Bigeye Tuna, Pacific Bluefin Tuna, Skipjack Tuna, Yellowfin Tuna

*Thunnus obesus, Thunnus orientalis, Katsuwonus pelamis and Thunnus albacares*

North Pacific, Western and Central Pacific

Unassociated purse seine (non-FAD), Floating object purse seine (FAD)

March 12, 2015 (updated January 8, 2018)

*Seafood Watch Consulting Researcher*

**Disclaimer**

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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

Pacific bluefin tuna are caught by a number of gears in the North Pacific Ocean, but primarily by purse seines which is the focus of part of this report. Bigeye, skipjack and yellowfin tuna are caught by a variety of gears throughout the Western and Central Pacific Ocean, with purse seines being the most common method used to capture yellowfin and skipjack tuna. This report also focuses on the associated and unassociated purse seine fisheries targeting bigeye, skipjack and yellowfin tuna.

Abundances of Pacific bluefin tuna have declined dramatically, recently being assessed at less than 6% of historic levels. Fishing mortality rates are also high and the unassociated purse seine fishery contributes significantly to this pressure. Populations of skipjack and yellowfin tuna are healthy and fishing mortality rates are currently sustainable. Bgeye tuna populations have increased in recent years and they are no longer considered overfished.

In addition to target species, the associated purse seine fishery also incidentally captures a number of additional species including sharks, sea turtles and other bony fish. Populations of two species of sharks commonly associated with this fishery, oceanic whitetip and silky, are both low and fishing pressure is too high. Sea turtles 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 associated with them.

The Western and Central Pacific Fisheries Commission (WCPO) and the Inter-American Tropical Tuna Commission (IATTC) manage Pacific bluefin tuna fisheries within the North Pacific Ocean. Both organizations have implemented management measures to improve the status of this species but these measures have not yet been proven successful. The WCPFC manages bigeye, skipjack and yellowfin tuna in the WCPO and although some purse seine specific management measures have been introduced, the success of these measures is not known. There are also management measures in place for sharks and sea turtles, although the success of these measures is not yet known.

Purse seine gears typically have little contact with bottom habitats, although FADs can be anchored to the bottom. However, the incidental capture of ecologically important species may be a concern.
## Final Seafood Recommendations

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<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>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific bluefin tuna North Pacific, Unassociated purse seine (non-FAD)</td>
<td>Red (1.41)</td>
<td>Green (5.00)</td>
<td>Red (1.73)</td>
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<td>Avoid (2.62)</td>
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<tr>
<td>Bigeye tuna Western and Central Pacific, Floating object purse seine (FAD)</td>
<td>Green (3.83)</td>
<td>Red (1.41)</td>
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<td>Red (2.00)</td>
<td>Avoid (1.81)</td>
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<tr>
<td>Skipjack tuna Western and Central Pacific, Floating object purse seine (FAD)</td>
<td>Green (5.00)</td>
<td>Red (1.41)</td>
<td>Red (1.00)</td>
<td>Red (2.00)</td>
<td>Avoid (1.94)</td>
</tr>
<tr>
<td>Skipjack tuna Western and Central Pacific, Unassociated purse seine (non-FAD)</td>
<td>Green (5.00)</td>
<td>Red (2.16)</td>
<td>Yellow (3.00)</td>
<td>Green (3.87)</td>
<td>Good Alternative (3.35)</td>
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<tr>
<td>Yellowfin tuna Western and Central Pacific, Floating object purse seine (FAD)</td>
<td>Green (5.00)</td>
<td>Red (1.41)</td>
<td>Red (1.00)</td>
<td>Red (2.00)</td>
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<td>Yellow (3.00)</td>
<td>Green (3.87)</td>
<td>Good Alternative (3.35)</td>
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</table>

### Summary

The overall recommendation for yellowfin and skipjack tuna caught in the unassociated purse seine fishery operating in the western and central Pacific Ocean is 'Good Alternative'. The overall recommendation for Pacific bluefin tuna caught in the unassociated purse seine fishery and for bigeye, skipjack and yellowfin tuna caught in associated purse seine fisheries is 'Avoid'. This is due to the current status of Pacific bluefin tuna, and issues with bycatch and management in the associated purse seine fishery.

### 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 Concern\(^2\), 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 focuses on the unassociated purse seine fishery for Pacific bluefin tuna (*Thunnus orientalis*) in the north Pacific and on the unassociated and associated purse seine fisheries for bigeye tuna (*Thunnus obesus*), skipjack tuna (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*) operating in the Western and Central Pacific Ocean (WCPO).

**Species Overview**

Pacific bluefin tuna are a single stock found throughout the North Pacific Ocean. Records indicate fisheries, specifically Japanese, 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 was improved by 1952. Since then annual catches have varied tremendously, peaking at 40,383 t in 1956 (ISCPBWG 2014).

Bigeye, skipjack and yellowfin tuna are found in tropical and subtropical waters of the Pacific Ocean (Harley et al. 2014)(Rice et al. 2014)(Davies et al. 2014). There are four populations of bigeye and yellowfin and five of skipjack: Western and Central Pacific Ocean, Eastern Pacific Ocean, Atlantic (eastern and western skipjack) and Indian Ocean. Globally purse seines are the primary gear used to capture skipjack and yellowfin tuna and although longlines have historically caught the majority of bigeye tuna, in recent years purse seines catches have been increasing (ISSF 2013b). Globally, bigeye, skipjack and yellowfin tuna catches have all increased substantially over time, peaking in the early 2000's for bigeye and yellowfin tuna and around 2009 for skipjack tuna (ISSF 2013b).

Pacific bluefin tuna in the North Pacific Ocean are managed by both the Western and Central Pacific Fisheries Commission (WCPO) and the Inter-American Tropical Tuna Commission. Bigeye, skipjack and yellowfin tuna are managed by the WCPFC in the Western and Central Pacific Ocean.

**Production Statistics**

Purse seine's catch the majority of Pacific bluefin tuna, followed by troll, longline and set nets in recent years. Information on historical Pacific bluefin catches (total) is limited, although data sets since 1804 and the early 1900's 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 have been caught by Japan. (ISCPBWG 2014).
The equatorial region of the Western and Central Pacific Ocean (WCPO) is where most of the bigeye catch is taken by several fisheries, including purse seines. Purse seine and other surface fisheries have had an equal or greater impact on bigeye tuna biomass in the WCPO along with longline fisheries. Specifically, in the western equatorial region of the WCPO and to a lesser extent in eastern equatorial region, the purse seine fishery has had a substantial impact on the biomass. Almost all bigeye purse seine catches in the WCPO are made during sets on natural and artificial objects (FADs). There is a lot of uncertainty surrounding purse seine catches of bigeye tuna in the Western and Central Pacific Ocean (WCPO). Catches corrected for through grab sampling peaked at 105,000 t in 1997 and have ranged from 36,00 t to 65,000 t since 2001. However, the original catch records indicate purse seine catches have only ranged from 21,000 t to 38,000 t since 1997 and prior to this did not exceed 20,000 t. Total catches of bigeye tuna in the western and central Pacific Ocean have increased over time, peaking in the mid 2000’s at just under 200,000 mt (Davies et al. 2014).
Skipjack tuna make up the majority of tuna in tuna fisheries within the Western and Central Pacific Ocean (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. The majority of skipjack catch has historically been taken from the western equatorial region. However, since the late 1990’s, with the increase in the purse seine fishery, catches in the eastern equatorial region have increased. In the beginning of the fishery, the pole and line fleets, primarily Japanese, dominated the fishery but this fishery has since declined in importance, while the purse seine fleets effort increased during the 1980’s. Catches have increased steadily since the 1970’s, doubling in the 1980’s. During the early 1990’s, 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. In 2013, purse seine fisheries caught 1,455,786 t of skipjack tuna. However, a severe problem with the accuracy of purse seine catch reported on logbooks has been identified. Logbook reported catches over-report skipjack tuna catches while under-reporting yellowfin and bigeye catches (Rice et al. 2014)(Lawson 2011).
Yellowfin tuna in the western and central Pacific Ocean (WCPO) are caught by a range of gears but primarily (68%) by purse seiners, which primarily fish in the western equatorial and tropical waters of the WCPO. Typically, 20-25% of all purse seine catches in the WCPO are made up of yellowfin tuna. Purse seine fisheries tend to catch a wide range of sizes. In purse seine fisheries, the reported catches of yellowfin tuna are thought to be significantly under-reported. For example, between 2005 and 2009 corrected catches were 110,000 t higher than uncorrected catches (Davies et al. 2014). Total catches of yellowfin tuna in the WCPO have increased over time from a low of under 50,000 t during the mid 1950’s to over 600,000 t in 2008 and 2012 (Davies et al. 2014).
Importance to the US/North American market.

During 2012, the United States imported the majority (36%) of Pacific bluefin tuna from Spain, followed by Japan (23%) and Mexico (15%). Total imports during 2012 were 128.5 t. Export data is for Atlantic and Pacific bluefin tuna combined. During 2012, 396.7 to t of fresh and 114.5 t of frozen bluefin tuna were exported, primarily to Japan (NMFS 2014).
The United States imported around 19% of bigeye tuna from Ecuador, 16% from the Marshall Islands and 14% from Sri Lanka during 2013. The United States imported over half of all skipjack tuna from Mexico (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).

Figure 6 Major contributors to US yellowfin tuna imports (%) all countries and regions (country of origin) (NMFS 2014)
Common and market names.

Pacific bluefin tuna are also known as giant bluefin, northern bluefin tuna, tunny and oriental tuna. Skipjack tuna are also known as ocean bonito and lesser tuna. In Hawaii, bigeye and yellowfin tuna are known as Ahi, and skipjack as Aku.
Primary product forms

Pacific bluefin, bigeye, skipjack and yellowfin tuna are primarily sold in fresh and frozen forms.
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>Region</th>
<th>Method</th>
<th>Country</th>
<th>Custom Group</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Score</th>
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<tbody>
<tr>
<td><strong>BIGEYE TUNA</strong></td>
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<td>Western and Central Pacific Floating object purse seine (FAD)</td>
<td>2.00: Medium</td>
<td>4.00: Low Concern</td>
<td>3.67: Low Concern</td>
<td>Green (3.83)</td>
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<th>Region</th>
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<th>Fishing Mortality</th>
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<tr>
<th>Region</th>
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<th>Fishing Mortality</th>
<th>Score</th>
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<tr>
<td><strong>SKIPJACK TUNA</strong></td>
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<td>5.00: Very Low Concern</td>
<td>5.00: Very Low Concern</td>
<td>Green (5.00)</td>
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</table>
The population of skipjack and yellowfin tuna in the Western and Central Pacific Ocean are healthy and fishing pressures appear to be sustainable. In recent years, the status of bigeye tuna in the region has improved and they are no longer overfished. However, Pacific bluefin tuna populations in the North Pacific Ocean have been drastically reduced, as much as 96% and current fishing pressure is too high.

**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.

**BIGEYE TUNA**

**Factor 1.1 - Inherent Vulnerability**

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**

**Medium**

FishBase assigned a "high" to "very high" vulnerability of 72 out of 100 (Froese and Pauly 2013). However, bigeye tuna life history characteristics suggest a "medium" vulnerability to fishing. For example, bigeye tuna reach sexual maturity around 100 to 125 cm, reach a maximum size of 200 cm and live around 11 years (Davies et al. 2014) (Froese et al. 2013). They are broadcast spawners and top predators (Froese and Pauly 2013). Based on the Seafood Watch productivity analysis table, these life history characteristics suggest a medium level of vulnerability. We acknowledge that other methods may suggest a different vulnerability rating. Nonetheless, because the stock status of bigeye tuna tuna is known, this inherent vulnerability score will not affect the overall outcome. We have therefore awarded a score of "medium" vulnerability based on the productivity table analysis.

**Factor 1.2 - Abundance**

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**

**Low Concern**

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/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_{\text{TEST}}/SB_{\text{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 1.3 - Fishing Mortality**

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**  
**Low Concern**

The median ratio of current fishing mortality rates to those that produce the maximum sustainable yield (F_{\text{current}}/F_{\text{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 low concern score based on the assessment results that overfishing is no longer occurring but not a very low concern because overfishing had previously been occurring for a very long time and there is still some uncertainty with regard to current fishing mortality rates.

**PACIFIC BLUEFIN TUNA**

**Factor 1.1 - Inherent Vulnerability**

**NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)**  
**Medium**

FishBase assigned a "high" vulnerability score of 60 out of 100 (Froese and Pauly 2013). Pacific bluefin tuna begin reaching sexual maturity around 150 cm in size and reach sexual maturity between 3 to 5 years of age (PBTWG 2012). A maximum size and age of 300 cm and 15 years respectively have been reported. Pacific bluefin tuna are broadcast spawners and have a high trophic level according to Fishbase (Froese and Pauly 2013). According to these life history characteristics, Pacific bluefin tuna have a "moderate" level of vulnerability and we have therefore adjusted the score.

**Factor 1.2 - Abundance**

**NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)**  
**High Concern**

An updated assessment for Pacific bluefin tuna was conducted in 2016. Based on the updated analysis, the ratio of the spawning stock biomass in 2014 to that of unfished levels was 2.6%. 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 2014) (ISC 2016). We have therefore awarded a score of "high" concern.

**Factor 1.3 - Fishing Mortality**

**NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)**  
**High Concern**
Based on the updated 2016 assessment, current fishing mortality rates (2011-2013) are higher than all potential biological reference points, except FMED and FLOSS. Because there are no currently defined reference points for Pacific bluefin tuna, the assessment presented two alternative results. Assuming an FMED reference point, the stock would be approaching an overfished status. Assuming an F20% reference point, overfishing would have been occurring for the majority of the assessed time period (1972-2015) (ISC 2016). We have awarded a high concern score because the best available data indicates that overfishing is likely occurring.

**SKIPJACK TUNA**

**Factor 1.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>Western and Central Pacific, Floating Object Purse Seine (FAD)</th>
<th>Western and Central Pacific, Unassociated Purse Seine (Non-FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medium</strong></td>
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</table>

FishBase assigned skipjack tuna a "moderate" vulnerability of 39 out of 100 (Froese and Pauly 2013). Their life history characteristics support this score. Sexual maturity is reached around 45 cm or 2 years of age, and they can reach a maximum size of 110 cm and age of 12 years. They are broadcast spawners and have a high trophic level (Froese and Pauly 2013).

**Factor 1.2 - Abundance**

<table>
<thead>
<tr>
<th>Western and Central Pacific, Floating Object Purse Seine (FAD)</th>
<th>Western and Central Pacific, Unassociated Purse Seine (Non-FAD)</th>
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<tbody>
<tr>
<td><strong>Very Low Concern</strong></td>
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</tbody>
</table>

Skipjack tuna in the Western and Central Pacific Ocean were 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 time period (1972 to 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 are not overfished and above target levels and we have awarded a score of "very low" concern.

**Factor 1.3 - Fishing Mortality**

<table>
<thead>
<tr>
<th>Western and Central Pacific, Floating Object Purse Seine (FAD)</th>
<th>Western and Central Pacific, Unassociated Purse Seine (Non-FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Low Concern</strong></td>
<td></td>
</tr>
</tbody>
</table>

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 and we have awarded a very low concern score.

**YELLOWFIN TUNA**

**Factor 1.1 - Inherent Vulnerability**
FishBase assigned Yellowfin tuna a "moderate" to "high" vulnerability for 46 out of 100 (Frose and Pauly 2013). Their life history characteristics support a "moderate" vulnerability score. They reach sexual maturity by 100 cm in length (although growth rates vary by location) and 2 to 3 years of age. They can attain a maximum size of 180 cm and live to at least four years of age and perhaps as many as nine years. They are broadcast spawners and important predators in the ecosystem (Davies et al. 2014) (Frose and Pauly 2013).

**Factor 1.2 - Abundance**

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 $SB_{MSY}$. We have subsequently awarded a score of "very low" concern.

**Factor 1.3 - Fishing Mortality**

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 and we have awarded a very low concern score.
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>Whitetip shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.41)</td>
</tr>
<tr>
<td>Silky shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.41)</td>
</tr>
<tr>
<td>Green sea turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
</tr>
<tr>
<td>Hawksbill turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
</tr>
<tr>
<td>Olive ridley turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
</tr>
<tr>
<td>Rainbow runner</td>
<td>2.00:Medium</td>
<td>3.00:Moderate Concern</td>
<td>2.33:Moderate Concern</td>
<td>Yellow (2.64)</td>
</tr>
<tr>
<td>False killer whale</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>3.67:Low Concern</td>
<td>Yellow (2.71)</td>
</tr>
<tr>
<td>rough-toothed dolphin</td>
<td>1.00:High</td>
<td>3.00:Moderate Concern</td>
<td>3.67:Low Concern</td>
<td>Green (3.32)</td>
</tr>
<tr>
<td>Skipjack 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>
<tr>
<td>Species</td>
<td>Inherent Vulnerability</td>
<td>Abundance</td>
<td>Fishing Mortality</td>
<td>Subscore</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------</td>
<td>---------------</td>
<td>-------------------</td>
<td>----------</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>

**PACIFIC BLUEFIN TUNA - NORTH PACIFIC - UNASSOCIATED PURSE SEINE (NON-FAD)**

**Subscore: 5.00**

<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>No other main species caught</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SKIPJACK TUNA - WESTERN AND CENTRAL PACIFIC - FLOATING OBJECT PURSE SEINE (FAD)**

**Subscore: 1.41**

<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>Whitetip shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.41)</td>
</tr>
<tr>
<td>Silky shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.41)</td>
</tr>
<tr>
<td>Green sea turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
</tr>
<tr>
<td>Hawksbill turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
</tr>
<tr>
<td>Olive ridley turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
</tr>
<tr>
<td>Rainbow runner</td>
<td>2.00:Medium</td>
<td>3.00:Moderate Concern</td>
<td>2.33:Moderate Concern</td>
<td>Yellow (2.64)</td>
</tr>
<tr>
<td>False killer whale</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>3.67:Low Concern</td>
<td>Yellow (2.71)</td>
</tr>
<tr>
<td>rough-toothed dolphin</td>
<td>1.00:High</td>
<td>3.00:Moderate Concern</td>
<td>3.67:Low Concern</td>
<td>Green (3.32)</td>
</tr>
<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>

**SKIPJACK TUNA - WESTERN AND CENTRAL PACIFIC - UNASSOCIATED PURSE SEINE (NON-FAD)**

**Subscore: 2.16**

<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>No other main species caught</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### YELLOWFIN TUNA - WESTERN AND CENTRAL PACIFIC - FLOATING OBJECT PURSE SEINE (FAD)

<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>Whale shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>2.33:Moderate Concern</td>
<td>Red (2.16)</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><strong>Subscore:</strong></th>
<th>1.41</th>
<th><strong>Discard Rate:</strong></th>
<th>1.00</th>
<th><strong>C2 Rate:</strong></th>
<th>1.41</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Species</strong></td>
<td><strong>Inherent Vulnerability</strong></td>
<td><strong>Abundance</strong></td>
<td><strong>Fishing Mortality</strong></td>
<td><strong>Subscore</strong></td>
<td></td>
</tr>
<tr>
<td>Whitetip shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.41)</td>
<td></td>
</tr>
<tr>
<td>Silky shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.41)</td>
<td></td>
</tr>
<tr>
<td>Green sea turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
<td></td>
</tr>
<tr>
<td>Hawksbill turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
<td></td>
</tr>
<tr>
<td>Olive ridley turtle</td>
<td>1.00:High</td>
<td>1.00:Very High Concern</td>
<td>3.67:Low Concern</td>
<td>Red (1.92)</td>
<td></td>
</tr>
<tr>
<td>Rainbow runner</td>
<td>2.00:Medium</td>
<td>3.00:Moderate Concern</td>
<td>2.33:Moderate Concern</td>
<td>Yellow (2.64)</td>
<td></td>
</tr>
<tr>
<td>False killer whale</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>3.67:Low Concern</td>
<td>Yellow (2.71)</td>
<td></td>
</tr>
<tr>
<td>Rough-toothed dolphin</td>
<td>1.00:High</td>
<td>3.00:Moderate Concern</td>
<td>3.67:Low Concern</td>
<td>Green (3.32)</td>
<td></td>
</tr>
<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>
<td></td>
</tr>
<tr>
<td>Skipjack 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>
<td></td>
</tr>
</tbody>
</table>

### YELLOWFIN TUNA - WESTERN AND CENTRAL PACIFIC - UNASSOCIATED PURSE SEINE (NON-FAD)

<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>Whale shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>2.33:Moderate Concern</td>
<td>Red (2.16)</td>
</tr>
<tr>
<td>Skipjack 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><strong>Subscore:</strong></th>
<th>2.16</th>
<th><strong>Discard Rate:</strong></th>
<th>1.00</th>
<th><strong>C2 Rate:</strong></th>
<th>2.16</th>
</tr>
</thead>
</table>
Purse seine fisheries do incidentally capture non-target species. Bycatch rates are much lower in unassociated compared to associated fisheries. Bycatch ratios in associated sets in the WCPO region are 1.7% and for unassociated 0.3% (Dagorn et al. 2012). 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 (north-east of EEZ) and the Solomon Islands (north-western 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). The purse seine fishery is thought to have little impact on the sustainability of marine mammals in this region (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 (1995-2007) of 0.1% on FAD and 0.8% on log sets (Hall and Roman 2013). The most commonly caught sea turtles, in descending order, are olive ridley, hawksbill and green (Hall and Roman 2013). Sea turtle interactions in animal associated sets are the highest, 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 associated 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 the tables below in this report. The worst scoring species in the associated fishery are silky sharks due to their status and fishing mortality rates and whale sharks in the unassociated fishery.

<table>
<thead>
<tr>
<th>Associated</th>
<th>Species</th>
<th>Justification</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>False killer whale</td>
<td>Common mammal bycatch species</td>
<td>OFP 2012b</td>
</tr>
<tr>
<td></td>
<td>Green sea turtle</td>
<td>IUCN listing Endangered; CITES Appendix I</td>
<td>Semioff 2004</td>
</tr>
<tr>
<td></td>
<td>Hawksbill sea turtle</td>
<td>IUCN listing Critically Endangered; CITES Appendix I</td>
<td>Mortimer and Donnelly 2008</td>
</tr>
<tr>
<td></td>
<td>Oceanic whitetip shark</td>
<td>Overfished</td>
<td>Rice and Harley 2012b</td>
</tr>
<tr>
<td></td>
<td>Olive ridley sea turtle</td>
<td>IUCN Vulnerable; ESA listing</td>
<td>Abreu-grobois and Plotkin 2008; Nil</td>
</tr>
<tr>
<td></td>
<td>Rough-toothed dolphin</td>
<td>Common mammal bycatch species with high discard mortality rates</td>
<td>OFP 2012b</td>
</tr>
<tr>
<td></td>
<td>Short-beaked common dolphin</td>
<td>Common mammal bycatch species with high discard mortality rates</td>
<td>OFP 2012b</td>
</tr>
</tbody>
</table>
Silky shark | Overfished | Rice and Harley 2012a
Rainbow runner | Third most commonly caught | OFP 2010

<table>
<thead>
<tr>
<th>Species</th>
<th>Justification</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whale shark</td>
<td>IUCN listing Vulnerable; ERA medium-high risk</td>
<td>Norman 2005; Kirby 2006; Kirby and Hobday 2007</td>
</tr>
</tbody>
</table>

**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)*

**WHITETIP SHARK**

**Factor 2.1 - Inherent Vulnerability**

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

High

Fishbase assigned a high to very high score of 75 out of 100 (Froese and Pauly 2013).

**Factor 2.2 - Abundance**

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

High Concern

The first stock assessment of oceanic whitetip sharks in the Western and Central Pacific Ocean (WCPO) was conducted in 2012. 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 spawning biomass (mature fish) is estimated to be far below the level needed to produce the maximum sustainable yield (SB_{current}/SB_{MSY} = 0.153), indicating the stock is overfished (Rice and Harley 2012b). We have awarded a high concern score because of the stock status.
Factor 2.3 - Fishing Mortality

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

High Concern

Oceanic whitetip sharks are caught as bycatch by purse seine vessels that primarily fish in equatorial waters between 100N to 100S. 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). However, it should be noted that research conducted in other oceans have suggested that the entanglement mortality from purse seine gear of other shark species may be 5-10 times the known bycatch (Filmalter et al. 2013). According to the first and only assessment conducted in the Western and Central Pacific Ocean (WCPO), fishing mortality far exceeds levels needed to produce the maximum sustainable yield ($F_{MSY}$ with $F_{Current}/F_{MSY} = 6.694$) and therefore overfishing is occurring (Rice and Harley 2012b). Recently the Western and Central Pacific Fisheries Commission banned the capture and sale of oceanic whitetip sharks (WCPFC 2012g). We have awarded a high and not critical concern score because although overfishing is occurring, there are management measures in place.

Factor 2.4 - Discard Rate

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

< 20%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (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). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OFP 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.

SILKY SHARK

Factor 2.1 - Inherent Vulnerability

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

High

Fishbase assigned a very high vulnerability of 79 out of 100 (Froese and Pauly 2013).

Factor 2.2 - Abundance

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

High Concern

The International Union for the Conservation of Nature (IUCN) considers silky sharks to be Near Threatened globally (Bonfil et al. 2009). The first assessment of silky sharks in the Western and Central Pacific Ocean (WCPO) was conducted in 2012 and updated during 2013 (Rice and Harley 2013). According to this model, the spawning biomass (abundance of mature fish), levels consistently declined over the modeled time period (1995-2009). The spawning biomass has declined 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 high concern score because the SSB is below MSY.

**Factor 2.3 - Fishing Mortality**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Concern</strong></td>
</tr>
<tr>
<td>According to the 2013 updated silky shark assessment in the Western and Central Pacific Ocean (WCPO), 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, second only to the longline fishery, on the stock, 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 2012b). It should also be noted that in other oceans, entanglement mortality rates of silky sharks in purse seine fisheries is estimated to be 5-10 times reported bycatch levels (Filmalter et al. 2013). We have awarded a high score based on the high fishing mortality rates (WCPFC 2013f).</td>
</tr>
</tbody>
</table>

**Factor 2.4 - Discard Rate**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20%</td>
</tr>
<tr>
<td>Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (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). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OFP 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.</td>
</tr>
</tbody>
</table>

**WHALE SHARK**

**Factor 2.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
</tr>
<tr>
<td>Fishbase assigned a very high vulnerability of 81 out of 100 (Froese and Pauly 2013).</td>
</tr>
</tbody>
</table>

**Factor 2.2 - Abundance**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Concern</strong></td>
</tr>
</tbody>
</table>
| The stock status of whale sharks in the Western and Central Pacific Ocean (WCPO) is not known. However, it is thought they are vulnerable to fishing related mortality, similar to other shark species, and observer
Factor 2.3 - Fishing Mortality

WESTERN AND CENTRAL 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. Between 2007 and 2009 and during 2010, 211 and 137 whale shark interactions respectively were observed in this fishery. The proportion of whale-shark sets may however be higher than those reported by observers. Total whale shark mortalities 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% of whale sharks were caught on sets made on drifting and anchored FADs respectively. During 2010, these percentages were 3% and 2% but an additional 4% were also caught during sets made on natural logs (OFP 2012a). In addition to mortalities from the purse seine fishery, there are additional non-tuna related fishery interactions along with targeted fishing in some locations (Rice and Harley 2012c)(OFP 2012b). We have awarded a moderate concern score because fishing mortality rates are unknown but there are management measures preventing sets being made around whale sharks, were recently put into place (WCPFC 2012e).

Factor 2.4 - Discard Rate

WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

< 20%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (WCPO) between 1995 and 2011 the estimated discard rate of tunas in purse seine fisheries was just over 3% (OFP 2012a). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OFP 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.
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>North Pacific / Unassociated purse seine (non-FAD)</td>
<td>1.00</td>
<td>3.00</td>
<td>Red (1.73)</td>
</tr>
<tr>
<td>Western and Central Pacific / Floating object purse</td>
<td>1.00</td>
<td>1.00</td>
<td>Red (1.00)</td>
</tr>
<tr>
<td>Western and Central Pacific / Unassociated purse</td>
<td>3.00</td>
<td>3.00</td>
<td>Yellow</td>
</tr>
<tr>
<td>Mining (non-FAD)</td>
<td></td>
<td></td>
<td>(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 (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]).

This report focuses on Pacific bluefin tuna caught in the unassociated purse seine fishery operating in the North Pacific Ocean. Two RFMOs, the Western and Central Pacific Fisheries Commission (WCPFC) in the Western and Central Pacific Ocean (WCPO) and the Inter-American Tropical Tuna Commission (IATTC) in the Eastern Pacific Ocean, manage this fishery (see below for member countries). Purse seine fisheries targeting other tunas in the WCPO are only managed by the WCPFC. The WCPFC has instituted several management measures specific to purse seine fishing and the IATTC has implemented a catch limit for Pacific bluefin tuna. However, these measures have not yet proven effective in protecting Pacific bluefin or bigeye tuna populations.


IATTC members: 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, and Venezuela.

### 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.
NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

Ineffective

There are few management measures in place for albacore tuna in the North Pacific Ocean. Measures were adopted in 2005 and have not been updated since then. Those management measures included maintaining current catch levels (average effort between 2002 and 2004) in order to maintain the long-term sustainability of the stock, and the Western and Central Pacific Fisheries Commission (WCPFC) was to work with members of the Inter-American Tropical Tuna Commission to agree on consistent management measures for the North Pacific population (IATTC 2005c) (WCPFC 2005).

In the Eastern Pacific Ocean, the Inter-American Tropical Tuna Commission (IATTC) implemented a catch limit of 6,600 t between during 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 implemented Catch Documentation Scheme (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).

There is an interim reference point (fishing mortality) for North Pacific albacore but no reference points for Pacific bluefin. Biomass based limit reference points are used to determine the status of tuna populations. Target reference points are not yet in place for any of these species, and there are no harvest control rules (ISSF 2013). However, the WCPFC has a working group that is currently working on identifying potential target reference points; they last met in 2013 (WCPFC 2013c). In contrast to the 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 type of harvest control rule in place and does not have interim target reference points for all species.

We have awarded an "ineffective" score because the management structure has allowed severe declines of Pacific bluefin tuna and only responded with an appropriate rebuilding plan when abundance reached less than 3% of virgin levels.

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

Ineffective

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 FAD's for all purse seine vessels in EEZ's between 20N and 20S and an additional two month FAD closure on the high seas (UCN 2017). Member nations must have a FAD management plan in place to help reduce the capture of small bigeye and yellowfin tunas, and implementing FAD closures (WCPFC 2012a) (WCPFC 2013b). In addition, member countries of the Parties to the Nauru Agreement have agreed to use a regional fishing vessel register, abide by a high seas pocket area closures and prohibition from fishing on FAD’s during set time periods, utilize a Vessel Day Scheme and retain all catch (PNA 2013) (PNA 2012) (PNA 2010). 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
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.

**NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)**

**Moderately Effective**

Pacific bluefin tuna are overfished. Fishing effort and catch limits were adopted after the 2012 assessment by the Inter-American Tropical Tuna Commission (IATTC) and Western and Central Pacific Fisheries Commission (WCPFC) (IATTC 2012) (ISCPBWG 2014) (WCPFC 2012a) (IATTC 2016) (NC 2017). According to the 2016 updated assessment, rebuilding to the SSB$_{MED}$ reference point by 2024 will be achieved with at least a 60% probability. However, these projections are based on assuming the management measures are fully
implemented, which is yet unknown. We have therefore awarded a "moderate" score.

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)
WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

N/A

No target species are currently overfished or undergoing overfishing.

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.

NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

Moderately Effective

Pacific bluefin tuna stocks are monitored and assessed on a regular basis. The last assessment was conducted in 2014 and included catch data, information on the size composition and catch per unit effort (CPUE) data from 1952 to 2013 for 14 fisheries to determine the status of bluefin tuna in the north Pacific (ISCPBWG 2014). However, issues with data quality and quantity have lead to uncertainty in the results, so we have awarded a "moderately effective" score.

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)
WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

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 are included in these assessments. However, these assessments generally have a high amount of uncertainty associated with them, so we have awarded a "moderately effective" score.

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.

NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

Moderately Effective

The 2012 stock assessment acknowledged that the recently implemented catch and effort controls put into place by the Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC), if properly implemented and enforced, could lead to an improved stock status. However, keeping fishing levels status quo (2007 to 2009), is unlikely to improve the status of Pacific bluefin tuna (ISCPBWG 2014). The Scientific Committee suggested that fishing mortality of Pacific bluefin tuna should be immediately reduced and that candidate limit and target reference points should be adopted (WCPFC 2013d). In 2013, a new resolution, which took into account scientific recommendations for the conservation of Pacific
bluefin tuna, was adopted by the IATTC (IATTC 2013). Included in this resolution is the requirement that future assessments include analysis to determine what the status of Pacific bluefin tuna would be with and without these measures in place. The WCPFC also adopted an interim measure in 2013 that aimed to reduce fishing mortality rates, and the Northern Committee has recently agreed upon additional management measures to reduce fishing mortality on juvenile fish, based on the results of the 2014 assessment (WCPFC 2013a) (WCPFC 2014). We have awarded a "moderately effective" score because scientific advice has mostly been followed.

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)
WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

**Moderately Effective**

The last bigeye, skipjack, and yellowfin tuna assessments made recommendations on ways to improve on the current statistical model used, and identified needs for data improvement, but 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 to 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 no 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 score of "moderately effective."

**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.

NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

**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 non-compliance, 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), and coverage and provision of scientific data (WCPFC 2012c). The Inter-American Tropical Tuna Commission (IATTC) has a compliance monitoring plan that includes collecting information from member nations on compliance and enforcement of measures, requiring a plan of action to improve any issues from member nations not under compliance, and allows the Commission to develop sanctions and incentives to improve compliance (IATTC 2011a).

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 December 31, 2013 (WCPFC 2012d). Measures are in place allowing for the
boarding and inspection of vessels in the Convention Area (WCPFC 2006b), and the WCPFC maintains a list of illegal, unreported and unregulated vessels (WCPFC 2010b). In the Eastern Pacific Ocean, vessels larger than 24 m in length must use VMS (IATTC 2004a) and a list of IUU vessels is maintained (IATTC 2005a).

A recent study, which developed a standard way of assessing transparency in RFMOs, found the WCPFC lacked transparency regarding the availability of compliance-related data, lacked 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 both the WCPFC and IATTC to be ineffective regarding compliance transparency; specifically, the IATTC does not appear to deal with compliance issues in a thorough manner, and because the WCPFC’s compliance assessment process (a compliance monitoring scheme is in place) (WCPFC 2013d) is closed to the public and it does not have ways of dealing with non-compliance. In 2013 the Commission finally started releasing some information on the compliance of individual nations (WCPFC 2013g).

Assessing the effectiveness of these enforcement measures is difficult because there is a general lack of transparency of information regarding surveillance activities, infractions and enforcement actions, and outcomes (Gilman et al. 2013).

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)
WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

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 non-compliance 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).

There are specific reporting requirements in place to monitor compliance with the FAD set limiting options (WCPFC 2013a). 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 December 31, 2013 (WCPFC 2012d). There are measures in place allowing for the boarding and inspection of vessels in the Convention Area (WCPFC 2006b) and the WCPFC maintains a list of illegal, unreported, and unregulated vessels (WCPFC 2010b).

A recent study, which developed a standard way of assessing transparency in RFMOs, found the WCPFC lacking in transparency regarding the availability of compliance related data, lacking incentive for countries to comply with management measures, and lacking the processes needed to respond to non-compliance (Gilman and Kingma 2013). Koehler (2013) also found issues with the WCPFC regarding compliance transparency, specifically because the WCPFC’s compliance assessment process (a compliance monitoring scheme is in place) (WCPFC 2013) is closed to the public and it does not have ways of dealing with non-compliance. In 2013 the Commission finally started releasing some information on the compliance of individual nations (WCPFC 2013g).

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

**NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)**

**Ineffective**

Management measures enacted by the Western and Central Pacific Fisheries Commission (WCPFC) and Inter-American Tropical Tuna Commission (IATTC) have shown mixed results in their ability to meet stock management objectives of principal market species (Gilman et al. 2013). In terms of Pacific bluefin tuna, the WCPFC and IATTC have been unable to maintain a healthy population (ISCPBWG 2014). We have therefore awarded a score of "ineffective."

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**

**WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)**

**Moderately Effective**

Management measures enacted by the Western and Central Pacific Fisheries Management Commission (WCPFC) have shown mixed results in their ability to meet stock management objectives of principal market species (Gilman et al. 2013). The WCPFC has been unable to maintain a healthy stock size for bigeye tuna. We have awarded a score of "moderately effective" due to mixed results for success of management measures in maintaining healthy populations.

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.

**NORTH 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 et. al. 2013) in some factors, but this has improved in recent years. The Inter-American Tropical Tuna Commission also allows for outside accredited observers, which can be made up of scientists, NGO's, or other interested parties who wish to attend meetings. We have therefore awarded a score of "moderately effective."
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 Strategy</th>
<th>Research</th>
<th>Advice</th>
<th>Enforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Pacific / Unassociated purse seine (non-FAD)</td>
<td>No</td>
<td>No</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
</tr>
<tr>
<td>Western and Central Pacific / Floating object purse seine (FAD)</td>
<td>No</td>
<td>No</td>
<td>Ineffective</td>
<td>Highly Effective</td>
<td>Moderately Effective</td>
</tr>
<tr>
<td>Western and Central Pacific / Unassociated purse seine (non-FAD)</td>
<td>No</td>
<td>No</td>
<td>Moderately Effective</td>
<td>Highly Effective</td>
<td>Moderately Effective</td>
</tr>
</tbody>
</table>

The Western and Central Pacific Fisheries Commission and Inter-American Tropical Tuna Commission have implemented some management measures for bycatch in purse seine fisheries but the success of these measures is not known. However, the unassociated fishery already has lower bycatch levels so we have awarded a highly effective score for that fishery.

Subfactor 3.2.2 – Management Strategy and Implementation

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize
the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).

### 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. For example, 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 30N can implement this measure or a comparable measure. If a whale shark is incidentally encircled, the vessel must take reasonable steps 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 to ensure its safe release and to report the incident (WCPFC 2012f). Pursé seine vessels must avoid encircling sea turtles (IATTC 2007)(WCPFC 2008b). Pursé 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 2006). 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). We have awarded a moderately effective score because bycatch is minimal and management measures are in place.

### WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

**Ineffective**

The Western and Central Pacific Fisheries Commission (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 used 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, the incident recorded and reported (WCPFC 2012g)(WCPFC 2013f). However, the success of this is highly dependent on quick release of silky sharks as 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 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 2010).

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. We have awarded an ineffective score because there are no bycatch limits for non-target species and it is not clear these management measures are effective at maintaining population levels of bycatch species or being put into place. In addition, the WCPFC has failed to adopt resolutions to require mandatory collection and reporting of FAD data or require the use of non-entangling FADs, which have been identified as necessary to reduce bycatch 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).
WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

**Moderately Effective**

Bycatch in unassociated purse seine fisheries is minimal and there are some management measures in place. For example, 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 30N can implement this measure or a comparable measure. If a whale shark is incidentally encircled, the vessel must take reasonable steps 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 and any incidentally caught sharks should be released, the incident recorded and reported (WCPFC 2012g)(WCPFC 2013f). However, the success of this is highly dependent on quick release of silky sharks as 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 to ensure its safe release and to report the incident (WCPFC 2012f). Purseseine vessels must avoid encircling sea turtles (WCPFC 2008b) and are prohibited for landing silky sharks (WCPFC 2013f).

We have awarded a moderately effective score because bycatch is minimal in this fishery and there are management measures in place.

**Subfactor 3.2.3 – Scientific Research and Monitoring**

*Considerations: Is bycatch in the fishery recorded/documente*d 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.

NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

**Moderately Effective**

Vessels fishing for “fresh fish” north of 20N in the western and central Pacific Ocean must implement observer programs and achieve 5% coverage by the end of 2014 (WCPFC 2012h). In the eastern Pacific Ocean, there is 100% observer coverage on purse seine vessels larger than 363 t (IATTC 2009b). This monitoring level is very low and data collection protocols are considered deficient (Gilman et al. 2013). However, bycatch rates are low in this fishery, so we have awarded a moderate score.

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

**Highly Effective**

Purse seine vessels fishing between 20S and 20N have been required to carry an observer since 2010, unless the vessel only fishes in one coastal state (WCPFC 2008a).

**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.

NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)
WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)
WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

Moderately Effective

The Scientific Committee has recently (2014) recommended several measures related to bycatch be adopted by the Commission. These include analyzing bycatch mitigation methods for sharks and evaluating the fin to carcass ration currently in effect. No additional scientific advice was provided in 2014 for sea turtles (WCPFC 2014b). Historically all scientific advice related to bycatch has not been adopted (i.e. WCPFC 2013e), so we have awarded a moderate concern score.

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.

NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)
WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)
WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

Moderately Effective

See harvest strategy section for determination.
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>North Pacific / Unassociated purse seine (non-FAD)</td>
<td>5.00: None</td>
<td>0.00: No Effective Mitigation</td>
<td>3.00: Moderate Concern</td>
<td>Green (3.87)</td>
</tr>
<tr>
<td>Western and Central Pacific / Floating object purse seine (FAD)</td>
<td>4.00: Very Low Concern</td>
<td>0.00: No Effective Mitigation</td>
<td>1.00: Very High Concern</td>
<td>Red (2.00)</td>
</tr>
<tr>
<td>Western and Central Pacific / Unassociated purse seine (non-FAD)</td>
<td>5.00: None</td>
<td>0.00: No Effective Mitigation</td>
<td>3.00: Moderate Concern</td>
<td>Green (3.87)</td>
</tr>
</tbody>
</table>

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

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
- 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**

<table>
<thead>
<tr>
<th>Region</th>
<th>Habitats</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)</td>
<td>None</td>
</tr>
<tr>
<td>WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)</td>
<td>Unassociated purse seine sets do not typically come in contact with the bottom.</td>
</tr>
<tr>
<td>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</td>
<td>Very Low Concern</td>
</tr>
</tbody>
</table>

Although purse seine fishing typically does not 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 4.3 - Ecosystem-Based Fisheries Management

NORTH PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

No Effective Mitigation

While 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 no effective mitigation score with respect to habitat impacts.

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

Very High Concern

Purse seine fisheries in the Western and Central Pacific Ocean catch several ecologically important groups including other 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 many changes such as 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 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 Dagorn 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. 2000a, Menard et al. 2000b, Josse et al. 1999, Josse et al. 2000). The negative long-term impacts of FAD fishing is difficult to evaluate due to insufficient qualitative data (Fonteneau et al. 2000) and therefore additional research should be undertaken to determine the potential effects of FADs on the ecosystem, including monitoring the number of FADs being used (Dagorn et al. 2012).

The Western and Central Pacific Fisheries Commission (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 “very high concern” score because there is a potential for negative ecological impacts from FADs and management is not designed to avoid these impacts.

WESTERN AND CENTRAL PACIFIC, UNASSOCIATED PURSE SEINE (NON-FAD)

Moderate Concern

Purse seine fisheries in the Western and Central Pacific Ocean catch several ecologically important groups including other 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 many changes such as 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 Western and Central Pacific Fisheries Commission (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).
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.*

*Seafood Watch would like to thank the consulting researcher and author of this report, Alexia Morgan, as well as twelve anonymous reviewers for graciously reviewing this report for scientific accuracy.*
References


Dagorn, L., K.N. Holland, V. Restrepo and G. Moreno. 2012. Is it good or bad to fish with FADs? What are the real impacts of the use of drifting FADs on pelagic marine ecosystem? Fish and Fisheries DOI:10.1111/j.1467-2979.2012.00478.x.


Inter-American Tropical Tuna Commission (IATTC). 2006. Consolidated resolution on bycatch. Resolution C-04-


Lawson, T. 2011. Purse-seine length frequencies corrected for selectivity bias in grab samples collected by


Rice, J. and Harley, S. 2012. Assessment of the whale shark as a key shark species. Scientific Committee Eighth Regular Session, Busan, Republic of Korea, 7-15 August 2012. WCPFC-SC8-2012/EB-WP-04. 9 P.


Western and Central Pacific Fisheries Commission (WCPFC). 2010b. Conservation and management measure to establish a list of vessels presumed to have carried out illegal, unreported and unregulated fishing activities in the WCPO. Conservation and Management Measure 2010-06. Seventh Regular Session, Honolulu, HI, 6-10 December 2010.


Regular Session, Manila, Philippines, 2-6 December 2012.


WCPFC. 2013c. WCPFC management objectives workshop 2. 28-29 November, 2013, Cairns, Australia.


WCPFC. 2013g. Commission for the Conservation and Management of highly migratory fish stocks in the Western and Central Pacific Ocean. Tenth Regular Session, Cairns, Australia, 2-6 December 2013.


Appendix A: Extra By Catch Species

FALSE KILLER WHALE

Factor 2.1 - Inherent Vulnerability

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
</tr>
<tr>
<td>Marine mammals have a high level of vulnerability due to their late at at maturity, long lifespan, and low reproductive output (Seafood Watch 2013).</td>
</tr>
</tbody>
</table>

Factor 2.2 - Abundance

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Concern</strong></td>
</tr>
<tr>
<td>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 from the coast of China and Japan are 16,000 (Miyashita 1993)(Barlow 2006). There are three populations of false killer whales in Hawaiian waters, a pelagic, Main Hawaiian Islands and Northwestern Hawaiian Islands and the combined estimated population size is 2,206 (Caretta et al. 2014). We have awarded a high concern score because the status is unknown in the Western and Central Pacific Ocean and they have a high inherent level of vulnerability to fishing.</td>
</tr>
</tbody>
</table>

Factor 2.3 - Fishing Mortality

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Concern</strong></td>
</tr>
<tr>
<td>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 2007-2009, 37% of toothed whales, including false killer whales, were caught on FAD sets, 20% on natural log sets and 16% on dFADs. 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 (Molony 2005) so we have awarded a low concern score.</td>
</tr>
</tbody>
</table>

Factor 2.4 - Discard Rate

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 20%</strong></td>
</tr>
<tr>
<td>Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (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). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard</td>
</tr>
</tbody>
</table>
rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OFP 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.

**GREEN SEA TURTLE**

**Factor 2.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
</tr>
<tr>
<td>Sea turtles have a high level of vulnerability due to their long life history which includes a late age at sexual maturity, long life span and low reproductive output (Seafood Watch 2013).</td>
</tr>
</tbody>
</table>

**Factor 2.2 - Abundance**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very High Concern</strong></td>
</tr>
<tr>
<td>The International Union for Conservation of Nature (IUCN) has classified green sea turtles as Endangered with a decreasing population trend. Green sea turtles have been listed on CITES since 1975 and are currently listed on CITES Appendix 1, meaning they threatened with extinction and international trade is prohibited. The mean annual number of nesting turtles has decreased between 48% and 67% throughout their range (Seminoff 2004). Out of 27 known nesting sites in Oceania, 3 had an increasing trend, 2 had decreasing trends and 2 had stable trends, while trends at the remaining sites were unknown (Maison et al. 2010). We have awarded a very high concern score because they are classified as Endangered.</td>
</tr>
</tbody>
</table>

**Factor 2.3 - Fishing Mortality**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Concern</strong></td>
</tr>
<tr>
<td>The incidental capture of sea turtles during purse seine sets is very low in the Western and Central Pacific Ocean (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 less 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 low concern score due to the low interaction rates but not very low concern due to the uncertainty surrounding fishing mortality estimates for sea turtles and because it is unclear how successful bycatch mitigation methods have been in this region.</td>
</tr>
</tbody>
</table>

**Factor 2.4 - Discard Rate**

<table>
<thead>
<tr>
<th>WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20%</td>
</tr>
</tbody>
</table>
Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (WCPO) between 1995 and 2011 the estimated discard rate of tunas in purse seine fisheries was just over 3% (OPF 2012a) and targeted tunas represented 98% of the total catch on log associated sets between 1994 and 2009 (OPF 2010). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OPF 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.

**HAWKBILL TURTLE**

**Factor 2.1 - Inherent Vulnerability**

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**

**High**

Sea turtles have a high level of vulnerability due to their long life history which includes a late age at sexual maturity, long life span and low reproductive output (Seafood Watch 2013).

**Factor 2.2 - Abundance**

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**

**Very 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). Hawksbill turtles have been listed on the Convention on International Trade in Endangered Species (CITES) since 1977 and are currently listed on CITES Appendix 1, meaning they 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, out of ten nesting locations, 7 have depleted or declining populations (Mortimer and Donnelly 2008). We have awarded a very high score to account for their Endangered status.

**Factor 2.3 - Fishing Mortality**

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**

**Low Concern**

The incidental capture of sea turtles during purse seine sets is very low in the Western and Central Pacific Ocean (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 less 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 low concern score due to the low interaction rates but not very low concern due to the uncertainty surrounding fishing mortality estimates for
sea turtles and because it is unclear how successful bycatch mitigation methods have been in this region.

**Factor 2.4 - Discard Rate**

| WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD) | < 20% |
---|---|

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (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). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OFP 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.

**OLIVE RIDLEY TURTLE**

**Factor 2.1 - Inherent Vulnerability**

| WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD) | High |
---|---|

Sea turtles have a high level of vulnerability due to their long life history which includes a late age at sexual maturity, long life span and low reproductive output (Seafood Watch 2013).

**Factor 2.2 - Abundance**

| WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD) | Very High Concern |
---|---|

The International Union for Conservation of Nature (IUCN) considers Olive Ridley sea turtles to be Vulnerable with a decreasing population trend. Olive Ridley turtles have been listed as Threatened on the US Endangered Species Act (ESA) since 1978 (NMFS 2012). 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 have decreased from 97-98% over time, while in Indonesia they have increased substantially. Overall, in the Western and Central Pacific Ocean there has been a decrease in annual nesting female's of 92%, from 1,412 to 108 (Abreu-grobois and Plotkin 2008). We have awarded a very high concern score based on the Endangered species listing.

**Factor 2.3 - Fishing Mortality**

| WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD) | Low Concern |
---|---|

The incidental capture of sea turtles during purse seine sets is very low in the Western and Central Pacific Ocean (WCPO). The three most common species, in descending order are olive ridley, hawksbill and green (Halla nd 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 less 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 low concern score due to the low interaction rates but not very low concern due to the uncertainty surrounding fishing mortality estimates for sea turtles and because it is unclear how successful bycatch mitigation methods have been in this region.

**Factor 2.4 - Discard Rate**

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**

< 20%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (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). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OFP 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.

**RAINFOUR RUNNER**

**Factor 2.1 - Inherent Vulnerability**

**WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)**

Medium

Fishbase assigned a moderate vulnerability score of 41 out of 100 (Froese and Pauly 2013).

**Factor 2.2 - Abundance**

**WESTERN AND 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 and we have awarded a moderate concern score.

**Factor 2.3 - Fishing Mortality**

**WESTERN AND 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 (41-45%) caught on floating object sets made between 1994 and 2009 (OFP 2010). We have awarded a moderate concern score because information on fishing mortality is not known.
Factor 2.4 - Discard Rate

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

< 20%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (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). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OFP 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.

ROUGH-TOOTHED DOLPHIN

Factor 2.1 - Inherent Vulnerability

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

High

Marine mammals have a high level of vulnerability due to their late at at maturity, long lifespan, and low reproductive output (Seafood Watch 2013).

Factor 2.2 - Abundance

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

Moderate Concern

The International Union for Conservation of Nature (IUCN) has identified Rough-toothed dolphins as a species of Least Concern with an unknown population trend (Hammond et al. 2012b.). The estimated population size in Hawaiian waters is just under 20,000 individuals (Calambokidis et al. 2008). We have awarded a moderate concern score because population relative to any reference points is unknown but based on the IUCN classification, it is not likely to be of high concern.

Factor 2.3 - Fishing Mortality

WESTERN AND 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. 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 low concern score because bycatch does not seem to be a large contributing factor to population declines (Hammond et al. 2012b).
Factor 2.4 - Discard Rate

WESTERN AND CENTRAL PACIFIC, FLOATING OBJECT PURSE SEINE (FAD)

< 20%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the Western and Central Pacific Ocean (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). There are regulations currently in place that prohibit the discarding of bigeye, yellowfin and skipjack tunas caught by purse seine vessels (WCPFC 2008a). The discard rate of marine mammals in purse seine sets made between 1994 and 2004 in the western and central Pacific Ocean was greater than 99% (OFP 2012b). However, marine mammals do not make up a large portion of the total catch so we have awarded a score of 1.
Appendix B:

Tuna WCPO purse seine, NOorth Pacific purse seine UPDATE: 1.1 and 1.2 updated for bigeye, skipjack, yellowfin and bluefin tuna, 3.1 edited for bluefin rec’s.