.3	2-2	オッタートロール	11941.60	1.36	16240.60	0.39	6252.62	2	48.10	3	1	0	0	2.0	重篤
2.3.3	3-1	オッタートロール	3821.00	1.36	5196.60	0.50	2619.08	4	42.90	3	2	1	1	3.0	一部で懸念
2.3.3	3-2	オッタートロール	4290.60	1.36	5835.20	0.53	3098.47	3	41.74	3	2	2	3	2.7	一部で懸念
2.3.3	4-1	オッタートロール	817.80	1.36	1112.20	0.72	800.82	4	49.45	3	1	0	0	2.7	一部で懸念
2.3.3	4-2	オッタートロール	1179.60	1.36	1604.20	0.71	1139.00	4	43.09	3	2	1	1	3.0	一部で懸念
2.3.3	5-1	オッタートロール	646.60	1.36	879.30	0.97	855.59	4	66.04	4	1	0	0	3.0	一部で懸念
2.3.3	5-2	オッタートロール	429.30	1.36	583.80	0.91	529.53	4	63.50	4	1	0	0	3.0	一部で懸念
対象漁業	底びき網	対象海域	太平洋北区					3.1		2.9	1.72		総合評価	2.57	重篤

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

2.3.5 Water Quality of the Environment

Legal frameworks to control the emission of substances into the ocean by ships have been established by international treaties such as the London Convention, MARPOL 73/78, and the Ballast Water Management Convention, as well as domestic laws such as the Basic Environmental Law and the Water Pollution Control Law of Japan. Directives from the Fisheries Agency and guidelines from the Ministry of the Environment have also been issued aiming at proper management of the disposal of fisheries waste. Here we evaluate whether the focal fisheries are properly handling fish offal, burnt debris, plastic and metal wastes, waste oil, etc. in compliance with these frameworks. Voluntary efforts to reduce emissions and reduce the impacts on water quality will also be evaluated.

For species undergoing stock enhancement, hatcheries (including intermediate growout facilities) are also evaluated. In this case, whether the hatcheries comply with any effluent management standards and perform appropriate treatment measures set by the authorities is evaluated.

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

2.3.6 Atmospheric Environment

The International Maritime Organization (IMO) has proposed a phased reduction in the emission of nitrogen oxides and sulfur oxides from marine engines. The Paris Agreement, which outlines the reduction of greenhouse gases such as carbon dioxide moving into 2020, has also come into effect. Here, we evaluate the impacts on the atmospheric environment based on whether the focal fisheries comply with emissions regulations regarding nitrogen oxides, sulfur oxides, carbon dioxide, etc., and whether they are taking measures to reduce them, as well as the fuel consumption and CO_2 emissions required per the amount of catch and landing.

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

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*: translated by SH”U”N Project Office

３． Fisheries Management

Overview

In this section, we evaluate whether fisheries have established management systems to ensure sustainable catch for the target species. Traditionally, assessments of fisheries management are often measured in three components known as MCS: monitoring, control, and surveillance (Cochrane 2002). Here, monitoring refers to the continuous measurement of indicators representing the state of the fishing industry, such as fishing operations, catch, profit figures, and employment statistics. This monitoring is a prerequisite for implementing management that is adaptive to uncertainty. Control refers to the measures and rules for controlling fishery operations. Surveillance refers to the observation by government and fisherman regarding whether the rules that have been set are actually being followed. Furthermore, in some cases a fourth evaluation factor Enforcement (E) is applied to devise ways of ensuring that stakeholders observe the rules and to set penalties for violations of those rules. In the SH“U”N Project the monitoring of operating conditions, resource abundances, and ecosystems are evaluated on Principles 1 and 2, and the monitoring of fishery management and local economies are evaluated on Principle 4. Therefore with this assessment, Principle 3 evaluates control, surveillance, and enforcement.

For fisheries management in Japan and the Asia-Pacific region, combining public government management and voluntary management by fishermen in what we call “Co-Management” is important. The Fisheries Agency’s report on the “Summary of Resource Management Study Group” (Fishery Agency 2014) pointed out the need to increase both public management and voluntary management, and ensure appropriate cooperation. Therefore, we also evaluate our efforts towards the advancement of co-management. In addition, if stock enhancement is being implemented as a part of resource management for the target species, the decision-making processes and the implementation systems are also evaluated.

Since the fishing industries in Japan and the Asia-Pacific region operate using various types of fishing gear and fishing methods, and target resources with diverse ecological characteristics, various types of management are necessary. There is no one type of “correct management” or “ideal management” that can be applied to all fisheries, and it is important to combine and adjust management policies according to the appropriate subjects (Makino 2013). Therefore, with the Principle 3, unlike the other Principles, obtaining high scores for all items is theoretically impossible and is not the purpose. It should also be noted that the evaluation here is performed focusing on whether appropriate management is implemented according to the specific characteristics of each subject.

Outline

① Identification of focal fisheries

The major fisheries for the target fish species to be evaluated are identified. The fisheries that cover at least 75% of the total annual catch for the target species are targeted. If less than 75% of total catch, the major fisheries are weighted and then assessed by catch.

② Identification of focal regions

The evaluations of the focal fisheries are generally made at the prefectural level. When the habitat of the target fish species extends across prefectures, information on the major fisheries for each prefecture are described, and prefectures with similar content are integrated and evaluated.

Fisheries that are internationally managed through Regional Fisheries Management Organizations will be handled collectively according to the focal fishery type.

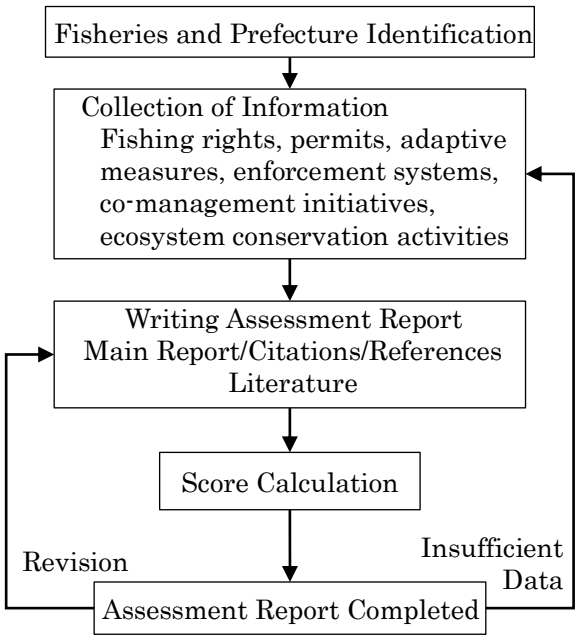
③ Collection and description of information on focal fisheries

The following information on the focal fisheries in each prefecture is collected.

1) Fishing rights, permits/licenses, and the details of various types of management shown below
2) Implementation systems including monitoring systems, penalties, and adaptive management initiatives
3) Co-management initiatives such as identification and organization of stakeholders, and participation in decision making.
4) Details of ecosystem conservation activities by stakeholders

④ Presence/absence of stock enhancement activities

A judgement is made based on the collection of data regarding whether there is stock enhancement for the target species, including whether the project is fishery or government initiated. However, it does not consider stock enhancement at the experimental scale conducted by research institutions.



3.1 Details of Management Measures

In this section we evaluate the Control (C) from among the 4 components of fisheries management, which cover the measures and rules for controlling fisheries operations. In general, measures to control fishing operations are divided into three categories; input controls to control fishing effort (number and size of fishing vessels, and engine and net size restrictions), output controls to control the amount of catch (setting catch limits or individual quotas), and technical controls to control the size and quality of the catch (limiting catch size and gender, prohibiting the catch of egg-bearing females, and so on).

3.1.1 Input Control and Output Control

Input controls and output controls are measures to manage the fishing pressure (fishing effort, catch, etc.) on fishery stocks and maintain healthy stocks. Depending on the distribution and production of fishery resources, and the diversity and scale of fishery types, the most appropriate measures are chosen. Therefore, in this section we evaluate quantitatively whether fishery management measures are properly implementing either input control, output control, or both. Even in cases where only control, input or output is being implemented, the highest is assigned if it is managed effectively. If the target is not clearly set, the evaluation is based on the annual changes in total catch.

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

3.1.2 Technical Control

Measures to control the quality of catch are considered technical controls. Some examples include prohibiting fishing near spawning and nursery grounds during the spawning seasons, efforts to protect juveniles and immature fish by placing size restrictions on catch, and prohibiting fishing methods that cause destruction to habitats. In this section we evaluate the focal fisheries are implementing technical control measures.

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

3.1.3 Improving Efficiency of Stock Enhancement (Only Regarding Stock Enhanced Species)

For species undergoing stock enhancement, in cooperation with resource management of natural stocks, we evaluate whether measures are being taken to enhance the effects of stocking, such as prohibiting the catch of artificially stocked seedlings, improving the environment of the nursery, and educating recreational fisherman (Fisheries Research Agency 2015).

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

3.1.4 Ecosystem Conservation

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

Depending on the fishing gear and fishing method, alterations in the structure of ecosystems, such as changes in the benthic ocean floor environment, can occur. In particular, seaweed beds, tidal flats, and coral reefs, as well as irregularities in seabed terrain have important functions for resource reproduction, and any changes in these can affect both stocks and ecosystems. Therefore in this section, in cases where the fishing gear has the potential to affect ecosystems and the environment, we evaluate whether measures have been introduced to minimize the impacts, through improving fishing gear, limiting the areas of operation, or limiting the seasons of operation. Additionally, considering the evaluation results from Principle 2 (Marine Environment and Ecosystems), if there is no risk of the focal fishing gear affecting the environment or ecosystem, a score 5 points is assigned.

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

3.1.4.2 Ecosystem Conservation and Restoration Activities

In this section, with the goal of preserving the target fisheries resources and ecosystems, we evaluate both the land and sea-based activities. For example, this includes forestation activities (tree planting) and restoration activities for seaweed beds and tidal flats (Science Council of Japan 2004). We assess whether the fishermen operating in the focal fisheries are involved in any of these activities. However, if the habitat of the target species is in the open ocean or if it is not affected by land-based human activities, and it is judged that these activities do not affect sustainability, a score of 5 is assigned.

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

3.2 Enforcement System

Here we evaluate the Surveillance (S) and Enforcement (E) parts of MCS+E (Cochrane 2002) concerning fisheries management.

3.2.1 Management Enforcement

3.2.1.1 Jurisdiction

In this section we evaluate whether the habitats of the target species are geographically covered under a single management system. Since it is difficult for a single system to cover widely distributed species, we will evaluate if there is a management system consisting of multi-party councils or federations established.

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

3.2.1.2 Surveillance System

In this section we overview the state of compliance regarding management and rules, and evaluate whether there is effective surveillance system (monitoring system) to identify violators. In addition to government led official monitoring activities such as patrol boats, Vessel Monitoring Systems (VMS), and observers, this system includes monitoring activities through commercial fishing organizations and civil groups such as NGOs. The mobility and distribution range of the target fish species, the characteristics of the fishing gear, and the number of fishing vessels are considered in order to judge whether the system is efficient or not.

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

3.2.1.3 Penalties and Sanctions

In this section we evaluate whether there are effective penalties and sanctions for offenders identified through monitoring. In addition to those that are officially government enacted (suspension of fishing, revocation of permits, fines, imprisonment, etc.), penalties and sanctions based on arrangements by fishing organizations and customary sanctions imposed by local communities (forfeiture of catch, suspension of fishing, fines, etc.) will be evaluated to determine if they are functioning effectively.

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

Because there are many uncertainties in the fishing industry, adaptive management is essential for sustainability. It is important to adapt fishery management in response to various observations on resources, catch statistics, impacts on ecosystems, implemented management measures, and local

economies. The time scale appropriate for decision making (how and when decisions are made and management is adjusted) is judged based on the contents of surveillance of target species and their biological characteristics. If management exists and it is adaptive, it will be assigned a score of 3-5 points. More specifically, if the total allowable catch or TAC has been set and the fishery is operating under it properly, 5 points are given. If there is not a set TAC but the management is continuously updated and implemented, then a score of 3 points is assigned.

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

Avoiding open access and properly controlling new entrants to a fishery are basic conditions for creating a fisheries co-management system. Therefore, here we evaluate the percentage of the fishermen or organizations who have permits and fishing rights (ratio of non-free fishing). The percentage is calculated by the ratio of catch amount derived from fisheries operating with official fishing rights and licenses to the total catch amount.

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

In order for fishermen identified by fishing rights and permits to formulate voluntary co-management strategies, and to effectively implement public management set by the government, it is effective to organize the fishermen involved (Jentoft 1985, Makino et al. 2014). Therefore, here we evaluate the percentage of fishermen operating within the focal fisheries who belong to some kind of organization. Here fishing organizations include organizations based on the Fisheries Cooperative Law such as fishery cooperatives and production cooperatives, as well as groups based on the type of fisheries and fish-specific groups that have established voluntary rules on fishing.

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

Fishing organizations can have strong influence on the management of fisheries, through developing and implementing management strategies, monitoring operations, and sanctioning offenders. Regional organizations have a lot of information on local ecosystems and economies, and fishing organizations

have a lot of information on the fish and fisheries, therefore there is great potential for the development of effective management (McCay and Jentoft 1996). This kind of management is expected to play an important role in implementing detailed strategies and measures that cannot be covered by public government driven management. Therefore, this section qualitatively assesses the extent to which fishing organizations are conducting activities related to the management of focal fisheries, and the resulting impacts on fisheries management. (Scores here do not double-count with the scores from section 3.1)

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

3.3.1.4 Activities of Fishing Organizations Related to Management and Economics

Fishing organizations can implement management activities such as co-purchasing, co-selling, and marketing for added value that would otherwise be difficult for individual fisherman to carry out (Jontoft 1985). Such activities play an important role in maximizing the value of limited marine resources. Therefore, here we evaluate the extent to which fishing organizations are involved in collective behavior, management, and marketing.

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

3.3.2 Involvement of Fishery Related Parties

3.3.2.1 Involvement of Fishery Related Parties in Voluntary Management

For effective implementation of voluntary management, persons related to the fishery need to be voluntarily involved in decision making processes and increase the legitimacy of decisions (Ostrom 1990). Here we evaluate the frequency of meetings as an indicator of voluntary participation in management. The fishermen operating within the focal fisheries are assessed based on the number of days per year they attend meetings relating to voluntary management activities. (This is the number of days per year that meetings are held, not the number of meeting hours converted into days)

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

3.3.2.2 Involvement of Fishery Related Parties in Public Management

It is important that persons related to the fishery actively participate in decision-making concerning the implementation of public management by administrative organizations such as national and prefectural governments. Therefore, this section assesses whether fishery related parties are properly participating in meetings and decision-making regarding public management. However, it is not necessary for fishery

related parties to participate in all public meetings (such as internal organization briefings), so we evaluate appropriate participation where it is needed.

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

3.3.2.3 Widespread Stakeholder Involvement

Management decisions should be made with the participation and consent of as wide a range of stakeholders as possible, in addition to those operating within the related focal fisheries. Therefore here we qualitatively evaluate the extent to which non-fishery stakeholders, such as recreational fishers, divers, and civil society groups, are involved in the decision making processes. We also evaluate cases where there are no major stakeholders, such as when considering the negligible impacts of small scale recreational fishing.

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

3.3.2.4 Decision Making for Management

Here we evaluate whether there is a decision-making system that includes stakeholders (administration, commercial fishermen, researchers, recreational fishermen, etc.) as participants, and whether sufficient review has been conducted to assess management measures and the PDCA cycle regarding stock enhancement activities, the necessity of resource management measures, management system, and resource development goals. We also evaluate whether the decision making processes regarding these points are based on scientific evidence and agreed on by the stakeholders. As stakeholder involvement was also evaluated in 3.3.2.3, here we mainly evaluate the PDCA cycle for decision making.

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

3.3.2.5 Understanding the Cost of Stock Enhancement (Only Regarding Stock Enhanced Species)

When stock enhancement activities are being conducted, we evaluate the situation regarding the fair cost sharing and economic transparency of the project necessary from the perspective of sustainability, considering the position of the commercial fishermen, recreational fishermen, related industries, and

consumers who act as beneficiaries (Fisheries Research Agency 2015).

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

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*: translated by SH”U”N Project Office

4. Regional Sustainability

Overview

An important issue in fisheries for the next generation is whether the focal fisheries and their related industries maintain their attractiveness while utilizing the resources sustainably. The fishing industry is one where the initial investments, such as fishing boats, are very large and the income potential is based on natural resources that fluctuate with factors like weather, making it an unstable industry in general. This evaluation is based on whether stable income and capital can be ensured, the instability of the fishing, and whether there is a system to make up for it. Post-harvest industries such as processing and distribution are also very important regional industries. Processing and distribution make it possible to sell products at higher prices and more widely. We also evaluate fisheries as an attractive industry for people to be involved with through considering income, social status, and living environment.

Outline

① Identification of focal fisheries

Identify the major fisheries for the target fish species to be evaluated. Focus the fisheries that cover at least 75% of the total annual catch for the target species. If less than 75% of total catch, the major fisheries are weighted and then assessed by catch.

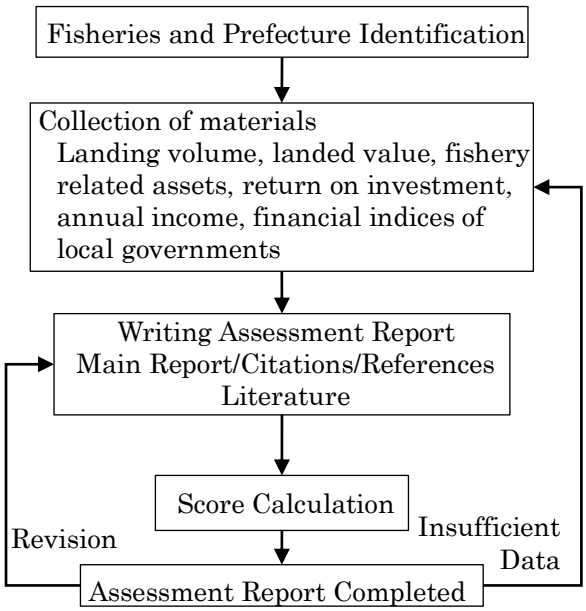
② Identification of focal regions

Evaluations of the focal fisheries are generally made at the prefecture level. When the habitat of the target species straddles prefectures and the characteristics of the focal regions are considered to be similar, the areas may be evaluated collectively. This evaluation factor will try to cover as much as possible if there is any noteworthy content within the focal sea area, even if moving over into prefectures that cover more than 75%.

③ Collection and description of information on focal regions

For the fisheries industry and other related industries in the focal regions, the following information and other necessary information described below will be collected.

1) Basic information on fishery types, limitations, etc.
2) Annual landing volumes and values for the past 11 years



3) Monthly landing volumes and values for the past 36 months
4) Average annual landing values of 5 or more regions in the same fishing industry over the past 3 years
5) Fishery related assets
6) Annual income compared to regional average for fisheries
7) Financial strength index of the local governments
8) Living comfort deviation value of coastal cities in each prefecture by "Livability Ranking" (Toyo Keizai Inc. 2019)

4.1 Status of Fisheries Production

4.1.1 Fisheries Assets

4.1.1.1 Fishery Income Trends

If the fishery is described as profitable, it is estimated that fishery income (fishery income and sales figures measured in the management survey) has reached the highest possible sustainable level (Scott 1955). Fisheries with declining trends in income may be the result of factors such as overfishing, improper marketing, or improper use of resources. It is also possible they may be the result of changes in the natural environment or economic conditions. Therefore, the criterion here is evaluated based on the ratio of the previous year's income to the average of the best three years' income over the past 10 years. Where inflation is significant, real income is adjusted by the CPI (Consumer Price Index). When past records on income levels are not available, the evaluation may be made based on information provided by related parties.

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

The richness of fisheries can be measured by income, and also by the relationship between fishery assets (capital necessary for fishing) and income levels. However, data on operating costs are generally difficult to obtain and it is often not possible to calculate revenue accurately. Therefore, here we use fisheries income as a proxy for actual income. This section evaluates how much the fishery earns for its assets. The criterion is based on the retention of the last five year’s average of the total required asset value and average income. If the investment value is excessive, the ratio will be lower. The required assets are added as much as is possible until they exceed 80% of the total. When the value of the fishing vessel is unknown, it is valued based on its size. The data include purchase prices, not lease prices.

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

If the fishery is profitable, it is estimated that fishery assets have reached the maximum sustainable range. Therefore, this section evaluates the ratio of the asset value for the top three years over the past ten years to the asset value of the present. Where inflation is significant, real income is adjusted by the CPI (Consumer Price Index). Where there is no accumulation of fishing vessels or fishing gear, a score of 1 is assigned. Also, it is not necessary to obtain all information on fishing gear. The target is to get data on at least 80% of the total asset value required for entry. The data include purchase prices, not lease prices. In fisheries with no past records, whether the asset value has increased or decreased, how much the asset value has increased or decreased, etc., may be evaluated based on information provided by related parties.

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

Fluctuations in income are used as one of the key measures of fisheries management stability. When future catch fluctuations and large variations and uncertainties in income levels are anticipated, it becomes difficult to maintain stable fishery management. Therefore, this section evaluates the ratio between the standard deviation of the difference in annual income with year before and the average income over the past 10 years. If the data are limited, the years with available information are used.

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

Fluctuations in catch are also used as another key measure of fisheries stability. As processors and retailers, as well as exporters, prefer long-term stable supplies and contracts, fluctuations and uncertainties in catch landings are hurdles to improving management. Therefore, this section evaluates the ratio between the standard deviation of the total annual catch with the year before and the average catch over the past 10 years. If the data are limited, the years with available information are used.

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

4.1.2.3 Economic Status of Commercial Fishing Organizations

Not only the fishermen themselves, but also the economic situation of the commercial fishing organizations, can be used as indicators of whether the fisheries are sound and sustainable or not. Especially in coastal fisheries, the sustainability of fishing organizations is often directly linked to the sustainability of management systems and local sustainability. Therefore, in this section, looking at coastal fisheries, we evaluate the ordinary profit by prefecture based on the information provided by concerned parties, or on statistics of the Fisheries Cooperative Association compiled by the Ministry of Agriculture, Forestry, and Fisheries. For offshore and pelagic fisheries, we evaluate information from various reports, including information provided by fishing organizations.

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

4.1.3 Working Status

4.1.3.1 Operational Safety

A safe working environment is one of the most important elements of a sustainable fishery. Therefore in this section, we use information on the status of occupational accidents by type of fishery (when fishery based information is not available, we use information on incidents by prefecture), and collect figures on accidents such as injuries and fatalities reported by the Japan Transport Safety Board (https: //jtsb.mlit.go.jp/jtsb/ship/sailordisaster.php) while utilizing the judgements of the Marine Accident Inquiry Agency (http://www.mlit.go.jp/jmat/saiketsu/saiketsu.htm), in order to evaluate the occupational safety through annual number of fatalities per 1,000 fishermen (captain or crew).

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

4.1.3.2 Contributions to Local Employment

Whether local fishermen are employed in the operational area and whether the ship owners, captains, etc. are residents of the local area are closely related to the regional economic activities. When there are many “non-local” fishermen who do not reside in the local area, the profits are not returned to the local area and do not become a driving force of the local economy. Therefore, this section evaluates what percentage of the fishery workers live in the local area.

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

Discrimination of specific workers, gender inequality, abuse of the foreigner apprentice training system, and the exploitation of labor create unfair economic situations and distort the structure of local industries and the sustainability of local communities. Therefore, in this section we look at cases in which some workers within fisheries are given different treatment due to reasons other than differences in ability, and whether there is reported unfair treatment, in order to evaluate the fair treatment of fishing industry workers referring to cases on violations for laws of labor standard committed for trial, etc.

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

4.2 Processing and Distribution Status

4.2.1 Market Pricing

Here we evaluate price formations at major fishery ports (landing ports) in various regions.

4.2.1.1 Buyers

When the market is occupied by only a small number of buyers, it is possible that fair pricing is more difficult to maintain (Jensen 2007, Kaplan 2000). Therefore, this section evaluates the number of typical buyers who have access to the fishermen (sellers) in the market. In the case when there are many landing ports, we evaluate the number of buyers at each port. When a fisherman has a contract with one buyer and is involved in margin trading, the number of buyers is regarded as one.

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

4.2.1.2 Market Information Availability

Market transparency is characterized by readily available and accurate pricing and trading volume data. A fair and efficient pricing system is important for fishermen to select landing ports and timing. This section evaluates whether timely information is released so fishermen can make determinations on what and when to land.

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

Fishermen naturally become more competitive when more trading partners are present, and more optimal resource allocation can be achieved. Additionally, low tariffs expand markets, improve price formation, and stimulate opportunities to increase capital. The effects of tariff reduction and trade liberalization depend greatly on the form of the management system (Hannesson 2001). Exports can produce sustainable profits in resource conscious fisheries with the implementation of catch controls and effective fisheries management, but while open access fisheries can lead to short term profits, in the long term they can put resources at risk and lead to lost profits. This section evaluates whether the fishery has the opportunity to trade fairly, regardless of tariffs and non-tariff barriers (quantitative regulation, restriction rules, investment regulations, regulations for customs clearance, direct government intervention, etc.) on imports and exports.

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

Here we evaluate where added value of landed catch is created by the processing and distribution industry.

4.2.2.1 Sanitary Management

Proper sanitation at landing ports is an important prerequisite for the processing and distribution industries to increase the added value of the catch and provide safe and secure products to consumers. Therefore, this section evaluates the sanitation management of the focal fisheries and landing ports.

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 Use Form

In this section, the more value-added products that are produced, the higher the overall score assigned. Where supply chains are more diverse, we value this section by averaging them with weighting. When a single fish species produces multiple products, each product is weighted and averaged. When the effects of branding and other value adding initiatives are reported, they are reflected in the score.

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

4.2.3 Working status

4.2.3.1 Labor safety

This section uses data on occupational accidents in the fishery processing industry within each prefecture (or otherwise the status of occupational accidents in the entire processing industry) in order to evaluate the number of injuries and fatalities per 1,000 people per year due to occupational accidents. In the fishery processing industry, unlike the fishing side, there are almost no fatal accidents, so the judgment is based on the number of injuries and fatalities.

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

4.2.3.2 Contributions to Local Employment

Whether the local distribution and processing industries are closely involved in the economics of regional areas, and whether their profits are returned to those local areas, become driving forces of regional economies. At the same time it also shows that local resources are being fully utilized. Whether or not the distribution processing industry contributes to the local region can be measured by comparing the relative number of processors in each prefecture with other prefectures.

This section evaluates the ratio of the number of processing companies in each prefecture and the national average in the Fisheries Processing Industry Management Survey (Fisheries Agency).

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

4.2.3.3 Fairness of Working Conditions

Inequality in working conditions, such as discrimination, gender inequality, abuse of the foreigner apprentice training system, and the exploitation of labor distorts the structure of local industries and the sustainability of local communities. Therefore, in this section we evaluate referring to cases of violations of standard labor laws committed for trial, whether workers in the fishery processing and distribution industries receive different treatment due to reasons other than differences in skill or ability, and whether they were treated unfairly.

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

4.3 Regional Status

4.3.1 Fisheries Infrastructure

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

Ice and freezing/refrigeration functions are indispensable infrastructure for the effective utilization of fishery resources. Without access to refrigeration techniques, catches degrade rapidly (Kantor et al. 1997), and when ice is not available, supply chain flexibility is significantly reduced (Shawyer and Pizzali 2003) making it difficult to fully enhance the value of these limited resources. Therefore, here we evaluate the state of preparation of these facilities.

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 quantity and supplies only the most expensive catches	Ice is available in a variety of forms, and can supply coverage for all catches that need it	Ice can be used in various forms at fishing ports, and refrigeration facilities are also in place

4.3.1.2 Introduction and Spread of Advanced Technology

The gathering of up-to-date information regarding processing and production technologies are important factors for the fishing industry to maintain international competitiveness and be profitable. These activities related to the adoption and spread of newer technologies play an important role in communicating information on the latest technologies, best management practices, market information, and changes in regulations. Therefore, in this section we evaluate the extent to which public and private

groups have improved their fishing techniques and management practices through these activities for producers, and the extent to which fisheries in the target areas are employing them.

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

4.3.1.3 Logistics System

Land, sea, and air logistics systems all influence company product distribution capabilities, leading to more market access, quality control, and minimization of transaction costs. Access to higher value-added markets leads to a richer local economy. This section evaluates fisheries' access from major landing ports to major transport routes (highways, ports, airports, etc.).

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

4.3.2 Living Conditions

4.3.2.1 Livability in Local Regions

The purpose of this section is to evaluate from the viewpoint of the sustainability of local industry whether public services are being enriched, if it is easy for the residents to live locally, and whether the economy is profitable and doing well. The quality of public services is linked to the ease of living in the local area, and economic status is an important proxy indicator for judging public services. As an index showing the economic strength of local governments, the financial strength index (averaged over the past three years) is generally used, and the higher the index the more financial resources that are available. However, there are opinions that financial strength is not directly linked to public services, and that municipalities with low financial strength try to provide public services by relying on local allocation tax and promoting private commission. Some have stated that the quality of public services cannot be judged solely by the financial strength index, and it has been considered difficult to evaluate this comprehensively.

In connection with this issue, Toyo Keizai Inc. has been using various city-based statistical data looking at the overall deviations among regions to publish an *Livability Ranking* since 1993 (Toyo Keizai Inc. 2019). As this indicator has recently been cited in many research reports (Nonaka and Ozawa 2017, Shimizuike and Yoshinaka 2014), we think that the total evaluation of the *Livability Ranking* is closer to the actual value the residents feel and more complete than what the financial strength index alone shows. So here we evaluate the average of the *Livability Ranking*'s total value for local areas located on the coastlines of the focal areas.

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

4.3.2.2 Income Levels of Fishery Workers

The income levels of workers are direct indicators of the wealth of fisheries. Here we evaluate whether fisheries are able to attract the best workers in the local communities, and whether fisheries are more profitable than other local industries, by comparing with the average income across all industries in the area.

This section uses the Ministry of Health, Labour, and Welfare's "Basic Wage Structure Statistical Survey" which calculates how the income levels of fisheries workers compare against the average of industry totals within each prefecture. The income level of the smallest class (10-99 workers), is used depending on the actual fishing situation. However, in some cases it is difficult to make comparisons of regional fisheries as there are instances where these data are not available and only the national average from the industry average of seafarer labor statistics, or the national average of the fishery economic survey can be used. Even if the data are available, in some cases it is necessary to include estimated values, such as an estimated calculation of the monthly salary per person from the labor costs and crew numbers described in the plan for "Moukaru Gyogyo (Fisheries Agency, 2015)."

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

4.3.3 Inheritance of Regional Culture

Regional societies are sources of cultural diversity. Diverse fishing, processing, and distribution methods rooted in local culture support the diversity of fishery and seafood cultures. Some of these cultures are handed down from ancient times, and some are fairly recent. In this section we evaluate whether there are unique fishing gear/methods or fishery processing/distribution cultures present within the focused areas, and whether they have been passed down and inherited.

4.3.3.1 Inheritance of Local Cultural Fishing Methods

Here we evaluate whether the traditional fishing gear and methods rooted in local culture are being actively passed down to the following generations in the focal area.

Due to the ambiguous nature of these items, if there is any noteworthy content in the focal area, we try to pick up as much as possible and give the total score as the average of the concerned prefectures.

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

Here we evaluate whether the traditional processing and distribution methods rooted in local culture are being actively passed down to the following generations in the focal area.

Due to the ambiguous nature of these items, if there is any noteworthy content in the focal area, we try to pick up as much as possible and give the total score as the average of the concerned prefectures.

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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*: translated by SH"U"N Project Office

５． Health, Safety, and Security

The information provided in this section is based on the following items and is referred to from publications and research results.

5.1 Nutritional Function

5.1.1 Nutritional Components

We refer to and display the latest version of the Food and Nutrition Composition Table.

5.1.2 Functional Components

Regarding the functional components of the target fish species, the published results to date as well as the summaries of the overview articles in publications related to the FRA are organized and published. The number of items varies with the fish species.

5.1.3 Seasonal and Expert Advice

If the amount of resources is negligible in size, or if it is a rare species that is not commonly seen, the description may be omitted in this report.

5.1.3.1 Season

The seasons of the target species are described based on the results of past research and publications related to the FRA.

5.1.3.2 Expert Advice

The knowledge for assessing the freshness and quality of the target fish resources are described based on the results of past research and publications related to the FRA.

5.2 Inspection System

5.2.1 Important Points When Serving as Food

Here we describe points to be noted when serving fish as food, such as concerns regarding food poisoning and parasites related to the target species. The number of items varies depending on the fish species.

5.2.2 Sanitary Inspections for Distribution and Related Laws and Regulations

Overview of general inspections and hygiene-related laws and regulations implemented in the distribution of food, such as food hygiene and radioactivity measurement.

5.2.3 Inspections for Specific Seafood Products

Overview of specific species with concerns for shellfish poisoning, puffer fish poisoning, norovirus, etc. referring to general articles in publications related to the FRA.

5.2.4 Treatments and Responses In the Case of a Positive Test

Overview of the actions to be taken if a positive measurement concerning food hygiene or radioactivity is found in distribution.

5.2.5 Important Points When Cooking at Home

Over view of points to note when cooking at home, concerning food poisoning, parasites, etc. related to the target fish species. The number of items varies depending on the fish species.

6. Assessment Point Table

Stock, locality _____ Score

Fisheries _____ 3.0

year _____

Resource Status

Major category	Sub-item	score of Sub-item	weight	weight	score of Major category	score of Principle
Biological Research and Monitoring of Target Species	Overview of Biological Information	3.0	1.0	1.0	3.0	3.0
	Monitoring Implementation System	3.0	1.0			
	Stock Assessment Methods and Objectivity of Assessment	3.0	1.0			
	Effects of Stock Enhancement*	3.0	1.0			
Target Species Abundance and Trend	Target Species Abundance and Trend	3.0	1.0	1.0	3.0	
Impacts of Fisheries on Target Species	Impacts of Current Fishery Pressures on Sustainable Production of Target Species	3.0	1.0	1.0	3.0	
	Stock Depletion Risk at Current Fishery Pressure	3.0	1.0			
	Influence of Stock Assessment on Fisheries Management	3.0	1.0			

Marine Environment and Ecosystems

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

Fisheries Management

Major category	Sub-item	score of Sub-item	weight	weight	score of Major category	score of Principle
Details of Management Measures	Input Control and Output Control	3.0	1.0	1.0	3.0	3.0
	Technical Control	3.0	1.0			
	Improving Efficiency of Stock Enhancement*	3.0	1.0			
	Ecosystem Conservation	3.0	1.0			
Enforcement System	Management Enforcement	3.0	1.0	1.0	3.0	
	Adaptive Management	3.0	1.0			
Co-Management Initiatives	Collective Action	3.0	1.0	1.0	3.0	
	Involvement of Fishery Related Parties	3.0	1.0			

Regional Sustainability

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

** Regarding Stock Enhanced Species*

Resource Status

Major category	Sub-item	Smaller item	Fisheries score weight	score	weight of smaller item	Score of sub-item
Biological Research and Monitoring of Target Species	Overview of Biological Information	Distributions and Migration		3	1.0	3.0
		Age, Growth, and Life-Span		3	1.0	
		Maturation and Spawning		3	1.0	
		Stock Enhancement*		3	1.0	
	Monitoring Implementation System	Scientific Research		3	1.0	3.0
		Survey of Catch Data		3	1.0	
		Survey of Fishing Operations		3	1.0	
		Biological Investigations on Landed Fish		3	1.0	
		Stock Enhancement Performance*		3	1.0	
		Identification of Naturally and Artificially Spawned Fishes*		3	1.0	
	Stock Assessment Methods and Objectivity of Assessment	Stock Assessment Methods		3	1.0	3.0
		Objectivity of Stock Assessment		3	1.0	
	Effects of Stock Enhancement*	Effects on Fisheries Production*		3	1.0	3.0
		Effects of Stock Enhancement*		3	1.0	
		Impacts on Natural Stocks*		3	1.0	
Target Species Abundance and Trend	Target Species Abundance and Trend	Target Species Abundance and Trend		3	1.0	3.0
Impacts of Fisheries on Target Species	Impacts of Current Fishery Pressures on Sustainable Production of Target Species	Impacts of Current Fishery Pressures on Sustainable Production of Target Species		3	1.0	3.0
	Stock Depletion Risk at Current Fishery Pressure	Stock Depletion Risk at Current Fishery Pressure		3	1.0	3.0
	Influence of Stock Assessment on Fisheries Management	Presence of Fisheries Management Measures		3	1.0	3.0
		Presence of Precautionary Measures		3	1.0	
		Considering Impacts of Climate Change		3	1.0	
		Formulation of Fisheries Management Measures		3	1.0	
		Considerations of Recreational, Foreign Commercial, and IUU Fishing for Fisheries Management Procedure		3	1.0	

* Regarding Stock Enhanced Species

Marine Environment and Ecosystems Fishing amounts (set net: 2,024 ton, purse seine: 4,182 ton, trolling: 586 ton, long line: 741 ton)

Major category	Sub-item	Smaller item	Fisheries	Score	weight	score	weight of smaller item	Score of sub-item
Environment and Ecosystem Data, Research, and Monitoring on the Target Sea Area	Overview of Basic Information	Overview of Basic Information				3	1.0	3.0
	Implementation of Scientific Research	Implementation of Scientific Research				3	1.0	3.0
	Monitoring through Fishery Activity	Monitoring through Fishery Activity	set net	3	0.27	3	1.0	3.0
			purse seine	3	0.55			
			trolling	3	0.08			
			long line	3	0.1			
Bycatch	Usable Bycatch Species	Usable Bycatch Species	set net	3	0.27	3	1.0	3.0
			purse seine	3	0.55			
			trolling	3	0.08			
			long line	3	0.1			
	Unusable Bycatch Species	Unusable Bycatch Species	set net	3	0.27	3	1.0	3.0
			purse seine	3	0.55			
			trolling	3	0.08			
			long line	3	0.1			
	Rare (Endangered or Threatened) Species	Rare (Endangered or Threatened) Species	set net	3	0.27	3	1.0	3.0
			purse seine	3	0.55			
			trolling	3	0.08			
			long line	3	0.1			
Ecosystems and Environments	Indirect Impacts through the Food Web	Predators				3	1.0	3.0
		Prey				3	1.0	
		Competitors				3	1.0	
	Whole Ecosystem	Whole Ecosystem	set net	3	0.27	3	1.0	3.0
			purse seine	3	0.55			
			trolling	3	0.08			
			long line	3	0.1			
	Effects of Stock Enhancement on Ecosystem*	Securing the Quantity of Bloodstock for Genetically Healthy Seedlings*				3	1.0	3.0
		Avoiding Gene Disruption*				3	1.0	
		Preventing Spread of Disease to Wild Stocks*				3	1.0	
	Benthic Ocean Environment	Benthic Ocean Environment	set net	3	0.27	3	1.0	3.0
			purse seine	3	0.55			
			trolling	3	0.08			
			long line	3	0.1			
	Water Quality of the Environment	Water Quality of the Environment	set net	3	0.27	3	1.0	3.0
			purse seine	3	0.55			
			trolling	3	0.08			
			long line	3	0.1			
	Atmospheric Environment	Atmospheric Environment	set net	3	0.27	3	1.0	3.0
			purse seine	3	0.55			
			trolling	3	0.08			
			long line	3	0.1			

* Regarding Stock Enhanced Species

Fisheries Management

Major category	Sub-item	Smaller item	Fisheries Score weight	score	weight of smaller item	Score of sub-item
Details of Management Measures	Input Control and Output Control	Input Control and Output Control		3	1.0	3.0
	Technical Control	Technical Control		3	1.0	3.0
	Improving Efficiency of Stock Enhancement*	Improving Efficiency of Stock Enhancement*		3	1.0	3.0
	Ecosystem Conservation	Regulations on Fishing Gear to Control Impacts on Ecosystems and Environments		3	1.0	3.0
		Ecosystem Conservation and Restoration Activities		3	1.0	
Enforcement System	Management Enforcement	Jurisdiction		3	1.0	3.0
		Surveillance System		3	1.0	
		Penalties and Sanctions		3	1.0	
	Adaptive Management	Adaptive Management		3	1.0	3.0
Co-Management Initiatives	Collective Action	Identifying Resource Users		3	1.0	3.0
		Ratio of Fishermen Belonging to Fishing Organizations		3	1.0	
		Influence of Fishing Organizations on Management		3	1.0	
		Activities of Fishing Organizations Related to Management and Economics		3	1.0	
	Involvement of Fishery Related Parties	Involvement of Fishery Related Parties in Voluntary Management		3	1.0	3.0
		Involvement of Fishery Related Parties in Public Management		3	1.0	
		Widespread Stakeholder Involvement		3	1.0	
		Decision Making for Management		3	1.0	
		Understanding the Cost of Stock Enhancement*		3	1.0	

* Regarding Stock Enhanced Species

Regional Sustainability

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