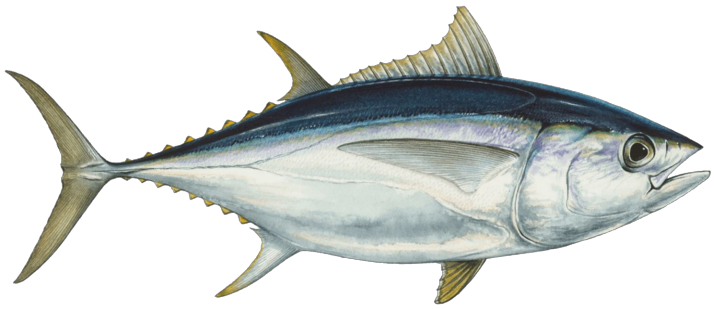
Western and Central Pacific Tunas and Swordfish

Thunnus alalunga, Thunnus obesus, Thunnus orientalis, Katsuwonus pelamis,
Thunnus maccoyii, Xiphias gladius, Thunnus albacares



© Diane Rome Peebles

Western and Central Pacific, North Pacific, South Pacific

Floating object purse seine (FAD), Unassociated purse seine (non-FAD), Drifting longlines, Handlines, Trolling lines, Handlines and hand-operated pole-and-lines

Seafood Watch Consulting Researcher

January 13, 2020

Seafood Watch Standard used in this assessment: Fisheries Standard v3

Table of Contents

About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard.Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report focuses on the longline, purse seine, trolling line and pole and line fisheries within the the western and central Pacific Ocean (WCPO), North Pacific and South Pacific that target the following seven species: swordfish and albacore, bigeye, Pacific bluefin, southern bluefin, skipjack, and yellowfin tuna. These species are caught by a variety of gears in the WCPO, including in the North and South Pacific regions. This report excludes all MSC certified fisheries that are Parties to the Nauru Agreement (PNA) operating in this region.

Populations of swordfish, albacore, skipjack and yellowfin tuna are healthy and fishing mortality rates are currently sustainable. A new stock assessment for bigeye suggests that it was never overfished. Populations of Pacific bluefin tuna in the North Pacific ocean, however, have been greatly reduced by as much as 96%, and fishing mortality rates are currently too high. Stocks of southern bluefin tuna remain overfished, but management measures have eliminated overfishing.

The FAD-associated purse seine fishery incidentally captures a number of species, including sharks, sea turtles, and other bony fish. Populations of two species of sharks commonly caught in this fishery, oceanic whitetip and silky, are both low and fishing pressure is too high. Sea turtle populations are also of concern, although bycatch in purse seine fisheries is not a major contributor to their overall mortality. The unassociated fisheries have much less bycatch than the FAD-associated fisheries, but mobulid bycatch is of concern.

Tunas, billfish, other fish, sharks, seabirds, sea turtles and marine mammals are incidentally caught in pelagic longline fisheries. Discard rates of these species vary from only 5% for tunas to 96% for sea turtles.

Trolling line, handline and hand-operated pole and line fisheries are highly selective and interactions with species of concern, such as marine mammals, sea turtles and sea birds have not been reported. Some shark species may be caught, but in very low amounts.

The Western and Central Pacific Fisheries Commission (WCPFC) manages bigeye, and yellowfin tuna in the WCPO and albacore tuna in the South Pacific, while the WCPFC and Inter-American Tropical Tuna Commission (IATTC) manage swordfish, albacore and Pacific bluefin tuna throughout the North Pacific Ocean in their respective convention areas. The Commission for the Conservation of Southern Bluefin Tuna manages southern bluefin tuna throughout their range. These organizations have provided some management measures specific to these species and have been moderately effective in enforcing them. In domestic waters, the National Marine Fisheries Service is responsible for albacore tuna management in the United States, the Department of Fisheries and Oceans Canada is responsible in Canadian waters and in Japanese waters the Ministry of Agriculture, Forestry and Fisheries is responsible.

Pelagic longline, purse seine, trolling line and pole and line gears typically have little to no contact with bottom habitats but do interact with ecologically important species, which could cause negative effects to the ecosystem.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Albacore | North Pacific Stock | Northwest Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Albacore | South Pacific Stock | Southwest Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Albacore | South Pacific Stock | Southwest Pacific | Hand-operated pole-and-lines	4.284	5.000	3.000	3.873	**Best Choice (3.972)**
Albacore | South Pacific Stock | South Pacific | Trolling lines	4.284	5.000	3.000	3.873	**Best Choice (3.972)**
Albacore | North Pacific Stock | Northeast Pacific | Trolling lines | Canada	4.284	5.000	3.000	4.472	**Best Choice (4.117)**
Albacore | North Pacific Stock | Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan	4.284	5.000	3.000	3.873	**Best Choice (3.972)**
Albacore | North Pacific Stock | Northwest Pacific | Trolling lines | Japan	4.284	5.000	3.000	3.873	**Best Choice (3.972)**
Albacore | North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States	4.284	5.000	3.000	3.873	**Best Choice (3.972)**
Albacore | North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Trolling lines | United States	4.284	5.000	3.000	3.873	**Best Choice (3.972)**
Bigeye tuna | Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Bigeye tuna | Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	4.284	1.000	1.000	3.162	**Avoid (1.918)**
Bigeye tuna | Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	4.284	3.413	3.000	3.873	**Best Choice (3.610)**
Pacific bluefin tuna | Northwest Pacific | Drifting longlines	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Pacific bluefin tuna | North Pacific | Unassociated purse seine (non-FAD)	1.000	5.000	1.000	3.873	**Avoid (2.098)**
Pacific bluefin tuna | Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery	1.000	5.000	1.000	3.873	**Avoid (2.098)**

Pacific bluefin tuna | Northwest Pacific | Trolling lines | Japan | Bluefin Fishery	1.000	5.000	1.000	3.873	**Avoid (2.098)**
Skipjack tuna | Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	5.000	1.000	1.000	3.162	**Avoid (1.994)**
Skipjack tuna | Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	5.000	3.413	3.000	3.873	**Best Choice (3.752)**
Skipjack tuna | Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines	5.000	5.000	3.000	3.873	**Best Choice (4.128)**
Skipjack tuna | Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)	5.000	1.000	3.000	3.873	**Good Alternative (2.761)**
Southern bluefin tuna | Southwest Pacific | Drifting longlines	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Swordfish | Northwestern and Central Pacific Stock | Northwest Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Swordfish | South Pacific Stock | Southwest Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Swordfish | Northwestern and Central Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	4.284	3.413	3.000	3.873	**Best Choice (3.610)**
Swordfish | South Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	4.284	3.413	3.000	3.873	**Best Choice (3.610)**
Yellowfin tuna | Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines	5.000	1.000	1.000	3.873	**Avoid (2.098)**
Yellowfin tuna | Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	5.000	1.000	1.000	3.162	**Avoid (1.994)**
Yellowfin tuna | Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	5.000	3.413	3.000	3.873	**Best Choice (3.752)**
Yellowfin tuna | Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines	5.000	5.000	3.000	3.873	**Best Choice (4.128)**
Yellowfin tuna | Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)	5.000	1.000	3.000	3.873	**Good Alternative (2.761)**

Summary

All swordfish, yellowfin and albacore tuna in the WCPO caught with drifting longlines have an avoid rating, but these three species caught with more selective gears such as trolling lines, handlines and hand operated pole and lines are rated best choice. All Pacific bluefin tuna, southern bluefin tuna and bigeye tuna are rated as an avoid irrespective of gear type. Skipjack and yellowfin tuna are an avoid rating when caught in FAD purse seines, a good alternative when caught in non-FAD or unassociated purse seines and best choice when caught in trolling lines.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report covers the tropical tuna pelagic longline fisheries for western and central Pacific populations of bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*), the northern and southern Pacific longline fisheries for swordfish (*Xiphias gladius*) and albacore tuna (*Thunnus alalunga*), the North Pacific longline fishery for Pacific bluefin (*Thunnus orientalis*) and the South Pacific longline fishery for southern bluefin (*Thunnus maccoyii*) tunas. It also covers the unassociated purse seine fishery for the North Pacific bluefin tuna, the FAD-associated purse seine fishery for bigeye tuna and the unassociated and associated purse seine fisheries for skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna operating in the western and central Pacific Ocean (WCPO). In addition, it covers the following trolling line, hand-operated pole and line or handline fisheries: Canadian, United States and Japanese-caught albacore tuna in the North and South Pacific, Japanese-caught Pacific bluefin tuna in the North Pacific, swordfish caught in the North and South Pacific and skipjack and yellowfin tuna caught in the WCPO.

This report does not cover the MSC certified Parties to the Nauru Agreement (PNA) or other MSC certified fisheries.

Species Overview

Swordfish are a widely distributed billfish species, found globally from 50°N to 50°S latitude and at all longitudes in the Pacific Ocean (Takeuchi et al. 2017). They are assessed as two populations in the North Pacific (western and central Pacific and eastern Pacific), a single population in the Southwest Pacific, two populations in the Atlantic (South and North), and a single population in both the Indian Ocean and Mediterranean Sea.

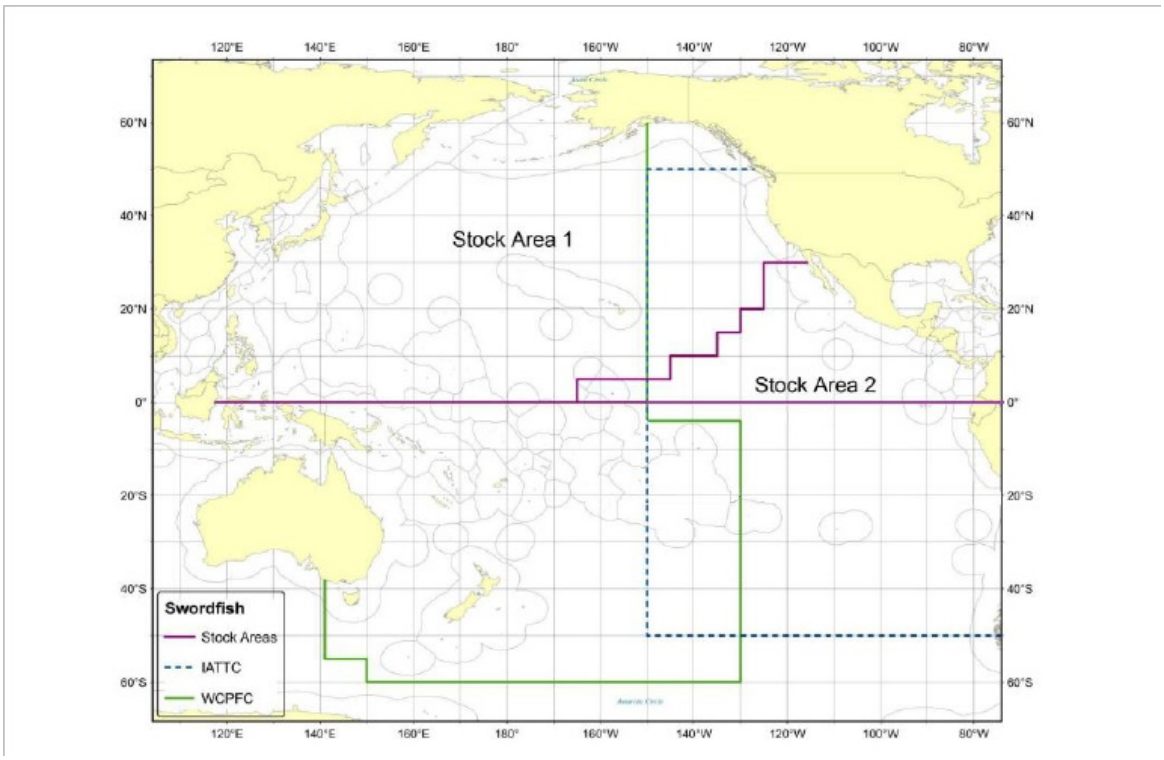


Figure 1: Stock boundaries of North Pacific Ocean swordfish (purple lines) (ISC 2018b).

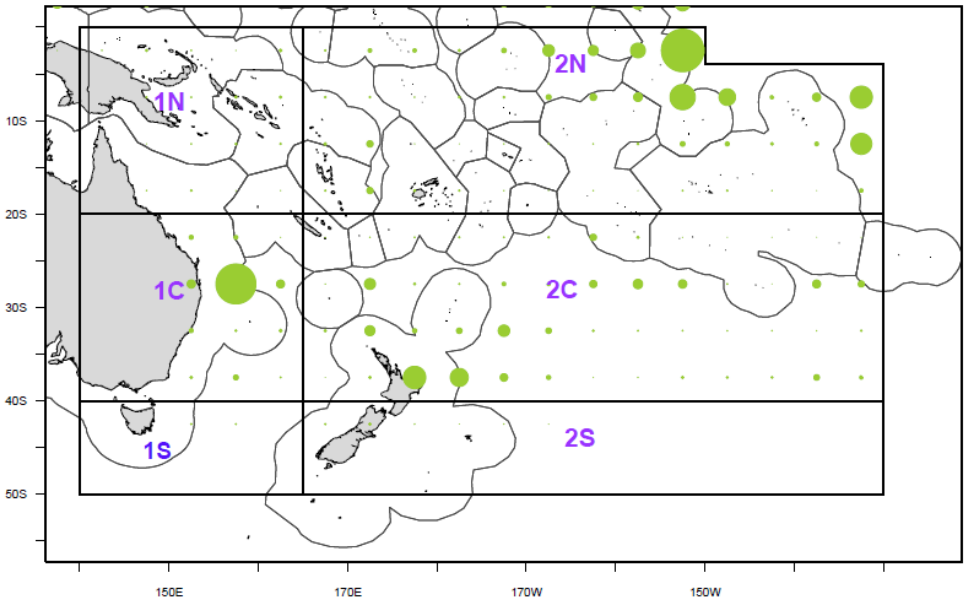


Figure 2: Swordfish catches in the south Pacific Ocean, 2006-2015, depicting two assessment regions and six fishery sub-areas within each region (from (Takeuchi et al. 2017)).

Albacore tuna are widely distributed in temperate and tropical waters in all oceans. There are six managed

populations of albacore tuna, North and South Pacific Ocean, North and South Atlantic Ocean, Indian Ocean and Mediterranean Sea.

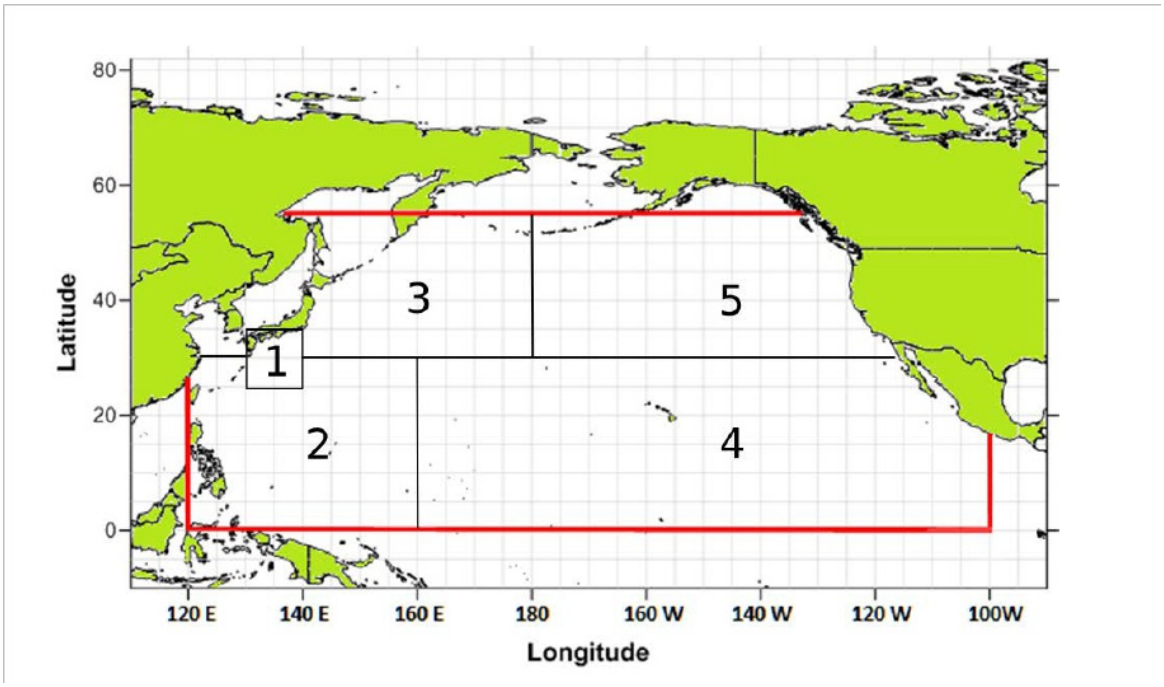


Figure 3: Spatial domain of the albacore stock in the North Pacific Ocean (ISC 2017)

Bigeye, skipjack and yellowfin tuna are found in tropical and subtropical waters of the Pacific Ocean {McKechnie et al. 2017} (Tremblay-Boyer et al. 2017) {McKechnie et al. 2016}. The following four populations of bigeye and yellowfin tuna are found in the western and central Pacific Ocean, eastern Pacific Ocean, Atlantic and Indian Ocean. There are five populations of skipjack tuna as follows: western and central Pacific Ocean, eastern Pacific Ocean, eastern Atlantic, western Atlantic and Indian Ocean. Yellowfin tuna reach a maximum size of around 180 cm. Sexual maturity is reached between 78 and 158 cm, around 2 to 3 years of age, and they can live up to 9 years (Froese and Pauly 2018). Bigeye tuna reach sexual maturity between 100 to 125 cm in size and around 3 years of age. They can reach a maximum size of 180 cm and live up to 11 years (Froese and Pauly 2018). Skipjack tuna reach sexual maturity around 40 cm in size. They can live up to 12 years and attain a maximum size of 110 cm (Froese and Pauly 2018).

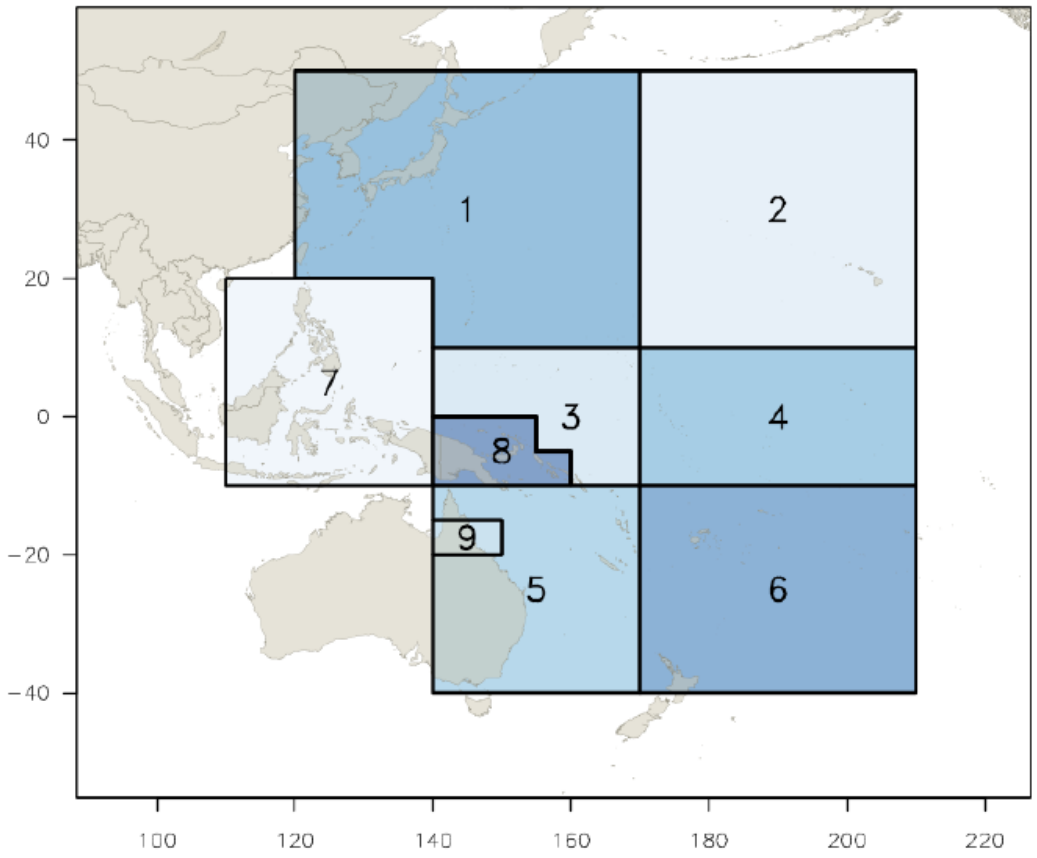


Figure 4: Geographical area covered by the yellowfin tuna stock assessment in the Western and Central Pacific Ocean and the 9 regions of the "2014 regional structure" (from (Tremblay-Boyer et al. 2017)).

Pacific bluefin tuna are a single stock found throughout the North Pacific Ocean. Juvenile bluefin tuna can make trans-Pacific migrations. Bluefin tuna can live more than 20 years and reach sexual maturity around 3 years of age or 100 cm in length (ISC 2018). Spawning occurs between May and June and from late June to August in the northwestern Pacific Ocean (ISC 2018).

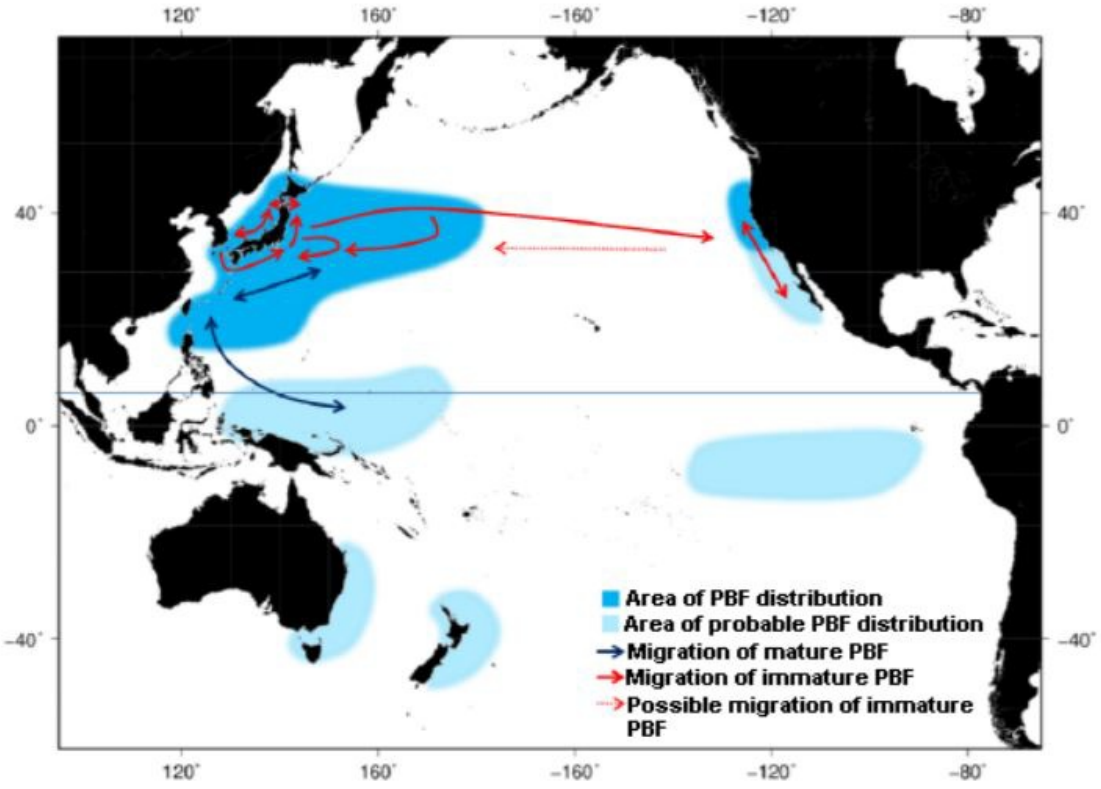


Figure 5: Distribution of Pacific bluefin tuna. Darker areas indicate core habitat (ISC 2018).

Records indicate Japanese fisheries as far back as 1804 targeted this species. The United States began targeting Pacific bluefin tuna during the early part of the 20th century, with catches throughout the region peaking between 1929 and 1940. Catch reporting during these early years was scant but improved by 1952. Since then annual catches have varied tremendously, peaking at 40,383 t in 1956 (ISC 2018).

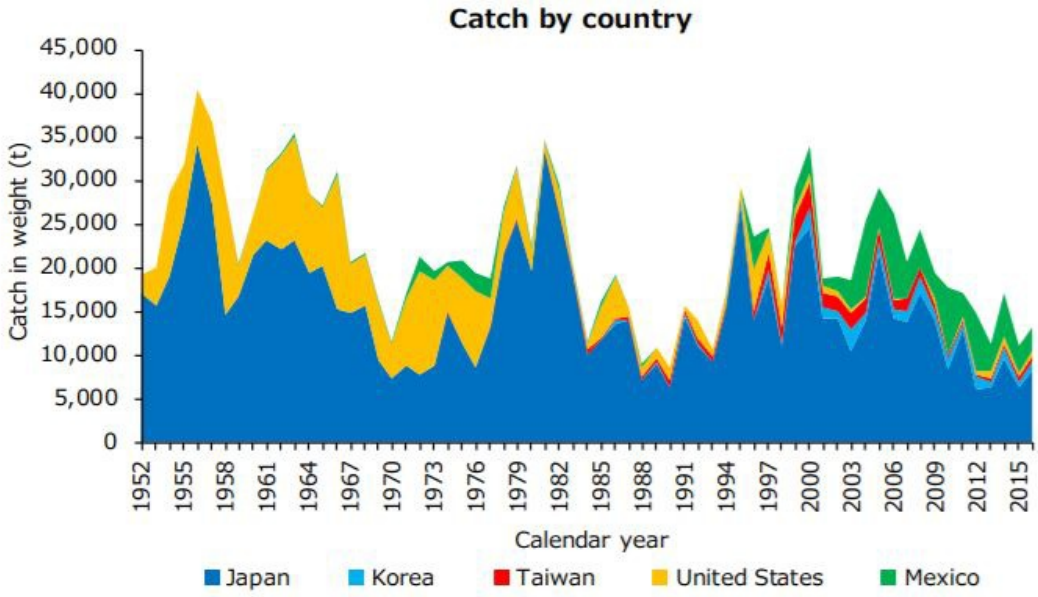


Figure 6: Annual catch of Pacific bluefin tuna by country (ISC 2018).

Southern bluefin tuna are only found in the southern hemisphere, primarily in the Indian, Atlantic and western Pacific Oceans and are uncommonly found in the eastern Pacific Ocean. This species migrates from the southern coast of Australia and the central Indian Ocean as juveniles and remains in offshore waters as an adult. There is only one known spawning location, southeast of Java, Indonesia in the Indian Ocean (CCSBT 2017).

Globally, longlines are the most common method used to capture swordfish, albacore and bigeye tuna, and purse seines are the primary gear used to capture Pacific bluefin and yellowfin tuna.

The Western and Central Pacific Fisheries Commission (WCPFC) manages swordfish, albacore, bigeye, skipjack and yellowfin tuna in the western and central Pacific Ocean. The Inter-American Tropical Tuna Commission (IATTC) also manages swordfish, Pacific bluefin and albacore tuna in the North and South (swordfish) Pacific Ocean. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) manages that species throughout its range. In addition, North Pacific albacore caught in the US, Canada and Japan are independently managed by their respective nation's fisheries agencies. The Pacific Fishery Management Council has jurisdiction within the US EEZ, Fisheries and Oceans Canada (DFO) has jurisdiction within Canada's EEZ, and within Japanese waters, the Ministry of Agriculture, Forestry and Fisheries is in charge. However, these fisheries target highly migratory species whose ranges span into international waters. North Pacific bluefin tuna caught in Japanese waters are independently and domestically managed by the Japanese Ministry of Agriculture, Forestry and Fisheries.

Production Statistics

Catches of swordfish in the western and central North Pacific Ocean have varied over time, peaking during the late 1950s and again during the early to mid 1990s. The majority of swordfish are caught by longlines.

Catches by longline fisheries in recent years have hovered between 16,000 to 19,000 t (WCPFC 2017). Total swordfish catch in the WCPO in 2016 was 20,139 t (WCPFC 2017).

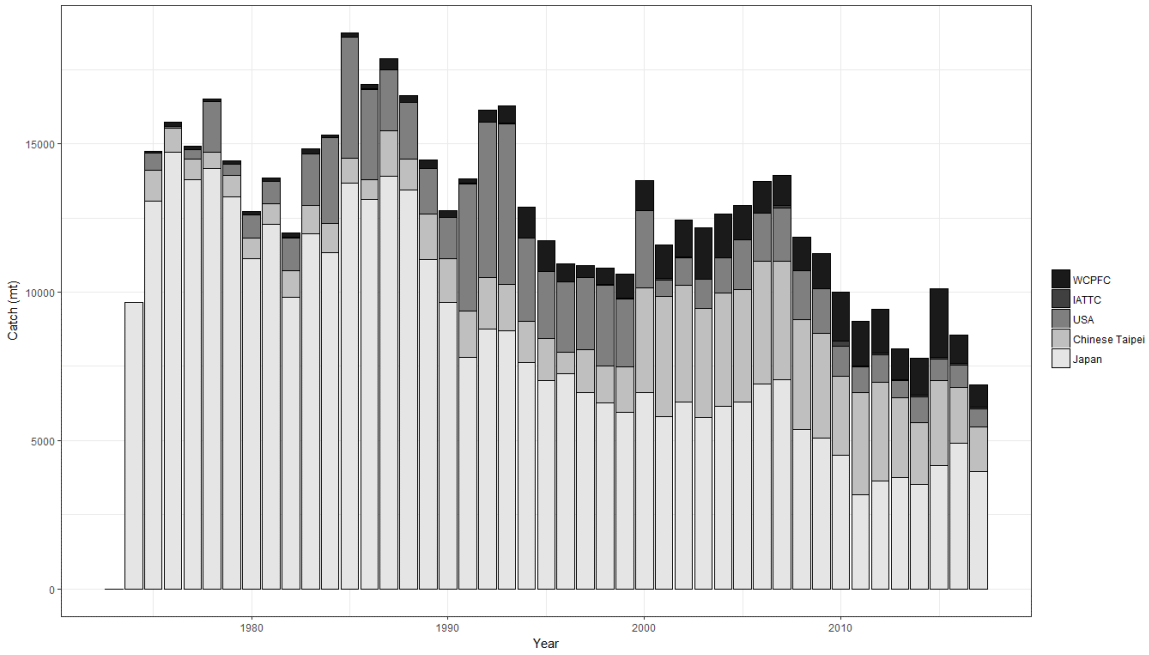


Figure 7: Catches of swordfish in the Pacific Ocean by region over time (WCPFC 2017).

The total catches of albacore in the Pacific Ocean in 2016 were 119,770 t (WCPFC 2017). Catches in the North Pacific were 51,169 t during 2016 and catches in the South Pacific were 68,601 t (WCPFC 2017). Longline fisheries catch the majority of albacore tuna in the Pacific Ocean (WCPFC 2017). The major fisheries for albacore tuna in the South Pacific are several distant water longline fleets (Japan, Chinese Taipei and China) along with some Pacific Island country domestic longline fleets. Longline fishing has increased since the mid-1990s due to the development and
expansion of small-scale fisheries in the Pacific Island countries (American Samoa, Cook Islands, Fiji, French Polynesia, New Caledonia, Samoa, Tonga and Vanuatu).

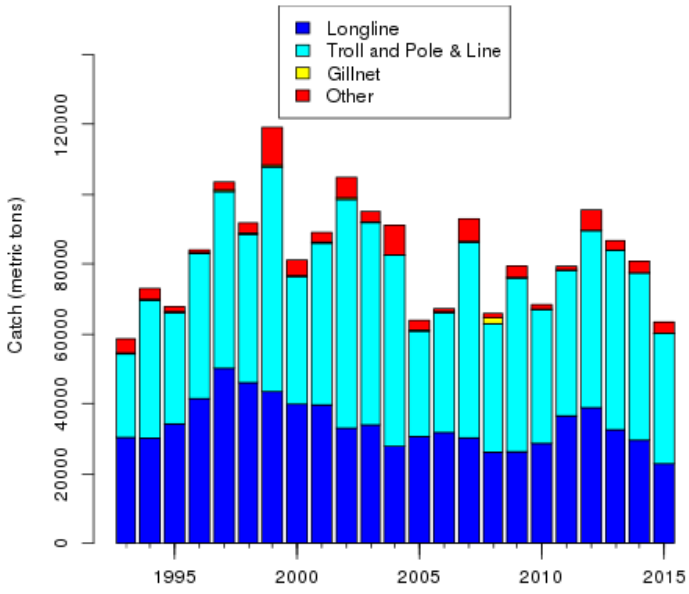


Figure 8: Catches of north Pacific albacore by gear type over time (ISC 2017).

Total catches of bigeye tuna in the western and central Pacific Ocean have increased over time, peaking in the mid 2000s at just under 200,000 MT. Total catches of bigeye were 152,805 t during 2016 (WCPFC 2017). Longline fisheries caught 64,131 t during 2016 (WCPFC 2017). The majority of bigeye catches occur within equatorial regions of the western and central Pacific Ocean {Williams and Terewasi 2014}.

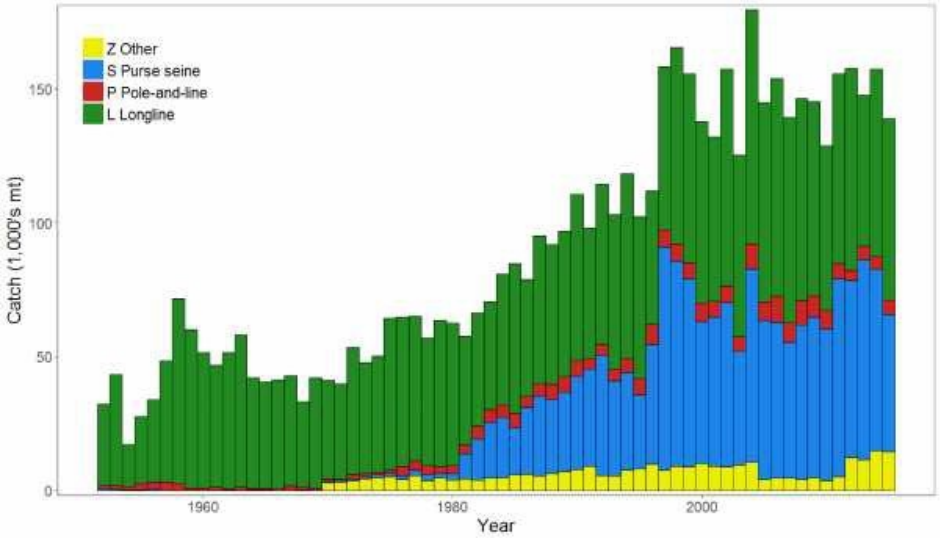


Figure 9: Catches of bigeye tuna in the WCPO by gear type (WCPFC 2017).

Total catches of yellowfin tuna in the WCPO have increased over time from a low of under 50,000 t during the mid 1950s to over 600,000 t in 2008 and 2012. Annual catches of yellowfin tuna by longliners in the WCPO have been around 70,000 to 80,000 t since the mid 1980s (WCPFC 2017). Longline fisheries caught 90,539 t of yellowfin during 2016 (WCPFC 2017). Total catches of yellowfin tuna during 2016 were

650,479 t (WCPFC 2017).

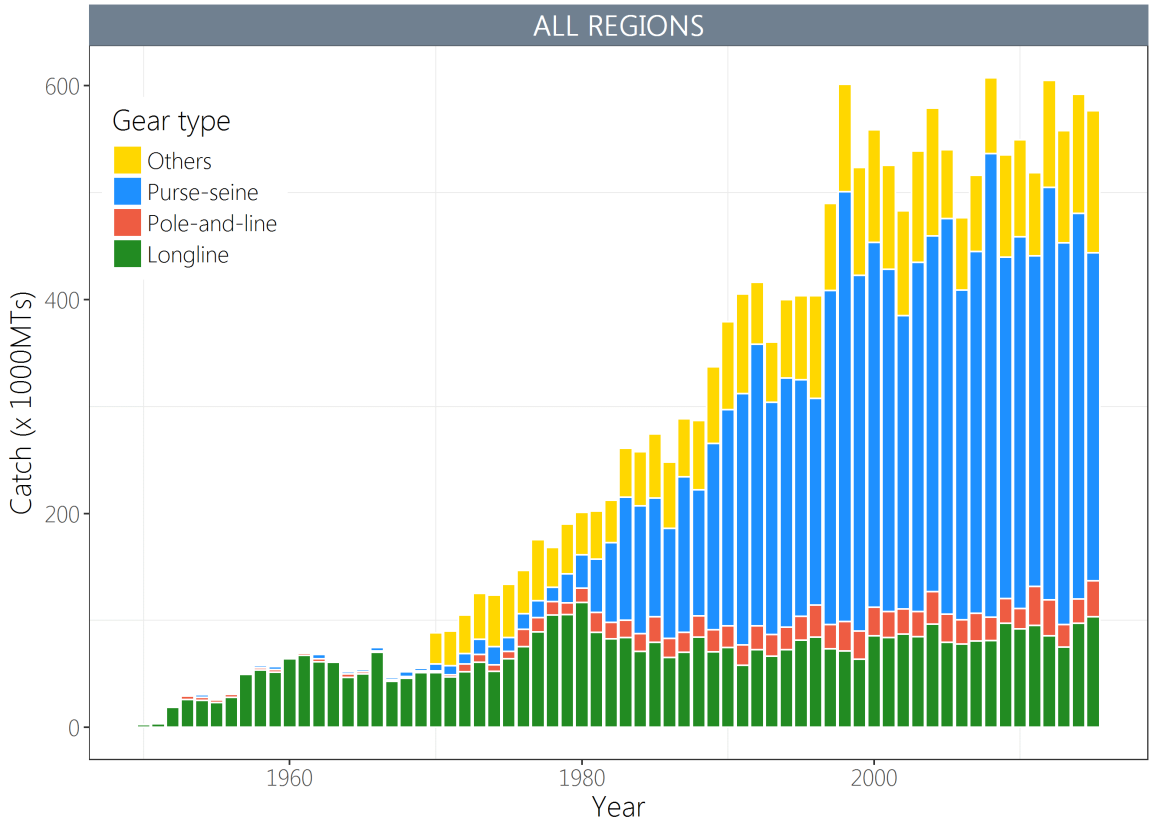


Figure 10: Catches by gear type of yellowfin tuna in the WCPO over time (WCPFC 2017).

Purse seines catch the majority of Pacific bluefin tuna, followed by trolling line, longline and set nets in recent years. Information on historical Pacific bluefin catches (total) is limited, although data since 1804 and the early 1900s are available from Japan and the US respectively. Catches were high from 1929 to 1940, peaking at 59,000 MT in 1935. In 1949, as the Japanese fleet moved across the North Pacific Ocean, catches increased
significantly. Since 1952 (when catch reporting improved), the majority of Pacific bluefin tuna had been caught by Japan. Historically the United States was the second-most important fishing nation for Pacific bluefin tuna. However, since the late 1990s Mexico has replaced the United States and is now the second-largest fishing nation. Annual catches have been under 20,000 t during the past few years (ISC 2016).

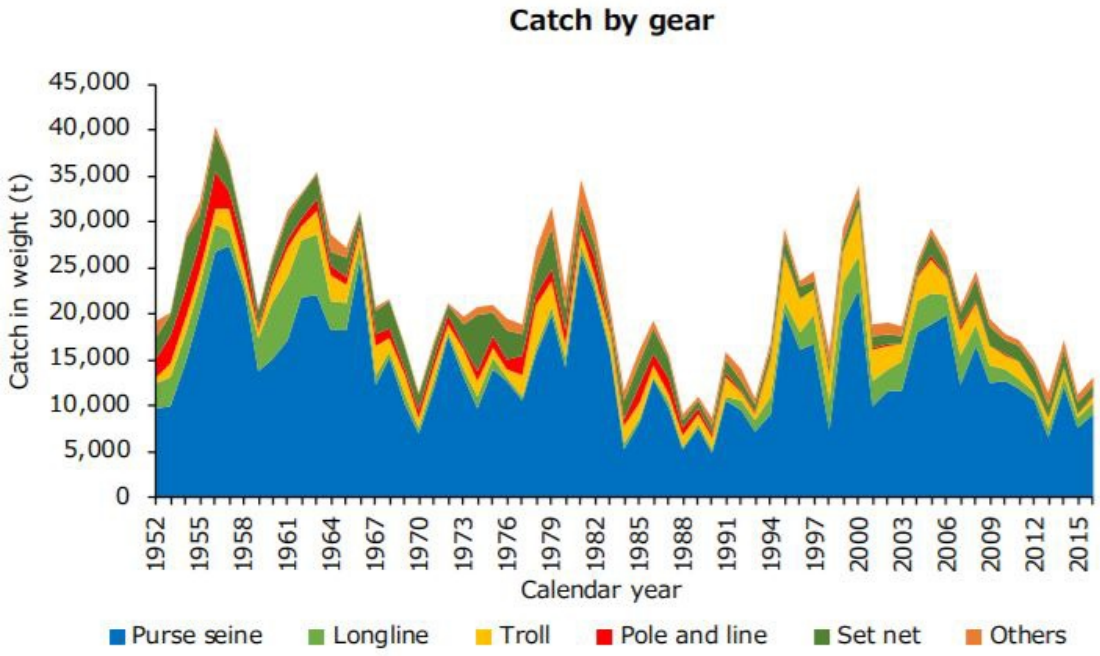


Figure 11: Annual catch of Pacific bluefin tuna by gear type from 1952-2016 (ISC 2018).

Skipjack make up the majority of tuna in tuna fisheries within the WCPO and are caught by a variety of gears, but primarily by purse seines. Purse seine fisheries for skipjack occur principally in equatorial waters, where the majority of all skipjack in the WCPO are caught. Historically, the majority of skipjack catch has been taken from the western equatorial region. However, since the late 1990s, with the escalation in the purse seine fishery, catches in the eastern equatorial region have increased. In the beginning, the pole and line fleets, primarily Japanese, dominated the fishery, but this fishery has since declined in importance, while effort of the purse seine fleets increased during the 1980s. Catches have increased steadily since the 1970s, doubling in the 1980s. During the early 1990s, catches were stable and approached 1,000,000 t per year and, by 2013, catches had reached 1.78 million t. Catches have remained near this level since. However, a severe problem with the accuracy of purse seine catch reported on logbooks has been identified. Catch reported in logbooks over-report the catch of skipjack tuna while under-report yellowfin and bigeye catches (Rice et al. 2014) (Lawson 2011).

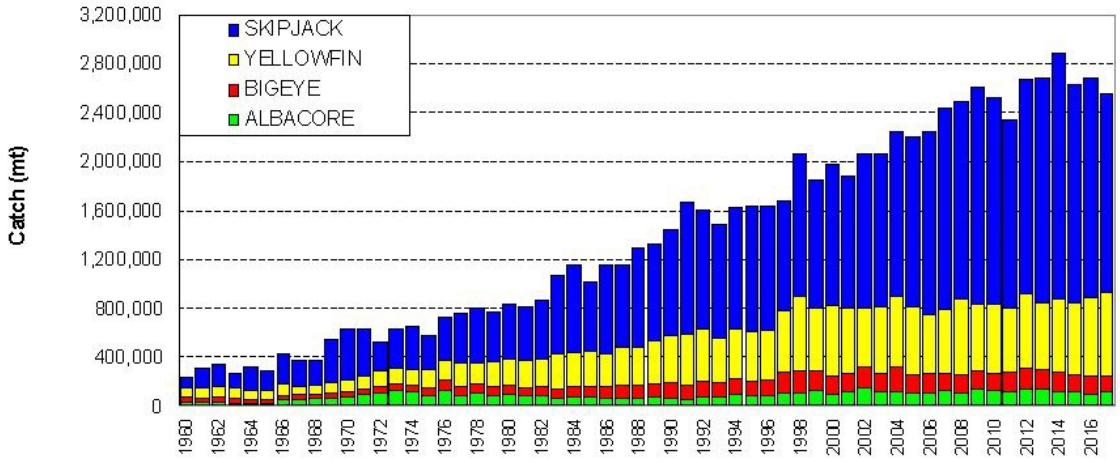


Figure 12: Catches in the WCPFC Statistical Area by species, 1960-2017 (from (OFP 2017)).

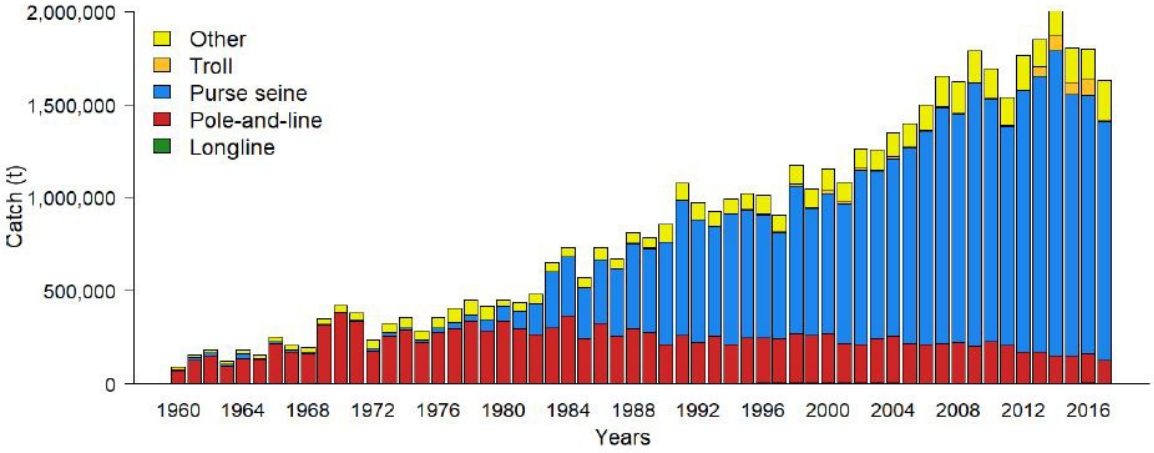


Figure 13: Catch of skipjack tuna in the WCPO 1960-2017 (Brouwer et al. 2018).

Only a small proportion of southern bluefin tuna (16%) are caught in the Pacific Ocean. Total catches of southern bluefin tuna peaked in the 1960s at around 82,000 t, with just under 80,000 t coming from the longline fishery. Catches have declined significantly since then, with only around 10,000 t caught in 2012, and around half of that by the longline fleet. Catches in the Pacific Ocean have ranged from 800 t to 19,000 t
since 1968, with an average catch of 5,500 t annually {CCBST 2016}.

Importance to the US/North American market.

During 2017, the United States imported the most (40%) albacore tuna from Thailand followed by Vietnam (20%) and Indonesia (12%) (NMFS 2017).

The US imports the majority of bigeye tuna from Brazil (21%), the Marshall Islands and Surname (~7%)

(NMFS 2017), and yellowfin primarily from Vietnam, Sri Lanka, and the Philippines (~10%) (NMFS 2017).

In 2017, swordfish imports into the US were primarily from Ecuador (24%), Brazil (10%), and Canada (10%) (NMFS 2017).

In 2017, all of the North Pacific bluefin tuna were imported from Japan (NMFS 2017). The US imported the majority of southern bluefin tuna from Australia (55%) in 2017 (NMFS 2017).

The US imports the majority of skipjack tuna from Mexico (31%) and Vietnam (32%) (NMFS 2017).

Common and market names.

Swordfish	broadbilled swordfish, broadbill, espada, emperado, mekajiki (Hawaii)
Albacore tuna	germon, longfinned tuna, albecore, T. germo, tombo ahi (Hawaii)
Skipjack tuna	ocean bonito, lesser tuna, Aku (Hawaii)
North Pacific Bluefin tuna	giant bluefin, northern bluefin, tunny, oriental tuna
Southern bluefin	southern tunn, tunny
Bigeye tuna Yellowfin tuna	Ahi (Hawaii)

Primary product forms

Swordfish, albacore, bigeye, skipjack and yellowfin tuna are sold in fresh and frozen forms and the tuna may be canned. Albacore tuna is sold primarily in canned form but also in fresh and frozen form. Pacific bluefin and southern bluefin tuna are primarily sold in fresh and frozen forms.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

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

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

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

Criterion 1 Summary

ALBACORE			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
North Pacific Stock | Northwest Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
South Pacific Stock | Southwest Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
South Pacific Stock | Southwest Pacific | Hand-operated pole-and-lines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
South Pacific Stock | South Pacific | Trolling lines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
North Pacific Stock | Northeast Pacific | Trolling lines | Canada	3.670: Low Concern	5.000: Low Concern	Green (4.284)
North Pacific Stock | Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan	3.670: Low Concern	5.000: Low Concern	Green (4.284)
North Pacific Stock | Northwest Pacific | Trolling lines | Japan	3.670: Low Concern	5.000: Low Concern	Green (4.284)
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States	3.670: Low Concern	5.000: Low Concern	Green (4.284)
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Trolling lines | United States	3.670: Low Concern	5.000: Low Concern	Green (4.284)

BIGEYE TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	3.670: Low Concern	5.000: Low Concern	Green (4.284)

PACIFIC BLUEFIN TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwest Pacific | Drifting longlines	1.000: High Concern	1.000: High Concern	Red (1.000)
North Pacific | Unassociated purse seine (non-FAD)	1.000: High Concern	1.000: High Concern	Red (1.000)
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery	1.000: High Concern	1.000: High Concern	Red (1.000)
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery	1.000: High Concern	1.000: High Concern	Red (1.000)

SKIPJACK TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

SOUTHERN BLUEFIN TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Southwest Pacific | Drifting longlines	1.000: High Concern	5.000: Low Concern	Yellow (2.236)

SWORDFISH			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northwestern and Central Pacific Stock | Northwest Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
South Pacific Stock | Southwest Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Northwestern and Central Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
South Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	3.670: Low Concern	5.000: Low Concern	Green (4.284)

YELLOWFIN TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

Populations of albacore tuna and swordfish in the North and South Pacific Ocean are healthy and fishing mortality rates appear sustainable. Throughout the western and central Pacific Ocean, yellowfin and skipjack tuna populations are healthy and fishing mortality rates are low. Recent models of the bigeye population show that it is not overfished and overfishing is not occurring. However, there is a large degree of uncertainty surrounding the results. Management efforts have increased southern bluefin abundance, but the stock is still overfished. Overfishing of southern bluefin tuna, however, is not occurring. North Pacific bluefin tuna populations have been drastically reduced, by as much as 96% and fishing pressure on North Pacific bluefin is high.

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Albacore

Factor 1.1 - Abundance

North Pacific Stock | Northwest Pacific | Drifting longlines
North Pacific Stock | Northeast Pacific | Trolling lines | Canada
North Pacific Stock | Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
North Pacific Stock | Northwest Pacific | Trolling lines | Japan
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Trolling lines | United States

Low Concern

The most recent stock assessment for albacore tuna in the North Pacific Ocean was conducted in 2017. The population of albacore in the north Pacific has never dropped below the adopted (by the WCPFC) limit reference point (20% of the current spawning stock biomass (SSB) when F=0). According to this assessment, the estimated spawning potential ratio (SPR) was 0.53 in 2015, which is considered a moderate exploitation intensity (ISC 2017). The SSB in 2015 was estimated to be 80,168 t, which is 2.47 times larger than the limit reference point threshold (32,614 t). The population is therefore not overfished (ISC 2017). The stock has fluctuated around the current SSB level for decades. We have awarded a score of "low" concern because the population is not overfished and biomass is above limit reference points.

Justification:

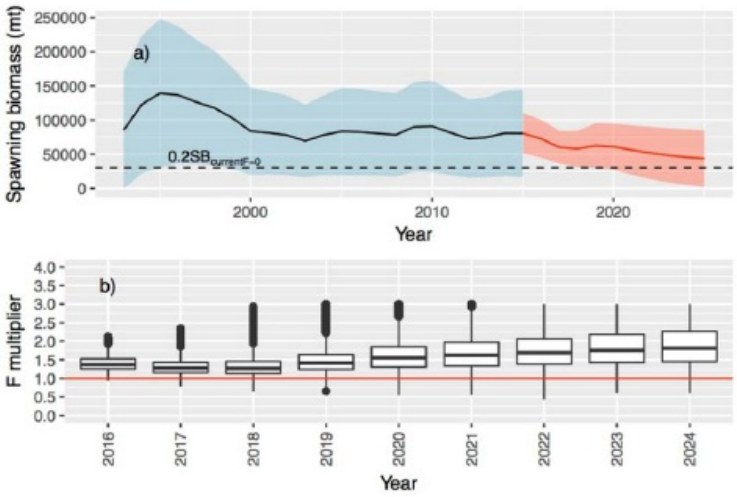


Figure 14: A) historical and future trajectory of north Pacific albacore female spawning biomass under constant catch harvest scenario. Dashed line indicates average limit reference point for 2012-2014. Black line and blue area indicate maximum likelihood estimates and 95% confidence intervals of historical female SSB. Red line and red area indicate mean value and confidence interval of projected female SSB, which only includes future recruitment variability and SSB uncertainty in the terminal year and B) projected fishing intensity relative to the current fishing intensity (2012-2014) under constant catch scenario (average 2010-2014) (ISC 2017)

South Pacific Stock | Southwest Pacific | Drifting longlines
South Pacific Stock | Southwest Pacific | Hand-operated pole-and-lines
South Pacific Stock | South Pacific | Trolling lines

Low Concern

Albacore tuna in the South Pacific was last assessed in 2018 (WCPFC 2018). According to the stock assessment model, the median spawning biomass depletion is estimated at 52% (32% to 72%) of unfished levels ($SB_{RECENT}/SB_{F=0}$) (Tremblay-Boyer et al. 2018) (WCPFC 2018). The recent (2013 to 2016) median spawning potential is above the limit reference point of 20%$SB_{F=0}$, indicating the population is likely not overfished (Tremblay-Boyer et al. 2018) (WCPFC 2018). The WCPFC recently agreed to use 56% of spawning biomass in the absence of fishing (0.56$SB_{F=0}$) as a target reference point (WCPFC 2018a). Since $SB_{RECENT}/SB_{F=0}$ is above the limit reference point, and more than 75% of the target reference point, we have awarded a score of "low" concern.

Justification:

Based on bio-economic modelling described in (Pilling et al. 2016), the range of $SB_{F=0}$ that would support break-even or 10% profits is 0.65–0.80$SB_{F=0}$, which is greater than the current median estimated $SB_{RECENT}/SB_{F=0}$ of 0.52 and greater than the target reference point of 0.56 (WCPFC 2018a). The objective of the new TRP is to increase CPUE in the longline fishery by 8% from 2013 levels. If the new, interim TRP does not result in the desired increase in CPUE, the WCPFC will revise the TRP (WCPFC 2018a). The TRP will be reviewed every 3 years.

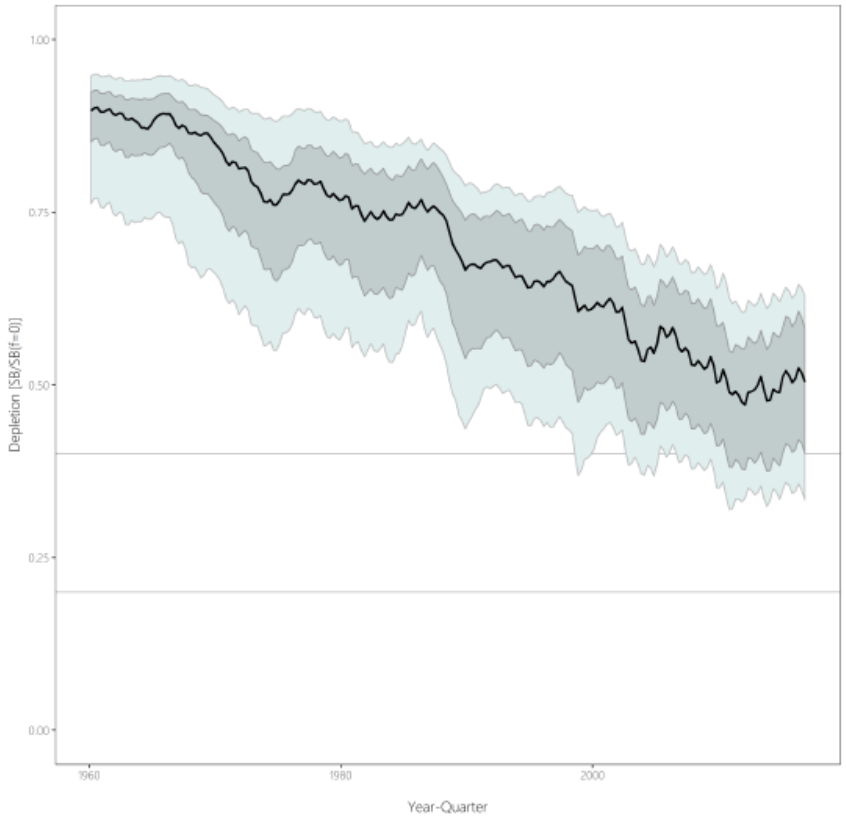


Figure 15: Distribution of time series depletion across the structural uncertainty grid (i.e., analysis of model structural uncertainty). Black line represents the median trajectory, dark gray = 50th percentile range, light gray = 90th percentile region (from (WCPFC 2018)).

Factor 1.2 - Fishing Mortality

North Pacific Stock | Northwest Pacific | Drifting longlines
North Pacific Stock | Northeast Pacific | Trolling lines | Canada
North Pacific Stock | Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
North Pacific Stock | Northwest Pacific | Trolling lines | Japan
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Trolling lines | United States

Low Concern

The current fishing mortality rate ($F_{2012\text{-}2014}$) for albacore tuna in the North Pacific Ocean is below potential F-based reference points (F_{MSY} $F_{0.1}$ and $F_{10\text{-}40\%}$ (fishing mortality that gives 10 to 40% reduction in the spawning potential ratio)) except for $F_{50\%}$. Albacore tuna in the North Pacific Ocean

are therefore not currently undergoing overfishing. However, increases in fishing mortality rates will significantly reduce the spawning biomass (ISC 2017). We have awarded a score of "low" concern because overfishing is likely not occurring.

South Pacific Stock | Southwest Pacific | Drifting longlines
South Pacific Stock | Southwest Pacific | Hand-operated pole-and-lines
South Pacific Stock | South Pacific | Trolling lines

Low Concern
According to the most recent stock assessment (2018), which does not include catches made in the IATTC Convention Area, the ratio of the current fishing mortality rate to that needed to produce the maximum sustainable yield was less than 1 ($F_{CURRENT}/F_{MSY}$ = 0.2 (0.08-0.41)). There is a low risk that overfishing is occurring (Tremblay-Boyer et al. 2018). We have therefore awarded a score of "low" concern.

Bigeye tuna

Factor 1.1 - Abundance

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern
Bigeye tuna in the western and central Pacific Ocean (WCPO) were most recently assessed in 2018, using a new age and growth curve (Vincent et al. 2018). According to the "updated new growth" model, the median ratio of the current average (2012 to 2015) spawning biomass to that needed to produce the maximum sustainable yield (SB_{RECENT}/SB_{MSY}) was 1.311 and the ratio of the latest (2015) spawning biomass (mature fish) to that needed to produce the maximum sustainable yield (SB_{LATEST}/SB_{MSY}) was 1.624 (Vincent et al. 2018). The median ratio of the recent spawning biomass to that spawning biomass with no fishing is 0.358, which is above the limit reference point of 0.20, indicating that the population is not overfished (Vincent et al. 2018). There is, however a lot of uncertainty regarding which growth model(s) is best and there is some movement between the eastern and western management areas.

We have awarded a score of "low" concern because bigeye tuna are not considered overfished and the spawning stock biomass is above that needed to produce maximum sustainable yield. We have not awarded a score of "very low" concern because of the high amount of uncertainty in the models.

Justification:
In 2018, the assessment was updated with additional new age and growth information and the status re-evaluated (Vincent et al. 2018). Models that used only the new growth model estimated a depletion value between 0.295 and 0.412, all above the limit reference point. When a 3:1 weighting

for the updated:old growth model were used, the depletion estimates ranged from 0.157 to 0.403 (14% estimated a ratio below the limit reference point (Vincent et al. 2018).

Factor 1.2 - Fishing Mortality

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern

The median ratio of recent (2012 to 2015) fishing mortality rates to those that produce the maximum sustainable yield (F_{RECENT}/F_{MSY}) was 0.768, indicating overfishing is not occurring (Vincent et al. 2018). This appears to be a substantial improvement from the last assessment (Harley et al. 2014). However, the status of the stock may not have changed, but rather the new models may suggest that perhaps the stock was not in such bad shape as previously estimated. We have awarded a score of "low" concern based on the assessment results that overfishing is not occurring.

Justification:

In 2018, an updated assessment was conducted that included additional new age and growth information, with the status being re-evaluated (Vincent et al. 2018). Thirty-two of the one hundred forty two models indicated a ratio larger than 1 (Vincent et al. 2018).

Pacific bluefin tuna

Factor 1.1 - Abundance

Northwest Pacific | Drifting longlines
North Pacific | Unassociated purse seine (non-FAD)
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

High Concern

An updated assessment for Pacific bluefin tuna was conducted in 2018. Based on the updated analysis, the ratio of the spawning stock biomass in 2015 to 2016 to that of unfished levels was 3.3%. Annual recruitment of North Pacific bluefin tuna is variable and unpredictable, which contributes to uncertainty in calculating abundance (ISC 2018). There are no defined reference points for Pacific bluefin tuna. However, the results were compared to other reference points and based on a reference point of $SSB_{20\%}$; the population would be considered overfished. In addition, based on this reference point, the population has been overfished for the majority of the assessed time period (1950 to 2015) (ISC 2018). We have therefore awarded a score of "high" concern.

Factor 1.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
North Pacific | Unassociated purse seine (non-FAD)
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

High Concern

Based on the updated 2018 assessment, current fishing mortality rates from all gears (2012 to 2014) (2015 to 2016) are higher than all potential biological reference points, except F_{MED} and F_{LOSS}. There are currently no defined reference points for Pacific bluefin tuna. However, the assessment results indicate overfishing is occurring relative to "most" of the potential reference points evaluated (ISC 2018). We have awarded a score of "high" concern because overfishing has been occurring for most of the assessed time period.

Justification:

	F_{max}	F0.1	Fmed	Floss	(1-SPR)/(1-SPRxx%)				Estimated SSB for terminal year of each reference period	Depletion ratio for terminal year of each reference period
					SPR10%	SPR20%	SPR30%	SPR40%		
2002-2004	1.77	2.47	1.04	0.78	1.07	1.21	1.38	1.61	40,707	6.3%
2012-2014	1.47	2.04	0.86	0.65	1.05	1.19	1.36	1.58	19,031	3.0%
2015-2016	1.32	1.85	0.78	0.58	1.02	1.15	1.32	1.54	21,311	3.3%

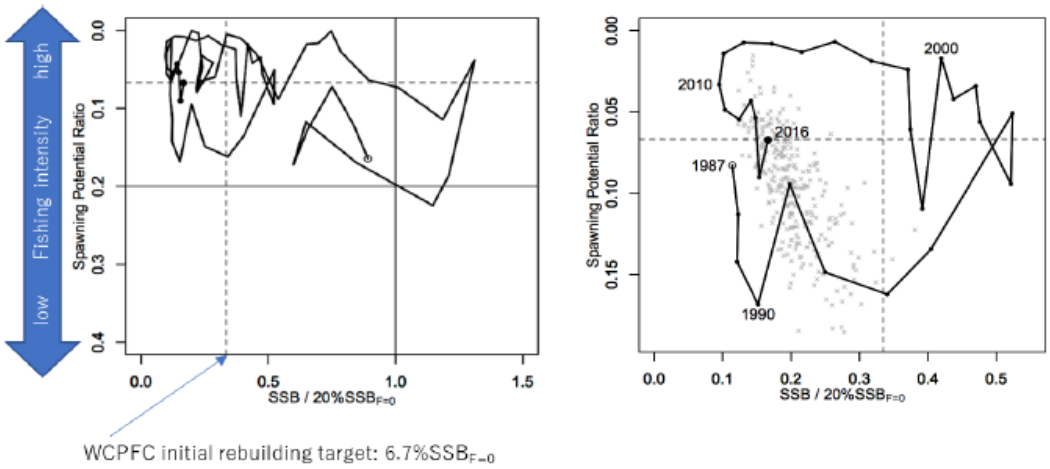


Figure 16: Ratios of the estimated fishing intensities mortalities (Fs and 1-SPRs for 2002-04, 2012-14, 2015- 16) relative to potential fishing intensity-based reference points, and terminal year SSB (t) for each reference period, and depletion ratios for the terminal year of the reference period for Pacific bluefin tuna (Thunnus orientalis) (ISC 2018).

Skipjack tuna

Factor 1.1 - Abundance

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)

Very Low Concern

Skipjack tuna in the western and central Pacific Ocean (WCPO) was last assessed in 2019. In the eight-region model, the median ratio of the latest spawning biomass (2018) and the recent spawning biomass (2015 to 2018) to that needed to produce the maximum sustainable yield is well above 1 (SB_{LATEST} /SB_{MSY} = 2.376 and SB_{RECENT}/SB_{MSY} = 2.581) (Vincent et al. 2019). Therefore, skipjack tuna is not overfished and is above target levels. We have awarded a score of "very low" concern.

Factor 1.2 - Fishing Mortality

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)

Low Concern

The current level of exploitation of skipjack tuna is below that needed to provide the maximum sustainable yield (MSY). Although fishing mortality rates have been increasing over time, the recent (2014 to 2017) median fishing mortality rate is below that needed to produce MSY (F_{RECENT}/F_{MSY} = 0.443) (Vincent et al. 2019). Therefore, overfishing of skipjack tuna is not occurring. We have awarded a score of "low" concern.

Southern bluefin tuna

Factor 1.1 - Abundance

Southwest Pacific | Drifting longlines

High Concern

According to the latest stock assessment conducted in 2017, the current spawning biomass of southern bluefin tuna has improved slightly since the last stock assessment (2014) but is still only 13% of the initial spawning stock biomass. It is currently below SSB_{MSY} (SSB/SSB_{MSY} = 0.49), and also below the 20% interim management target (CCSBT 2017). However, abundance has been

increasing since the 2011 implementation of management measures (CCSBT 2017). The stock is still currently overfished, so we have awarded a score of "high" concern.

Factor 1.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

Low Concern

Fishing mortality rates have decreased for southern bluefin tuna and are now below those needed to produce the maximum sustainable yield ($F_{CURRENT}/F_{MSY}$ = 0.50 (0.38-0.66)). In addition, reported catches are below the maximum sustainable yield (MSY) levels and current exploitation rates are considered moderate (CCSBT 2017). The latest advice was that the current total allowable catch quota should continue {CCBST 2017}. We have awarded a score of "low" concern because fishing mortality rates are below MSY levels.

Swordfish

Factor 1.1 - Abundance

Northwestern and Central Pacific Stock | Northwest Pacific | Drifting longlines
Northwestern and Central Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern

An assessment for swordfish in the North Pacific was conducted in 2018. Although there are no agreed-upon reference points, the female biomass in 2016 was estimated to be 29,403 MT, which is around 87% above the maximum sustainable yield (MSY) level (ISC 2018b). The spawning potential ratio of the stock is currently estimated at 45% (ISC 2018b). Model sensitivity analysis revealed a few runs that indicated the stock was overfished, and the assessment does not incorporate model uncertainty (ISC 2018b). Swordfish in the North Pacific likely are not overfished, but because the base case model does not incorporate uncertainty and there is a lack of reference points, we score abundance as "low" concern, rather than "very low" concern.

Justification:

This assessment considered one of the populations in the western and central Pacific (WCPO) (ISC 2018b). According to this assessment, the population has been fairly stable with a slight decline until the mid-1990s followed by a slight increase since 2000 (ISC 2018b). The spawning stock biomass has remained above MSY levels throughout the time series of the assessment (ISC 2018b).

South Pacific Stock | Southwest Pacific | Drifting longlines
South Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern

The most recent assessment for swordfish in the southwestern Pacific Ocean was conducted in 2017 (Takeuchi et al. 2017). There are no reference points adopted for this population. The

assessment indicated that the stock biomass is above limit reference points (20%SB*F=0) used for tuna. The median estimate was 0.35 (Takeuchi et al. 2017). The ratio of the latest spawning biomass to that needed to produce the maximum sustainable yield ($SB_{LATEST}SB_{MSY}$) was 1.61 {Takeuchi et al. 2107}. It is likely the stock is not overfished, but because there are no reference points in place, we have awarded a score of "low" concern, rather than a score of "very low" concern.

Factor 1.2 - Fishing Mortality

Northwestern and Central Pacific Stock | Northwest Pacific | Drifting longlines
Northwestern and Central Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern
An assessment for swordfish in the North Pacific was conducted in 2018. Exploitation rates in this region peaked in the 1960s and have declined since. The current fishing mortality rate ($H_{2013-2015}$) is 0.08, which is around 45% lower than the level necessary to produce the maximum sustainable yield (H_{MSY}=25%). It is very unlikely (<1%) that fishing mortality rates (H) are unsustainable and therefore overfishing is not occurring (ISC 2018b). We have therefore awarded a score of "low" concern.

South Pacific Stock | Southwest Pacific | Drifting longlines
South Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern
According to the updated 2017 stock assessment of swordfish in the South Pacific, fishing mortality rates are sustainable. The ratio of recent fishing mortality rates to those needed to produce the maximum sustainable yield (MSY) was estimated to be 0.86 (0.42 to 1.46) (Takeuchi et al. 2017). Overfishing is not currently occurring, so we have awarded a score of "low" concern.

Yellowfin tuna

Factor 1.1 - Abundance

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)

Very Low Concern

The biomass based reference points for the reference model used in the 2017 assessment (SB_{RECENT}/SB_{MSY} - the median ratio of the current (2011 to 2014) spawning (mature fish) biomass to that needed to produce the maximum sustainable yield) was 1.39. The median ratio of the latest (2015) spawning biomass to the level needed to produce the maximum sustainable yield (SB_{LATEST}/SB_{MSY}) also was 1.39. The median ratio of the recent spawning biomass to the biomass with no fishing mortality is 0.32, which is higher than the limit reference point (0.20). Therefore, yellowfin tuna are not in an overfished state (Tremblay-Boyer et al. 2017) and biomass is well above appropriate target levels such as SB_{MSY}. We have subsequently awarded ascore of "very low" concern.

Factor 1.2 - Fishing Mortality

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)

Low Concern

The current fishing mortality rate is below levels needed to produce the maximum sustainable yield (F_{RECENT}/F_{MSY} = 0.79) for the most realistic models. Therefore overfishing is not occurring (Tremblay-Boyer et al. 2017) and we have awarded a score of "low" concern.

Criterion 2: Impacts on Other Species

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

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

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

Guiding principles

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

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

ALBACORE			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
North Pacific Stock | Northwest Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
South Pacific Stock | Southwest Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
South Pacific Stock | Southwest Pacific | Hand-operated pole-and-lines	5.000	1.000: < 100%	Green (5.000)
South Pacific Stock | South Pacific | Trolling lines	5.000	1.000: < 100%	Green (5.000)
North Pacific Stock | Northeast Pacific | Trolling lines | Canada	5.000	1.000: < 100%	Green (5.000)
North Pacific Stock | Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan	5.000	1.000: < 100%	Green (5.000)
North Pacific Stock | Northwest Pacific | Trolling lines | Japan	5.000	1.000: < 100%	Green (5.000)
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States	5.000	1.000: < 100%	Green (5.000)
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Trolling lines | United States	5.000	1.000: < 100%	Green (5.000)

BIGEYE TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	3.413	1.000: < 100%	Green (3.413)

PACIFIC BLUEFIN TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwest Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
North Pacific | Unassociated purse seine (non-FAD)	5.000	1.000: < 100%	Green (5.000)
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery	5.000	1.000: < 100%	Green (5.000)
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery	5.000	1.000: < 100%	Green (5.000)

SKIPJACK TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	3.413	1.000: < 100%	Green (3.413)
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines	5.000	1.000: < 100%	Green (5.000)
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)	1.000	1.000: < 100%	Red (1.000)

SOUTHERN BLUEFIN TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Southwest Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)

SWORDFISH			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northwestern and Central Pacific Stock | Northwest Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
South Pacific Stock | Southwest Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Northwestern and Central Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	3.413	1.000: < 100%	Green (3.413)
South Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	3.413	1.000: < 100%	Green (3.413)

YELLOWFIN TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	3.413	1.000: < 100%	Green (3.413)
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines	5.000	1.000: < 100%	Green (5.000)
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)	1.000	1.000: < 100%	Red (1.000)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

EASTERN CENTRAL PACIFIC, NORTHEAST PACIFIC | HANDLINES AND HAND-OPERATED POLE-AND-LINES | UNITED STATES			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)

EASTERN CENTRAL PACIFIC, NORTHEAST PACIFIC | TROLLING LINES | UNITED STATES			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTH PACIFIC | UNASSOCIATED PURSE SEINE (NON-FAD)			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Pacific bluefin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)

NORTHEAST PACIFIC | TROLLING LINES | CANADA			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTHWEST PACIFIC | DRIFTING LONGLINES			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Black-footed albatross	1.000: High Concern	1.000: High Concern	Red (1.000)
Leatherback turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Pacific bluefin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Striped marlin	1.000: High Concern	1.000: High Concern	Red (1.000)
Whitetip shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Laysan albatross	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Opah	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Blue marlin	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Blue shark	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Shortfin mako shark	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTHWEST PACIFIC | HANDLINES AND HAND-OPERATED POLE-AND-LINES | JAPAN			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTHWEST PACIFIC | HANDLINES AND HAND-OPERATED POLE-AND-LINES | JAPAN | BLUEFIN FISHERY			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Pacific bluefin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)

NORTHWEST PACIFIC | TROLLING LINES | JAPAN			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)

NORTHWEST PACIFIC | TROLLING LINES | JAPAN | BLUEFIN FISHERY			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Pacific bluefin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)

NORTHWEST PACIFIC, WESTERN CENTRAL PACIFIC | HANDLINES AND HAND-OPERATED POLE-AND-LINES			
SUB SCORE: 3.413	DISCARD RATE: 1.000	**SCORE: 3.413**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Finfish	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Swordfish	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Yellowfin tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

SOUTH PACIFIC | TROLLING LINES			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)

SOUTHWEST PACIFIC | DRIFTING LONGLINES			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Shortfin mako shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Leatherback turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Flesh-footed shearwater	1.000: High Concern	1.000: High Concern	Red (1.000)
Whitetip shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Blue shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Green turtle	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Grey petrel	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Light-mantled albatross	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
White-chinned petrel	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Olive Ridley turtle	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Salvin's albatross	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Striped marlin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Wandering albatross	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Southern bluefin tuna	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Opah	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Black marlin	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Black-browed albatross	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Blue marlin	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)

SOUTHWEST PACIFIC | HAND-OPERATED POLE-AND-LINES			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)

SOUTHWEST PACIFIC, WESTERN CENTRAL PACIFIC | HANDLINES AND HAND-OPERATED POLE-AND-LINES			
SUB SCORE: 3.413	DISCARD RATE: 1.000	**SCORE: 3.413**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Finfish	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Swordfish	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Yellowfin tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

WEST PACIFIC | TROLLING LINES			
SUB SCORE: 5.000	DISCARD RATE: 1.000	**SCORE: 5.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Skipjack tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Yellowfin tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

WEST PACIFIC | UNASSOCIATED PURSE SEINE (NON-FAD)			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Manta ray (unspecified)	1.000: High Concern	1.000: High Concern	Red (1.000)
Whale shark	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Skipjack tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Yellowfin tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

WESTERN CENTRAL PACIFIC | DRIFTING LONGLINES			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Hawksbill turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Leatherback turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Striped marlin	1.000: High Concern	1.000: High Concern	Red (1.000)
Whitetip shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Green turtle	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Olive Ridley turtle	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Black marlin	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Opah	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Bigeye tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Blue marlin	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Blue shark	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Shortfin mako shark	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Yellowfin tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

WESTERN CENTRAL PACIFIC | FLOATING OBJECT PURSE SEINE (FAD)			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Whitetip shark	1.000: High Concern	1.000: High Concern	Red (1.000)
False killer whale	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Green turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Hawksbill turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Olive Ridley turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Rough-toothed dolphin	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Rainbow runner	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Bigeye tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Skipjack tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Yellowfin tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

WESTERN CENTRAL PACIFIC | HANDLINES AND HAND-OPERATED POLE-AND-LINES			
SUB SCORE: 3.413	DISCARD RATE: 1.000	**SCORE: 3.413**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Finfish	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Bigeye tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Skipjack tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Yellowfin tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

Purse seines

Purse seine fisheries incidentally capture non-target species. Bycatch rates are much lower in unassociated fisheries compared to associated fisheries. Bycatch ratios in unassociated sets in the WCPO region are 1.7% and 3% for associated (Dagorn et al. 2012). Unassociated sets tend to have higher bycatch rates of billfish species and can have higher bycatch rates of manta and devil rays (Hall and Roman 2013). Between 2000 and 2007, captures of manta and devil rays ranged between 900 and 3,300 t (Hall and Roman 2013). According to (Restrepo et al. 2017), rays make-up less than 0.1% of the catch by weight. However, most manta and devil rays are listed as "Threatened" or "Near-threatened" under the IUCN (IUCN 2018). Manta and devil ray bycatch in purse seines are not distinguished to the species level, so we have chosen to lump them together. Species such as mahi mahi and wahoo are most typically incidentally captured in associated purse seine sets (Hall and Roman 2013).

The purse seine fishery is thought to have little impact on the sustainability of marine mammals in this region (Molony 2005). In associated fisheries, marine mammals are most often caught during sets made in the western section of the tropical western and central Pacific Ocean, specifically near Papua New Guinea (northeast of EEZ) and the Solomon Islands (northwestern EEZ). Sets made on floating objects (logs, dFADs, FADs, whales and whale sharks) caught the most marine mammals. In most instances, it was not recorded whether marine mammals were alive or dead when returned, but when it was recorded, the majority were alive. Based on the catch per unit effort of incidental catches, less than 3,500 marine mammals are caught per year in the entire purse seine fleet and the mortality rate is estimated to be less than 10% (Molony 2005).

Sea turtle interactions with the purse seine fishery in the western and central Pacific Ocean are not common, with an estimated encounter frequency (1995 to 2007) of 0.1% in FADs and 0.8% in log sets and 0.6% in unassociated sets (Hall and Roman 2013). The most commonly caught sea turtles in associated sets, in descending order, are olive ridley, hawksbill, and green (Hall and Roman 2013). Sea turtle interactions in animal-associated sets are the highest in this region (1.6%), resulting in around 105 captures per year. However the majority are released alive {Hall and Molony 2013}. It is estimated that total turtle captures in the purse seine fishery are 200 per year, with fewer than 20 mortalities (Molony 2005).

There is no information available on bycatch linked with the north Pacific bluefin unassociated purse seine fishery. However, any bycatch of marine mammals, sea turtles, or sharks is likely to be minimal because sets are made on free swimming schools of bluefin tuna. Observer records from the tropical region of the western and central Pacific Ocean suggest most interactions between marine mammals and purse seines occurred during sets made on floating objects. We have included the species identified in this report in the tables below.

The worst scoring species in the associated fishery is silky sharks (due to its status and fishing mortality rates) and whale sharks in the unassociated fishery.

Longlines

North Pacific

In the North Pacific longline fishery that operates in the western and central Pacific region, information on bycatch is limited due to low observer coverage rates (5%), although some fisheries have substantially higher coverage rates. Tunas, billfish, other fish, sharks, sea birds, sea turtles and marine mammals have been reported as bycatch species in these longline fisheries (OFP 2010). According to observer records north of 10°N, the majority of tuna species are kept, although skipjack tuna had a discard rate of 35% between 1994 and 2009. Swordfish are the most commonly discarded billfish species (44%), while blue and black marlin are primarily retained. Discard rates for sharks in the North Pacific are very high for the majority of species (OFP 2010). Laysan and black-footed albatross are incidentally captured in the North Pacific region, where they have a high breeding and non-breeding overlap with longline fisheries {Clarke et al. 2013} {ACP 2008}. The area of most concern for seabird interactions in this region is between 20° to 40° N. Information on bycatch of sea turtles in the North Pacific longline fishery is limited {Work and Balazs 2002}. The majority of sea turtles are observed caught in the tropical longline fisheries outside of the North Pacific region (Molony 2005).

South Pacific

In the South Pacific, information on bycatch interactions is available through observer programs, primarily from those of Australia and New Zealand as well as from Marine Stewardship Council (MSC) assessments for several fisheries (i.e., Fiji and Cook Islands). Seabird interactions with pelagic longline gear are mostly recorded in EEZ waters in the South Pacific around New Zealand and Australia between 20° to 50° S {Clarke et al. 2013}, (Baker and Wise 2005), {Baker and Finley 2008}, {Anderson et al. 2011}. A recent study in the South Pacific New Zealand longline fishery suggested total estimated annual potential seabird fatalities is 6,275 birds (Abraham et al. 2017). Observers often have a difficult time identifying birds to species level, so estimates based on observer data may under-report interactions (Molony 2005). The majority of sea turtles are observed caught in the tropical longline fisheries that occur west of 180° and interaction rates are much lower than in other ocean basins (Clarke et al. 2014). Marine mammal interactions and associated mortality rates with the South Pacific albacore tuna longline fishery are reported to be very low (Molony 2005).

Western and Central Pacific

In the western and central Pacific (WCPO) longline fishery, tunas, billfish, other fish, sharks, seabirds, sea turtles and marine mammals are incidentally caught as bycatch. Discard rates of these species vary from only 5% for tunas to 96% for sea turtles (OFP 2010), (OFP 2012a).

<u>Sharks</u>

Common shark species include blue, shortfin mako, silky, and oceanic whitetip sharks (ISC 2017b) (Clarke et al. 2018) (ISC 2018c) (Rice and Harley 2012b). Blue sharks represented 19.5%, silky shark 3.5%, mako sharks 2.2%, and oceanic whitetip sharks 1.4% of the total observed catch between 1994 and 2009 (OFP 2010).

Seabirds

An ecological risk assessment of seabirds in the WCPO indicated that populations of ten species (combined) of large and small albatross and petrels were most likely to be impacted by bycatch in longline fisheries operating in this region, primarily in the northern and southern regions, rather than the equatorial regions (separated in this report) (Waugh et al. 2012). Observer data from the region indicate a total of 991 seabirds caught in the WCPO region from 2007 to 2016, with black-footed and black-browed albatross as the two most commonly caught species (Peatman et al. 2017).

Sea Turtles

The majority of sea turtles are observed caught in the tropical longline fisheries that occur west of 180°, with the highest catch rates occurring in the tropical, shallow longline fishery {Wallace et al. 2013b} (Wallace et al. 2010). The majority of these are released alive, compared to the tropical, deepwater longline fishery, where most turtles are returned dead (Molony 2005). Overall between 4,000 and 15,000 turtles (all species) are estimated to have been caught annually by these longline fisheries. Mortality rates for sea turtles are low, less than 26% in all years and total annual mortalities for all turtle species ranged from 500 to 3,000 between 1980 and 2004 (Molony 2005).

Marine Mammals

Marine mammal catch rates are very low, although in general the tropical, shallow longline fishery has the highest catch rates. Observer records from 1980 to 2004 indicated many years where no marine mammal interactions with longline fisheries occurred. However, when observer estimates were extrapolated out to the entire fishery (not just the proportion observed), up to 2,200 marine mammal interactions are estimated to occur per year {Molony 2005} (Molony 2007). Between 2000 and 2004, both catch and mortality rates of marine mammals declined. In general, less than 200 marine mammal mortalities were estimated to have occurred between 2000 and 2004 {Molony 2005} (Molony 2007). There were 22 reported interactions between the US longline fishery and marine mammals between 2015 and 2016, mostly involving false killer whales (59%) (NOAA 2018).

Pole and line, Trolling Line, and Handline Fisheries

Bycatch in troll and pole fisheries is generally very low (Kelleher 2005). Bycatch may consist of other tunas, billfish, other fish, and sharks, but not in large amounts (e.g., less than 5% of the total catch for an individual species). Although baitfish are used in this fishery, the ratio of tuna to baitfish is around 30:1. In addition, baitfishing typically makes up only a small proportion of the total fishing effort on bait species (Gillett 2012). For these reasons, baitfish species are not included in this report.

We have only included the two target species, skipjack and yellowfin tuna, as well as bigeye tuna. Although a small percentage of the catch is bigeye, this fishery accounts for more than 5% of the total mortality of bigeye tuna throughout the WCPO, which is considered sufficient for inclusion as a "main species" in Criterion 2.

The yellowfin handline and hand-operated pole-and-line fisheries target yellowfin tuna, bigeye tuna, and

skipjack tuna. Other small tuna species and billfish, including swordfish (which is covered in this report), may be caught in handline fisheries. Swordfish may make up 3 to 5% of the catch in some areas (e.g., Vietnam). Handline and hand-operated pole-and-lined catches of bigeye tuna in the WCPO make up approximately 8% of the total catch of bigeye in the region and pole and line fisheries comprise approximately 11% of the skipjack tuna catch (WCPFC 2020). We have therefore assessed swordfish in the yellowfin targeted handline fishery, but have also considered and rated the impact of the fishery on other assorted finfish species. We have also rated bigeye tuna and skipjack tuna in the hand-operated pole-and-line fisheries.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

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

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Black marlin

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Moderate Concern

No assessment for black marlin has been conducted in the western and central Pacific Ocean. The International Union for Conservation of Nature (IUCN) has classified this species as "Data Deficient" with an unknown population trend (Collette et al. 2011b). Black marlin have a medium vulnerability to fishing (PSA=3.18 see detailed section below). We have awarded a score of "moderate" concern because abundance is unknown and they have a medium vulnerability to fishing.

Justification:

Average age at maturity	Unknown	*N/A*
Average maximum age	11 years {Sun et al. 2015a}	2
Fecundity	11,000,000 {Sun et al. 2015b}	1
Average maximum size (fish only)	400 cm (Sun et al. 2015a)	3
Average size at maturity (fish only)	209 cm {Sun et al. 2015b}	3
Reproductive strategy	Broadcast spawner	3
Trophic level	4.5 (Froese and Pauly 2018)	1
Productivity score		2.17

Susceptibility Attribute	**Relevant Information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap (Considers all fisheries)	There is areal overlap with black marlin	3
Vertical overlap (Considers all fisheries)	There is vertical overlap with black marlin	3
Selectivity of fishery (Specific to fishery under assessment)	Black marlin are selective to the fishery	2

Post-capture mortality (Specific to fishery under assessment)	Information on post-capture mortality is limited	3

Susceptibility score = 2.325

PSA Score = 3.178

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Moderate Concern

No stock assessment has been conducted for black marlin in the western and central Pacific Ocean (WCPO), but there is information on catches and discard rates from observer programs. The International Union for Conservation of Nature (IUCN) notes that this species could be threatened by capture in longline fisheries, but fishing mortality rates in the WCPO are not available (Collette et al. 2011b). Reported catches of black marlin in longline fisheries in the WCPO ranged from 1,172 t to 2,734 t between 2000 and 2016 (WCPFC 2017). These catches represent between 3% and 7% of the total longline catch of billfish during this time (OFP 2018). Forty-five percent of black marlin were discarded between 1992 and 2009 and of these 60% were dead in the south Pacific albacore fishery. Discard rates in the tropical longline fishery ranged from 0 to 6%, with a mortality rate of 35-73% (OFP 2010). We have awarded a score of "moderate" concern because fishing mortality rates are unknown and the species suffers high discard mortality rates.

Black-browed albatross

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines

Low Concern

The International Union for Conservation for Nature (IUCN) has classified black-browed albatross as "Least Concern" with an increasing population trend (BirdLife International 2018a). This is a change from previous designations as "Near Threatened" with a decreasing population trend (BirdLife International 2018a). The total population of mature birds is estimated to be 1,400,000 {Birdlife International 2018a}. The status in the western and central Pacific Ocean is unknown. We have awarded a score of "low" concern based on the population size and trend.

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

Moderate Concern

Interactions between black-browed albatross and the South Pacific albacore tuna fishery, although

low in number, have been reported and the species is considered at medium to high risk of bycatch in western and central Pacific and New Zealand longline fisheries; {Waugh et al., 2012} and (Rowe 2013) considered it moderate-to-high risk in New Zealand fisheries. Management measures have been adopted by most fleets to mitigate the incidental capture of seabirds in longline fisheries operating in the South Pacific region of the western and central Pacific Ocean (Clarke et al. 2014). We have therefore awarded a score of "moderate" concern.

Justification:
From 1980 to 2004, 22 black-browed albatross interactions with pelagic longline gear were observed south of 31°S (Molony 2005). Between 1992 and 2009, 95% of black-browed albatross captured in the albacore South Pacific longline fishery were discarded and of those 71% were dead (Molony 2005). Observer data collected from the WCPO region between 2007 and 2016 indicated 79 black-browed albatross were observed to be incidentally captured (Peatman et al. 2017).

Black-footed albatross

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines

High Concern
According to the International Union for Conservation of Nature (IUCN), black-footed albatross is classified as "Near Threatened" with a stable to increasing population trend (BirdLife International 2017b) (Arata et al. 2009). The breeding season population is estimated to be 69,404 pairs (ACAP 2012). Despite the stable/increasing population, the "Near Threatened" IUCN status and high vulnerability to fishing interactions leads to a Seafood Watch score of "high" concern.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines

High Concern
Black-footed albatross is one of the more commonly observed bird species in the western and central Pacific Ocean (WCPO) with interactions primarily occurring in the North Pacific longline fisheries (BirdLife International 2017b). Some studies have suggested the mortality associated with North Pacific tuna longline fisheries may threaten black-footed albatross. We have awarded a score of "high" concern because seabirds are considered highly vulnerable and their stock status is of high concern; current mortality rates are unknown but could be high and have population level impacts.

Justification:
The population could probably sustain a maximum mortality rates of 10,000 to 12,000 birds per year but mortality from pelagic longline fisheries may exceed this {Lewison and Crowder 2003} (Crowder and Myers 2001) {Arata and Naughton 2009}. From 1992 to 2009, 100% of black-footed albatross caught in longline fisheries north of 10°N were discarded dead (OFP 2010). The total estimated mortality of this species in the central north Pacific between 1994 and 2000 ranged

from 5,200 to 13,800 birds (Gilman 2001). Observer data collected from the WCPO region between 2007 and 2016 indicated 247 black-footed albatross were observed to be incidentally captured (Peatman et al. 2017). Reducing sea-bird interactions in this region could improve their IUCN listing status.

Blue marlin

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Low Concern
The International Union for Conservation of Nature (IUCN) has classified blue marlin as "Vulnerable" with a decreasing population trend (Collette et al. 2011c). The most recent population assessment in the Pacific Ocean was completed in 2016. There have been long-term declines in the stock biomass over time. The population has declined around 40% from virgin levels in 2014. Despite this decline the female biomass is 25% above sustainable levels (SSB_{MSY}); therefore, blue marlin are not overfished (ISC 2016) and we have awarded a score of "low" concern.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Low Concern
The last assessment for blue marlin was conducted in 2016. Fishing mortality rates (F = 0.28) estimated in this assessment are currently below levels needed to produce the maximum sustainable yield (F_{MSY} = 0.32). Based on these results, blue marlin are currently not subject to overfishing (ISC 2016). We have therefore awarded a score of "low" concern.

Blue shark

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Low Concern
An updated assessment of blue sharks in the North Pacific was completed during 2017. According to this assessment, the population of blue sharks in the North Pacific has increased since the lowest levels between 1990 and 1995 to near series highs in recent years (ISC 2017b). The female

spawning biomass is estimated to be 71% above sustainable levels (SB_{2015}/SB_{MSY}) (ISC 2017b). This indicates that the population is not overfished and we have therefore awarded a score of "low" concern.

Southwest Pacific | Drifting longlines

High Concern

A stock assessment for blue sharks in the southern Pacific was conducted in 2016 (Takeuchi et al. 2016). However, due to a lack of data, poor model fit and high uncertainty, the authors do not recommend that management decisions rely on the stock status estimates (Takeuchi et al. 2016). Assessments are based on tagging data, differences in abundance, and evidence of pregnant females in high latitudes (in both the North and South Pacific Ocean). The population in the South Pacific is likely a separate population from the North Pacific (Kleiber et al. 2009). The International Union for the Conservation of Nature (IUCN) considers blue sharks to be "Near Threatened" globally (Stevens 2009). We have awarded a score of "high" concern based on the "Near Threatened" IUCN status and high inherent vulnerability of sharks to fishing.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Low Concern

Blue sharks are widely distributed throughout the North Pacific and dominate shark catches in that region. According to the 2017 updated assessment, the fishing mortality rate estimated in recent years ($F_{2012-2014}$) was around 37% of that needed to produce the maximum sustainable yield (F_{MSY}) (ISC 2017b). Therefore overfishing is not occurring and we have awarded a score of "low" concern.

Southwest Pacific | Drifting longlines

High Concern

Blue sharks are widely distributed throughout the Western and Central Pacific Ocean including in the South Pacific region. A stock assessment for blue sharks in the southern Pacific was conducted in 2016 (Takeuchi et al. 2016). However, due to a lack of data, poor model fit and high uncertainty, the authors do not recommend that management decisions rely on the stock status estimates (Takeuchi et al. 2016). Some trends in catch rates for various fisheries have been analyzed. We have awarded a score of "high" concern because there is little information on fishing mortality, they are highly susceptible to longline capture, and there are no management measures in place.

Justification:

In the South Pacific, catch rates declined until 2003 and have since increased to mid-1990's levels. There has been no trend in the size or sex of blue sharks in any part of the WCPO over time (Walsh et al. 2009) (Clarke 2011). Some information on catch levels is available. The estimated average annual longline catches between 1992 and 2009 was 1,611 t (Lawson 2001) (Clarke 2011), and from 1992 to 2009, blue sharks made up 10% of the total bycatch in the South Pacific albacore tuna longline fishery {OPF 2010}. During this time period, 30% of blue sharks were observed discarded in this fishery and of those only 7% were dead (OFP 2010).

False killer whale

Factor 2.1 - Abundance

Western Central Pacific | Floating object purse seine (FAD)

High Concern

The International Union for Conservation of Nature (IUCN) considers false killer whales to be a "Data Deficient" species with an unknown population trend (Taylor et al. 2008). Population estimates are 16,000 from the coast of China and Japan (Miyashita 1993) (Barlow 2006). There are three populations of false killer whales in Hawaiian waters, a pelagic population, a Main Hawaiian Islands population, and a population at the northwestern Hawaiian Islands, with a combined estimated population size of 1,667 (NOAA 2017). We have awarded a score of "high" concern because the status is unknown in the western and central Pacific Ocean and they have a high inherent level of vulnerability to fishing.

Factor 2.2 - Fishing Mortality

Western Central Pacific | Floating object purse seine (FAD)

Low Concern

From 2007 through 2009, 216 false killer whales were observed caught on 42 sets. The overall mortality rate was 51% and based on these observations it was estimated that 239 animals were killed throughout the fishery during 2009. During 2010, 47 animals were observed caught during 18 sets with a mortality rate of 28%, indicating a total mortality rate of 25 for the entire fishery during 2010. From 2007 to 2009, 37% of toothed whales, including false killer whales, were caught on FAD sets, 20% on natural log sets and 16% on drifting FADs (OFP 2012b). During 2010, these percentages were 6%, 29%, and 50% respectively (OFP 2012b). The purse seine fishery is thought to have little impact on the sustainability of marine mammals, including false killer whales, in this region (Gascoigne 2015) (Molony 2005) (Taylor et al. 2008); therefore, we have awarded a score of "low" concern.

Finfish

Factor 2.1 - Abundance

Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Western Central Pacific | Handlines and hand-operated pole-and-lines

Moderate Concern

Handline fisheries that target yellowfin tuna and swordfish also capture several small tuna species,

such as bullet and kawakawa. We have awarded a score of "moderate" concern based on the Seafood Watch Unknown Bycatch Matrix for finfish species.

Factor 2.2 - Fishing Mortality

Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern
According to the Seafood Watch Unknown Bycatch Matrix, finfish score as "low" concern for fishing mortality in handline fisheries.

Flesh-footed shearwater

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines

High Concern
According to the International Union for Conservation of Nature (IUCN), flesh-footed shearwater are classified as "Near Threatened," with a decreasing population trend (BirdLife International 2017c). This is a change from the previous "Least Concern" IUCN status (BirdLife International 2012). The change in classification is due to the realization that previous estimates were too high and the current population is substantially smaller, with 74,000 breeding pairs (Lavers 2014). We have awarded a score of "high" concern due to the IUCN classification.

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

High Concern
Flesh-footed shearwaters have a large range and subsequently a large overlap with this fishery. High bycatch rates have been observed in the Australian Eastern Tuna and Billfish Fishery and this species is the third most at-risk species in New Zealand fisheries (Baker and Wise 2005), {Richard and Abraham 2013}. This species has a high susceptibility to the fishery and fishing mortality rates are unknown. Mitigation measures have been adopted by many fleets in the southwest Pacific Ocean (Clarke et al. 2014), but compliance is often lacking (WCPFC 2017b) (WCPFC 2016). Therefore, we have awarded a score of "high" concern.

Justification:
Flesh-footed shearwaters appear to be incidentally caught in pelagic longline fisheries operating in the South Pacific (BirdLife International 2017c). For example, between 1980 and 2004, 124 flesh-footed shearwater interactions with pelagic longline gear were observed in waters south of 31°S (Molony 2005). From 1992 to 2009, 92% of flesh-footed shearwaters captured in the albacore

South Pacific longline fishery were discarded and of those 85% were dead (OFP 2010). Observer data collected from the WCPO region between 2007 and 2016 indicated 8 flesh-footed shearwaters were observed to be incidentally captured (Peatman et al. 2017).

Green turtle

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)

High Concern
The International Union for Conservation of Nature (IUCN) has classified green sea turtles worldwide as "Endangered" with a decreasing population trend (Seminoff 2004). Wallace et al. identified the Northwest Pacific Regional Management Unit (RMU) of green sea turtles as at high risk of population decline, but with low threats (i.e., combination of bycatch, take, coastal development, pollution/pathogens and climate change) (Wallace et al. 2011) (Wallace et al. 2013). The southwest Pacific RMU had low risk, but high threats, while the Coral Triangle had high risk and high threats and a critical need for data. Finally, the West Central Pacific RMU had low risk and low threats. (Wallace et al. 2011). We have awarded a score of "high" because more than one RMU is at high risk of population decline and some have high threat levels.

Justification:
Green sea turtles have been listed in the Convention on International Trade of Endangered Species (CITES) since 1975, and are currently listed as CITES Appendix 1, meaning they are threatened with extinction and international trade is prohibited. The mean annual number of nesting turtles worldwide have decreased between 48% to 67% over the past 100 to 150 years (Seminoff 2004). Out of 27 known nesting sites in Oceania, 3 had an increasing trend, 2 had decreasing trends, and 2 had stable trends, and trends at the remaining sites were unknown (Maison et al. 2010).

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Moderate Concern
The incidental capture of green sea turtles is considered a major threat to their populations worldwide (Seminoff 2004). Although green sea turtles are one of the more commonly caught turtle species in the South Pacific region (Williams et al. 2009), the impact from bycatch to the population is low in the south central Pacific and western and central Pacific Ocean and those populations are considered to be at low risk (Wallace et al. 2011) {Wallace et al. 2013b} (Wallace et al. 2010). Bycatch mitigation methods have been adopted by the Western and Central Pacific Fisheries Commission, but their use and effectiveness is unknown and there are issues with compliance (Clarke et al. 2014). Also, bycatch monitoring and reporting is very low in much of this region We have awarded a score of "moderate" concern because bycatch in this fishery does not appear to be

threatening the population, but impacts are not fully known.

Western Central Pacific | Floating object purse seine (FAD)

Low Concern

The incidental capture of sea turtles during purse seine sets is very low in the WCPO. The three most common species, in descending order, are olive ridley, hawksbill and green (Hall and Roman 2013). We have awarded a score of "low" concern due to the low interaction rates between FAD sets and green sea turtles, which suggests that FAD purse seines may not be a substantial contributor to green sea turtle fishing mortality in tuna fisheries in the WCPO.

Justification:

The encounter rate in purse seine fisheries ranges from 0% to 1.6%, being highest in animal associated sets, followed by log sets (0.8%) (Williams et al. 2009) (Hall and Roman 2013). Between 1990 and 2004, only 5 green sea turtles, 8 hawksbill, and 10 olive ridley sea turtles were observed caught (average observer coverage rate between 1995 and 2004 was 3.6%), as were 80 additional unidentified sea turtles (Molony 2005). It is estimated that fewer than 20 sea turtle moralities occur per year in purse seine fisheries operating in the WCPO (Molony 2005). Other studies have indicated that although the observer coverage is higher than in other fisheries, it is not high enough to produce good estimates of total sea turtle encounters in the region (Williams et al. 2009).

Grey petrel

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines

High Concern

The International Union for Conservation of Nature (IUCN) classifies grey petrels as "Near Threatened" with a decreasing population trend (BirdLife International 2017d). The global population is estimated to be 80,000 pairs worldwide {BirdLIfe International 2017d}. We have awarded a score of "high" concern to account for the IUCN rating.

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

Moderate Concern

Between 1980 and 2004, 126 grey petrel interactions with pelagic longline gear were observed, primarily south of 31°S (Molony 2005), and from 1992 to 2009 100% of incidentally capture grey petrels in the south Pacific albacore tuna fishery were discarded and all of them were dead (OFP 2010). In New Zealand waters of the South Pacific, it has historically been one of the most commonly killed bird species in the tuna longline fishery, with estimates of 45,000 birds being caught during a the 1980s and 1990s {BirdLIfe International 2017d}. However, New Zealand has implemented the use of several bycatch mitigation measures in tuna fisheries (NZG 2018). Incidental mortality in fisheries off the coast of Australia have also been reported (BirdLife International

2017d). We have awarded a score of "moderate" concern because, although bycatch has been reduced in New Zealand waters, information gaps in other areas suggest that this species should remain a "moderate" concern.

Hawksbill turtle

Factor 2.1 - Abundance

Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)

High Concern
The International Union for Conservation of Nature (IUCN) has classified hawksbill turtles as "Critically Endangered" with a decreasing population trend (Mortimer and Donnelly 2008). The North Central, West Central and West Pacific hawksbill RMUs are at a high risk of population decline with high threats (Wallace et al. 2011) (Wallace et al. 2013). Hawksbill turtles have been listed in CITES since 1977 and are currently listed in CITES Appendix 1, meaning they are threatened with extinction and international trade is prohibited. It has been estimated that populations in the Pacific Ocean have declined by over 75% over three generations (Mortimer and Donnelly 2008). In the Western Pacific, 7 out of 10 nesting locations have depleted or declining populations (Mortimer and Donnelly 2008). We have awarded a score of "high" concern based on the IUCN listing and because more than one RMU is at high risk with high threats.

Factor 2.2 - Fishing Mortality

Western Central Pacific | Drifting longlines

High Concern
Interactions between hawksbill turtles and pelagic longline gear in the Western and Central Pacific Ocean (WCPO) do occur but do not appear to be frequent in nature. Recorded interactions are more frequent in tropical and subtropical waters compared to temperate (Williams et al. 2009). Between 1980 and 2004, only 12 hawksbill turtles were observed incidentally caught in tuna longline fisheries in the WCPO (Molony 2005), although mortality rates associated with this capture are high (OFP 2010). A meta data analysis indicated this population had a high risk but low bycatch impact {Wallace et al. 2013b}. Bycatch mitigation measures are being used by some fleets, but there are issues with compliance (WCPFC 2016). We have awarded a high concern score because the population is depleted, the fishery impact is not fully known, and mitigation methods may not be effective.

Western Central Pacific | Floating object purse seine (FAD)

Low Concern
The incidental capture of sea turtles during purse seine sets is very low in the WCPO. The three most common species, in descending order, are olive ridley, hawksbill and green (Hall and Roman 2013). We have awarded a score of "low" concern due to the low interaction rates between FAD sets and hawksbill sea turtles, which suggests that FAD purse seines may not be a substantial contributor

to hawksbill sea turtle fishing mortality in tuna fisheries in the WCPO.

Justification:
The encounter rate in purse seine fisheries ranges from 0% to 1.6%, which is highest in animal-associated sets, followed by log sets (0.8%) (Williams et al. 2009) (Hall and Roman 2013). Between 1990 and 2004 only 5 green sea turtles, 8 hawksbill and 10 olive ridley sea turtles were observed caught (average observer coverage rate between 1995 and 2004 was 3.6%), as were 80 additional unidentified sea turtles (Molony 2005). It is estimated that fewer than 20 sea turtle moralities occur per year in purse seine fisheries operating in the WCPO (Molony 2005). Other studies have indicated that although the observer coverage is higher than in other fisheries, it is not high enough to produce good estimates of total sea turtle encounters in the region (Williams et al. 2009).

Laysan albatross

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines

High Concern
The International Union for Conservation of Nature (IUCN) lists the Laysan albatross as "Near Threatened" but with a stable population trend (BirdLife International 2017e). Globally, there are an estimated 800,000 breeding pairs or 1.6 million mature birds (Arata et al. 2009). We have awarded a score of "high" concern due to the IUCN listing.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines

Moderate Concern
Laysan albatross have a very high overlalp within the northern region of the western and central Pacific Ocean (ACAP 2010). Pelagic longline vessels fishing in the North Pacific Ocean may kill around 8,000 laysan albatross a year, although in recent years these numbers have been reduced due to the use of mitigation measures (BirdLife International 2017e). Between 1992 and 2009, 100% of incidentally captured Laysan albatross from the North Pacific albacore tuna fishery were discarded and of these 67% were dead (OFP 2010). Observer data collected from the WCPO region between 2007 and 2016 indicated 77 laysan albatross were observed to be incidentally captured (Peatman et al. 2017). We have awarded a score of "moderate" concern because fishing mortality rates are unknown but there are mitigation measures in place (Clarke et al. 2014).

Leatherback turtle

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines

Southwest Pacific | Drifting longlines

Western Central Pacific | Drifting longlines

High Concern

Leatherback sea turtles have been listed as "Endangered" by the United States Endangered Species Act (ESA) since 1970 {FR 1970}. The International Union for Conservation of Nature (IUCN) classified leatherback turtles as "Vulnerable" with a decreasing population trend in 2000 {Wallace 2013}. Wallace et al. identified the West Pacific leatherback RMU to be at a high risk of population declines (Wallace et al. 2010) (Wallace et al. 2011) (Wallace et al. 2013). Leatherback turtles have been listed in the Convention on International Trade in Endangered Species (CITES) since 1975 and are currently listed on CITES Appendix 1, meaning they are threatened with extinction and international trade is prohibited. Over the past 25 years the population of leatherbacks in the Pacific Ocean has decreased significantly (Wallace et al. 2013). Recent estimates from the eastern and western central Pacific Ocean suggest a population size of 294,068 turtles and out of these 6,199 are adults (Jones et al. 2012). We have awarded a score of "high" concern based on the ESA, IUCN and CITES listings and RMU status.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines

Southwest Pacific | Drifting longlines

Western Central Pacific | Drifting longlines

High Concern

Fishing mortality is thought to be a major threat to leatherback turtles, especially for juveniles and adults that can be incidentally captured in fisheries along their migration routes (Wallace et al. 2013) (Zug and Parham 1996) (Roe et al. 2014). The available data in the Western and Central Pacific Ocean are spotty, due to low reporting by some nations and low observer coverage. In addition, due to this low reporting, there is a high amount of uncertainty surrounding current estimates (Brouwer and Bertram 2009) (Williams et al. 2009). Some fleets within the WCPO have adopted management measures to aid in reducing the incidental capture of sea turtles but others have not complied with mandated bycatch mitigation methods (WCPFC 2016). We have awarded a score of "high" concern because the population is depleted, bycatch mortality appears to be a factor in this depletion, and management measures may not be currently effective.

Justification:

Interactions with leatherbacks are typically higher in sub-tropical and temperate areas (Williams et al. 2009). For example, a recent study indicated that nesting leatherback turtles have a high risk of bycatch in several areas within the North and Central Pacific Ocean (Roe et al. 2014). Other research has estimated that leatherback turtles suffer a 12% annual mortality rate from pelagic longline fisheries in the WCPO and based on these estimates, bycatch mortality in longline fisheries, along with other factors such as coastal mortality, should be reduced to avoid extinction (Kaplan 2005). Other estimates suggest 20,000 leatherback turtles were caught in longlines throughout the entire Pacific Ocean during 2000, with 1,000 to 3,200 of these being killed as a result. These results also suggest that continued bycatch in longline fisheries will have major consequences for leatherback turtles in the Pacific Ocean and that the mortality threshold for this species in the Pacific may have been exceeded {Lewison et al. 2004}. Other analyses have suggested leatherback turtles have a high

population risk but low bycatch threat throughout the western Pacific Ocean {Wallace et al. 2013}.

Light-mantled albatross

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines

High Concern

The International Union for Conservation of Nature (IUCN) classifies light-mantled albatross as "Near Threatened" with a decreasing population trend (BirdLife International 2018). The total breeding population is estimated to be 19,000 to 24,000 pairs or about 58,000 individuals (BirdLife International 2018). We have awarded a score of "high" concern based on the IUCN listing.

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

Moderate Concern

Specific longline fleets in the South Pacific that have reported this species as incidentally caught (in small amounts) in tuna fisheries include New Zealand and Australia (BirdLife International 2018) (ACAP 2009). Unfortunately, the information quality is low. The species is at high-to-medium risk in longline fisheries despite mitigation measures adopted by New Zealand (Waugh et al. 2012). Interactions are infrequent, breeding areas have all adopted bycatch avoidance methods since 2000 and the majority of its foraging range is within the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) region (ACAP 2009). However, they have a medium-to-high susceptibility to bycatch and given their small population numbers, bycatch impacts to the population could be high, so we have awarded a score of "moderate" concern.

Justification:

Between 1980 and 2004, 38 interactions between light-mantled albatross and pelagic longline gear, primarily south of 31°S, were observed (Molony 2005) and from 1992 and 2009, 100% of light-mantled albatross were discarded dead in the South Pacific albacore tuna fishery (OFP 2010).

Loggerhead turtle

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

High Concern

The International Union for Conservation of Nature (IUCN) classified loggerhead turtles in the North Pacific Regional Management Unit (RMU) as "Least Concern" with an increasing population trend

{Casale and Matsuzawa 2015}, and loggerheads in the South Pacific RMU as "Critically Endangered" with a decreasing population trend. Wallace et al. identified the North Pacific RMU of loggerhead sea turtles as among the 11 most endangered sea turtle RMUs in the world, and that loggerheads are at a high risk of population declines and have high threat levels in the North and South Pacific Ocean (Wallace et al. 2010) (Wallace et al. 2011). Loggerheads are listed in Appendix 1 of the Convention on International Trade in Endangered Species (CITES). In the North Pacific Ocean, loggerheads have been listed as "Endangered" on the United States Endangered Species Act list since 1978 (FR 2011). We have therefore awarded a score of "high" concern.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

High Concern
The incidental capture of loggerhead turtles has historically been considered a primary threat to their populations (Casale and Tucker 2017). Juvenile loggerheads are susceptible to bycatch in the North Pacific region, especially by shallow-set longline fisheries targeting swordfish {Lewison and Crowder 2003}. However, data related to incidental captures is typically scarce due to low reporting by some countries and low observer coverage rates (~1%) (Brouwer and Bertram 2009) (Williams et al. 2009). Some estimates, based on extrapolation from data sets, from the entire Pacific Ocean suggested that 67,000 loggerhead sea turtles were incidentally captured throughout the Pacific Ocean during 2000 and of these, 2,600 to 6,000 were killed by this incidental capture. Based on these estimates, it is possible their mortality threshold was exceeded in this region {Lewison et al. 2004}. Other studies from the Pacific Ocean suggest there is a low impact from bycatch but high risk to the population (Wallace et al. 2011) (Clarke et al. 2014). Bycatch mitigation methods are mandated by the Western and Central Pacific Fisheries Commission, but their effectiveness is unknown and there are issues of compliance with these measures (Clarke et al. 2014). We have therefore awarded a score of "high" concern.

Manta ray (unspecified)

Factor 2.1 - Abundance

West Pacific | Unassociated purse seine (non-FAD)

High Concern
There are eleven species of manta/devil rays. The giant devil ray is considered "Endangered" by the International Union for the Conservation of Nature (IUCN) (Notarbartolo di Sciara 2015), and the spinetail devil ray, *Mobula munkiana*, longhorned pygmy devil ray, and bentfin devil ray are considered "Near Threatened" (White et al. 2006) (Bizzaro et al. 2006) (Pierce and Bennet 2003) (Walls et al. 2016). The giant manta ray, reef manta ray, and sicklefin devil ray, are considered "Vulnerable" by the IUCN (Marshall et al. 2018a) (Marshall et al. 2018b) (Pardo et al. 2016). Species specific information on manta/devil ray bycatch in the western and central Pacific purse seine fisheries is lacking, but information from the eastern Pacific indicates giant manta,

Munk's devil ray, spinetail mobula, and smoothtail mobula are incidentally captured (Hall and Roman 2013). We have awarded a score of "high" concern based on IUCN status.

Factor 2.2 - Fishing Mortality

West Pacific | Unassociated purse seine (non-FAD)

High Concern
Manta/devil rays are among the most common ray species incidentally captured in purse seine fisheries (Hall and Roman 2013) (Croll et al. 2015). They are most commonly captured in unassociated sets (Hall and Roman 2013). Overall this bycatch is considered low in this fishery, but the cumulative impacts of fishing pressure are a conservation concern for these species (Croll et al. 2015). Therefore, we have awarded a score of "high" concern. Each individual fishery's contribution is unknown and likely low. However, the unassociated purse seine fishery in the WCPO collectively could be a substantial contributor to fishing mortality of mobulids (due to the high vulnerability of the taxon).

Olive Ridley turtle

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)

High Concern
The International Union for Conservation of Nature (IUCN) considers Olive Ridley sea turtles to be "Vulnerable" globally with a decreasing population trend {Abreu-Grobis and Plotkin 2008}. Olive Ridley turtles have been listed as "Threatened" on the United States Endangered Species Act (ESA) since 1978 (FR 1978). Overall, in the western and central Pacific Ocean there has been a decrease in annual nesting females of 92%, from 1,412 to 108 {Abreu-Grobis and Plotkin 2008}. More recent information by Wallace et al., however, shows that the West Pacific olive ridley sea turtle RMU is at low risk of population decline but has high threats (Wallace et al. 2010) (Wallace et al. 2011). Despite historic declines, they are highly abundant and largely stable (B. P. Wallace, personal communication). We have awarded a score of "high" concern, however, because abundance is unknown, and sea turtles are highly vulnerable to the effects of fishing mortality.

Justification:
Along several beaches in Thailand, current estimates of the number of nests/km/day are around 20, while in Indonesia this number is 230. It is estimated that the annual nesting sub-population on these Thai beaches has decreased from 97 to 98% over time, while in Indonesia they have increased substantially.

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

Western Central Pacific | Drifting longlines

Moderate Concern

The incidental capture of olive ridley turtles occurs worldwide, although the impact from other fisheries such as trawls and gillnets appear to have a larger negative impact compared to longlines {Wallace et al. 2013b} (Abreu-Grobois and Plotkin 2008). Data related to incidental captures is scarce due to low reporting by some countries and low observer coverage rates (~1%) (Brouwer and Bertram 2009) (Williams et al. 2009). However, bycatch of olive ridleys is reported to be especially high in some albacore fisheries operating in the South Pacific region (Huang 2014) but not others (Akroyd et al. 2017). Bycatch is a high threat to the West Pacific RMU, although the population currently is at low risk of population declines (Wallace et al. 2011). Bycatch mitigation methods have been put into place by some fisheries operating in the Western and Central Pacific Fisheries Commission, but there are issues with compliance and the effectiveness of these measures is unknown (Clarke 2013). We have awarded a score of "moderate" concern because population is not at high risk of decline, but threats to the RMU are high.

Western Central Pacific | Floating object purse seine (FAD)

Low Concern

The incidental capture of sea turtles during purse seine sets is very low in the WCPO. The three most common species, in descending order are olive ridley, hawksbill and green (Hall and Roman 2013). The encounter rate in purse seine fisheries ranges from 0% to 1.6%, being highest in animal associated sets, followed by log sets (0.8%) (Williams et al. 2009) (Hall and Roman 2013). Between 1990 and 2004, only 5 green sea turtles, 8 hawksbill and 10 olive ridley sea turtles were observed caught (average observer coverage rate between 1995 and 2004 was 3.6%), as were 80 additional unidentified sea turtles (Molony 2005). It is estimated that fewer than 20 sea turtle mortalities occur per year in purse seine fisheries operating in the WCPO (Molony 2005). Other studies have indicated that although the observer coverage is higher than in other fisheries, it is not high enough to produce good estimates of total sea turtle encounters in the region (Williams et al. 2009). We have awarded a score of "low" concern due to the low interaction rates between FAD sets and olive ridley turtles, which suggests that FAD purse seines may not be a substantial contributor to olive ridley sea turtle fishing mortality in tuna fisheries in the WCPO.

Opah

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Moderate Concern

The status of opah in the western and central Pacific Ocean is unknown. Opah have a medium vulnerability to fishing based on the SFW productivity and susceptability table (PSA=2.73 see detailed section). We have awarded a score of "moderate" because the abundance is unknown and they have a medium vulnerability to fishing.

Justification:

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	*[Include and reference information needed to score each attribute as needed]*	*[Numerical score (1-3) for each attribute]*
Average maximum age		
Fecundity		
Average maximum size (fish only)	200 cm (Gon 1990)	2
Average size at maturity (fish only)		
Reproductive strategy	Broadcast spawner (Froese and Pauly 2018)	1
Trophic level	4.2 (Froese and Pauly 2018)	1
Density dependence (invertebrates only)		

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	There is areal overalp with opah	3
Vertical overlap (Considers all fisheries)	There is vertical overlap with opah	3
Selectivity of fishery (Specific to fishery under assessment)	Opah are selective to the fishery	2
Post-capture mortality (Specific to fishery under assessment)	Information on post-capture mortality is limited	3

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Moderate Concern

There is no information on fishing mortality rates for opah in the western and central Pacific Ocean.

Between 1987 and 2001, observers recorded a total of 6,569 opahs caught by longliners in the Western and Central Pacific Ocean, primarily around Australia and New Zealand, representing 9.3% of the "other fish" catch. "Other fish" represented 7.6% of the total catch (Lawson 2001). From 1992 to 2009, 23% of opah caught in the South Pacific longline fishery were discarded and of these 25% were dead (OFP 2010). We have awarded a score of "moderate" concern because fishing mortality is unknown relative to reference points and impacts to the health of the stock.

Rainbow runner

Factor 2.1 - Abundance

Western Central Pacific | Floating object purse seine (FAD)

Moderate Concern

No assessments have been conducted in the western and central Pacific Ocean and so their status is unknown. Rainbow runner have moderate vulnerability to fishing based on the productivity and susceptibility table (2.89) shown in the "detailed" section below. Because their status is unknown and they are not highly vulnerable to fishing pressure, we have awarded a score of "moderate" concern.

Justification:

Productivity Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity		
Average maximum age	6 (Molony 2008)	1
Fecundity	2 million (Pinheiro et al. 2011)	1
Average maximum size (fish only)	180 (Claro 1994)	2
Average size at maturity (fish only)	64 (Trindade-Santos and Freire 2015)	2
Reproductive strategy	Broadcast spawner (Froese and Pauly 2018)	1
Trophic level	4.3 (Froese and Pauly 2018)	3
Density dependence (invertebrates only)		

Susceptibility Attribute	Relevant Information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap (Considers all fisheries)	There is likely some overlap with the fishery and rainbow runner	*3*
Vertical overlap (Considers all fisheries)	There is vertical overlap with the fishery and rainbow runner	3

Selectivity of fishery (Specific to fishery under assessment)	Rainbow runner have selectivity to the fishery	2
Post-capture mortality (Specific to fishery under assessment)	Post capture mortality is unknown for rainbow runner	3

Factor 2.2 - Fishing Mortality

Western Central Pacific | Floating object purse seine (FAD)

Moderate Concern

Fishing mortality rates for rainbow runner are not available in the western and central Pacific Ocean, but they are frequently caught in the floating object purse seine fishery (OFP 2010) (Xuefang et al. 2013). Rainbow runner was the most commonly observed non-target species (41 to 45%) caught on floating object sets made between 1994 and 2009 (OFP 2010). We have awarded a score of "moderate" concern because information on fishing mortality is not known.

Rough-toothed dolphin

Factor 2.1 - Abundance

Western Central Pacific | Floating object purse seine (FAD)

High Concern

The IUCN has identified rough-toothed dolphins as a species of "Least Concern" with an unknown population trend (Hammond et al. 2012). The estimated population size in Hawaiian waters is just under 20,000 individuals (Calambokidis et al. 2008). We have awarded a score of "high" concern based on the Seafood Watch definition that marine mammals with an unknown status are highly susceptible to serious injury and mortality in fisheries {Seafood Watch 2016}.

Factor 2.2 - Fishing Mortality

Western Central Pacific | Floating object purse seine (FAD)

Low Concern

In the western and central Pacific Ocean, interactions between marine mammals and purse seine fisheries are not a common event but they do occur. Between 2007 and 2009, 37% of toothed whales caught in purse seine fisheries, including rough-toothed dolphins, were caught on fish aggregating device (FAD) sets, 20% on natural log sets and 16% on drifting FADs (dFADs). During 2010, these percentages were 6%, 29% and 50% respectively (OFP 2012b). The estimated total mortality of rough-toothed dolphins, based on observed interactions, ranged from 10 to 158 individuals between 2009 and 2010 (OFP 2012b). We have awarded a score of "low" concern because bycatch does not seem to be a large contributing factor to population declines (Hammond et al. 2012).

Salvin's albatross

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines

High Concern

According to the International Union for Conservation of Nature (IUCN), Salvin's albatross are considered "Vulnerable" and it is unknown whether their populations are increasing or decreasing (BirdLife International 2017f). It is estimated there are 79,900 mature individuals or around 110,000 total birds (Baker et al. 2014). We have awarded a score of "high" concern based on the IUCN listing.

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

Moderate Concern

Salvin's albatross are more commonly reported as incidentally caught by New Zealand tuna longliners than in other areas of the western and central Pacific Ocean (WCPO). For example, between 1996 and 2005, observers reported 150 interactions with this species aboard New Zealand longliners {BirdLife International 2017g}. Observer data collected from the WCPO region between 2007 and 2016 indicated 9 Salvin's albatross were incidentally captured (Peatman et al. 2017). We have awarded a score of "moderate" (rather than "high") concern because bycatch mitigation measures have been adopted by the New Zealand fleet (NZG 2018) and almost all of the breeding and foraging areas for this species occur in New Zealand waters (ACAP 2010).

Shortfin mako shark

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Low Concern

A stock assessment of shortfin mako sharks in the north Pacific was conducted in 2018 (ISC 2018c). The average (1975 to 2016) spawning abundance (SA) was estimated to be 910,000 sharks, and the current SA (2016) is estimated to be 860,200 sharks (ISC 2018c). This SA is estimated to be 36% above the estimated SA at the maximum sustainable yield (ISC 2018c). Based on these results it is likely (>50%) that shortfin mako sharks in the north Pacific are not overfished (ISC 2018c). The International Union for Conservation of Nature (IUCN) has listed this species globally as "Endangered," mainly due to steep population declines in the Atlantic Ocean (Rigby et al. 2019). We have awarded a score of "low" concern based on the assessment results.

Southwest Pacific | Drifting longlines

High Concern

No population assessment of shortfin mako sharks in the South Pacific region of the western and central Pacific Ocean has been conducted. The center of abundance for this species appears to be northwest of New Zealand (Lawson 2001). The International Union for the Conservation of Nature has assessed this species globally as "Endangered" (Rigby et al. 2019). According to the IUCN, the population in the south Pacific appears to be increasing. We have, however, awarded a score of "high" concern based on the IUCN listing and lack of a stock assessment to override the listing.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Low Concern

In 2018 a stock assessment of shortfin mako sharks in the North Pacific was conducted (ISC 2018c). Annual fishing intensity was estimated to be 0.16, which is 62% of fishing intensity at maximum sustainable yield levels (ISC 2018c). It is likely (>50%) that overfishing is not occurring and we have therefore awarded a score of "low" concern.

Southwest Pacific | Drifting longlines

High Concern

No assessment of shortfin mako sharks has been conducted in the South Pacific region. However, some information on catch and discard rates is available. For example, between 1994 and 2009, 1,047 t of mako sharks were observed caught in the Western and Central Pacific Ocean longline fisheries, representing 2.2% of the total catch. During this time period, 26% of shortfin mako sharks were discarded and of these 24% were dead (OFP 2010). We have awarded a score of "high" concern because information on fishing mortality rates in the South Pacific are not available, the population is depleted and susceptible to longline gear, and no management is place to protect the species.

Silky shark

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)

High Concern

The IUCN considers silky sharks to be "Vulnerable" globally (Rigby et al. 2017). The first assessment of silky sharks in the WCPO was conducted in 2012 and updated during 2013 (Rice and Harley 2013). A Pacific-wide assessment was conducted in 2018 (Clarke et al. 2018). The results of this

assessment are considered highly uncertain and not sufficient enough to provide an assessment of silky shark stock status in the Pacific Ocean (Clarke et al. 2018). However, it should be noted that there were several indications that the population has likely declined considerably over the past twenty years (Clarke et al. 2018) (Rigby et al. 2017). The previous 2013 assessment showed that the spawning biomass (abundance of mature fish) levels consistently declined over the modeled time period (1995 to 2009) by 67% since 1995. The spawning biomass in 2009 was far below target levels needed to produce the maximum sustainable yield ($SB_{CURRENT}/SB_{MSY}$=0.70 95% CI 0.51-1.23) and therefore the stock is overfished. We have awarded a score of "high" concern based on the IUCN assessment.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)

High Concern
A new Pacific-wide stock assessment of silky sharks was conducted in 2018 (Clarke et al. 2018). The results of the assessment are not considered robust enough to determine the status of silky sharks in the Pacific Ocean (Clarke et al. 2018). However, there is some indication that fishing mortality has increased considerably over the past twenty years and this may have resulted in population declines (Clarke et al. 2018). The previous assessment, conducted in 2013, indicated that fishing mortality rates in 2009 (the last year of the modeled period) exceeded levels needed to produce the maximum sustainable yield ($F_{CURRENT}/F_{MSY}$=4.48 (1.41-7.96)). This indicates that overfishing is occurring (Rice and Harley 2013). Bycatch from the associated purse seine fishery has had a large impact on the stock, second only to the longline fishery, even though catches are much higher in the longline fishery (Rice 2012). For example, in the associated purse seine fishery, F increased to 0.15 by 2009, which is above F_{MSY} (0.077) (Rice and Harley 2013). It should also be noted that in other oceans, entanglement mortality rates of silky sharks in purse seine fisheries is estimated to be 5 to 10 times the reported bycatch levels (Filmalter et al. 2013). We have awarded a score of "high" concern based on previous indications that fishing mortality rates are too high combined with recent analysis that also suggests increased fishing mortality may have resulted in biomass decreases (Rice and Harley 2013) (Clarke et al. 2018).

Striped marlin

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

High Concern
Striped marlin in the western and central North Pacific Ocean were assessed in 2019. The results of this model show a long-term decline in biomass (ISC 2019). There are no target or limit reference

points but compared to maximum sustainable yield (MSY) based reference points, the spawning biomass in 2017 was 62% below that needed to attain MSY. Therefore striped marlin is overfished (ISC 2019); we have therefore awarded a score of "high" concern.

Southwest Pacific | Drifting longlines

High Concern

The most recent population assessment of striped marlin in the Southwestern Pacific Ocean was conducted in 2019 (Ducharme-Barth et al. 2019). Both the total and spawning biomass declined to at least half of their virgin levels by 1970. Despite high levels of uncertainty around certain input paramaters, 69% of 300 model runs showed SB is less than SB_{MSY}, suggesting striped marlin are overfished (Ducharme-Barth et al. 2019). The median value of SB_{RECENT} (2014-2017)/SB_{MSY} = 0.737 (0.152 – 3.312) and median value for SB_{LATEST}(2017)/SB_{MSY} = 0.898 (0.174 – 3.924) (Ducharme-Barth et al. 2019). We have awarded a score of "high" concern because the stock is likely overfished.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

High Concern

There has been a long-term decline in catches of striped marlin in the western and central North Pacific Ocean (ISC 2019). Since the 1990s, longline fishing has accounted for over 60% of the total striped marlin catches in this region. Fishing mortality rates are high, F=0.64 from 2015 to 2017, about 7% above levels needed to produce the maximum sustainable yield (F_{MSY}) (ISC 2019). There are no target or limit reference points but compared to MSY-based reference points, overfishing is occurring (ISC 2019). We have therefore awarded a score of "high" concern.

Southwest Pacific | Drifting longlines

Moderate Concern

A population assessment of striped marlin in the southwest Pacific Ocean was conducted in 2019. The entire longline fleet has substantially affected the population size of striped marlin in the southwestern Pacific Ocean (Ducharme-Barth et al. 2019). Catches during recent years appear to be approaching MSY levels because of recent low recruitment levels (Ducharme-Barth et al. 2019). The fishing mortality based reference point $F_{RECENT(2014-2017)}/F_{MSY}$ = 0.991 (0.03-3.5) with 44% of the model runs greater than 1. This indicates the stock is close to undergoing overfishing. We have awarded a score of "moderate" concern because the stock is approaching overfishing.

Swordfish

Factor 2.1 - Abundance

North Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-

operated pole-and-lines

North Pacific Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern

The most recent assessment for swordfish in the southwestern Pacific Ocean was conducted in 2017 (Takeuchi et al. 2017). There are no reference points adopted for this population. The assessment indicated that the stock biomass is above limit reference points (20%SB*F=0) used for tuna. The median estimate was 0.35 (Takeuchi et al. 2017). The ratio of the latest spawning biomass to that needed to produce the maximum sustainable yield ($SB_{LATEST}SB_{MSY}$) was 1.61 {Takeuchi et al. 2107}. It is likely the stock is not overfished, but because there are no reference points in place, we have awarded a score of "low" concern, rather than a score of "very low" concern.

South Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

South Pacific Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern

An assessment for swordfish in the North Pacific was conducted in 2018. Although there are no agreed-upon reference points, the female biomass in 2016 was estimated to be 29,403 MT, which is around 87% above the maximum sustainable yield (MSY) level (ISC 2018b). The spawning potential ratio of the stock is currently estimated at 45% (ISC 2018b). Model sensitivity analysis revealed a few runs that indicated the stock was overfished, and the assessment does not incorporate model uncertainty (ISC 2018b). Swordfish in the North Pacific likely are not overfished, but because the base case model does not incorporate uncertainty and there is a lack of reference points, we score abundance as "low" concern, rather than "very low" concern.

Justification:

This assessment considered one of the populations in the western and central Pacific (WCPO) (ISC 2018b). According to this assessment, the population has been fairly stable with a slight decline until the mid-1990s followed by a slight increase since 2000 (ISC 2018b). The spawning stock biomass has remained above MSY levels throughout the time series of the assessment (ISC 2018b).

Factor 2.2 - Fishing Mortality

North Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

North Pacific Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern

According to the updated 2017 stock assessment of swordfish in the South Pacific, fishing mortality rates are sustainable. The ratio of recent fishing mortality rates to those needed to produce the maximum sustainable yield (MSY) was estimated to be 0.86 (0.42 to 1.46) (Takeuchi et al. 2017). Overfishing is not currently occurring, so we have awarded a score of "low" concern.

South Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
South Pacific Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern
An assessment for swordfish in the North Pacific was conducted in 2018. Exploitation rates in this region peaked in the 1960s and have declined since. The current fishing mortality rate ($H_{2013-2015}$) is 0.08, which is around 45% lower than the level necessary to produce the maximum sustainable yield (H_{MSY}=25%). It is very unlikely (<1%) that fishing mortality rates (H) are unsustainable and therefore overfishing is not occurring (ISC 2018b). We have therefore awarded a score of "low" concern.

Wandering albatross

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines

High Concern
The International Union for Conservation of Nature (IUCN), considers the wandering albatross population to be "Vulnerable" with a decreasing population trend (BirdLife International 2017h). The global population is around 20,100 mature individuals but the status of this species in the western and central Pacific Ocean is unknown (BirdLife International 2017h). We have awarded a score of "high" concern based on the IUCN classification.

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

Moderate Concern
Wandering albatross are threatened by longline fisheries, which have been identified as a leading cause of their global declines. This is primarily a factor of their large range, which makes them susceptible to capture by a variety of fleets (BirdLife International 2017h). Between 1980 and 2004, 107 interactions between wandering albatrosses and pelagic longline gear, primarily south of 31S, were observed (Molony 2005), and from 1992 to 2009 53% of incidentally captured seabirds died (OFP 2010). Observer data collected from the WCPO region between 2007 and 2016 indicated 25 wandering albatross were observed to be incidentally captured (Peatman et al. 2017). Wandering albatross are impacted by even low bycatch rates due to their small population size (ACAP 2009a). The majority of breeding area for this species occurs in South African territories (ACAP 2009a). Management measures have been adopted by many fleets in the southwestern Pacific Ocean to reduce the incidental capture of seabirds. However, these measures have not been adopted by all fleets operating in their breeding region (ACAP 2009a). Due to the impact from even low bycatch rates, combined with the fact that bycatch mitigation measures have not been fully adopted by all fleets, we have awarded a score of "moderate" concern.

Whale shark

Factor 2.1 - Abundance

West Pacific | Unassociated purse seine (non-FAD)

High Concern

The stock status of whale sharks in the WCPO is not known. However, it is thought they are vulnerable to fishing-related mortality, similar to other shark species, and observer records indicate whale sharks have been impacted by tuna purse seine fisheries in the WCPO (Rice and Harley 2012). Ecological risk assessments (ERA) have identified whale sharks as having a moderate to high susceptibility to purse seine capture (Kirby 2006) (Kirby and Hobday 2007). The IUCN Red List of Threatened Species considers whale sharks to be "Endangered" (Pierce and Norman 2016), and so we have awarded a score of "high" concern.

Factor 2.2 - Fishing Mortality

West Pacific | Unassociated purse seine (non-FAD)

Moderate Concern

There is information available from observer programs pertaining to the number and mortality rates of whale sharks in the tropical purse seine fishery. During 2014, there were 109 observed interactions with whale sharks. This indicates that as many as 323 whale sharks were incidentally encircled by the entire fleet during 2014 (Clarke 2015). Approximately 5 to 10% of these whale sharks die as a result of incidental capture (Clarke 2015). In addition to mortalities from the purse seine fishery, there are non-tuna related fishery interactions and targeted fishing in some locations (Rice and Harley 2012) (OFP 2012b). It has been suggested that interactions between whale sharks and purse seines will not be reduced through only a ban on setting; rather, techniques to safely release them are needed (Clarke 2015). We have awarded a score of "moderate" concern because fishing mortality rates are unknown but there are management measures preventing sets being made around whale sharks, and it appears compliance is high with these measures (WCPFC 2017d).

Justification:

Between 2007 and 2009 and during 2010, 211 and 137 whale shark interactions respectively were observed in this fishery. However, the proportion of whale shark sets may be higher than those reported by observers. Total whale shark moralities between 2007 and 2009 were 56 (12%) and 19 (5%) in 2010 (OFP 2012a). This includes interactions in the purse seine fishery through both direct targeting of tunas in association with whale sharks and through interactions where the whale shark is encircled, sometimes because they are not seen prior to the set being made. However, the majority of whale sharks are not caught during sets made on floating objects. For example, from 2007 to 2009, 6% and 1% (respectively) of whale sharks were caught on sets made on drifting and anchored FADs. During 2010, these percentages were 3% and 2%, but an additional 4% were caught during sets made on natural logs (OFP 2012a).

White-chinned petrel

Factor 2.1 - Abundance

Southwest Pacific | Drifting longlines

High Concern

The International Union for Conservation of Nature (IUCN), has listed white-chinned petrel as "Vulnerable" and their populations are decreasing (BirdLife International 2017a). The global population is estimated to have declined from 1,430,000 pairs in the 1980s to 1,200,000 breeding pairs currently. There are around 3 million mature birds (Brooke 2004) (BirdLife International 2017a). We have awarded a score of "high" concern based on the IUCN listing.

Factor 2.2 - Fishing Mortality

Southwest Pacific | Drifting longlines

Moderate Concern

White-chinned petrels are one of the most vulnerable bird species to bycatch in fisheries operating in the southern hemisphere (ACAP 2009b). Estimates from the 1990s in the Australian longline fishery suggest over 800 white-chinned petrels were incidentally caught per year. In the New Zealand longline fishery, 14.5% of incidentally caught birds in longline (and trawl) fisheries between 2003 and 2005 were white-chinned petrels (BirdLife International 2017a). Observer data collected from the WCPO region between 2007 and 2016 indicated 20 white-chinned petrels were observed to be incidentally captured (Peatman et al. 2017). White-chinned petrels also have a very high mortality rate as a result of this incidental capture (OFP 2010). White-chinned petrels have a high areal and vertical overlap with pelagic longline gear (BirdLife International 2017a), and many fisheries outside of this region may also be contributing to a cumulative effect on population size (ACAP 2009b). However, management measures to reduce the incidental capture of seabirds have been adopted by many fleets in the south Pacific (Clarke et al. 2014), but compliance with these measures is mixed (WCPFC 2016). Therefore, we have awarded a score of "moderate" concern.

Whitetip shark

Factor 2.1 - Abundance

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)

High Concern

The International Union for the Conservation of Nature (IUCN) considers oceanic whitetip sharks to be "Vulnerable" globally (Baum et al. 2015). The most recent stock assessment of oceanic whitetip

sharks in the western and central Pacific Ocean (WCPO) was conducted in 2019 (Tremblay-Boyer et al. 2019). It is the first stock assessment since the implementation of CMM2011-04, which became active in 2013, enacting a no-retention measure for this species for WCPFC members, cooperating non-members, and participating territories. Although results are reported in relation to maximum sustainable yield (MSY) reference points, reference points to manage this stock have not yet been identified by the scientific committee or Commission. According to the assessment, the median spawning biomass (mature fish) of 648 model runs is estimated to be far below the level needed to produce the maximum sustainable yield (SB_{RECENT}/SB_{MSY} = 0.09), indicating the stock is overfished (Tremblay-Boyer et al. 2019). We have awarded a score of "high" concern because of the severely overfished stock status.

Factor 2.2 - Fishing Mortality

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)

High Concern

Fishing mortality relative to F_{MSY} has declined dramatically since the 2012 stock assessment and the implementation of CMM2011-04, which became active in 2013, enacting a no-retention measure for this species for WCPFC members, cooperating non-members, and participating territories. The most recent stock assessment estimates that fishing mortality still exceeds levels needed to produce the maximum sustainable yield, with median F_{RECENT}/F_{MSY} = 3.92 (Tremblay-Boyer et al. 2019). Therefore, overfishing is occurring (Tremblay-Boyer et al. 2019). We have awarded a score of "high" concern because overfishing is occurring.

Justification:

Oceanic whitetip sharks are caught as bycatch by purse seine vessels that primarily fish in equatorial waters between 10°N to 10°S. Sharks as a group are reported to have an observed bycatch ratio of 1.1% on purse seine sets made on fish aggregating devices (FAD) in the western and central Pacific Ocean (Dagorn et al. 2012). Research conducted in other oceans, however, suggests that the entanglement mortality from purse seine gear of other shark species may be 5 to 10 times the known bycatch (Filmalter et al. 2013). Recently the Western and Central Pacific Fisheries Commission banned the capture and sale of oceanic whitetip sharks (WCPFC 2012g).

Yellowfin tuna

Factor 2.1 - Abundance

Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Western and Central Pacific (WCPO) Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Very Low Concern

The biomass based reference points for the reference model used in the 2017 assessment (SB_{RECENT}/SB_{MSY} - the median ratio of the current (2011 to 2014) spawning (mature fish) biomass to that needed to produce the maximum sustainable yield) was 1.39. The median ratio of the latest (2015) spawning biomass to the level needed to produce the maximum sustainable yield (SB_{LATEST}/SB_{MSY}) also was 1.39. The median ratio of the recent spawning biomass to the biomass with no fishing mortality is 0.32, which is higher than the limit reference point (0.20). Therefore, yellowfin tuna are not in an overfished state (Tremblay-Boyer et al. 2017) and biomass is well above appropriate target levels such as SB_{MSY}. We have subsequently awarded ascore of "very low" concern.

Factor 2.2 - Fishing Mortality

Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Western and Central Pacific (WCPO) Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Low Concern

The current fishing mortality rate is below levels needed to produce the maximum sustainable yield (F_{RECENT}/F_{MSY} = 0.79) for the most realistic models. Therefore overfishing is not occurring (Tremblay-Boyer et al. 2017) and we have awarded a score of "low" concern.

Factor 2.3 - Discard Rate/Landings

North Pacific | Unassociated purse seine (non-FAD)
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)

< 100%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). Between 1995 and 2011 the estimated discard rate of tunas in purse seine fisheries was just over 3% in the WCPO (OFP 2012a).

North Pacific Stock | Northeast Pacific | Trolling lines | Canada
North Pacific Stock | Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
North Pacific Stock | Northwest Pacific | Trolling lines | Japan
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Trolling lines | United States
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

< 100%

The average discard rate in tuna pole and line fisheries worldwide is 0.1% (Kelleher 2005). This rate can be slightly higher, up to 0.4%, in some fisheries operating in the western and central Pacific Ocean (Kelleher 2005). The discard rate in the Canadian North Pacific albacore troll and pole fishery has been reported to be 0.02% of the total catch by weight (Holmes 2012).

Trolling line fisheries typically use colorful jigs and lures, eliminating the need for bait (Scofield 1956). Pole and line fisheries depend heavily on the use of baitfish (baitfish most often come from other fisheries) to lure the tuna (Gillett 2012). The amount of tuna caught is typically much greater than the amount of baitfish used, with a tuna to bait ratio typically around 30 to 1 (Gillett 2012). This ratio can vary by fishery due to differences in the baitfish used, and the fishing technique (Gillett 2012). We have given a score of <100% because discards are low and the ratio of discards plus bait use to landings is less than 100% in these fisheries.

North Pacific Stock | Northwest Pacific | Drifting longlines
Northwest Pacific | Drifting longlines
Northwestern and Central Pacific Stock | Northwest Pacific | Drifting longlines

< 100%

The average overall discard rate in tuna longline fisheries worldwide is 22%. In the western and central Pacific Ocean (WCPO), distant water longline vessels may have a discard rate as high as 40% (Kelleher 2005). Information from observer records collected in the North Pacific indicate 36% of the total catch is discarded. Specifically, in the area north of 10°N, discard rates for tuna ranged from 0 to 35%, for billfish from 3 to 44%, for sharks and rays from 0 to 100%, 0 to 100% for other bony fish, and 100% for marine mammals, sea birds and turtles (OFP 2010). Bait is used in this fishery but information on the percentage of bait to total landings is not available. It's unlikely combined discards and bait use are greater than 100% of the total landings.

South Pacific Stock | Southwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines

< 100%

The average overall discard rate in tuna longline fisheries worldwide is 22%, but in the western and central Pacific Ocean (WCPO), distant water longline vessels may have a discard rate as high as 40% (Kelleher 2005). According to observer data from the Fiji pelagic longline fishery in the South Pacific, discard rates very by species but are around 6% of the total catch for all species combined {Akroyd et al. 2012}. For example, tuna, mahi mahi, and opah have very low discard rates, <5%, but sharks have very high discard rates, >95% (Akroyd et al. 2012). However, it should be noted that Fiji bans the retention of sharks and therefore discard rates may be skewed. Observer data from the South Pacific albacore fishery indicates discard rates for tuna ranged from 3 to 100%, for billfish from 4 to 45%, for sharks and rays from 0 to 100%, 0 to 100% for other bony fish, 100% for marine mammals, 0 to 100% for seabirds, and 71 to 100% for turtles (OFP 2010). The overall discard rate, according to observer records, is around 18% (OFP 2010). Bait is used in this fishery but information on the percentage of bait to total landings is not available. Its unlikely combined discards and bait use are greater than 100% of the total landings.

South Pacific Stock | Southwest Pacific | Hand-operated pole-and-lines
South Pacific Stock | South Pacific | Trolling lines
Northwestern and Central Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
South Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

< 100%

The average discard rate in tuna pole and line and trolling line fisheries is 0.1%, although it is slightly higher in the western and central Pacific Ocean, 0.4% (Kelleher 2005). Trolling line and pole and line fisheries depend heavily on the use of baitfish, which most often comes from other fisheries (Gillett 2012). However, the amount of tuna caught is much greater than the amount of baitfish used. The tuna to bait ratio is typically around 30 to 1, although this can vary by fishery due to differences in the baitfish used, and fishing technique (Gillett 2010). Therefore, we have left the score as <100%.

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines

< 100%

The average overall discard rate in tuna longline fisheries worldwide is 22%, but in the western and central Pacific Ocean (WCPO), distant water longline vessels may have a discard rate as high as 40% (Kelleher 2005). In the WCPO pelagic longline fisheries around 5% of targeted tuna (bigeye, yellowfin, and albacore) were estimated to have been discarded between 1994 and 2011 (OFP 2012a). Discard rates of skipjack tuna are higher (20%) (OFP 2010). Earlier estimates through 2009 indicated the total discard rate of targeted tunas was around 5%. Discard rates for non-targeted species between 1994 and 2009 were 11% for billfish, 54% for other bony fish, 49% for elasmobranchs, 73% for seabirds, 94% for marine mammals, and 96% for turtles (OFP 2010). According to this second study, based on observer data, the overall discard rate for the WCPO longline fishery is 15% (OFP 2010). Bait is used in this fishery but information on the percentage of bait to total landings is not available. It's unlikely combined discards and bait use are greater than 100% of the total landings.

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)

< 100%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the WCPO between 1995 and 2011 the estimated discard rate of tunas in purse seine fisheries was just over 3% (OFP 2012a) and targeted tunas represented 98% of the total catch on log associated sets between 1994 and 2009 (OFP 2010).

Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines

< 100%

The average discard rate in tuna pole and line fisheries is 0.1%, although slightly higher at 0.4% in

the western and central Pacific Ocean (Kelleher 2005). Yellowfin-targeted, deep-set handline fisheries typically target large tuna, while other fisheries (e.g., skipjack pole and line) may target juvenile tunas {Davies 2014}. Troll/pole and handline fisheries can depend heavily on the use of baitfish (some fisheries may use tuna and/or squid), which most often comes from other fisheries (Gillett 2012). However, the amount of tuna caught is much greater than the amount of baitfish used. The tuna to bait ratio is typically around 30:1, although this can vary by fishery due to differences in the baitfish used and in fishing technique (Gillett 2010).

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

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

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States	Moderately Effective	Highly effective	Highly effective	Highly effective	Highly effective	**Yellow (3.000)**
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States	Moderately Effective	Highly effective	Highly effective	Highly effective	Highly effective	**Yellow (3.000)**
North Pacific | Unassociated purse seine (non-FAD)	Ineffective	Moderately Effective	N/A	N/A	N/A	**Red (1.000)**

Northeast Pacific | Trolling lines | Canada	Moderately Effective	Highly effective	Highly effective	Highly effective	Highly effective	**Yellow (3.000)**
Northwest Pacific | Drifting longlines	Ineffective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan	Moderately Effective	Highly effective	Highly effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery	Ineffective	Highly effective	N/A	N/A	N/A	**Red (1.000)**
Northwest Pacific | Trolling lines | Japan	Moderately Effective	Highly effective	Highly effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery	Ineffective	Highly effective	N/A	N/A	N/A	**Red (1.000)**
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
South Pacific | Trolling lines	Moderately Effective	Highly effective	Highly effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
Southwest Pacific | Drifting longlines	Moderately Effective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Southwest Pacific | Hand-operated pole-and-lines	Moderately Effective	Highly effective	Highly effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
West Pacific | Trolling lines	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
West Pacific | Unassociated purse seine (non-FAD)	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**
Western Central Pacific | Drifting longlines	Moderately Effective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Western Central Pacific | Floating object purse seine (FAD)	Ineffective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Western Central Pacific | Handlines and hand-operated pole-and-lines	Moderately Effective	Highly effective	Moderately Effective	Moderately Effective	Moderately Effective	**Yellow (3.000)**

The United Nations Straddling and Highly Migratory Fish Stocks Agreement (1995) indicated that the management of straddling and highly migratory fish stocks should be carried out through regional fisheries management organizations (RFMOs). RFMOs are the only legally mandated fishery management body on the high seas and within EEZ waters. There are currently 18 RFMOs (www.fao.org) and they cover nearly all of the world's waters. Member countries must abide by the management measures set forth by individual RFMOs in order to fish in their waters (Cullis-Suzuki and Pauly 2010). Some RFMOs manage all marine living resources within their authority (i.e., General Fisheries Commission for the Mediterranean [GFCM]), while others manage a group of species such as tunas (i.e., Inter-American Tropical Tuna Commission [IATTC]).

WCPFC members are as follows: Australia, China, Canada, Cook Islands, European Union, Federated States of Micronesia, Fiji, France, Indonesia, Japan, Kiribati, Republic of Korea, Republic of Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, United States of America, Vanuatu.

IATTC members are as follows: Belize, Canada, China, Colombia, Costa Rica, Ecuador, El Salvador, European Union, France, Guatemala, Japan, Kiribati, Korea, Mexico, Nicaragua, Panama, Peru, Chinese Taipei, United States, Vanuatu, Venezuela.

CCSBT members include the following countries: Australia, Japan, New Zealand, Republic of Korea, Indonesia, Taiwan, and the European Union. Cooperating non-members include South Africa and the Philippines.

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States

Moderately Effective
Albacore tuna in Pacific waters are managed by the WCPFC in the western and central Pacific, and the IATTC in the eastern Pacific. The United States is a party to both the WCPFC and IATTC, meaning they must abide by their management measures when fishing within the respective convention areas. Although the IATTC's convention area includes the entire eastern Pacific region up to the North American coastline, the WCPFC measures are designed primarily for the high seas, with the goal of compatible measures in each country's EEZ (some measures do apply to EEZ waters).

Measures were adopted by the WCPFC and IATTC in 2005. Those management measures included maintaining current catch levels in order to maintain the long-term sustainability of the stock, and the WCPFC was to work with members of the IATTC to agree on consistent management measures for the North Pacific population {IATTC 2005} (WCPFC 2005). In 2013, IATTC adopted a new resolution requiring member countries to report the average catches of North Pacific albacore tuna between 2007 and 2012 by gear type, along with a list of vessels that fish for albacore in the North Pacific. In addition, the Commissions both plan to work toward the development of target and limit reference points, as well as the development of harvest control rules for this species (IATTC 2013) (WCPFC 2015).

Domestically, albacore tuna is managed under the Pacific Fishery Management Council Fishery Management Plan for US West Coast Fisheries for Highly Migratory Species (PFMC 2018). This plan uses precautionary measures to preserve albacore and other highly migratory stocks, but no precautionary harvest guidelines or quotas are in place for albacore tuna (PFMC 2018). In addition, there is a treaty between the US and Canada that allows for licensed vessels to fish in respective waters (PFMC 2018). We have awarded a score of "moderately effective" to account for both international and domestic management measures being in place. We have not awarded a score of "highly effective" because there is currently no target reference point or harvest control rule in place.

North Pacific | Unassociated purse seine (non-FAD)

Ineffective
We have awarded a score of "ineffective" because the management structure has allowed severe declines of Pacific bluefin tuna and only responded with an appropriate rebuilding plan when abundance got to less than 3% of virgin levels, biomass remains very low despite the adoption of a rebuilding plan, the short-term, initial rebuild goal of the plan is very low, and there are no enforcement mechanisms within the RFMO to ensure compliance (ISC 2018).

Justification:
In the eastern Pacific Ocean, the Inter-American Tropical Tuna Commission (IATTC) implemented a catch limit of 6,600 t between 2017 and 2018 (3,300 t/year) for Pacific bluefin tuna caught in the Convention Area. Countries must implement measures to reduce the catch of bluefin weighing less

than 30 kg by 50% (IATTC 2016).

In the western and central Pacific Ocean, the Western and Central Pacific Fisheries Commission (WCPFC) has limited fishing effort for Pacific bluefin tuna. Vessels fishing north of 20°N must stay below 2002 to 2004 fishing effort. In addition, catches of bluefin tuna less than 30 kg in weight shall be reduced by 50% of the 2002 to 2004 average level (WCPFC 2016). There is also a recently developed Catch Documentation Scheme that has yet to be implemented (WCPFC 2013a).

In 2017, the IATTC and WCPFC worked together to develop a new rebuilding plan for Pacific bluefin tuna, which included a target to rebuild the population to 20% of virgin levels by 2034. If the chances of meeting this rebuilding target fall below 60%, additional catch limitations will be put into place (NC 2017). However, the initial, short-term rebuild goal of the plan is low (6% SSB) (ISC 2018).

Northeast Pacific | Trolling lines | Canada

Moderately Effective

Albacore tuna in Pacific waters are managed by the WCPFC in the western and central Pacific, and the IATTC in the eastern Pacific. Canada is a party to both the WCPFC and IATTC, meaning they must abide by their management measures when fishing within the respective convention areas. Although the IATTC's convention area includes the entire eastern Pacific region up to the North American coastline, the WCPFC measures are designed primarily for the high seas, with the goal of compatible measures in each country's EEZ (some measures do apply to EEZ waters).

Measures were adopted by the WCPFC and IATTC in 2005. Those management measures included maintaining current catch levels in order to maintain the long-term sustainability of the stock, and the WCPFC was to work with members of the IATTC to agree on consistent management measures for the North Pacific population {IATTC 2005} (WCPFC 2005). In 2013, IATTC adopted a new resolution requiring member countries to report the average catches of North Pacific albacore tuna between 2007 and 2012 by gear type, along with a list of vessels that fish for albacore in the North Pacific. In addition, the Commissions both plan to work toward the development of target and limit reference points, as well as the development of harvest control rules for this species (IATTC 2013) (WCPFC 2015).

Canada has developed a management plan in the North Pacific that uses a risk averse and precautionary manner, based on the best scientific advice to conserve albacore tuna populations (FOC 2017). Under this plan, there is a treaty between the United States and Canada, allowing Canadian fishermen to fish in US waters during certain times of the year, with a limited number of vessels allowed under this treaty. In addition, there are fishing seasons, area restrictions, and catch and effort reporting requirements (FOC 2017), but no precautionary harvest guidelines or quotas are in place for albacore tuna (FOC 2017). The majority of Canadian troll vessels fish in coastal waters of Canada and the United States, but some fishing does occur in international waters. We have awarded a score of "moderately effective" to account for both international and domestic management measures being in place. We have not awarded a score of "highly effective" because there is currently no target reference point or harvest control rule in place.

Northwest Pacific | Drifting longlines

Ineffective

We have awarded a score of "ineffective" because the management structure has allowed severe declines of Pacific bluefin tuna and only responded with an appropriate rebuilding plan when abundance got to less than 3% of virgin levels, biomass remains very low despite the adoption of a rebuilding plan, the short-term, initial rebuild goal of the plan is very low, and there are no enforcement mechanisms within the RFMO to ensure compliance (ISC 2018).

Justification:

Albacore

There are few management measures in place for albacore tuna in the North Pacific Ocean. Measures were adopted by the Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC) in 2005, 2013 (IATTC), and 2018 (IATTC). Those management measures included maintaining current catch levels in order to maintain the long-term sustainability of the stock, and the WCPFC was to work with members of the IATTC to agree on consistent management measures for the North Pacific population {IATTC 2005} (WCPFC 2005). In 2013, IATTC adopted a new resolution requiring member countries to report the average catches of North Pacific albacore tuna between 2007 and 2012 by gear type, along with a list of vessels that fish for albacore in the North Pacific. In 2018 a new measure (amendment to the 2013 measure) requires new data reporting standards (IATTC 2018). In addition, the Commissions both plan to work toward the development of target and limit reference points, as well as the development of harvest control rules for this species (IATTC 2018) (WCPFC 2015).

Bluefin Tuna

In the Eastern Pacific Ocean, the Inter-American Tropical Tuna Commission (IATTC) implemented a catch limit of 6,600 t during 2017 and 2018 (3,300 t/year) for Pacific bluefin tuna caught in the Convention Area. In the western and central Pacific Ocean, the Western and Central Pacific Fisheries Commission (WCPFC) has limited fishing effort for Pacific bluefin tuna. Vessels fishing north of 20°N must stay below 2002 to 2004 fishing effort. In addition, catches of bluefin tuna less than 30 kg in weight shall be reduced by 50% of the 2002 to 2004 average level (WCPFC 2016b). There is also a recently developed Catch Documentation Scheme that has yet to be implemented (WCPFC 2013a). In 2017, the IATTC and WCPFC worked together to develop a new rebuilding plan, which includes a plan for implementing the harvest strategy agreed on by the Northern Committee, which included a target to rebuild the population to 20% of virgin levels by 2024. If the chances of meeting this rebuilding target fall below 60%, additional catch limitations will be put into place (NC 2017) (WCPFC 2017g). However, the initial, short-term rebuild goal of the plan is low (6% SSB) (ISC 2018).

Swordfish

There are no measures in place for swordfish in the north Pacific Ocean but the stock is currently considered to be healthy.

Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery

Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

Ineffective

The Ministry of Agriculture, Forestry and Fisheries is responsible for the management of Pacific bluefin tuna in Japanese waters. The Japanese trolling line fishery is currently an open access fishery. Japan registers some of the vessels that fish in the Sea of Japan and the western side of Kyusyu. These vessels are required to report catch and effort information (Oshima et al. 2012). Japan is a member of two (in the Pacific) regional fishery management organizations: the Western and Central Pacific Fisheries Commission and the Inter-American Tropical Tuna Commission. Most Japanese trolling line and handline fisheries operate in coastal waters (ISCPBWG 2014). Japan has implemented a new TAC system and a notification system so fishermen know when they are getting close to their catch limit (Ota 2018). However, there is little evidence to substantiate that this system is robust. We have awarded a score of 'ineffective' because the biomass remains very low despite the adoption of a rebuilding plan, the short-term, initial rebuild goal of the plan is low (6% SSB), and there are no enforcement mechanisms within the RFMO to ensure compliance (ISC 2018).

Justification:

In the Eastern Pacific Ocean, the Inter-American Tropical Tuna Commission (IATTC) implemented a catch limit of 6,600 t during 2017 and 2018 (3,300 t/year) for Pacific bluefin tuna caught in the Convention Area. In the Western and Central Pacific Ocean, the Western and Central Pacific Fisheries Commission (WCPFC) has limited fishing effort for Pacific bluefin tuna. Vessels fishing north of 20-degrees N must stay below 2002-2004 fishing effort. In addition, catches of bluefin tuna less than 30 kg in weight shall be reduced by 50% of the 2002-2004 average level (WCPFC 2016). There is also a recently developed Catch Documentation Scheme that has yet to be implemented (WCPFC 2013a). In 2017, the IATTC and WCPFC worked together to develop a new rebuilding plan, which includes a plan for implementing the harvest strategy agreed on by the Northern Committee, for Pacific bluefin tuna, which included a target to rebuild the population to 20% of virgin levels by 2024. If the chances of meeting this rebuilding target fall below 60%, additional catch limitations will be put into place (NC 2017)(WCPFC 2017).

Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
Northwest Pacific | Trolling lines | Japan

Moderately Effective

Albacore tuna in Pacific waters are managed by the WCPFC in the western and central Pacific, and the IATTC in the eastern Pacific. Japan is a party to both the WCPFC and IATTC, meaning they must abide by their management measures when fishing within the respective convention areas. Although the IATTC's convention area includes the entire eastern Pacific region up to the North American coastline, the WCPFC measures are designed primarily for the high seas, with the goal of compatible measures in each country's EEZ (some measures do apply to EEZ waters).

Measures were adopted by the WCPFC and IATTC in 2005. Those management measures included maintaining current catch levels in order to maintain the long-term sustainability of the stock, and the WCPFC was to work with members of the IATTC to agree on consistent management measures for the North Pacific population {IATTC 2005} (WCPFC 2005). In 2013, IATTC adopted a new resolution requiring member countries to report the average catches of North Pacific albacore tuna between 2007 and 2012 by gear type, along with a list of vessels that fish for albacore in the North Pacific. In addition, the Commissions both plan to work toward the development of target and limit

reference points, as well as the development of harvest control rules for this species (IATTC 2013) (WCPFC 2015).

Japan has both offshore and distant water pole, and line fisheries for albacore tuna (Uosaki et al. 2017). The Ministry of Agriculture, Forestry, and Fisheries is responsible for the management of albacore tuna in Japanese waters. In domestic waters, fishers report catch and effort through a logbook program, but there are no catch limits in place (Uosaki et al. 2017). We have awarded a score of "moderately effective" to account for both international and domestic management measures being in place. We have not awarded a score of "highly effective" because there is currently no target reference point or harvest control rule in place.

Southwest Pacific | Drifting longlines

Moderately Effective

We have awarded a score of "moderately effective" because, while management has been unable to maintain healthy populations of southern bluefin tuna, the Pacific fishery catches only a small portion of the total catch and management has been fairly effective for the other species.

Justification:

Albacore

Few management measures have been enacted for albacore tuna in the South Pacific. The Western and Central Pacific Fisheries Commission (WCPFC) has limited the number of fishing vessels actively fishing for albacore to not exceed 2005 levels or historical levels (2000 to 2004). WCPFC member countries shall work to ensure the long-term sustainability of albacore tuna in this region, which includes collaborative research (WCPFC 2010b). Biomass based limit reference points have been adopted by the WCPFC for albacore tuna and are used to determine the status of their populations, and the WCPFC has recently agreed to implement interim target reference points (WCPFC 2018a). However, there are no harvest control rules (WCPFC 2015) (WCPFC 2018). We have awarded a score of "moderately effective" based on the current management scheme, which includes some management but does not currently include harvest control rules.

Swordfish and other retained species

In 2009, the WCPFC limited the number of vessels targeting swordfish and catches to levels from any year between 2000 and 2005 and required this information to be reported to the Commission (WCPFC 2009). Management measures adopted for other retained species include effort restrictions for striped marlin (WCPFC 2006).

Bluefin tuna

Management measures adopted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), which is responsible for the management of southern bluefin tuna throughout their range, include a total allowable catch (TAC) set on a three-year cycle, divided between eight countries and the European Community, and a Management Procedure (MP), which the CCSBT uses to aid in the setting of the TAC. The MP has been in place since 2012. In addition, there is a meta-rule process that the CCSBT can use to deal with certain situations such as untested recruitment or abundance estimates or "substantial" improvements with regard to unknown or missing data (CCSBT 2017b).

Southwest Pacific | Hand-operated pole-and-lines
South Pacific | Trolling lines

Moderately Effective
Few management measures have been enacted for albacore tuna in the South Pacific. The Western and Central Pacific Fisheries Commission (WCPFC) has limited the number of fishing vessels actively fishing for albacore to not exceed 2005 levels or historical levels (2000 to 2004). WCPFC member countries shall work to ensure the long-term sustainability of albacore tuna in this region, which includes collaborative research (WCPFC 2010b). Biomass based limit reference points have been adopted by the WCPFC for albacore tuna and are used to determine the status of their populations, and the WCPFC has recently agreed to implement interim target reference points (WCPFC 2018a). However, there are no harvest control rules (Harley et al. 2015) (WCPFC 2015) (WCPFC 2018). We have awarded a score of "moderately effective" based on the current management scheme, which includes some management but does not currently include harvest control rules.

West Pacific | Unassociated purse seine (non-FAD)

Moderately Effective
In 2017 a bridging measure was adopted to manage tropical tunas in the WCPO (WCPFC 2017). Only a few management measures specific to unassociated purse seine fisheries are included in this measure. There are effort limits, high seas purse seine closures and retention rules to disuade waste and non-incidental capture of juvenile fish in the fishery (WCPFC 2017). A recent analysis of the bridging measures indicates there is a risk of >20% of breaching the current limit reference point for bigeye tuna (WCPFC 2017e).

Biomass-based limit reference points have been adopted by the WCPFC for bigeye, yellowfin, albacore and skipjack tuna, and are used to determine the status of tuna populations. There are no target reference points in place for bigeye and yellowfin, although the WCPFC has a working group that is developing reference points for other species {WCPFC 2013c}. There is a target reference point in place for skipjack tuna (WCPFC 2015). The WCPFC has no type of harvest control rule in place and does not have interim target reference points for all species. We have awarded a score of "moderately effective" based on the current management scheme.

Western Central Pacific | Drifting longlines

Moderately Effective
Management measures for targeted tuna species in the Western and Central Pacific Ocean (WCPO) longline fisheries have been adopted by the Western and Central Pacific Fisheries Commission (WCPFC). At the most recent Commission meeting (2017) a tropical tuna bridging measure was adopted, which increased the bigeye catch limits for the longline fishery, which is not inline with the scientific advice for maintaining the biomass of bigeye tuna (WCPFC 2017). It is too early to determine if compliance with the new measures has been good. Biomass-based limit reference points have been adopted by the WCPFC for bigeye, and yellowfin tuna and are used to determine the status of tuna populations (WCPFC 2015). Target reference points are not yet in place for any of these species, and there are no harvest control rules, although there is a plan and timeline in place for the adoption of harvest control rules (WCPFC 2015). We have awarded a score of "moderately

effective" because measures currently in place have had mixed results in protecting tuna populations from overfishing; however improvements are still needed.

Western Central Pacific | Floating object purse seine (FAD)

Ineffective

Many vessels are using increasingly advanced FADs to increase their fishing efficiency (Davies et al. 2014) (Griffiths et al. 2019). Temporary closures alone, without limits on FADs, can increase overall catch and effort in the western and central Pacific Ocean. This has occurred despite the fact that bigeye and yellowfin tuna populations cannot sustain much increase in catch or effort (Griffiths et al. 2019). High catch of bigeye and yellowfin juveniles in FAD fisheries has contributed to depleting these populations (Griffiths et al. 2019). Due to the lack of harvest control rules and controls on fishing effort, the health of the stocks appear to be related to fisheries management. Therefore the fishery lacks management measures that are reasonably expected to be effective.

Justification:

The Western and Central Pacific Fisheries Commission (WCPFC) has implemented several management measures specific to the purse seine fisheries. There is a three-month prohibition on setting on FADs for all purse seine vessels in EEZs between 20°N and 20°S and an additional two-month FAD closure on the high seas (UCN 2017) (WCPFC 2017). Member nations must have a FAD management plan in place to help reduce the capture of small bigeye and yellowfin tunas, and implement FAD closures (WCPFC 2012a) (WCPFC 2013b).

Yellowfin tuna catches in purse seine fisheries are not to be increased {WCPFC 2013c}. Biomass-based limit reference points have been adopted by the WCPFC for bigeye, yellowfin, albacore and skipjack tuna and are used to determine the status of tuna populations. Target reference points are not yet in place for any of these species, except for in the short-term for bigeye tuna, and there are no harvest control rules. However, the WCPFC has a working group that is currently working on identifying potential target reference points; they last met in 2013 {WCPFC 2013c}.

Western Central Pacific | Handlines and hand-operated pole-and-lines
West Pacific | Trolling lines
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Moderately Effective

At the most recent Commission meeting (2017) a tropical tuna bridging measure was adopted (SeafoodSource 2017). In fisheries other than longline and purse seine, such as the trolling line and handline, members of the Western and Central Pacific Fisheries Commission (WCPFC) must keep total effort in their tuna fisheries below the average level from 2001 to 2004 or in 2004 (WCPFC 2012a) (WCPFC 2014b).

Target reference points are in place for skipjack, but no other species (WCPFC 2015). However, biomass-based limit reference points have been adopted by the WCPFC for bigeye, yellowfin, and

skipjack tuna and are used to determine the status of tuna populations, but there are no harvest control rules (WCPFC 2015).

There are no formally adopted reference points for swordfish or smaller tuna species. In 2009, however, the WCPFC limited the number of vessels targeting swordfish and catches to levels from any year between 2000 and 2005 and required this information to be reported to the Commission (WCPFC 2009).

The trolling line fishery captures small amounts of bigeye tuna, which are retained. Therefore, they have been included in this report. For many years, bigeye tuna had been considered overfished and undergoing overfishing. However, the most recent assessment indicates the stock has improved and is no longer considered overfished or undergoing overfishing {McKechnie et al. 2017f}. The most recent Conservation and Management Measures for these tuna were adopted in 2017 (WCPFC 2017).

In contrast to the Inter-American Tropical Tuna Commission (IATTC), which has been much more proactive in using interim target and limit reference points and currently an interim harvest control rule in place for tropical tunas and albacore (IATTC 2016), the WCPFC has no type of harvest control rule in place and does not have interim target reference points for all species. We have awarded a score of "moderately effective" because some management measures are in place for some of the species in these fisheries, but not all.

Factor 3.2 - Bycatch Strategy

Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States

Highly effective
Bycatch in trolling line, handline and hand-operated pole and line fisheries is extremely low. However, any bycatch interactions with the albacore tuna troll/pole fishery are reported in logbooks {PFMC 20007} (PFMC 2018).

North Pacific | Unassociated purse seine (non-FAD)

Moderately Effective
Bycatch in unassociated purse seine fisheries is minimal and there are some management measures in place. It appears countries are compliant with most of these measures but their effectiveness is not well known (WCPFC 2017d). We have awarded a score of "moderately effective" because bycatch is minimal and management measures are in place.

Justification:
Purse seine vessels in the western and central Pacific Ocean are prohibited from setting on a school of tuna with a whale shark, although members that fish north of 30°N can implement this measure or a comparable measure (WCPFC 2012e). If a whale shark is incidentally encircled, the vessel must

take "reasonable steps" (not defined) to ensure its safe release and report the incident (WCPFC 2012e).

In addition, vessels are restricted from making a set on a school of tuna associated with a cetacean, and if this does occur they must take measures (i.e., stopping the net roll and not starting up fishing again until the animal has been released) to ensure its safe release and to report the incident (WCPFC 2012f). Purse seine vessels must avoid encircling sea turtles (WCPFC 2008b).

Purse seine fisheries in the eastern Pacific Ocean (EPO) are also required to release, as soon as possible, all sharks, billfish, rays, dorado and other non-target species (IATTC 2002). Oceanic whitetip sharks are protected in both the WCPO and EPO, silky sharks are protected in the WCPO, and finning is prohibited (IATTC 2005b) (IATTC 2011b) {WCPFC 2010}.

Northeast Pacific | Trolling lines | Canada

Highly effective

Bycatch rates in trolling line and hand-operated pole and line fisheries are very low (Kelleher 2005) and Canada has measures in place to report any incidental bycatch (Holmes 2012). Therefore, we have awarded a score of "highly effective."

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Ineffective

Low observer coverage in the WCPO (max 5%) has hampered the ability of assessing whether adopted management measures have been effective (Gilman 2011). Thus, we do not know actual bycatch levels. Clarke identified that compliance with implementing WCPFC-adopted management measures specific to sharks is at best 60% and lower for some measures (Clarke 2013). There are additional compliance issues with the implementation of sea turtle, shark, and seabird management measures (WCPFC 2016). We have awarded a score of "ineffective" because there are no bycatch limits for non-target species, there is limited mandated mitigation measures for sea turtles and seabirds, and it is unclear if current management measures are effective at maintaining population levels of bycatch species.

Justification:

The Western and Central Pacific Fisheries Commission (WCPFC) and Inter-American Tropical Tuna Commission (IATTC) have adopted management measures to protect vulnerable bycatch species. For example, WCPFC and IATTC members are asked to implement the International Plan of Action for Reducing Incidental Catches of Seabirds in Longline Fisheries. Vessels fishing north of 23°N in the western and central Pacific Ocean (WCPO) and eastern Pacific Ocean (EPO) are required to use at least two mitigation measures including at least one of the following: side setting, night setting, tori line or weighted branch line. Members must submit annual reports detailing the mitigation measures used and are encouraged to undertake additional mitigation research (IATTC 2011b) (WCPFC 2012e) (WCPFC 2017b). In the WCPO, small longliners fishing north of 23° N must use one of these mitigation measures (WCPFC 2017b). Even in these zones, however, the

management system provides only a menu of mitigation methods from which to choose. Some of those methods are known to be effective only under certain conditions, but because the fishers can choose which to use, they can choose the least costly and likely least effective method. Therefore, even meeting the mitigation requirements to the letter does not mean that effective mitigation methods are being used.

Members of both the WCPFC and IATTC must implement the FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations. Proper handling and release guidelines should be used when hard-shell turtles are incidentally captured, and longline vessels must carry line cutters and de-hookers to allow for the safe handling and release of turtles. Longline fisheries are also urged to research mitigation techniques such as the use of circle hooks {WCPFC 2008} (IATTC 2007).

Vessels conducting shallow set fishing targeting swordfish also must comply with mitigation measures (i.e., circle hooks, whole bait or other reviewed technique) (WCPFC 2008b) (IATTC 2006). In addition, fisheries observers record and report interactions with seabirds and turtles (IATTC 2011c) (WCPFC 2012e) (WCPFC 2008b).

Members of both the WCPFC and IATTC are prohibited from retaining, transshipping, storing or landing oceanic whitetip and silky sharks; any incidentally caught sharks should be released, the incident recorded and reported (IATTC 2011d) (WCPFC 2012f) (WCPFC 2013f). Vessels must comply with one of the following mitigation measures to reduce shark interactions: 1) prohibit carrying/using wire trace as branch lines or leaders or 2) prohibit use of branch lines running directly off the longline floats, known as "shark lines" (WCPFC 2014). Members must also implement the FAO International Plan of Action for the Conservation and Management of Sharks, and National Plans of Action should have policies in place to reduce waste and discarding of sharks. Information on catch and effort for key species should be reported and shark finning is banned (5% ratio) (IATTC 2005b) (WCPFC 2010a).

Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
Northwest Pacific | Trolling lines | Japan
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

Highly effective
Bycatch in trolling line, handline and hand-operated pole and line fisheries is extremely low, but any bycatch species would likely be recorded and reported (Uosaki et al. 2017).

Southwest Pacific | Hand-operated pole-and-lines
South Pacific | Trolling lines

Highly effective
Bycatch in handline and hand-operated pole and line fisheries is minimal (Kelleher 2005).

West Pacific | Unassociated purse seine (non-FAD)

Moderately Effective

Bycatch in unassociated purse seine fisheries is minimal and there are some management measures in place. It appears countries are compliant with most of these measures but their effectiveness is not well known (WCPFC 2017d). We have awarded a score of "moderately effective" because bycatch is minimal in this fishery and there are management measures in place.

Justification:

Purse seine vessels in the western and central Pacific Ocean are prohibited from setting on a school of tuna if a whale shark is present, although members that fish north of 30°N can implement this measure or a comparable measure. If a whale shark is incidentally encircled, the vessel must take "reasonable steps" (not defined) to ensure its safe release and report the incident (WCPFC 2012e).

Members of the WCPFC are prohibited from retaining, transshipping, storing or landing oceanic whitetip and silky sharks; any incidentally caught sharks should be released and the incident recorded and reported (WCPFC 2012g) (WCPFC 2013f). However, the success of this is highly dependent on quick release of silky sharks because their post release mortality rates increase with time (Hutchinson et al. 2013).

In addition, vessels are restricted from making a set on a school of tuna associated with a cetacean, and if this does occur they must take measures (e.g., stopping net rolling and not starting fishing until the animal is released) to ensure its safe release and to report the incident (WCPFC 2012f).

Purse seine vessels must avoid encircling sea turtles (WCPFC 2008b) and are prohibited from landing silky sharks (WCPFC 2013f).

Western Central Pacific | Floating object purse seine (FAD)

Ineffective

We have awarded a score of "ineffective" because there are no bycatch limits for non-target species and it is not clear that management measures are effective at maintaining population levels of bycatch species or if they are being put into place. In addition, the WCPFC has failed to adopt resolutions to require mandatory collection and reporting of FAD data or to require the use of non-entangling FADs, which have been identified as necessary to reduce bycach mortality (Dagorn et al. 2012). Entanglement mortality of sharks has been shown to be very high in other areas such as the Indian Ocean (Filmalter et al. 2013).

Justification:

The WCPFC has adopted several management measures to protect vulnerable bycatch species. Members of the WCPFC are to implement the FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations. Proper handling and release guidelines should be followed when hard-shell turtles are incidentally captured (WCPFC 2008b). In addition, fisheries' observers record and report interactions with seabirds and turtles (WCPFC 2012e) (WCPFC 2008b).

Members of the WCPFC are prohibited from retaining, transshipping, storing or landing oceanic whitetip and silky sharks, and any incidentally caught sharks should be released and the incident recorded and reported (WCPFC 2012g) (WCPFC 2013f). However, the success of this is highly dependent on the quick release of silky sharks, since their post-release mortality rates increase with

time (Hutchinson et al. 2013). Members are also to implement the FAO International Plan of Action for the Conservation and Management of Sharks and National Plans of Action, and should have policies in place to reduce waste and discarding of sharks. Information on catch and effort for key species is to be reported and shark finning is banned (5% ratio) (WCPFC 2010a).

In a recent report, the WCPFC scored an average of 42% across 5 broad bycatch governance categories in a study conducted by (Gilman et al. 2013). It has been suggested that sea turtle and shark bycatch could be reduced by restricting setting on FADs or through the implementation of bycatch avoidance/mitigation devices {Gilman et al. 2011}, which have not been implemented by the WCPFC.

Western Central Pacific | Handlines and hand-operated pole-and-lines
West Pacific | Trolling lines
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Highly effective
Bycatch in trolling line, hand-operated pole-and-line, and handline fisheries is extremely low. All non-target species in these fisheries are retained and their management is assessed in C3.1.

Factor 3.3 - Scientific Research And Monitoring

Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States

Highly effective
Albacore tuna stocks are monitored and assessed on a regular basis and the last assessment was conducted in 2011 (ISC 2017). Information on catches, catch per unit effort, and size at catch data from multiple fisheries targeting albacore tuna in the North Pacific was included in the assessment (ISC 2017). We have awarded a score of "highly effective" because assessments, which include fishery-independent and -dependent data are conducted on a regular basis, the stock is peer reviewed by a scientific body and includes all major, relevant sources of fishing mortality and adequate observer coverage or video monitoring.

Northeast Pacific | Trolling lines | Canada

Highly effective
Albacore tuna stocks are monitored and assessed on a regular basis and the last assessment was conducted in 2011 (ISC 2017). Information on catches, catch per unit effort, and size at catch data from multiple fisheries targeting albacore tuna in the North Pacific was included in the assessment (ISC 2017). We have awarded a score of "highly effective" because assessments, which include fishery-independent and -dependent data are conducted on a regular basis, the stock is peer reviewed by a scientific body, includes all major relevant sources of fishing mortality, and adequate

observer coverage or video monitoring.

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)
North Pacific | Unassociated purse seine (non-FAD)
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

N/A

Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
Northwest Pacific | Trolling lines | Japan

Highly effective
Albacore tuna stocks are monitored and assessed on a regular basis and the last assessment was conducted in 2011 (ISC 2017). Information on catches, catch per unit effort, and size at catch data from multiple fisheries targeting albacore tuna in the North Pacific was included in the assessment (ISC 2017). We have awarded a score of "highly effective" because assessments, which include fishery-independent and -dependent data are conducted on a regular basis, the stock is peer reviewed by a scientific body, includes all major, relevant sources of fishing mortality and adequate observer coverage or video monitoring.

Southwest Pacific | Hand-operated pole-and-lines
South Pacific | Trolling lines

Highly effective
Albacore tuna stocks are monitored and assessed on a regular basis (ISC 2011), and include information on catches, catch per unit effort, length frequency information and tagging data. In December 2018, the WCPFC adopted an interim target reference point for this species (Tremblay-Boyer et al. 2018), (WCPFC 2018a). The WCPFC has created a bio-economic model for south Pacific albacore, which will benefit the fishery {Harley et al. 2017}. The stock assessment is peer reviewed by a scientific body, includes all major, relevant sources of fishing mortality and contains both fishery-independent data, including abundance data, and appropriate fishery-dependent data and adequate observer coverage or video monitoring. Finally, transshipment at sea is only for purse seine vessels and is prohibited except when an exemption is granted by the WCPFC. We have therefore awarded a score of 'highly effective.'

West Pacific | Unassociated purse seine (non-FAD)

Moderately Effective
Bigeye, yellowfin, and skipjack tuna stocks are regularly monitored and assessed {McKechnie et al. 2017} {McKechnie et al. 2016} (Tremblay-Boyer et al. 2017). A variety of information, including catch and effort data, size (for some species), and biological information is included in these assessments. However, these assessments generally have a high amount of uncertainty associated

with them, so we have awarded a score of "moderately effective."

Western Central Pacific | Handlines and hand-operated pole-and-lines
West Pacific | Trolling lines
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Moderately Effective
Bigeye, yellowfin, and skipjack tuna and swordfish stocks are regularly monitored and assessed (Tremblay-Boyer et al. 2017){McKechnie et al. 2016} {McKechnie et al. 2017}. A variety of information including catch and effort data, size (for some species), and biological information is included in these assessments, but there are cited issues regarding some countries' compliance with collecting and providing these data to the Commission. This noncompliance can lead to high uncertainty in these assessments (Tremblay-Boyer et al. 2017). Other species that are not regularly assessed are not typical bycatch species in this fishery. We have awarded a score of "moderately effective" due to the large uncertainty surrounding some assessment results.

Factor 3.4 - Enforcement Of Management Regulations

Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States

Highly effective
Domestically, the Pacific Fishery Management Council is in charge of enforcement, such as air and sea surveillance (PFMC 2018) through the US Coast Guard and NOAA Office of Law Enforcement. We have therefore, awarded a score of "highly effective."

Northeast Pacific | Trolling lines | Canada

Highly effective
Domestically, Canada has a compliance plan that includes the use of marine enforcement officers, public awareness campaigns, and aerial surveillance (FOC 2017). Canada also has a good compliance record with international reporting requirements (FOC 2017). We have awarded a score of "highly effective" to account for domestic measures, since the majority of fishing occurs in Canadian and US waters.

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)
North Pacific | Unassociated purse seine (non-FAD)
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin

Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

N/A

Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
Northwest Pacific | Trolling lines | Japan

Moderately Effective
Domestically, Japan uses vessel monitoring and landing site inspections and air and sea surveillance (Uosaki et al. 2017). The effectiveness of domestic measures are not known, so we have awarded a score of "moderately effective."

Southwest Pacific | Hand-operated pole-and-lines
South Pacific | Trolling lines

Moderately Effective
The Western and Central Pacific Fisheries Commission (WCPFC) assesses members' compliance with obligations, identifies areas of conservation and management that may need refinement, responds to non-compliance, and monitors and resolves non-compliance issues. The Commission evaluates members' compliance annually with respect to catch and effort limits and reporting for target species, spatial and temporal closures, observer and vessel monitoring systems (VMS) coverage and provision of scientific data (WCPFC 2012a). Vessel monitoring systems are required on all vessels fishing for highly migratory species in the western and central Pacific Ocean south of 20°N and east of 175°E. The area north of 20°N and west of 175°W had an activation date for VMS of 31 December 2013 (WCPFC 2012c). There are measures in place allowing for the boarding and inspection of vessels in the convention area (WCPFC 2006) and the WCPFC maintains a list of illegal, unreported and unregulated vessels (WCPFC 2010a).

However, assessing the effectiveness of these enforcement measures is difficult because there is a general lack of transparency of surveillance activities, infractions, and enforcement actions and outcomes (Gilman et al. 2013). A recent report found the WCPFC lacked transparency regarding the availability of compliance-related data, a lack of incentives for countries to comply with management measures, and no processes for responding to non-compliance (Gilman and Kingma 2013). (Koehler 2013) also found issues with the WCPFC related to compliance transparency, specifically because the WCPFC's compliance assessment process (there is a compliance monitoring scheme in place (WCPFC 2013)) is closed to the public and it has no way of dealing with non-compliance. In 2013, the Commission finally started releasing information on the compliance of individual nations and that continues today {WCPFC 2013g} (WCPFC 2017b). Enforcement measures are in place, but the lack of transparency regarding compliance has led to a score of "moderately effective."

West Pacific | Unassociated purse seine (non-FAD)

Moderately Effective
The WCPFC has a compliance monitoring scheme in place that assesses members' compliance with obligations, identifies areas of conservation and management that may need refinement, and monitors and resolves non-compliance issues. The Commission evaluates compliance by members

annually with respect to catch and effort limits and reporting for target species, spatial and temporal closures, observer and vessel monitoring systems (VMS) coverage, and provision of scientific data (WCPFC 2012c) (WCPFC 2017a).

Assessing the effectiveness of these enforcement measures is difficult because there is a general lack in the transparency of information regarding surveillance activities, infractions, and enforcement actions and outcomes (Gilman et al. 2013). We have therefore awarded a score of "moderately effective."

Justification:
There are specific reporting requirements in place to monitor compliance with the FAD set limiting options (WCPFC 2013a) (WCPFC 2017a). Vessel Monitoring Systems are required on all vessels fishing for highly migratory species in the western and central Pacific Ocean south of 20°N and east of 175°E. The area north of 20°N and west of 175°W had an activation date of 31 December 2013 for VMS implementation (WCPFC 2012d).

There are measures in place allowing for the boarding and inspection of vessels in the Convention Area (WCPFC 2006) and the WCPFC maintains a list of illegal, unreported and unregulated vessels (WCPFC 2010b) (WCPFC 2017c).

A study, which developed a standard way of assessing transparency in RFMOs, found the WCPFC had a lack of transparency regarding the availability of compliance-related data, a lack of incentive for countries to comply with management measures and lacked the processes needed to respond to non-compliance (Gilman and Kingma 2013). (Koehler 2013) also found issues in the WCPFC regarding compliance transparency, specifically because the WCPFC's compliance assessment process (there is a compliance monitoring scheme in place (WCPFC 2013)) is closed to the public and does not have methods of dealing with non-compliance.

In 2013, the Commission finally started releasing some information on the compliance of individual nations {WCPFC 2013g}.

Western Central Pacific | Handlines and hand-operated pole-and-lines
West Pacific | Trolling lines
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Moderately Effective
The Western and Central Pacific Fisheries Commission (WCPFC) has a compliance monitoring scheme in place that assesses members' compliance with obligations, identifies areas of conservation and management that may need refinement, responds to noncompliance, and monitors and resolves noncompliance issues. The Commission annually evaluates compliance by members with respect to catch and effort limits and reporting for target species, spatial and temporal closures, observer and Vessel Monitoring Systems (VMS) coverage, and provision of scientific data (WCPFC 2012a).

Vessel Monitoring Systems are required on all vessels fishing for highly migratory species in the western and central Pacific Ocean south of 20°N and east of 175°E. The area north of 20°N and west of 175°E had a VMS activation date of 31 December 2013 (WCPFC 2012c). There are measures in place allowing for the boarding and inspection of vessels in the Convention Area (WCPFC 2006), and the WCPFC maintains a list of illegal, unreported, and unregulated vessels (IUU) {WCPFC 2010}. But assessing the effectiveness of these enforcement measures is difficult because there is a general lack of transparency of information with regard to surveillance activities, infractions, and enforcement actions and outcomes (Gilman et al. 2013).

The WCPFC's compliance assessment process (there is a compliance monitoring scheme in place {WCPFC 2013c}) is closed to the public and it does not have ways of dealing with noncompliance. In 2013 the Commission finally started releasing some information on the compliance of individual nations {WCPFC 2013g}. We have awarded a score of "moderately effective" because enforcement and/or monitoring are in place to ensure goals are successfully met, although effectiveness of enforcement/monitoring is uncertain.

Factor 3.5 - Stakeholder Inclusion

Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States

Highly effective
The Pacific Fishery Management Council, in charge of albacore in US waters, allows for the input and inclusion of stakeholder views in determining management plans, including rebuilding overfished species (PFMC 2018). We have, therefore, awarded a score of "highly effective."

Northeast Pacific | Trolling lines | Canada

Highly effective
Domestically, Canada has an open and transparent consultation process during the development of management measures (FOC 2017). An assessment of this consultation process during 2010 indicated that the objectives were met (FOC 2017). We have awarded a score of "high" for domestic measures.

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines
Western Central Pacific | Floating object purse seine (FAD)
North Pacific | Unassociated purse seine (non-FAD)
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

N/A

Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
Northwest Pacific | Trolling lines | Japan

Highly effective
Japan uses a co-management system, meaning the government shares power with resource users, to manage the various fisheries sectors (Schmidt 2003) (Uosaki et al. 2017). Therefore, we have awarded a score of "highly effective."

Southwest Pacific | Hand-operated pole-and-lines
South Pacific | Trolling lines

Moderately Effective
The Western and Central Pacific Fisheries Commission allows for accredited observers to participate in most meetings. Historically, the WCPFC has lacked transparency in some factors (Gilman et al. 2013), but there has been improvement in recent years. We have therefore awarded a score of "moderately effective."

West Pacific | Unassociated purse seine (non-FAD)

Moderately Effective
The Western and Central Pacific Fisheries Commission allows for accredited observers to participate in most meetings. Historically the WCPFC has lacked transparency (Gilman and Kingma 2013) in some factors, but this has been improved in recent years. We have therefore awarded a score of "moderately effective."

Western Central Pacific | Handlines and hand-operated pole-and-lines
West Pacific | Trolling lines
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Moderately Effective
The Western and Central Pacific Fisheries Commission allows for accredited observers to participate in most meetings. Historically, the WCPFC has lacked transparency (Gilman et al. 2013) in some factors, but this has improved in recent years {WCPFC 2013c}. We have therefore awarded a score of “moderately effective.”

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

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

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Trolling lines | United States	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
North Pacific | Unassociated purse seine (non-FAD)	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
North Pacific Stock | Northeast Pacific | Trolling lines | Canada	Score: 5	Score: 0	Low Concern	**Green (4.472)**
North Pacific Stock | Northwest Pacific | Drifting longlines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
North Pacific Stock | Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
North Pacific Stock | Northwest Pacific | Trolling lines | Japan	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Northwestern and Central Pacific Stock | Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
South Pacific Stock | South Pacific | Trolling lines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
South Pacific Stock | Southwest Pacific | Drifting longlines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
South Pacific Stock | Southwest Pacific | Hand-operated pole-and-lines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
South Pacific Stock | Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Western and Central Pacific (WCPO) Stock | West Pacific | Trolling lines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Western and Central Pacific (WCPO) Stock | West Pacific | Unassociated purse seine (non-FAD)	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Drifting longlines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Floating object purse seine (FAD)	Score: 5	Score: 0	High Concern	**Yellow (3.162)**
Western and Central Pacific (WCPO) Stock | Western Central Pacific | Handlines and hand-operated pole-and-lines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**

Purse seine fisheries tend to have minimal contact with the bottom habitat, although FADs can be anchored to the bottom. However, they do incidentally capture some ecologically important species and the impact of this on the ecosystem is not known.

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

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

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

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

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem

impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

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

North Pacific | Unassociated purse seine (non-FAD)
West Pacific | Unassociated purse seine (non-FAD)

Score: 5
Unassociated purse seine sets do not typically come in contact with the bottom.

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Score: 5
Although pelagic longlines are surface fisheries, contact with the seabed can occur in shallow-set fisheries, such as the Hawaiian shallow-set fishery (Passfield and Gilman 2010). However, these effects are still considered to be a low risk to bottom habitats (Gilman et al. 2013) so we have awarded a score of "no impact."

Southwest Pacific | Hand-operated pole-and-lines
South Pacific | Trolling lines
Northeast Pacific | Trolling lines | Canada
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
Northwest Pacific | Trolling lines | Japan
Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States
Western Central Pacific | Handlines and hand-operated pole-and-lines
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery
West Pacific | Trolling lines
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Score: 5
Vertical gear rarely impacts bottom habitats. Tuna are pelagic species, so trolling line and handline fisheries targeting them operate in deep water where bottom contact is not likely.

Western Central Pacific | Floating object purse seine (FAD)

Score: 5
Although purse seine fishing does not typically result in the nets coming in contact with the bottom, anchored FADs could result in contact with the bottom (Beverly et al. 2012) {Seafood Watch 2013}.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Northeast Pacific | Trolling lines | Canada
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
Northwest Pacific | Trolling lines | Japan
Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

Score: 0
Not applicable because this type of fishing gear does not come into contact with bottom habitats.

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Score: 0
Pelagic longline gear typically does not come into contact with bottom habitats.

Southwest Pacific | Hand-operated pole-and-lines
South Pacific | Trolling lines
Western Central Pacific | Handlines and hand-operated pole-and-lines
West Pacific | Trolling lines
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Score: 0
Vertical fishing gear does not come in contact with bottom habitats.

Western Central Pacific | Floating object purse seine (FAD)
North Pacific | Unassociated purse seine (non-FAD)
West Pacific | Unassociated purse seine (non-FAD)

Score: 0
Although there are restrictions on when FAD sets can be made (WCPFC 2013b), there are no restrictions on
where FADs can be placed in the region, so we have awarded a score of "no effective mitigation" with respect to
habitat impacts.

Factor 4.3 - Ecosystem-based Fisheries Management

Eastern Central Pacific, Northeast Pacific | Handlines and hand-operated pole-and-lines | United States
Eastern Central Pacific, Northeast Pacific | Trolling lines | United States

Moderate Concern
The Pacific Fishery Management Council has developed a Pacific Coast Fishery Ecosystem Plan, which was developed by the council to enhance their current species specific management with broader ecosystem components. The draft was adopted in April 2013, and reviewed in 2015 (PFMC 2013).

Internationally, one of the core articles of the WCPFC Convention is to assess the impacts of fishing on target and non-target species. Management measures are in place to protect bycatch and target species and ecological risk assessments are being conducted. There is a section on Ecosystem Monitoring and Analysis within the Secretariat of the Pacific Community, which provides scientific assistance to the WCPFC (SPC 2008). IATTC has objectives that address incorporating ecosystem considerations into management and work has been done within IATTC to create ecosystem-based models, along with other types of analysis. IATTC considered management measures aimed at protecting dolphins, sea turtles, and sea birds as addressing ecosystem considerations (IATTC 2012).

The US pole and line fishery uses northern anchovy for bait which is considered an "exceptional species." The trolling line fishery also uses bait that may be considered "exceptional species." Bait fisheries are managed off the US west coast, but not necessarily under other jurisdictions (Gillett 2012) (FAO 2014). We have therefore awarded a score of "moderate" concern.

North Pacific | Unassociated purse seine (non-FAD)

Moderate Concern
The North Pacific unassociated purse seine fishery that targets Pacific bluefin tuna does not interact with many bycatch species but bluefin tuna are considered an "exceptional species." It should be noted that the WCPFC has conducted assessments on bycatch species and implemented management measures for them (Rice and Harley 2013) (Rice and Harley 2012b). In addition, the WCPFC has initiated studies to monitor changes to the food web and to examine predator-prey relationships (Allain 2010) (Allain et al. 2012). IATTC has objectives that address incorporating ecosystem considerations into management and work has been done within IATTC to create ecosystem-based models and other types of analysis. IATTC adopted management measures aimed at protecting dolphins, sea turtles, and sea birds to address some ecosystem impacts {IATTC 2012c}. We have awarded a score of "moderate" concern because "exceptional species" are caught and there is effort underway to assess the ecosystem impact of this loss.

Northeast Pacific | Trolling lines | Canada

Low Concern
Canada has an integrated management plan in place and uses an ecosystem science approach to

manage fisheries (DFO 2007). Internationally, one of the core articles of the WCPFC Convention is to assess the impacts of fishing on target and non-target species. Management measures are in place to protect bycatch and target species, and ecological risk assessments are being conducted. There is a section on Ecosystem Monitoring and Analysis within the Secretariat of the Pacific Community, which provides scientific assistance to the WCPFC (SPC 2008). IATTC has objectives that address incorporating ecosystem considerations into management and work has been done within IATTC to create ecosystem-based models, along with other types of analysis. IATTC considered management measures aimed at protecting dolphins, sea turtles, and sea birds as addressing ecosystem considerations (IATTC 2017).

Canadian trolling line fisheries have very little bycatch and use jigs rather than live bait (FOC 2017). We have therefore awarded a score of "low" concern.

Northwest Pacific | Drifting longlines
Southwest Pacific | Drifting longlines
Western Central Pacific | Drifting longlines

Moderate Concern

The pelagic longline fishery in the western and central Pacific Ocean catches a number of ecologically important species including other tunas, billfish, and sharks. Sharks are top predators in many ecosystems and play a critical role in how these ecosystems are structured and function (Piraino et al. 2002) (Stevens et al. 2000). The loss of these predators can lead to changes in prey abundances that can cascade throughout the foodweb (Myers et al. 2007) (Duffy 2003) (Ferretti et al. 2010) (Schindler et al. 2002), and also lead to behavioral changes (Heithaus et al. 2007). In the North Pacific Ocean, the removal of blue sharks and tunas by longline fisheries has caused an increase in the number of short-lived fast growing species such as mahi mahi (Polovina 2009).

The Western and Central Pacific Fisheries Commission has begun identifying key shark species impacted by fisheries in the Convention Area and has to date completed stock assessments on two species (oceanic white tip and silky sharks) and adopted several management measures to protect bycatch species {Rice and Harley 2013} (Rice and Harley 2012b). In addition, the WCPFC has initiated studies to monitor changes to the food-web and to examine predator-prey relationships (Allain 2010) (Allain et al. 2012).

We have awarded a score of "moderate" concern because this fishery catches exceptional species, but there are some efforts to incorporate their ecological role into management.

Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan
Northwest Pacific | Trolling lines | Japan
Northwest Pacific | Handlines and hand-operated pole-and-lines | Japan | Bluefin Fishery
Northwest Pacific | Trolling lines | Japan | Bluefin Fishery

Moderate Concern

It is unknown if ecosystem impacts are addressed in Japan. Internationally one of the core articles of the WCPFC Convention is to assess the impacts of fishing on target and non-target species.

Management measures are in place to protect bycatch and target species and ecological risk assessments are being conducted. There is a section on Ecosystem Monitoring and Analysis within the Secretariat of the Pacific Community, which provides scientific assistance to the WCPFC (SPC 2008). IATTC has objectives that address incorporating ecosystem considerations into management and work has been done within IATTC to create ecosystem-based models, along with other types of analysis. IATTC considered management measures aimed at protecting dolphins, sea turtles, and sea birds as addressing ecosystem considerations (IATTC 2012).

Japanese pole and line fisheries rely on live baitfish, which could include "exceptional species" such as Japanese anchovy and Japanese pilchard, and the effect of the removal of these species on the ecosystem is unknown. Similarly, the bait used in the trolling line fisheries also may include "exceptional species." Few baitfish fisheries are managed (Gillett 2012) (FAO 2014). We have therefore awarded a score of "moderate" concern.

Southwest Pacific | Hand-operated pole-and-lines
South Pacific | Trolling lines

Moderate Concern
One of the core articles of the WCPFC Convention is to assess the impacts of fishing on target and non-target species. There are management measures in place to protect bycatch and target species, ecological risk assessments are being conducted, and there is an ecosystem monitoring and analysis section within the Secretariat of the Pacific Community, which provides scientific assistance to the WCPFC (SPC 2008). However, trolling line and hand-operated pole and line fisheries rely on live baitfish, which could include "exceptional species" such as anchovy or sardines; the effect of the removal of these species on the ecosystem is unknown and few baitfish fisheries are managed (Gillett 2010) (FAO 2014). Due to these uncertainties, we have scored this factor as "moderate" concern.

West Pacific | Unassociated purse seine (non-FAD)

Moderate Concern
Purse seine fisheries in the western and central Pacific Ocean catch several ecologically important groups including tunas and sharks. In particular, sharks are considered top predators in many ecosystems and play a critical role in how these ecosystems are structured and function (Piraino et al. 2002) (Stevens et al. 2000). The loss of these predators can cause changes to prey abundances, which can lead to a cascade of other affects (Myers et al. 2007) (Duffy 2003) (Ferretti et al. 2010) (Schindler et al. 2002) and behavioral changes (Heithaus et al. 2007). The WCPFC has begun identifying key shark species impacted by fisheries in the Convention Area and has to date completed stock assessments on two species (oceanic white tip and silky sharks) (Rice and Harley 2013) (Rice and Harley 2012b). In addition, the WCPFC has initiated studies to monitor changes to the food web and to examine predator-prey relationships (Allain 2010) (Allain et al. 2012). We have awarded a score of "moderate" concern because some ecosystem impacts have been addressed.

Western Central Pacific | Floating object purse seine (FAD)

High Concern
Purse seine fisheries in the western and central Pacific Ocean catch several ecologically important

groups, including tunas and sharks. In particular, sharks are considered top predators in many ecosystems and play a critical role in how these ecosystems are structured and function (Piraino et al. 2002) (Stevens et al. 2000). The loss of these predators can change prey abundances, which can lead to a cascade of other effects (Myers et al. 2007) (Duffy 2003) (Ferretti et al. 2010) (Schindler et al. 2002) as well as behavioral changes (Heithaus et al. 2007).

The use of FADs in the western and central Pacific Ocean could impact the surrounding ecosystems. Smaller tuna, specifically bigeye and yellowfin, are often associated with FADs and this could lead to growth and recruitment overfishing (Freon and Dagrom 2000). In addition, behavioral changes in tunas could be associated with the introduction of FADs into the Pacific region. These include increases in the biomass of tunas under FADs, reduced free-school abundance, changes in school movement patterns and structure, and differences between the age and size of free and FAD associated schools (Fonteneau 1991) (Menard et al. 2000) (Menard et al. 2000b) (Josse et al. 1999) (Josse et al. 2000). The negative, long-term impacts of FAD fishing are difficult to evaluate due to insufficient data (Fonteneau et al. 2000); therefore, additional research should be undertaken to determine its potential effects on the ecosystem, including monitoring the number of FADs being used (Dagorn et al. 2012).

The WCPFC has begun identifying key shark species impacted by fisheries in the Convention Area and has, to date, completed stock assessments on two species (oceanic white tip and silky sharks) (Rice and Harley 2013) (Rice and Harley 2012b). In addition, the WCPFC has initiated studies to monitor changes to the food web and to examine predator-prey relationships (Allain 2010) (Allain et al. 2012), and has instituted some FAD specific management measures (WCPFC 2012a). We have awarded a score of "high" concern because there is a potential for negative ecological impacts from FADs and management is not designed to avoid these impacts.

Western Central Pacific | Handlines and hand-operated pole-and-lines
West Pacific | Trolling lines
Northwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines
Southwest Pacific, Western Central Pacific | Handlines and hand-operated pole-and-lines

Moderate Concern

One of the core articles of the WCPFC Convention is to assess the impacts of fishing on target and non-target species. Management measures are in place to protect bycatch and target species, ecological risk assessments are being conducted, and there is an Ecosystem Monitoring and Analysis section within the Secretariat of the Pacific Community, which provides scientific assistance to the WCPFC (SPC 2010). It is unknown if this fishery causes detrimental impacts to the food web and it's possible more stringent measures are needed. We have therefore awarded a score of "moderate" concern.

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

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