



Monterey Bay Aquarium Seafood Watch®

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

Thunnus obesus, Thunnus orientalis, Katsuwonus pelamis and Thunnus albacares



Image © Monterey Bay Aquarium

Western Central Pacific Ocean, North Pacific
Purse Seine

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Disclaimer

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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 fished¹ 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 wild-catch 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.

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, but bigeye tuna populations are not healthy and fishing pressure is too high.

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.

Table of Conservation Concerns and Overall Recommendations

Stock / Fishery	Impacts on the Stock	Impacts on Other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Pacific Bluefin Tuna North Pacific - Purse Seine, Unassociated	Red (1.41)	Green (5.00)	Red (1.73)	Green (3.87)	Avoid (2.624)
Bigeye Tuna Western Central Pacific - Purse Seine, Floating Object	Red (1.41)	Red (1.41)	Red (1.00)	Red (2.00)	Avoid (1.414)
Skipjack Tuna Western Central Pacific - Purse Seine, Floating Object	Green (5.00)	Red (1.41)	Red (1.00)	Red (2.00)	Avoid (1.939)
Yellowfin Tuna Western Central Pacific - Purse Seine, Floating Object	Green (5.00)	Red (1.41)	Red (1.00)	Red (2.00)	Avoid (1.939)
Yellowfin Tuna Western Central Pacific - Purse Seine, Unassociated	Green (5.00)	Red (2.16)	Yellow (3.00)	Green (3.87)	Good Alternative (3.347)
Skipjack Tuna Western Central Pacific - Purse Seine, Unassociated	Green (5.00)	Red (2.16)	Yellow (3.00)	Green (3.87)	Good Alternative (3.347)

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, **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, **and** does not meet the criteria for Best Choice (above)
- **Avoid/Red** = Final Score ≤2.2, **or** either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern,² **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).

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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).

Overview of the species and management bodies

Pacific bluefin tuna are a single stock found throughout the North Pacific Ocean. Records indicate fisheries, specifically Japanese, targeted this species as far back as 1804. 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: one in the western and central Pacific Ocean, one in the eastern Pacific Ocean, one in the Atlantic (eastern and western skipjack) and another in the 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 2000s 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 seines catch the majority of Pacific bluefin tuna, followed by troll, longline and set nets in recent years. Historical information on Pacific bluefin catches (total) is limited, although data sets from 1804 and up to the early 1900s are available from Japan and the US respectively. Catches were high from 1929 to 1940, peaking at 59,000 mt in 1935. In 1949, as the Japanese fleet moved across the North Pacific Ocean, catches increased significantly. Since

1952 (when catch reporting improved), the majority of Pacific bluefin tuna catch has been caught by Japan. (ISCPBWG 2014).

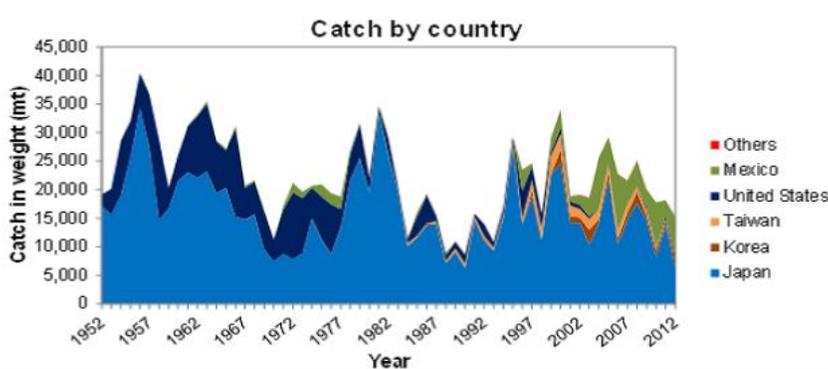


Figure 1. Historical annual catch of Pacific bluefin tuna (*Thunnus orientalis*) by country from 1952 through 2012 (calendar year).

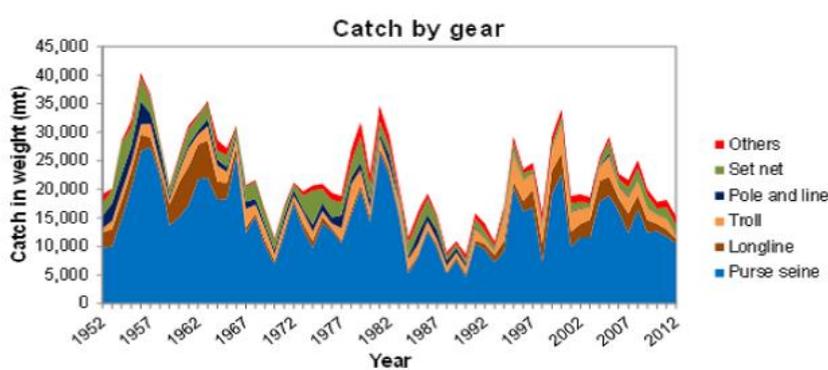


Figure 1: Annual catch of Pacific bluefin tuna by gear (1952-2013) (ISWPBWG 2014)

The equatorial region of the 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 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 ranged from 21,000 t to 38,000 t only 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-2000s at just under 200,000 mt (Davies et al. 2014).

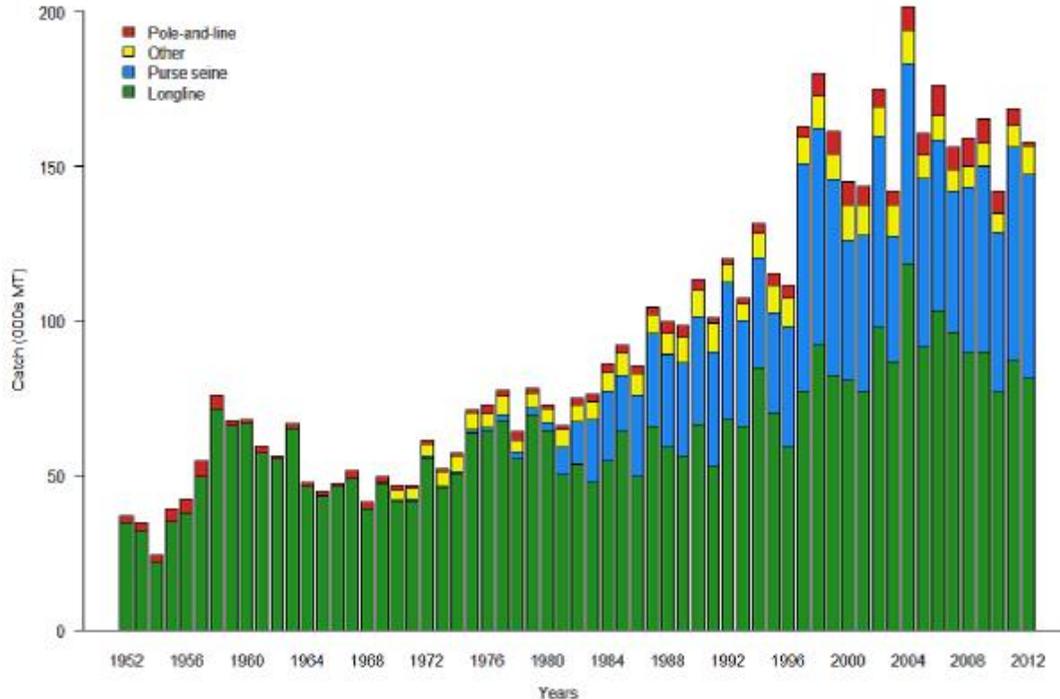


Figure 2: Total annual catch (1000s mt) of bigeye tuna from the WCPO by fishing method from 1952-2012 (Harley et al. 2014)

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

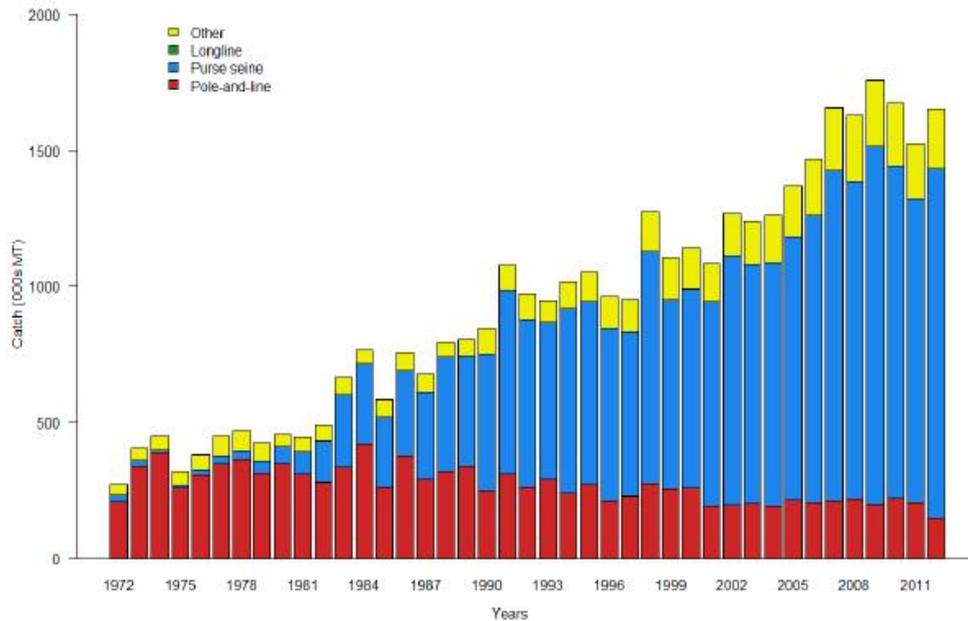


Figure 3: Skipjack catches, 1972-2012, in the WCPO by fishing gear (Rice et al. 2014)

Yellowfin tuna in the WCPO are caught by a range of gears, but primarily (68%) by purse seiners, which fish most often 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-1950s to over 600,000 t in 2008 and 2012 (Davies et al. 2014).

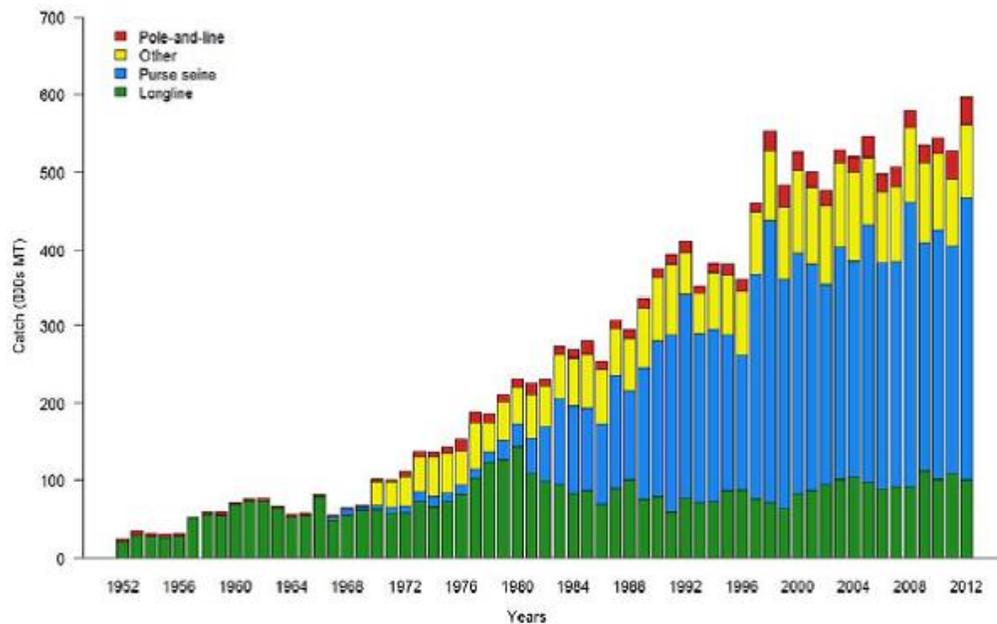


Figure 4: Annual catches (1000 t) of yellowfin tuna in the WCPO from 1952 -2012 by fishing gear (Davies et al. 2014)

Importance to the US/North American market

During 2012, the United States imported the majority (36%) of Pacific bluefin tuna from Spain, followed in quantity 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 t of fresh and 114.5 t of frozen bluefin tuna were exported, primarily to Japan (NMFS 2014).

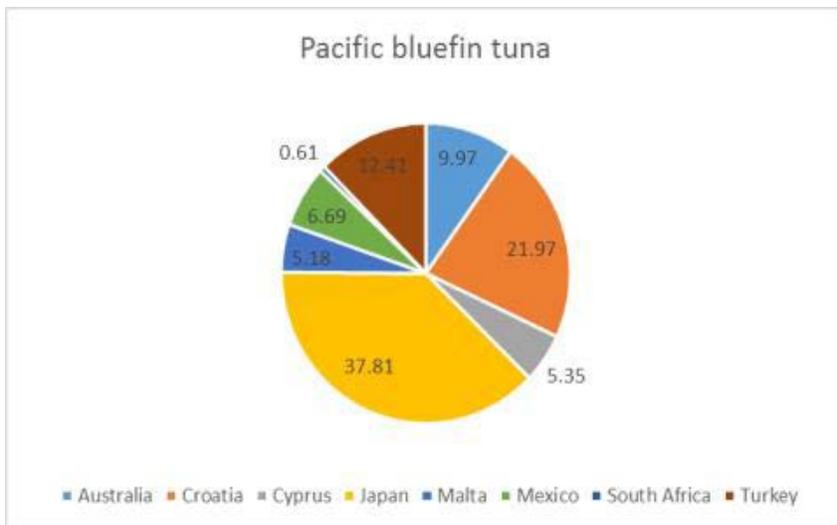


Figure 5: Pacific bluefin tuna imports (percentage), 2013, for all countries and regions (country of origin) (NMFS 2014)

The United States imported around 19% of its bigeye tuna from Ecuador, 16% from the Marshall Islands and 14% from Sri Lanka, during 2013. Additionally, the United States imported over half of its skipjack tuna from Mexico (55%) during 2013. Other important countries (in relation to size of import) included the Philippines (15%) and Mexico (13%). The majority of captured yellowfin tuna were imported from Trinidad and Tobago in 2013 (49%) (NMFS 2014).

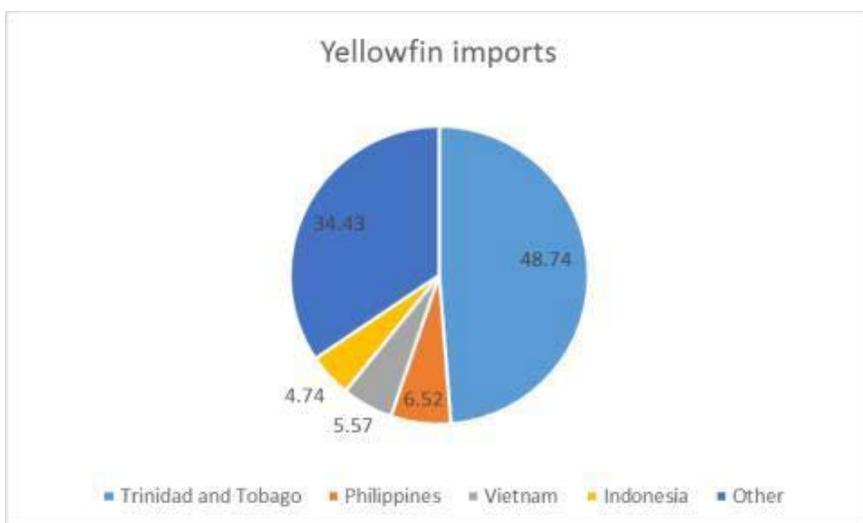


Figure 6: Major contributors to US yellowfin tuna imports (%) all countries and regions (country of origin) (NMFS 2014)

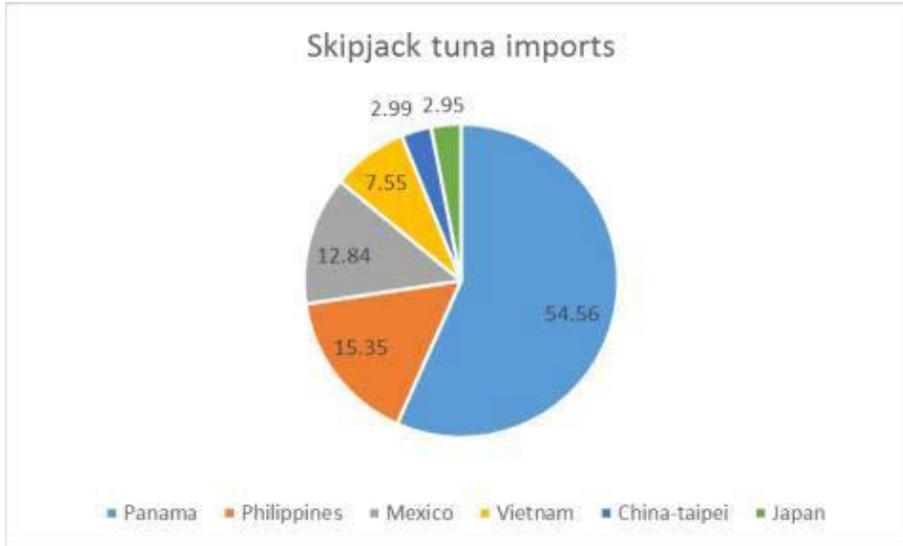


Figure 7: Major contributors to US skipjack tuna imports (%) all countries and regions (country of origin) (NMFS 2014)

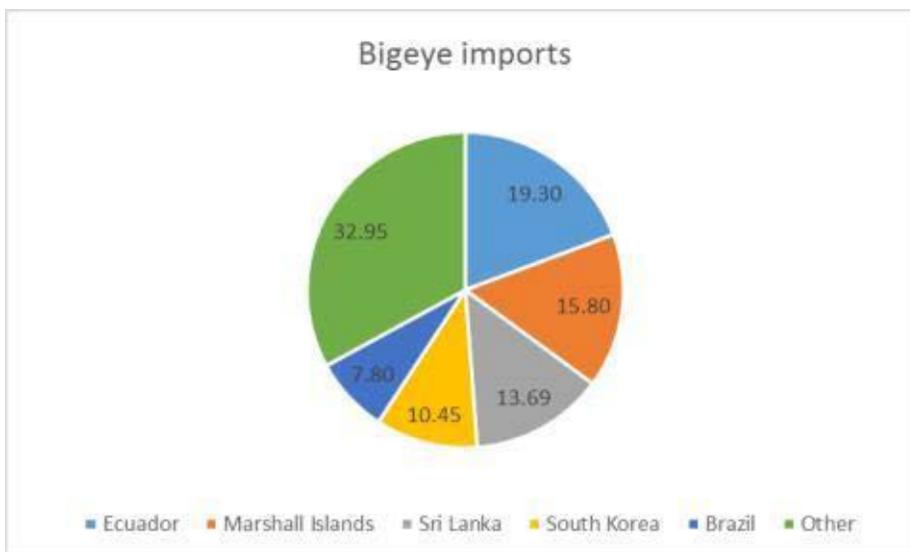


Figure 8: Major contributors to US bigeye tuna imports (%) all countries (country of origin) (NMFS 2014)

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 sold primarily 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: Stock for which you want a recommendation

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

BIGEYE TUNA				
Region / Method	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Western Central Pacific Purse Seine, Floating Object	2.00:Medium	2.00:High Concern	1.00:High Concern	Red (1.414)

PACIFIC BLUEFIN TUNA				
Region / Method	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
North Pacific Purse Seine, Unassociated	2.00:Medium	2.00:High Concern	1.00:High Concern	Red (1.414)

SKIPJACK TUNA				
Region / Method	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Western Central Pacific Purse Seine, Floating Object	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)
Western Central Pacific Purse Seine, Unassociated	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)

YELLOWFIN TUNA				
Region / Method	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Western Central Pacific Purse Seine, Floating Object	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)
Western Central Pacific Purse Seine, Unassociated	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)

The population of skipjack and yellowfin tuna in the western and central Pacific Ocean are healthy and fishing pressures appear to be sustainable. However, Pacific bluefin tuna populations in the North Pacific Ocean have been drastically reduced, by as much as 96%; Bigeye tuna are overfished and overfishing is occurring. Fishing pressures on both Pacific bluefin and bigeye tuna are also high.

Criterion 1 Assessment

BIGEYE TUNA

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *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.*

Western Central Pacific, Purse Seine, Floating Object

Medium

FishBase assigned a high to very high vulnerability of 72 out of 100 (Froese and Pauly 2013). However, bigeye tuna's life history characteristics suggest a medium vulnerability to fishing. For example, bigeye tuna reach sexual maturity around 100-125 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; however, because the stock status of bigeye 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

Scoring Guidelines

- 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.

Western Central Pacific, Purse Seine, Floating Object

High Concern

Bigeye tuna in the western and central Pacific Ocean (WCPO) were last assessed in 2014. According to the base case model, the ratio of the current average (2008-2011) spawning biomass to that needed to produce the maximum sustainable yield ($SB_{current}/SB_{MSY}$) was 0.94. Additionally, the ratio of the latest (2012) spawning biomass (mature fish) to that needed to produce the maximum sustainable yield (SB_{latest}/SB_{MSY}) was 0.77, indicating that the population is overfished (Harley et al. 2014). We have therefore awarded a score of 'high concern.'

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- 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 ($\leq 5\%$ 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.*

Western Central Pacific, Purse Seine, Floating Object

High Concern

The ratio of current fishing mortality rates to those that produce the maximum sustainable yield ($F_{\text{current}}/F_{\text{MSY}}$) for all model runs were much higher than 1, with the ratio from all runs estimated at 1.57, indicating overfishing is occurring. Based on this estimate, fishing mortality needs to be reduced by more than 30% from the 2008-2011 levels in order to become sustainable (Harley et al. 2014), and so we have awarded a score of 'high concern.'

PACIFIC BLUEFIN TUNA

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *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.

North Pacific, Purse Seine, Unassociated

Medium

FishBase assigned a high vulnerability score of 60 out of 100 (Froese and Pauly 2013). Pacific bluefin tuna reach sexual maturity between 3 and 5 years of age and around 150 cm (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

Scoring Guidelines

- *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.*

North Pacific, Purse Seine, Unassociated

High Concern

The most recent stock assessment for Pacific bluefin tuna was conducted in 2014. There are no accepted target or limit reference points for Pacific bluefin tuna, but the ratio of spawning stock biomass (SSB) in 2012 to virgin levels is low, indicating that the SSB is currently only 2%–5% of the unfished level. The population of Pacific bluefin tuna is therefore considered overfished (ISCPBWG 2014) and we have awarded a score of ‘high concern.’

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *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 ($\leq 5\%$ 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.*

North Pacific, Purse Seine, Unassociated

High Concern

There are no target or limit reference points for Pacific bluefin tuna, but the current F (2009-2011 average) is higher than all target and biological reference points commonly used in other fisheries (Fmax, Fmed and F20%). It is currently thought that overfishing is occurring (ISCPBWG 2014). Additional management measures have recently been agreed upon that will help reduce fishing mortality rates for this species. However, according to the scientific advice, the agreed upon measures will not be enough to rebuild the population within 10 years (WCPFC 2014)(ISCPBWG 2014). We have awarded a score of 'high concern' instead of 'critical concern' because measures are being taken to reduce fishing mortality rates for this species.

SKIPJACK TUNA

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *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.

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Medium

FishBase assigned 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

Scoring Guidelines

- *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.*

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Very Low Concern

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 (BMSY—the biomass needed to produce the maximum sustainable yield) over the entire time period (1972-2010). The current total biomass is around 52% of virgin levels (B0) 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

Scoring Guidelines

- *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 ($\leq 5\%$ 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.*

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Very Low Concern

The current level of exploitation of skipjack tuna is below that needed to provide the maximum sustainable yield (MSY). Although fishing mortality rates have been increasing over time, the current fishing mortality rate is below that needed to produce MSY ($F_{\text{current}}/F_{\text{MSY}}=0.62$) (Rice et al. 2014). Therefore overfishing of skipjack tuna is not occurring and we have awarded a score of ‘very low concern.’

YELLOWFIN TUNA

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *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.

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Medium

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

Factor 1.2 - Abundance

Scoring Guidelines

- 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.

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Very Low Concern

The biomass based reference points for the reference model used in the 2014 assessment was 1.37 (SB_{current}/SB_{BMSY} - the ratio of the current (2008-2011) spawning (mature fish) biomass to that needed to produce the maximum sustainable yield). The ratio of the latest (2012) spawning biomass to the level needed to produce the maximum sustainable yield (SB_{current}/SB_{BMSY}) was 1.24. Therefore, yellowfin tuna are above target levels and not in an overfished state (Davies et al. 2014b). We have therefore awarded a score of 'very low concern.'

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- 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 ($\leq 5\%$ 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.*

Western Central Pacific, Purse Seine, Floating Object**Western Central Pacific, Purse Seine, Unassociated****Very Low Concern**

The current fishing mortality rate is below levels needed to produce the maximum sustainable yield ($F_{\text{current}}/F_{\text{MSY}} = 0.72$) for the most realistic models. Therefore, overfishing is not occurring (Davies et al. 2014). We have therefore awarded a score of ‘very low concern.’

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. The Criterion 2 rating is determined as follows:

- Score >3.2=Green or Low Concern
 - Score >2.2 and <=3.2=Yellow or Moderate Concern
 - Score <=2.2=Red or High Concern
- Rating is Critical if Factor 2.3 (Fishing Mortality) is Critical.

Criterion 2 Summary

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

Bigeye Tuna: Western Central Pacific, Purse Seine, Floating Object				
Subscore:	1.414	Discard Rate:	1.00	C2 Rate: 1.414
Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BIGEYE TUNA	Medium	2.00: High Concern	1.00: High Concern	1.414
OCEANIC WHITETIP SHARK	High	2.00: High Concern	1.00: High Concern	1.414
SILKY SHARK	High	2.00: High Concern	1.00: High Concern	1.414
GREEN SEA TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
HAWKSBILL TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
OLIVE RIDLEY TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
RAINBOW RUNNER	Medium	3.00: Moderate Concern	2.33: Moderate Concern	2.644
FALSE KILLER WHALE	High	2.00: High Concern	3.67: Low Concern	2.709
ROUGH-TOOTHED DOLPHIN	High	3.00: Moderate	3.67: Low Concern	3.318

		Concern		
SKIPJACK TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000

Pacific Bluefin Tuna: North Pacific, Purse Seine, Unassociated

Subscore: 5.000 Discard Rate: 1.00 C2 Rate: 5.000

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
PACIFIC BLUEFIN TUNA	Medium	2.00: High Concern	1.00: High Concern	1.414

Skipjack Tuna: Western Central Pacific, Purse Seine, Floating Object

Subscore: 1.414 Discard Rate: 1.00 C2 Rate: 1.414

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BIGEYE TUNA	Medium	2.00: High Concern	1.00: High Concern	1.414
OCEANIC WHITETIP SHARK	High	2.00: High Concern	1.00: High Concern	1.414
SILKY SHARK	High	2.00: High Concern	1.00: High Concern	1.414
GREEN SEA TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
HAWKSBILL TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
OLIVE RIDLEY TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
RAINBOW RUNNER	Medium	3.00: Moderate Concern	2.33: Moderate Concern	2.644
FALSE KILLER WHALE	High	2.00: High Concern	3.67: Low Concern	2.709
ROUGH-TOOTHED DOLPHIN	High	3.00: Moderate Concern	3.67: Low Concern	3.318
SKIPJACK TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000

Skipjack Tuna: Western Central Pacific, Purse Seine, Unassociated**Subscore: 2.159****Discard Rate: 1.00****C2 Rate: 2.159**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
WHALE SHARK	High	2.00: High Concern	2.33: Moderate Concern	2.159
SKIPJACK TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000

Yellowfin Tuna: Western Central Pacific, Purse Seine, Floating Object**Subscore: 1.414****Discard Rate: 1.00****C2 Rate: 1.414**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BIGEYE TUNA	Medium	2.00: High Concern	1.00: High Concern	1.414
OCEANIC WHITETIP SHARK	High	2.00: High Concern	1.00: High Concern	1.414
SILKY SHARK	High	2.00: High Concern	1.00: High Concern	1.414
GREEN SEA TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
HAWKSBILL TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
OLIVE RIDLEY TURTLE	High	1.00: Very High Concern	3.67: Low Concern	1.916
RAINBOW RUNNER	Medium	3.00: Moderate Concern	2.33: Moderate Concern	2.644
FALSE KILLER WHALE	High	2.00: High Concern	3.67: Low Concern	2.709
ROUGH-TOOTHED DOLPHIN	High	3.00: Moderate Concern	3.67: Low Concern	3.318
SKIPJACK TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000

Yellowfin Tuna: Western Central Pacific, Purse Seine, Unassociated**Subscore: 2.159****Discard Rate: 1.00****C2 Rate: 2.159**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
WHALE SHARK	High	2.00: High Concern	2.33: Moderate Concern	2.159
SKIPJACK TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	5.000

Purse seine fisheries do incidentally capture non-target species. Bycatch rates are much lower in unassociated fisheries compared to associated fisheries. Bycatch ratios in associated sets in the WCPO region are 1.7% and 3% for unassociated (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 FADs 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 linked with the north Pacific bluefin unassociated purse seine fishery. However, any bycatch of marine mammals, sea turtles or sharks is likely to be minimal because sets are made on free swimming schools of bluefin tuna. Observer records from the tropical region of the western and central Pacific Ocean suggest most interactions between marine mammals and purse seines occurred during sets made on floating objects.

We have included the species identified in this report, in the tables below. The worst scoring species in the associated fishery is silky sharks (due to its status and fishing mortality rates) and whale sharks in the unassociated fishery.

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

Unassociated		
Species	Justification	Source
Whale shark	IUCN listing Vulnerable; ERA medium- high risk	Norman 2005; Kirby 2006; Kirby and Hobday 2007

Criterion 2 Assessment

OCEANIC WHITETIP SHARK

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Floating Object

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Floating Object

High Concern

The first stock assessment of oceanic whitetip sharks in the 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 the 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 score of 'high concern' because of the stock status.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Floating Object

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 (Filmlalter et al. 2013). According to the first and only assessment conducted in the 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 score of 'high concern' and not 'critical concern' because, although overfishing is occurring, there are management measures in place.

Factor 2.4 - Discard Rate

Western Central Pacific, Purse Seine, Floating Object

< 20%

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

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Floating Object

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Floating Object

High Concern

The IUCN considers silky sharks to be Near Threatened globally (Bonfil et al. 2009). The first assessment of silky sharks in the 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)—by 67% since 1995. The spawning biomass in 2009 was far below target levels needed to produce the maximum sustainable yield ($SB_{\text{current}}/SB_{\text{MSY}}=0.70$ 95% CI 0.51-1.23) and therefore the stock is overfished. We have awarded a score of ‘high concern’ because the SSB is below MSY.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Floating Object

High Concern

According to the 2013 updated silky shark assessment in the WCPO, fishing mortality rates in 2009 (the last year of the modeled period) exceeded levels needed to produce the maximum sustainable yield ($F_{\text{current}}/F_{\text{MSY}}=4.48$ (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 (Filmlalter et al. 2013). We have awarded a score of ‘high concern’ based on the high fishing mortality rates (WCPFC 2013f).

Factor 2.4 - Discard Rate**Western Central Pacific, Purse Seine, Floating Object****< 20%**

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

Region / Method	Management of Retained Species	Management of Non-Retained Species	Overall Recommendation
North Pacific Purse Seine, Unassociated	1.000	3.000	Red(1.732)
Western Central Pacific Purse Seine, Floating Object	1.000	1.000	Red(1.000)
Western Central Pacific Purse Seine, Unassociated	3.000	3.000	Yellow(3.000)

Factor 3.1: Harvest Strategy

Scoring Guidelines

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

Factor 3.1: Management of fishing impacts on retained species							
Region / Method	Strategy	Recovery	Research	Advice	Enforce	Track	Inclusion
North Pacific Purse Seine, Unassociated	Ineffective	Ineffective	Moderately Effective	Moderately Effective	Moderately Effective	Ineffective	Moderately Effective
Western Central Pacific Purse Seine, Floating Object	Ineffective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective
Western Central Pacific Purse Seine, Unassociated	Moderately Effective						

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

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 WCPO and the IATTC in the Eastern Pacific Ocean manage this fishery (see below for member countries). Purse seine fisheries targeting other tunas in the WCPO are managed only 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.

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

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

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, Purse Seine, Unassociated

Ineffective

In the eastern Pacific Ocean, the Inter-American Tropical Tuna Commission implemented a catch limit for Pacific bluefin tuna caught in the Convention Area: 10,000 t between 2012 and 2013 (5,600 in 2012 and 4,400 in 2013) and 5,000 t for 2014, (IATTC 2012)(IATTC 2013). In the western and central Pacific Ocean, the Western and Central Pacific Fisheries Commission has limited fishing effort for Pacific bluefin tuna. Vessels fishing north of 20N must stay below 2002-2004 fishing effort levels during 2013 (WCPFC 2012a). In addition, starting in 2015 all catches of fish less than 30 kg must be reduced by 50% of the 2002-2004 average annual level. (WCPFC 2014) There is also a catch documentation scheme, which was adopted in 2013 (WCPFC 2013a). There are currently no reference points in place for this species or harvest control rules. However, the WCPFC has a working group that is developing reference points for other species and has recently taken the first steps toward developing reference points and harvest control rules for Pacific bluefin tuna (WCPFC 2013b)(WCPFC 2014). We have awarded a score of 'ineffective' because current management strategy has been unable to maintain sustainable populations of Pacific bluefin tuna.

Western Central Pacific, Purse Seine, Floating Object

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 FADs for all purse seine vessels in EEZs and high seas between 20N and 20S. In addition, members must institute additional measures to reduce FAD sets, such as an annual limit on the number of sets or additional closures. Coastal states must reduce purse seine effort to 2010 levels if they participate in the Parties to the Nauru Agreement, otherwise they must reduce their effort to 2001-04 average levels and the number of purse seine vessels fishing for other countries cannot be increased. Member nations must have an FAD management plan in place to help reduce the capture of small bigeye and yellowfin tunas, and be prepared to implement FAD closures. Discarding bigeye, skipjack or yellowfin tuna is prohibited (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, are prohibited from fishing on FADs 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 short term, bigeye tuna, and there are no harvest control rules (ISSF 2013). However, the WCPFC has a working group, which last met in 2013, that is identifying potential target reference points (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.

The WCPFC's management of FAD fisheries does not currently include any limits on the number of FAD sets allowed each year, and updated reporting and verification methods are needed. Many vessels are using increasingly advanced FADs to improve their fishing efficiency. Temporary closures alone, without limits on FADs, have been shown to allow for an increase in overall catch and effort in the western and central Pacific Ocean. This has occurred despite the fact that bigeye and yellowfin tuna populations cannot sustain much increase in catch or effort. High catch of bigeye and yellowfin juveniles in FAD fisheries has contributed to depleting these populations. Due to these deficiencies, combined with the inability of current measures to maintain healthy populations of bigeye tuna, we have awarded a score of 'ineffective.'

Western Central Pacific, Purse Seine, Unassociated

Moderately Effective

Only a few management measures specific to unassociated purse seine fisheries have been enacted by the WCPFC. Coastal states must reduce purse seine effort to 2010 levels in they participate in the Parties to the Nauru Agreement, otherwise to 2001-04 average or 2010 levels. All bigeye, skipjack and yellowfin tuna must be kept, in an effort to reduce mortality on small tunas (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, utilize a Vessel Day scheme and retain all catch (PNA 2013)(PNA 2012) [PNA 2010). The number of purse seine vessels fishing for countries (other than small island nations) cannot be increased (WCPFC 2013b). In addition, biomass-based limit reference points have been adopted by the WCPFC for bigeye, yellowfin, albacore and skipjack tuna and are used to determine the status of tuna populations. There are no reference points in place for this species, although the WCPFC has a working group that is developing reference points for other species (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 a score of ‘moderately effective’ based on the current management scheme.

Subfactor 3.1.2 – Recovery of Species of Concern

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

North Pacific, Purse Seine, Unassociated

Ineffective

Pacific bluefin tuna are overfished. Fishing effort and catch limits were adopted after the 2012 assessment by the IATTC and WCPFC (IATTC 2012) (ISCPBWG 2014)(WCPFC 2012a). According to the 2014 updated assessment, these management measures were not sufficient to allow the population to recover. Recently agreed upon measures by the WCPFC Northern Committee (to reduce catches by 50% of 2002-2004 levels of Pacific bluefin tuna 35 kg in size and under) are not projected to be sufficient to allow the population to recover (ISCPBWG 2014)(WCPFC 2014). We have therefore awarded a score of ‘ineffective.’

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Moderately Effective

Most species targeted in the fishery are not overfished. Bigeye tuna are classified as overfished in the most recent stock assessment and are experiencing overfishing and management measures have been

ineffective at reducing bigeye fishing mortality rates (Harley et al. 2014). However, bigeye is not a main target of the unassociated fishery and the vast majority is caught in the associated fishery and the longline fishery. In addition, bigeye tuna have only recently been classified as overfished and it is too early to determine if the fishery will be able to recover the population in a timely manner. We have therefore awarded a score of ‘moderately effective.’

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, Purse Seine, Unassociated

Moderately Effective

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

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Moderately Effective

Bigeye, yellowfin, and skipjack tuna stocks are regularly monitored and assessed (Harley et al. 2014)(Rice et al. 2014)(Davies et al. 2014). A variety of information, including catch and effort data, size (for some species) and biological information, is included in these assessments. However, these assessments generally have a high amount of uncertainty associated with them, so we have awarded a score of ‘moderately effective.’

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, Purse Seine, Unassociated

Moderately Effective

The 2012 stock assessment acknowledged that the recently implemented catch and effort controls put into place by the WCPFC and the IATTC, if properly implemented and enforced, could lead to an improved stock status. However, keeping fishing levels status quo (2007-2009) 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 reduced immediately 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). This resolution requires 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 score of 'moderately effective' because scientific advice has mostly been followed.

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

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% below the 2008-2011 level in order to be sustainable. The scientific committee noted that spatial management could be utilized for yellowfin tuna and that catches should not be increased from 2012 levels (WCPFC 2014b). In addition, reducing the fishing mortality on juveniles would increase the overall yield (Harley et al. 2014). The scientific committee did recommend, in 2009, that the Commission consider fishing limits for skipjack (Rice et al. 2014). The Commission does recognize that fishing mortality needs to be reduced to improve the status of bigeye and yellowfin tuna in this region (WCPFC 2012), and has recently prohibited discarding of these species, but there are not catch limits for either species in this fishery. The 2014 Commission meeting had not occurred at the time of this report, so it is unknown if additional management measures are to be adopted based on the updated 2014 stock assessments. We have therefore awarded a 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, Purse Seine, Unassociated

Moderately Effective

The WCPFC has a compliance monitoring scheme in place that assesses members' compliance with obligations, identifies areas of conservation and management that may need refinement, and monitors and resolves non-compliance issues. The Commission evaluates compliance by members annually with respect to catch and effort limits and reporting for target species, spatial and temporal closures, observer and vessel monitoring systems (VMS) coverage, and provision of scientific data (WCPFC 2012c). The 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 allowing 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 20N and east of 175E. The area north of 20N and west of 175W had an activation date of December 31, 2013 for VMSs (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). 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 had a lack of transparency with regard to the availability of compliance related data, a lack of incentive for countries to comply with management measures and lacked the processes needed to respond to non-compliance (Gilman and Kingma 2013). Koehler (2013) also found both the WCPFC and IATTC to be ineffective with regards to 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 (there is a compliance monitoring scheme 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 information on the compliance of individual nations (WCPFC 2013g)

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

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Moderately Effective

The WCPFC has a compliance monitoring scheme in place that assesses members' compliance with obligations, identifies areas of conservation and management that may need refinement, and monitors and resolves non-compliance issues. The Commission evaluates compliance by members annually with respect to catch and effort limits and reporting for target species, spatial and temporal closures, observer and vessel monitoring systems (VMS) coverage, and provision of scientific data (WCPFC 2012c).

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 20N and east of 175E. The area north of 20N and west of 175W had an activation date of December 31, 2013 for VMSs (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 had a lack of transparency with regard to the availability of compliance related data, a lack of incentive for countries to comply with management measures and lacked the processes needed to respond to non-compliance (Gilman and Kingma 2013). Koehler (2013) also found issues in the WCPFC in regards to compliance transparency, specifically because the WCPFC's compliance assessment process (there is a compliance monitoring scheme in place) (WCPFC 2013) is closed to the public and it does not have methods of dealing with non-compliance. In 2013, the Commission finally started releasing some information on the compliance of individual nations (WCPFC 2013g).

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

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, Purse Seine, Unassociated

Ineffective

Management measures enacted by the WCPFC and 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 Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Moderately Effective

Management measures enacted by the WCPFC have shown mixed results in their ability to meet stock management objectives of principal market species (Gilman et al. 2013). In terms of bigeye tuna, the WCPFC has been unable to maintain a healthy stock size. We have awarded a score of ‘moderately effective. due to the mixed results in terms of the 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, Purse Seine, Unassociated

Moderately Effective

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

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 been improved in recent years. We have therefore awarded a score of ‘moderately effective.’

Bycatch Strategy

Factor 3.2: Management of fishing impacts on bycatch species						
Region / Method	All Kept	Critical	Strategy	Research	Advice	Enforce
North Pacific Purse Seine, Unassociated	No	No	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective
Western Central Pacific Purse Seine, Floating Object	No	No	Ineffective	Highly Effective	Moderately Effective	Moderately Effective
Western Central Pacific Purse Seine, Unassociated	No	No	Moderately Effective	Highly Effective	Moderately Effective	Moderately Effective

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, and so we have awarded a score of ‘highly effective’ for that fishery.

Subfactor 3.2.1 – 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, Purse Seine, Unassociated

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). Purse seine vessels must avoid encircling sea turtles (IATTC 2007)(WCPFC 2008b). Purse seine fisheries in the eastern Pacific Ocean (EPO) are also required to release, as soon as possible, all sharks, billfish, rays, dorado and other non-target species (IATTC 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 score of 'moderately effective' because bycatch is minimal and management measures are in place.

Western Central Pacific, Purse Seine, Floating Object

Ineffective

The WCPFC has adopted several management measures to protect vulnerable bycatch species. Members of the WCPFC are to implement the FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations. Proper handling and release guidelines should be 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 and the incident recorded and reported (WCPFC 2012g)(WCPFC 2013f). However, the success of this is highly dependent on the quick release of silky sharks 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, and should have policies in place to reduce waste and discarding of sharks. Information on catch and effort for key species is to be reported and shark finning is banned (5% ratio) (WCPFC 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 a score of 'ineffective' because there are no bycatch limits for non-target species and it is not clear that these management measures are effective at maintaining population levels of bycatch species or if they are being put into place. In addition, the WCPFC has failed to adopt resolutions to require mandatory collection and reporting of FAD data or to require the use of non-entangling FADs, which have been identified as necessary to reduce 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 (Filmlalter et al. 2013).

Western Central Pacific, Purse Seine, Unassociated

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 if a whale shark is present, 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; any incidentally caught sharks should be released and the incident recorded and reported (WCPFC 2012g)(WCPFC 2013f). However, the success of this is highly dependent on quick release of silky sharks because their post release mortality rates increase with time (Hutchinson et al. 2013). In addition, vessels are restricted from making a set on a school of tuna associated with a cetacean and if this does occur they must take measures to ensure its safe release and to report the incident (WCPFC 2012f). Purse seine vessels must avoid encircling sea turtles (WCPFC 2008b) and are prohibited from landing silky sharks (WCPFC 2013f).

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

Subfactor 3.2.2 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented 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, Purse Seine, Unassociated

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, and so we have awarded a score of 'moderately effective.'

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

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 3.2.3 – 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, Purse Seine, Unassociated

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

Moderately Effective

The Scientific Committee has recently (2014) recommended several measures related to bycatch to the Commission. These include analyzing bycatch mitigation methods for sharks and evaluating the fin to carcass ratio currently in effect. No additional scientific advice for sea turtles was provided in 2014 (WCPFC 2014b). Historically, no scientific advice related to bycatch has been adopted (i.e., WCPFC 2013e), and so we have awarded a score of ‘moderately effective.’

Subfactor 3.2.4 – 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, Purse Seine, Unassociated

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

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

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Overall Recomm.
North Pacific Purse Seine, Unassociated	5.00:None	0.00:No Effective Mitigation	3.00:Moderate Concern	Green (3.873)
Western Central Pacific Purse Seine, Floating Object	4.00:Very Low Concern	0.00:No Effective Mitigation	1.00:Very High Concern	Red (2.000)
Western Central Pacific Purse Seine, Unassociated	5.00:None	0.00:No Effective Mitigation	3.00:Moderate Concern	Green (3.873)

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

Justification of Ranking

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

Scoring Guidelines

- *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.

North Pacific, Purse Seine, Unassociated

None

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

Western Central Pacific, Purse Seine, Floating Object

Very Low Concern

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

Western Central Pacific, Purse Seine, Unassociated

None

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

Factor 4.2 – Mitigation of Gear Impacts

Scoring Guidelines

- *+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.*

North Pacific, Purse Seine, Unassociated

Western Central Pacific, Purse Seine, Floating Object

Western Central Pacific, Purse Seine, Unassociated

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 score of ‘no effective mitigation’ with respect to habitat impacts.

Factor 4.3 – Ecosystem-Based Fisheries Management

Scoring Guidelines

- *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 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.*

North Pacific, Purse Seine, Unassociated

Moderate Concern

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

Western Central Pacific, Purse Seine, Floating Object

Very High Concern

Purse seine fisheries in the western and central Pacific Ocean catch several ecologically important groups, including tunas and sharks. In particular, sharks; considered top predators in many ecosystems and which 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 aal. 2010) (Schindler et al. 2002) as well as behavioral changes (Heithaus et al. 2007).

The use of FADs in the western and central Pacific Ocean could impact the surrounding ecosystems. Smaller tuna, specifically bigeye and yellowfin, are often associated with FADs and this could lead to growth and recruitment overfishing (Freon and 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 its potential effects on the ecosystem, including monitoring the number of FADs being used (Dagorn et al. 2012).

The WCPFC has begun identifying key shark species impacted by fisheries in the Convention Area and has, to date, completed stock assessments on two species (oceanic white tip and silky sharks)(Rice and Harley 2013)(Rice and Harley 2012b). In addition, the WCPFC has initiated studies to monitor changes to the food web and to examine predator-prey relationships (Allain 2010) (Allain et al. 2012) and has instituted some FAD specific management measures (WCPFC 2012a).

We have awarded a score of 'very high concern' because there is a potential for negative ecological impacts from FADs and management is not designed to avoid these impacts.

Western Central Pacific, Purse Seine, Unassociated

Moderate Concern

Purse seine fisheries in the western and central Pacific Ocean catch several ecologically important groups including tunas and sharks. In particular, sharks; considered top predators in many ecosystems and which 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 aal. 2010) (Schindler et al. 2002) and behavioral changes (Heithaus et al. 2007).

The WCPFC has begun identifying key shark species impacted by fisheries in the Convention Area and has to date completed stock assessments on two species (oceanic white tip and silky sharks)(Rice and Harley 2013)(Rice and Harley 2012b). In addition, the WCPFC has initiated studies to monitor changes to the food web and to examine predator-prey relationships (Allain 2010) (Allain et al. 2012) and has instituted some FAD specific management measures (WCPFC 2012a).

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Appendix A

FALSE KILLER WHALE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Floating Object

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Floating Object

High Concern

The International Union for Conservation of Nature (IUCN) considers false killer whales to be a Data Deficient species with an unknown population trend (Taylor et al. 2008). Population estimates are 16,000 from the coast of China and Japan (Miyashita 1993)(Barlow 2006). There are three populations of false killer whales in Hawaiian waters, a pelagic population, a Main Hawaiian Islands population and a population at the Northwestern Hawaiian Islands, with a combined estimated population size of 2,206 (Caretta et al. 2014). We have awarded a score of 'high concern' because the status is unknown in the western and central Pacific Ocean and they have a high inherent level of vulnerability to fishing.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Floating Object

Low Concern

From 2007 through 2009, 216 false killer whales were observed caught on 42 sets. The overall mortality rate was 51% and, based on these observations, it was estimated that 239 animals were killed

throughout the fishery during 2009. During 2010, 47 animals were observed caught during 18 sets with a mortality rate of 28%, indicating a total mortality rate of 25 for the entire fishery during 2010. From 2007 to 2009, 37% of toothed whales, including false killer whales, were caught on FAD sets, 20% on natural log sets and 16% on 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), and so we have awarded a score of 'low concern.'

Factor 2.4 - Discard Rate

Western Central Pacific, Purse Seine, Floating Object

< 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.

GREEN SEA TURTLE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Floating Object

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

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Floating Object

Very High Concern

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 are 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 increasing trends, 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 score of 'very high concern' because they are classified as endangered.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Floating Object

Low Concern

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

< 20%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the WCPO

between 1995 and 2011 the estimated discard rate of tunas in purse seine fisheries was just over 3% (OFP 2012a) and targeted tunas represented 98% of the total catch on log associated sets between 1994 and 2009 (OFP 2010). 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, and so we have awarded a score of 1.

HAWKSBILL TURTLE

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Floating Object

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

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Floating Object

Very High Concern

The 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 are threatened with extinction and international trade is prohibited. It has been estimated that populations in the Pacific Ocean have declined by more than 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 score of 'very high concern' to account for their Endangered status.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Floating Object

Low Concern

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

< 20%

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

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Floating Object

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

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Floating Object**Very High Concern**

The 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% to 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 females of 92%, from 1,412 to 108 (Abreu-grobois and Plotkin 2008). We have awarded a score of 'very high concern' based on the Endangered species listing.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Floating Object**Low Concern**

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

< 20%

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

RAINBOW RUNNER

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Floating Object

Medium

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Floating Object

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 score of 'moderate concern.'

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Floating Object

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 score of ‘moderate concern’ because information on fishing mortality is not known.

Factor 2.4 - Discard Rate

Western Central Pacific, Purse Seine, Floating Object

< 20%

Purse seine fisheries have an average discard rate of just under 5% (Kelleher 2005). In the WCPO between 1995 and 2011 the estimated discard rate of tunas in purse seine fisheries was just over 3% (OFP 2012a) and targeted tunas represented 98% of the total catch on log associated sets between 1994 and 2009 (OFP 2010). 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, and so we have awarded a score of 1.

ROUGH-TOOTHED DOLPHIN

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Floating Object

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Floating Object

Moderate Concern

The 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 score of 'moderate concern' 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

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Floating Object

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 score of 'low concern' because bycatch does not seem to be a large contributing factor to population declines (Hammond et al. 2012b).

Factor 2.4 - Discard Rate

Western Central Pacific, Purse Seine, Floating Object

< 20%

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

WHALE SHARK

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Western Central Pacific, Purse Seine, Unassociated

High

FishBase assigned a very high vulnerability of 81 out of 100 (Froese and Pauly 2013).

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Western Central Pacific, Purse Seine, Unassociated

High Concern

The stock status of whale sharks in the WCPO is not known. However, it is thought they are vulnerable to fishing related mortality, similar to other shark species, and observer records indicate whale sharks have been impacted by tuna purse seine fisheries in the WCPO (Rice and Harley 2012c). Ecological risk assessments (ERA) have identified whale sharks as having a moderate to high susceptibility to purse seine capture (Kirby 2006)(Kirby and Hobday 2007). The IUCN Red List of Threatened Species considers whale sharks to be Vulnerable (Norman 2005), and so we have awarded a score of 'high concern.'

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Western Central Pacific, Purse Seine, Unassociated

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% (respectively) of whale sharks were caught on sets made on drifting and anchored FADs. During 2010, these percentages were 3% and 2%, but an additional 4% were caught during sets made on natural logs (OFP 2012a). In addition to mortalities from the purse seine fishery, there are non-tuna related fishery interactions along with targeted fishing in some locations (Rice and Harley 2012c)(OFP 2012b). We have awarded a score of 'moderate concern' because fishing mortality rates are unknown but there are management measures preventing sets being made around whale sharks, which were recently put into place (WCPFC 2012e).

Factor 2.4 - Discard Rate

Western Central Pacific, Purse Seine, Unassociated

< 20%

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