Skipjack tuna, Yellowfin tuna, Swordfish

*Katsuwonus pelamis, Thunnus albacares, Xiphias gladius*

Western and Central Pacific

*Troll/Pole, Handlines*

*July 11, 2017 (updated January 8, 2018)*

*Seafood Watch Consulting Researcher*

**Disclaimer**
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Seafood Watch Standard used in this assessment: Standard for Fisheries vF2
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About Seafood Watch

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

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

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.
Guiding Principles

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

Based on this principle, Seafood Watch had developed four sustainability criteria for evaluating wildcatch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery’s management?
- How does the fishing affect habitats and the stability of the ecosystem?

Each criterion includes:

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

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

**Best Choice/Green:** Are well managed and caught in ways that cause little harm to habitats or other wildlife.

**Good Alternative/Yellow:** Buy, but be aware there are concerns with how they’re caught.

**Avoid/Red** Take a pass on these for now. These items are overfished or caught in ways that harm other marine life or the environment.

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1 “Fish” is used throughout this document to refer to finfish, shellfish and other invertebrates
Summary

This report covers the troll, handline (a single line fished by hand), and pole and line (hooked line attached to a pole) fisheries operating in the Western and Central Pacific Ocean (WCPO) for skipjack tuna (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares), and swordfish (Xiphias gladius). The yellowfin tuna handline fishery operates primarily in the Philippines and Indonesia, and it is considered a separate fishery within this report. The handline tuna fishery in Vietnam also catches swordfish, which is addressed in this report. Kite fishing (a kite with a drop line attached to a hook and bait that is fished on the surface) is also used in certain regions of Indonesia (e.g., central Maluku) to target yellowfin tuna.

Both tuna species covered in this report have medium inherent vulnerability to fishing pressure based on life-history characteristics, including when they reach sexual maturity, maximum size, and spawning strategy. These species occupy a high trophic level in the ecosystem.

The skipjack and yellowfin tuna populations are healthy in this region: both species’ population levels are above target levels, and exploitation levels are below what is necessary for maximum sustainable yield. Swordfish populations in the North Pacific are healthy, while the status of swordfish in the South Pacific is less certain.

Troll, handline, and pole fisheries have a low amount of bycatch, and interactions are rare with species of concern (e.g., marine mammals, seabirds, and sea turtles).

The Western and Central Pacific Fisheries Commission (WCPFC) manages these species in the WCPO. Management of skipjack and yellowfin tunas by the WCPFC has been moderately effective. Recent management measures have been put in place to rebuild bigeye tuna that is caught together with skipjack and yellowfin, and bigeye is no longer considered overfished.

Troll/pole gear does not typically come in contact with the bottom, so it has little to no impact on bottom habitats.
## Final Seafood Recommendations

<table>
<thead>
<tr>
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<th>CRITERION 1: IMPACTS ON THE SPECIES</th>
<th>CRITERION 2: IMPACTS ON OTHER SPECIES</th>
<th>CRITERION 3: MANAGEMENT EFFECTIVENESS</th>
<th>CRITERION 4: HABITAT AND ECOSYSTEM</th>
<th>OVERALL RECOMMENDATION</th>
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<tr>
<td>Skipjack tuna Western and Central Pacific, Troll/Pole</td>
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<tr>
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<td>Green (3.83)</td>
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<td>Green (3.87)</td>
<td>Best Choice (3.86)</td>
</tr>
<tr>
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<td>Green (3.87)</td>
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</tr>
<tr>
<td>Swordfish: North Pacific Western and Central Pacific, Handlines</td>
<td>Green (5.00)</td>
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<td>Swordfish: South Pacific Western and Central Pacific, Handlines</td>
<td>Yellow (3.05)</td>
<td>Green (3.32)</td>
<td>Yellow (3.00)</td>
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<td>Best Choice (3.29)</td>
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</tbody>
</table>

### Summary

Skipjack and yellowfin tuna caught in the western and central Pacific Ocean (WCPO) troll/pole fishery and yellowfin tuna and swordfish caught in the handline fishery and swordfish are 'Best Choice'.

### 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.
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 skipjack tuna (*Katsuonus pelamis*) and yellowfin tuna (*Thunnus albacares*) troll, handline (single fishing line fished by hand), and pole and line (hooked line attached to a pole) fisheries operating in the Western and Central Pacific Ocean. The yellowfin tuna handline fishery primarily operates in the Philippines and Indonesia and is considered a separate fishery within this report. Kite fishing (a kite with a drop line attached to a hook and bait that is fished on the surface) is also used in certain regions of Indonesia (i.e., central Maluku) to target yellowfin tuna.

Species Overview

Skipjack and yellowfin tuna are found in tropical and subtropical waters of the Pacific Ocean (Harley et al. 2014) (Rice et al. 2014) (Langely et al. 2011). There are four populations of yellowfin and five of skipjack: Western and Central Pacific Ocean, Eastern Pacific Ocean, Atlantic (eastern and western skipjack) and Indian Ocean.

Globally, purse seines capture the majority of skipjack and yellowfin tuna. Skipjack and yellowfin tuna catches have increased substantially over time, peaking in the early 2000s for yellowfin tuna and around 2009 for skipjack tuna (ISSF 2013b).

The Western and Central Pacific Fisheries Commission manages these three species within the Western and Central Pacific Ocean.

Production Statistics

Troll and pole fisheries do not represent a major proportion of the total catch of tunas in the Western and Central Pacific Ocean (WCPO).

Skipjack tuna caught in the WCPO represent 36% of all worldwide tuna landings (ISSF 2013b). Pole and line fisheries for skipjack tuna historically dominated the catch, peaking at 380,000 t in 1984. The Japanese distant-water and offshore pole and line fisheries and the island country domestic pole and line fisheries are some of the primary pole and line fisheries for skipjack tuna in the region. Catches of skipjack tuna in the WCPO have increased over time, reaching 1.6 million tons in 2009. The importance of the pole and line fishery has diminished in recent years as the purse seine fleet expanded (Rice et al. 2014).
Yellowfin tuna is caught by a range of gears including troll and pole and line. 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 2012 (Davies et al. 2014b). Between 2005 and 2008, only 18% of yellowfin tuna catches were made up by a variety of surface gears including pole and line. Catches from the Japanese distant-water pole and line fishery and the Solomon Islands and Papua New Guinea pole and line fisheries peaked at around 8,000 t in the late 1970s and early 1980s, but have been insignificant since 2000. Catches by the Japanese coastal surface fishery peaked in the mid-1980s at 15,000 t but, in recent years, catches have only been around 5,000 t (Davies et al. 2014b).
**Importance to the US/North American market.**

The United States imported over half of all skipjack tuna from Panama (55%) during 2013. Other important countries included the Philippines (15%) and Mexico (13%). The majority of yellowfin tuna were imported from Trinidad and Tobago in 2013 (49%) (NMFS 2014).
Around 200 t of bigeye and skipjack and 300 t of yellowfin were exported in 2011. Exports of bigeye tuna and yellowfin tuna were higher in 2012 (679 t and 843 t, respectively). Skipjack tuna exports during 2012 were 339 t (NMFS 2013).

**Common and market names.**
Skipjack tuna is also known as ocean bonito and lesser tuna, and in Hawaii as aku. Yellowfin tuna is known as ahi in Hawaii.

**Primary product forms**
Skipjack and yellowfin tuna are sold as fresh and frozen products and can be canned.
Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown.

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

Criterion 1 Summary

<table>
<thead>
<tr>
<th>SKIPIACK TUNA</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Score</th>
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<td>Region</td>
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<td>Swordfish / North Pacific</td>
<td>Region</td>
<td>Method</td>
<td>Custom Group</td>
<td>2.00: Medium</td>
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<td>Western and Central Pacific</td>
<td>Handlines</td>
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<tr>
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<td>Handlines</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

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The skipjack and yellowfin tuna populations are healthy in this region: both species' population levels are above target levels, and exploitation levels are below what is necessary for maximum sustainable yield. Swordfish populations in the North Pacific are healthy, although the status of swordfish in the South Pacific is less certain.

Criterion 1 Assessment

**SCORING GUIDELINES**

**Factor 1.1 - Inherent Vulnerability**
- **Low**—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).
- **Medium**—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).
- **High**—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make it particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator). Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

**Factor 1.2 - Abundance**
- **5 (Very Low Concern)**—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.
- **4 (Low Concern)**—Population may be below target abundance level, but it is considered not overfished
- **3 (Moderate Concern)**—Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.
- **2 (High Concern)**—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.
- **1 (Very High Concern)**—Population is listed as threatened or endangered.

**Factor 1.3 - Fishing Mortality**
- **5 (Very Low Concern)**—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).
• **3.67 (Low Concern)**—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).

• **2.33 (Moderate Concern)**—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.

• **1 (High Concern)**—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.

• **0 (Critical)**—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

**SKIPJACK TUNA**

**Factor 1.1 - Inherent Vulnerability**

**WESTERN AND CENTRAL PACIFIC, TROLL/POLE**

**Medium**

FishBase assigned a moderate vulnerability of 39 out of 100 (Froese and Pauly 2013). The life-history characteristics support this score. Sexual maturity is reached around 45 cm or 2 years of age, and skipjack can reach a maximum length of 110 cm and age of 12. It is a broadcast spawner and has a high trophic level (Froese and Pauly 2013). According to the SWAT productivity and susceptibility table, these life-history characteristics suggest a moderate level (2.16) level of vulnerability.

**Justification:**

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<th>Life history attribute</th>
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<td>Average maximum size</td>
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<td>Average size at maturity</td>
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<td>Reproductive strategy</td>
<td>broadcast spawner</td>
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</tr>
<tr>
<td>Trophic level</td>
<td>&gt;3.25</td>
<td>1</td>
</tr>
</tbody>
</table>

**Factor 1.2 - Abundance**

**WESTERN AND CENTRAL PACIFIC, TROLL/POLE**

**Very Low Concern**

Skipjack tuna in the Western and Central Pacific Ocean (WCPO) was last assessed in 2014. According to the assessment, the total biomass has been higher than the reference point ($B_{MSY}$, the biomass needed to produce the maximum sustainable yield) over the entire period (1972–2010). The current total biomass is around 52% of virgin levels ($B_0$) and the ratio of the current spawning biomass to that needed to produce the maximum sustainable yield is well above 1 ($SB_{current}/SB_{MSY} = 1.94$) (Rice et al. 2014). Therefore, skipjack tuna is not overfished and is above target levels. We have awarded a “very low” concern score.

**Factor 1.3 - Fishing Mortality**
### SWORDFISH / NORTH PACIFIC

**Factor 1.1 - Inherent Vulnerability**

**Very 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 current fishing mortality rate is below that needed to produce MSY ($F_{current}/F_{MSY} = 0.62$) (Rice et al. 2014). Therefore, overfishing of skipjack tuna is not occurring. We have awarded a “very low” concern score.

### SWORDFISH / SOUTH PACIFIC

**Factor 1.1 - Inherent Vulnerability**

**WESTERN AND CENTRAL PACIFIC, TROLL/POLE**  
**Very 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 current fishing mortality rate is below that needed to produce MSY ($F_{current}/F_{MSY} = 0.62$) (Rice et al. 2014). Therefore, overfishing of skipjack tuna is not occurring. We have awarded a “very low” concern score.

**WESTERN AND CENTRAL PACIFIC, HANDLINES**  
**Medium**

FishBase assigned a high to very high vulnerability of 72 out of 100 (Froese and Pauly 2013). But the life history characteristics of swordfish indicate a lower vulnerability to fishing. Swordfish reaches sexual maturity at around 180 cm in size and around 5 years of age. It reaches a maximum length of 455 cm and lives more than 10 years. Swordfish is a broadcast spawner and a top predator (Froese and Pauly 2013). This is more indicative of a moderate vulnerability to fishing.

**Factor 1.2 - Abundance**

**WESTERN AND CENTRAL PACIFIC, HANDLINES**  
**Very Low Concern**

In 2014, an assessment for swordfish in the North Pacific was conducted. This assessment considered two populations: one in the Western and Central Pacific (WCPO) and one in the Eastern Pacific Ocean. According to this model, the exploitable biomass for the population in the WCPO region fluctuated at or above the level needed to produce the maximum sustainable yield ($B_{MSY}$) for most of the time series (1951–2012), and there is a low probability (14%) of the biomass being below $B_{MSY}$ in 2012 (ISCBWG 2014). We have therefore awarded a "very low" concern score.

**Factor 1.3 - Fishing Mortality**

**WESTERN AND CENTRAL PACIFIC, HANDLINES**  
**Very Low Concern**

In 2014, an assessment for swordfish in the North Pacific was conducted. Exploitation rates in this region peaked in the 1960s and have declined since. The current fishing mortality rate ($H_{2010-2012}$) is 15%, which is 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, so overfishing is not occurring (ISC 2014). We have therefore awarded a "very low" concern score.

### SWORDFISH / SOUTH PACIFIC

**Factor 1.1 - Inherent Vulnerability**

**WESTERN AND CENTRAL PACIFIC, HANDLINES**

Very Low Concern

In 2014, an assessment for swordfish in the North Pacific was conducted. Exploitation rates in this region peaked in the 1960s and have declined since. The current fishing mortality rate ($H_{2010-2012}$) is 15%, which is 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, so overfishing is not occurring (ISC 2014). We have therefore awarded a "very low" concern score.
**Factor 1.1 - Inherent Vulnerability**

**YELLOWFIN TUNA**

FishBase assigned a "moderate" to "high" vulnerability of 46 out of 100 (Froese and Pauly 2013). The life-history characteristics support a "moderate" vulnerability score. Yellowfin tuna reaches sexual maturity by 100 cm in length (although growth rates vary by location), and 2 to 3 years of age (Itano 2000). It can attain a maximum length of 180 cm and live to at least 4 and perhaps 9 years. It is a broadcast spawner and an important predator in the ecosystem (Davies et al. 2014) (Froese and Pauly 2013). These life-history characteristics support a "moderate" vulnerability score.

**Factor 1.2 - Abundance**

**WESTERN AND CENTRAL PACIFIC, HANDLINES**

**Low Concern**

In 2013, an updated assessment of swordfish in the southern region of the Western and Central Pacific Ocean (WCPO) was conducted. This updated stock assessment included both the South-West Pacific (SWP) as well as the South-Central Pacific (SCP). Compared to the 2008 assessment, this recent assessment was able to determine abundance estimates for both regions. But considerable uncertainty still surrounded the assumptions regarding growth, maturity, and mortality (age-specific). Standardized catch rates for the main fleets declined drastically between 1997 and 2011, and the mean size also decreased in the main fisheries. The total biomass and spawning biomass have declined since the late 1990s, and the current levels are 44%–68% and 27%–55%, respectively, of virgin levels. The ratios of the biomass and spawning biomass (mature fish) to the levels needed to produce the maximum sustainable yield (MSY) range from 1.15–1.85 and 1.15–3.53, respectively, indicating that the population is not overfished (Davies et al. 2013). We have awarded a "low" concern and not very low concern score because of the high level of uncertainty.

**Factor 1.3 - Fishing Mortality**

**WESTERN AND CENTRAL PACIFIC, HANDLINES**

**Moderate Concern**

According to the updated 2013 assessment of swordfish in the Southwest Pacific Ocean, catches are around the levels needed to produce the maximum sustainable yield (MSY) (82%–102%). The fishing mortality rate for juvenile swordfish increased in the mid-1990s, and the ratios of the current fishing mortality rates to those needed to produce MSY range from 0.33 to 1.77. These indicate that, under some assumptions, the population may be undergoing overfishing (Davies et al. 2013). We have therefore awarded a "moderate" concern and not a low concern score.
characteristics suggest a "moderate" level of vulnerability (2.33), according to the SWAT productivity and susceptibility analysis.

**Justification:**

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<thead>
<tr>
<th>Life history attribute</th>
<th>Value</th>
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</thead>
<tbody>
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<tr>
<td>Average size at maturity</td>
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<tr>
<td>Reproductive strategy</td>
<td>broadcast spawner</td>
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</tr>
<tr>
<td>Trophic level</td>
<td>&gt;3.25</td>
<td>1</td>
</tr>
</tbody>
</table>

**Factor 1.2 - Abundance**

WESTERN AND CENTRAL PACIFIC, TROLL/POLE
WESTERN AND CENTRAL PACIFIC, HANDLINES

**Very Low Concern**

The biomass-based reference points for the reference model used in the 2017 assessment (SB_{RECENT}/SB_{MSY} – the ratio of the current (2011 to 2014) spawning (mature fish) biomass to that needed to produce the maximum sustainable yield) was 1.37. The ratio of the latest (2014) spawning biomass to the level needed to produce the maximum sustainable yield (SB_{CURRENT}/SB_{MSY}) was 1.38. The ratio of the recent spawning biomass to the biomass with no fishing mortality is 0.31, 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}. (Tremblay-Boyer et al. 2017). We have therefore awarded a score of "very low" concern.

**Factor 1.3 - Fishing Mortality**

WESTERN AND CENTRAL PACIFIC, TROLL/POLE
WESTERN AND CENTRAL PACIFIC, HANDLINES

**Very 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 "very low" concern.
Criterion 2: Impacts on other species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. 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.

To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

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

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

Criterion 2 Summary

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigeye tuna</td>
<td>2.00:Medium</td>
<td>4.00:Low Concern</td>
<td>3.67:Low Concern</td>
<td>Green (3.83)</td>
</tr>
<tr>
<td>Yellowfin tuna</td>
<td>2.00:Medium</td>
<td>5.00:Very Low Concern</td>
<td>5.00:Very Low Concern</td>
<td>Green (5.00)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swordfish / South Pacific</td>
<td>2.00:Medium</td>
<td>4.00:Low Concern</td>
<td>2.33:Moderate Concern</td>
<td>Yellow (3.05)</td>
</tr>
<tr>
<td>Finfish</td>
<td>2.00:Medium</td>
<td>3.00:Moderate Concern</td>
<td>3.67:Low Concern</td>
<td>Green (3.32)</td>
</tr>
<tr>
<td>Yellowfin tuna</td>
<td>2.00:Medium</td>
<td>5.00:Very Low Concern</td>
<td>5.00:Very Low Concern</td>
<td>Green (5.00)</td>
</tr>
</tbody>
</table>
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., 5% or more 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 {Gillet 2012}. For these reasons, baitfish species are not included in this report, and 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 fishery targets only yellowfin tuna, and bycatch of bigeye and skipjack tuna is less than 5% of the total catch. 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 catches of bigeye tuna in the WCPO make up less than 1% of the total catch of bigeye in the region (WCPFC 2014). We have therefore assessed yellowfin and swordfish in the yellowfin targeted handline fishery, but have also considered and rated the impact of the fishery on other assorted finfish species.

**Criterion 2 Assessment**

**SCORING GUIDELINES**

**Factor 2.1 - Inherent Vulnerability**
(same as Factor 1.1 above)

**Factor 2.2 - Abundance**
(same as Factor 1.2 above)

**Factor 2.3 - Fishing Mortality**
(same as Factor 1.3 above)

**BIGEYE TUNA**

**Factor 2.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, TROLL/POLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medium</strong></td>
</tr>
</tbody>
</table>

FishBase assigned a "high" to "very high" vulnerability of 72 out of 100 (Froese and Pauly 2013). However, bigeye tuna's life-history characteristics suggest a "medium" vulnerability to fishing. For example, bigeye tuna reaches sexual maturity at around 100 to 125 cm, reaches a maximum length of 200 cm, and lives around 11 years (Davies et al. 2014) (Froese et al. 2013). It is a broadcast spawner and top predator (Froese and Pauly 2013). Based on the Seafood Watch productivity analysis table, these life-history characteristics suggest a "medium" level of vulnerability according to the SWAT productivity and susceptibility table (inherent vulnerability = 2). We acknowledge that other methods may suggest a different vulnerability rating. But the stock status of bigeye tuna is known, so this inherent vulnerability score will not affect the overall outcome. Thus, this factor is awarded a score of "medium" vulnerability based on the productivity table analysis.

**Justification:**

<table>
<thead>
<tr>
<th>Life history attribute</th>
<th>Value</th>
<th>PSA score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average maximum age</td>
<td>10 to 25 years</td>
<td>2</td>
</tr>
<tr>
<td>Average maximum size</td>
<td>100 to 300 cm</td>
<td>2</td>
</tr>
<tr>
<td>Average size at maturity</td>
<td>40 to 200 cm</td>
<td>2</td>
</tr>
<tr>
<td>Reproductive strategy</td>
<td>broadcast spawner</td>
<td>3</td>
</tr>
<tr>
<td>Trophic level</td>
<td>&gt;3.25</td>
<td>1</td>
</tr>
</tbody>
</table>

**Factor 2.2 - Abundance**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, TROLL/POLE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Concern</strong></td>
</tr>
</tbody>
</table>

Bigeye tuna in the Western and Central Pacific Ocean (WCPO) were most recently assessed in 2017. According
to the base case model, the median ratio of the current average (2011 to 2014) spawning biomass to that
needed to produce the maximum sustainable yield ($SB_{RECENT} / SB_{MSY}$) was 1.21 and the ratio of the latest
(2014) spawning biomass (mature fish) to that needed to produce the maximum sustainable yield
($SB_{LATEST} / SB_{MSY}$) was 1.42. The median ratio of the recent spawning biomass to that spawning biomass with
no fishing is 0.34, which is above the limit reference point of 0.20, indicating that the population is not
overfished (McKechnie et al. 2017). This is a significant change and improvement from the 2014 assessment
(Harley et al. 2014). We have awarded a score of "low" concern because bigeye tuna are no longer overfished
and the spawning stock biomass is above that needed to produce maximum sustainable yield.

Factor 2.3 - Fishing Mortality

WESTERN AND CENTRAL PACIFIC, TROLL/POLE

Low Concern

The median ratio of current fishing mortality rates to those that produce the maximum sustainable yield
($F_{CURRENT} / F_{MSY}$) was 0.83, indicating overfishing is not occurring (McKechnie et al. 2017). This is a significant
improvement from the last assessment (Harley et al. 2014). We have awarded a score of "low" concern based
on the assessment results that overfishing is no longer occurring but not a "very low" concern due to
considerable uncertainty in the results.

Factor 2.4 - Discard Rate

WESTERN AND CENTRAL PACIFIC, TROLL/POLE

< 20%

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
captured 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).
Therefore, we have left the score as <20%, our lowest score possible.

FINFISH

Factor 2.1 - Inherent Vulnerability

WESTERN AND CENTRAL PACIFIC, HANDLINES

Medium

Finfish have a moderate vulnerability to fishing (SFW 2013).

Factor 2.2 - Abundance

WESTERN AND CENTRAL PACIFIC, HANDLINES

Moderate Concern

Handline fisheries that target yellowfin tuna also capture several small tuna species, such as bullet and
kawakawa. We have awarded a “moderate” concern score based on the Seafood Watch unknown bycatch matrix for finfish species (SFW 2013).

**Factor 2.3 - Fishing Mortality**

WESTERN AND CENTRAL PACIFIC, HANDLINES

**Low Concern**

According to the Seafood Watch unknown bycatch matrix, finfish score a "low" concern for fishing mortality (SFW 2013).

**Factor 2.4 - Discard Rate**

WESTERN AND CENTRAL PACIFIC, HANDLINES

< 20%

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). Therefore, we have left the score as <20%, our lowest score possible.
Criterion 3: Management Effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. 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 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern

Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Harvest Strategy</th>
<th>Bycatch Strategy</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western and Central Pacific / Troll/Pole</td>
<td>3.00</td>
<td>0.00</td>
<td>Yellow (3.00)</td>
</tr>
<tr>
<td>Western and Central Pacific / Handlines</td>
<td>3.00</td>
<td>0.00</td>
<td>Yellow (3.00)</td>
</tr>
</tbody>
</table>

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Harvest Strategy

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- 5 (Very Low Concern)—Rated as ‘highly effective’ for all seven subfactors considered
- 4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated ‘highly effective’ and all other subfactors rated at least ‘moderately effective.’
- 3 (Moderate Concern)—All subfactors rated at least ‘moderately effective.’
- 2 (High Concern)—At minimum, meets standards for ‘moderately effective’ for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated ‘ineffective.’
- 1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated ‘ineffective.’
- 0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.

Factor 3.1 Summary
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) that 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 (e.g., General Fisheries Commission for the Mediterranean (GFCM)), while others manage a group of species such as tunas (e.g., Inter-American Tropical Tuna Commission (IATTC)).

This report focuses on troll/pole and handline fisheries targeting tunas within the Western and Central Pacific Ocean (WCPO). The RFMO in charge in this region is the Western and Central Pacific Fisheries Management Council (WCPFC) (see below for member countries). Management of bigeye, skipjack, and yellowfin tunas by the WCPFC have been moderately effective. Recent management measures have been put into place for overfished bigeye tuna but so far have been unsuccessful. In addition, scientific advice is not always followed and there is no proved track record for successful enforcement of enacted measures.


**Subfactor 3.1.1 – 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? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.*

**WESTERN AND CENTRAL PACIFIC, TROLL/POLE**

**WESTERN AND CENTRAL PACIFIC, HANDLINES**

**Moderately Effective**

In fisheries other than longline and purse seine, such as the troll/pole, members of the Western and Central Pacific Fisheries Commission (WCPFC) must keep total effort in their tuna fisheries below the average level from 2001–2004 or in 2004 (WCPFC 2012a) (WCPFC 2014b). 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. Target reference points are not yet in place for these species, except for bigeye tuna (in the short term), although the WCPFC has a working group that is developing reference points for other species (WCPFC 2013b). 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 has an interim harvest control rule in place for tropical tunas and albacore, the WCPFC has no
Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/endangered species or to limit fishery’s impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

WESTERN AND CENTRAL PACIFIC, TROLL/POLE

N/A

No target species are currently overfished or undergoing overfishing.

WESTERN AND CENTRAL PACIFIC, HANDLINES

N/A

Yellowfin tuna are not overfished and therefore not in need of a recovery plan. We have therefore awarded a N/A score.

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery’s impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

WESTERN AND CENTRAL PACIFIC, TROLL/POLE

WESTERN AND CENTRAL PACIFIC, HANDLINES

Moderately Effective

Bigeye, yellowfin, and skipjack tuna stocks are regularly monitored and assessed (Harley et al. 2014) (Rice et al. 2014) (Davies et al. 2014). 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 with regard to some countries’ compliance with collecting and providing this data to the Commission. This noncompliance can lead to great degrees of uncertainty in these assessments (Davies et al. 2014). Other species that are not regularly assessed are not typical bycatch species in this fishery. We have awarded a “moderately effective” score due to the large uncertainty surrounding some assessment results.

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.
Subfactor 3.1.5 – 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.

**WESTERN AND CENTRAL PACIFIC, TROLL/POLE**

**WESTERN AND CENTRAL PACIFIC, HANDLINES**

**Moderately Effective**

The last bigeye, skipjack, and yellowfin tuna assessments recommended ways to improve the current statistical model used and identified needs for data improvement, but they did not identify specific management measures (Davies et al. 2014) (Davis et al. 2011) (Rice et al. 2014) (Davies et al. 2014). Based on the assessment results, bigeye fishing mortality levels need to be 36% less than the 2008–2011 level in order to be sustainable. The Scientific Committee noted that spatial management could be utilized for yellowfin tuna and that catches should not be increased from 2012 levels (WCPFC 2014b). In addition, reducing the fishing mortality on juveniles would increase the overall yield (Harley et al. 2014). The Scientific Committee did recommend in 2009 that the Commission consider fishing limits for skipjack (Rice et al. 2014). The Commission does recognize that fishing mortality needs to be reduced to improve the status of bigeye and yellowfin tuna in this region (WCPFC 2012). The Commission has recently prohibited discarding of these species but there are not catch limits for either species in this fishery. The 2014 Commission meeting had not occurred at the time of this report, so it is unknown if additional management measures are to be adopted based on the updated 2014 stock assessments. We have therefore awarded a “moderately effective” score.

**WESTERN AND CENTRAL PACIFIC, TROLL/POLE**

**WESTERN AND CENTRAL PACIFIC, HANDLINES**

**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 December 31, 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 2010a). 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).

A recent study, which developed a standard way of assessing transparency in RFMOs, found the WCPFC had a lack of transparency with regard to 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 noncompliance (Gilman and Kingma 2013). Koehler (2013) also found both the WCPFC and IATTC to be ineffective with regard to compliance transparency; specifically, the WCPFC’s compliance assessment process (there is a compliance monitoring scheme in place (WCPFC 2013d)) is closed to the public and it does not have ways of dealing with noncompliance, while the IATTC does not appear to deal with compliance issues in a thorough
Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

WESTERN AND CENTRAL PACIFIC, TROLL/POLE

Moderately Effective

Management measures enacted by the Western and Central Pacific Fisheries Commission (WCPFC) have shown mixed results in their ability to meet stock management objectives of principal market species (Gilman et al. 2013). In terms of bigeye tuna, the WCPFC has been unable to reduce fishing mortality rates to appropriate levels (Harley et al. 2014), and it is unclear if newly enacted management measures will be successful (WCPFC 2014b). We have therefore awarded a “moderately effective” score.

WESTERN AND CENTRAL PACIFIC, HANDLINES

Moderately Effective

Management appears to have allowed yellowfin tuna populations to remain healthy throughout most of the region, although fishing mortality rates have not been reduced (Davies et al. 2014) (WCPFC 2014b). We have therefore awarded a “moderately effective” score.

Subfactor 3.1.7 – 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 and includes stakeholder input.

WESTERN AND CENTRAL PACIFIC, TROLL/POLE

WESTERN AND CENTRAL PACIFIC, HANDLINES

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 2013g). We have therefore awarded a “moderately effective” score.

Factor 3.2 - Bycatch Strategy

SCORING GUIDELINES

Four subfactors are evaluated: Management Strategy and Implementation, Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations. Each is rated as ‘ineffective,’ ‘moderately effective,’ or ‘highly effective.’ Unless reason exists to rate Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations differently, these rating are the same as in 3.1.
5 (Very Low Concern)—Rated as 'highly effective’ for all four subfactors considered
4 (Low Concern)—Management Strategy rated ‘highly effective’ and all other subfactors rated at least ‘moderately effective.’
3 (Moderate Concern)—All subfactors rated at least ‘moderately effective.’
2 (High Concern)—At minimum, meets standards for ‘moderately effective’ for Management Strategy but some other factors rated ‘ineffective.’
1 (Very High Concern)—Management exists, but Management Strategy rated 'ineffective.’
0 (Critical)—No bycatch management even when overfished, depleted, endangered or threatened species are known to be regular components of bycatch and are substantially impacted by the fishery

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>All Kept</th>
<th>Critical</th>
<th>Strategy</th>
<th>Research</th>
<th>Advice</th>
<th>Enforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western and Central Pacific / Troll/Pole</td>
<td>Yes</td>
<td>All Species Retained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western and Central Pacific / Handlines</td>
<td>Yes</td>
<td>All Species Retained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subfactor 3.2.3 – Scientific Research and Monitoring**

Considerations: Is bycatch in the fishery recorded документed and is there adequate monitoring of bycatch to measure fishery’s impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met.

**Subfactor 3.2.4 – Management Record of Following Scientific Advice**

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

**Subfactor 3.2.5 – Enforcement of Management Regulations**

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen’s compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.
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 (plus the mitigation of gear impacts score) and the Ecosystem Based Fishery Management 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 cannot be Critical for Criterion 4.

Criterion 4 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Gear Type and Substrate</th>
<th>Mitigation of Gear Impacts</th>
<th>EBFM</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western and Central Pacific / Troll/Pole</td>
<td>5.00: None</td>
<td>0.00: Not Applicable</td>
<td>3.00: Moderate Concern</td>
<td>Green (3.87)</td>
</tr>
<tr>
<td>Western and Central Pacific / Handlines</td>
<td>5.00: None</td>
<td>0.00: Not Applicable</td>
<td>3.00: Moderate Concern</td>
<td>Green (3.87)</td>
</tr>
</tbody>
</table>

Troll/pole and handline gear does not typically come in contact with the bottom and therefore has limited (if any) impact to bottom habitats.

Criterion 4 Assessment

SCORING GUIDELINES

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

- 5 (None) - Fishing gear does not contact the bottom
- 4 (Very Low) - Vertical line gear
- 3 (Low)—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. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (e.g. cobble or boulder)
- 2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand
- 1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)
- 0 (Very High)—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 - Mitigation of Gear Impacts**

- **+1 (Strong Mitigation)**—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of ‘moderate’ mitigation measures.
- **+0.5 (Moderate Mitigation)**—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.
- **+0.25 (Low Mitigation)**—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced
- **0 (No Mitigation)**—No effective measures are in place to limit gear impacts on habitats

**Factor 4.3 - Ecosystem-Based Fisheries Management**

- **5 (Very Low Concern)**—Substantial efforts have been made to protect species’ ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators)
- **4 (Low Concern)**—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.
- **3 (Moderate Concern)**—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts
- **2 (High Concern)**—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.
- **1 (Very High Concern)**—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.

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

| WESTERN AND CENTRAL PACIFIC, TROLL/POLE |
| WESTERN AND CENTRAL PACIFIC, HANDLINES |

None

Vertical gear rarely impact bottom habitats. Tuna are pelagic species, so troll, handline, and pole fisheries targeting them operate in deep water where bottom contact is not likely.

**Factor 4.2 - Mitigation of Gear Impacts**

| WESTERN AND CENTRAL PACIFIC, TROLL/POLE |
| WESTERN AND CENTRAL PACIFIC, HANDLINES |

Not Applicable

**Factor 4.3 - Ecosystem-Based Fisheries Management**

| WESTERN AND CENTRAL PACIFIC, TROLL/POLE |
| WESTERN AND CENTRAL PACIFIC, HANDLINES |
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). But troll, handline, and pole 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 (Gillet 2012) (FAO 2014). In addition, tuna are considered “exceptional species,” so we have only awarded a “moderately effective” score.
Acknowledgements

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

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Appendix A: Updated January 8, 2017

1.1 and 1.2 updated for Yellowfin, 2.1 and 2.2 updated for Bigeye.