Bigeye tuna (*Thunnus obesus*)
Skipjack tuna (*Katsuwonus pelamis*)
Yellowfin tuna (*Thunnus albacares*)

Indian Ocean
Purse seine: Floating object & Unassociated

October 3, 2016
Alexia Morgan, Consulting Researcher

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 fished\(^1\) or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

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

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

Each criterion includes:

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

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

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

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

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

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\(^1\) "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates
Summary
This report focuses on the associated and unassociated purse seine fisheries in the Indian Ocean that target skipjack (*Katsuwonus pelamis*), bigeye (*Thunnus obesus*), and yellowfin tuna (*Thunnus albacares*).

All the tuna species in this report are of medium inherent vulnerability to fishing pressure based on life history characteristics, including when they reach sexual maturity, maximum size, and spawning strategy. Almost all these species are either top predators or occupy a high trophic level in the ecosystem.

Bigeye tuna populations in the Indian Ocean are healthy according to the most recent assessment, which shows that current biomass levels are well above target levels for producing maximum sustainable yield and that fishing mortality rates are low, indicating that overfishing is not occurring. Skipjack tuna populations also are not overfished and overfishing is not occurring, based on fishing mortality rates being below target reference points. Yellowfin tuna populations are overfished with overfishing occurring.

Bycatch is typically higher in associated compared to unassociated purse seine fisheries. This report includes species that typically make up 5% or more of the total catch, or whose status (e.g., endangered or threatened) justifies their inclusion in this report, per the Seafood Watch criteria. The associated fishery incidentally captures silky shark, which is a species of concern because its status in the Indian Ocean is uncertain and it is considered "Near Threatened" by the IUCN. The unassociated fishery incidentally captures several species of large rays (e.g., devil fish and manta ray), which have been included in this report because of their unknown status in the Indian Ocean.

These three tuna species are managed within the Indian Ocean by the Indian Ocean Tuna Commission (IOTC). Although there are a number of management measures in place, including a new harvest control rule for skipjack tuna and measures to reduce overfishing of yellowfin tuna, management has a mixed record on compliance and adherence to scientific advice. Overall, management is considered moderately effective.

There are management measures in place in the Indian Ocean to mitigate the incidental capture of bycatch species in purse seine fisheries, including prohibiting vessels from intentionally setting a purse seine net around cetaceans, sea turtles, or whale sharks. Interactions between a vessel and sea turtles must be reported to the IOTC, and fishers are required to attempt proper mitigation measures, to aid in recovery when necessary, and to release all incidentally captured sea turtles. In addition, oceanic whitetip shark is prohibited from capture and landing and should be released if incidentally captured. But there are no bycatch catch limits in place, and ghost fishing of sharks continues to be a major concern in this fishery. The IOTC requires at least 5% observer coverage on all vessels; however, only two or three member countries have been able to achieve this, so information is lacking on bycatch species such as sharks and turtles.

Purse seine gears typically have little contact with bottom habitats, although fish aggregating devices (FADs) can be anchored to the bottom. The incidental capture of ecologically important species by FADs has the potential for negative ecological impacts, and management is not designed to avoid these impacts.

Final Seafood Recommendations

<table>
<thead>
<tr>
<th>SPECIES/FISHERY</th>
<th>CRITERION 1: IMPACTS ON THE SPECIES</th>
<th>CRITERION 2: IMPACTS ON OTHER SPECIES</th>
<th>CRITERION 3: MANAGEMENT EFFECTIVENESS</th>
<th>CRITERION 4: HABITAT AND ECOSYSTEM</th>
<th>OVERALL RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigeye tuna</td>
<td>Green (5.000)</td>
<td>Red (1.414)</td>
<td>Red (1.732)</td>
<td>Red (2.000)</td>
<td>Avoid (2.224)</td>
</tr>
<tr>
<td>Indian Ocean,</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Floating object</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>purse seine</td>
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</tbody>
</table>
**Scoring Guide**

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

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

- **Best Choice/Green** = Final Score > 3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score > 2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern, and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score ≤ 2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

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<table>
<thead>
<tr>
<th>Fish</th>
<th>Indian Ocean, Floating object</th>
<th>Purse Seine</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skipjack tuna</td>
<td>Green (5.000)</td>
<td>Red (1.414)</td>
<td>Red (1.732)</td>
</tr>
<tr>
<td>Yellowfin tuna</td>
<td>Red (1.414)</td>
<td>Red (1.414)</td>
<td>Red (1.732)</td>
</tr>
<tr>
<td>Skipjack tuna</td>
<td>Green (5.000)</td>
<td>Red (1.414)</td>
<td>Yellow (3.000)</td>
</tr>
<tr>
<td>Yellowfin tuna</td>
<td>Red (1.414)</td>
<td>Red (1.414)</td>
<td>Yellow (3.000)</td>
</tr>
</tbody>
</table>

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

Scope of the analysis and ensuing recommendation

This report focuses on bigeye (*Thunnus obesus*), skipjack (*Katsuwonus pelamis*), and yellowfin tuna (*Thunnus albacares*) caught by purse seines (associated and unassociated) in the Indian Ocean.

Species Overview

Bigeye, skipjack, and yellowfin tuna are found in tropical and subtropical waters worldwide including the Indian Ocean. These species are all assessed as single populations in the Indian Ocean. In the Pacific Ocean, there are two populations: Eastern Pacific, and Western and Central Pacific. In the Atlantic Ocean, there is one population of bigeye and yellowfin and two of skipjack (Eastern and Western). Bigeye, skipjack, and yellowfin tuna are highly migratory and commonly found as juveniles schooling together below floating objects (IOTC 2013b) (IOTC 2013c) (IOTC 2013d).

Globally, longlines are the most common method used to capture bigeye tuna, and purse seines are the primary gear used to capture skipjack and yellowfin tuna. 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).

In the Indian Ocean, tuna are managed by the Indian Ocean Tuna Commission (IOTC).

Production Statistics

Purse seine fishing accounts for around 19% of the total bigeye tuna catch in the Indian Ocean. After steady increases in total catches between 1950 and 1999 (160,000 MT, total catches), total annual catches in more recent years have decreased to 115,000 MT (5,217 MT unassociated and 7,180 MT associated) in 2012. This decrease in total catches is most likely due to piracy in the northwest Indian Ocean, which has subsequently reduced longline effort in this region. The top purse seine fishing nations for bigeye tuna in the Indian Ocean (in decreasing order) are Spain, Seychelles, France, Indonesia, and Japan (IOTC 2013b).

![Figure 1 Bigeye tuna annual catches, 1950-2012, in the Indian Ocean (IOTC 2013b).](image)

Historically, the pole-and-line and trolling fisheries captured the majority of skipjack tuna in the Indian Ocean.
until the mid-1980s, when purse seining was introduced. After the introduction of the purse seine fisheries, skipjack tuna became one of the most important tuna species in the Indian Ocean. Total catches of skipjack tuna have been increasing over time as sets made on floating objects (FADs) increased. Total catches peaked in 2006 at around 600,000 MT, with close to 50% coming from the purse seine fishery. Since 2006, catches of skipjack tuna have decreased to 384,537 MT in 2012, with 9,000 MT coming from the unassociated and 123,056 MT from the associated purse seine fisheries. The top fishing nations using purse seines (in decreasing order) are Spain, Indonesia, and Seychelles (IOTC 2013c).

Figure 2 Skipjack tuna annual catches, 1950-2012, in the Indian Ocean (IOTC 2013c).

Total annual catches of yellowfin tuna have increased significantly since the expansion of the purse seine fishery during the early 1980s. Total catches peaked in 2004 at 528,797 MT (168,392 MT unassociated and 59,655 MT associated) but have since dropped, with total catches in 2012 being 370,000 MT (64,593 MT unassociated and 66,166 MT associated). The top purse seine fishing nations (in decreasing order) are Spain, Seychelles, France, Indonesia, and Iran (IOTC 2013d).

Figure 3 Yellowfin tuna annual catches, 1950-2012, in the Indian Ocean (IOTC 2013d).

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

Figure 4 Major contributors to U.S. bigeye tuna imports (%), all countries (country of origin) (NMFS 2014).
Figure 5 Major contributors to U.S. skipjack tuna imports (%), all countries and regions (country of origin) (NMFS 2014).
Common and market names.

In Hawaii, bigeye and yellowfin tuna are known as ahi, and skipjack as aku.

Primary product forms

These species are sold in fresh and frozen form and for the sushi and sashimi markets.
Assessment

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

Criterion 1: Impacts on the species under assessment

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

The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

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

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

Criterion 1 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIGEYE TUNA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian Ocean Floating object purse seine</td>
<td>2.00: Medium</td>
<td>5.00: Very Low Concern</td>
<td>5.00: Very Low Concern</td>
<td>Green (5.000)</td>
</tr>
<tr>
<td><strong>SKIPJACK TUNA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian Ocean Floating object purse seine</td>
<td>2.00: Medium</td>
<td>5.00: Very Low Concern</td>
<td>5.00: Very Low Concern</td>
<td>Green (5.000)</td>
</tr>
<tr>
<td>Indian Ocean Unassociated purse seine</td>
<td>2.00: Medium</td>
<td>5.00: Very Low Concern</td>
<td>5.00: Very Low Concern</td>
<td>Green (5.000)</td>
</tr>
<tr>
<td><strong>YELLOWFIN TUNA</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian Ocean Floating object purse seine</td>
<td>2.00: Medium</td>
<td>2.00: High Concern</td>
<td>1.00: High Concern</td>
<td>Red (1.414)</td>
</tr>
<tr>
<td>Indian Ocean Unassociated purse seine</td>
<td>2.00: Medium</td>
<td>2.00: High Concern</td>
<td>1.00: High Concern</td>
<td>Red (1.414)</td>
</tr>
</tbody>
</table>

Bigeye and skipjack tuna populations are all currently healthy and sustainably fished. Yellowfin tuna is currently overfished and undergoing overfishing.
**Criterion 1 Assessment**

**SCORING GUIDELINES**

**Factor 1.1 - Inherent Vulnerability**

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

**Factor 1.2 - Abundance**

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

**Factor 1.3 - Fishing Mortality**

- **5 (Very Low Concern)**—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).
- **3.67 (Low Concern)**—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).
- **2.33 (Moderate Concern)**—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.
- **1 (High Concern)**—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.
- **0 (Critical)**—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.
**BIGEYE TUNA**

**Factor 1.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>FishBase assigned a high to very high vulnerability of 72 out of 100 for bigeye tuna (Froese and Pauly 2013). But bigeye tuna’s life history characteristics suggest a medium vulnerability to fishing. For example, bigeye tuna reaches sexual maturity around 100 cm or 3 years of age, reaches a maximum size of 200 cm, and lives around 15 years (IOTC 2013b). It is a broadcast spawner and top predator (Froese and Pauly 2013). Based on these life history characteristics, we have awarded a “medium” score.</td>
<td></td>
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</table>

**Factor 1.2 - Abundance**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
<th>Very Low Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>According to the most recent assessment, the biomass is estimated to currently be well above target levels that produce the maximum sustainable yield ( (SB_{2012}/SB_{MSY} = 1.44 (0.87–2.22)) ). The current biomass is around 40% of virgin levels (IOTC 2013b). We have awarded a “very low” concern score because the biomass is well above target levels.</td>
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</table>

**Factor 1.3 - Fishing Mortality**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
<th>Very Low Concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing mortality rates are estimated to be below the provisional target levels needed to produce the maximum sustainable yield ( (F_{MSY}) ) as well as below the interim limit reference point. Currently, fishing mortality is only 42% (21%–80% range) of ( F_{MSY} ) and therefore overfishing is not occurring. Catches over the last 5 years have been below MSY levels. Maintaining catches at the current level should not negatively impact the population (IOTC 2013b), so we have awarded a “very low” concern score.</td>
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</tbody>
</table>

**SKIPJACK TUNA**

**Factor 1.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
<th>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</th>
<th>Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>FishBase assigned a moderate vulnerability score of 39 out of 100 (Froese and Pauly 2013). Skipjack’s life history characteristics support this score. Sexual maturity is reached around 41–43 cm and before 2 years of age, and skipjack can reach a maximum size of 110 cm and age of 12 years. It is a broadcast spawner and has a high trophic level (Froese and Pauly 2013) (IOTC 2013c).</td>
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**Factor 1.2 - Abundance**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
<th>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</th>
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</thead>
<tbody>
<tr>
<td><strong>Very Low Concern</strong></td>
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<tr>
<td>Skipjack tuna populations in the Indian Ocean are considered to be healthy. The ratio of the biomass in 2011 to that needed to produce the maximum sustainable yield (SB_{2011}/SB_{MSY}) was estimated to be well above the interim target reference point of 1 (1.20 (1.01–1.40)), indicating that the population is not overfished. In addition, there is a low probability of the biomass falling below the limit reference point (0.4 × B_{MSY}) over the next 3 to 10 years (IOTC 2013c). We have therefore awarded a “very low” concern score based on these results.</td>
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**Factor 1.3 - Fishing Mortality**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
<th>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Low Concern</strong></td>
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<tr>
<td>Total catches of skipjack tuna in the Indian Ocean have been declining over time and were well below the maximum sustainable yield (MSY) (478,000 t) in 2011. Fishing mortality rates (F_{2011}) in 2011 were estimated to be 80% (68%–92%) of those needed to produce the maximum sustainable yield (F_{MSY}), the provisional target reference point, and were also below the provisional limit reference point (1.5 × F_{MSY}) (IOTC 2013c). There is a low probability that fishing mortality rates will exceed the limit reference point in 3 to 10 years. In addition, there is a low risk of catches exceeding MSY levels if catches are maintained at current levels, or even increased slightly to levels from 2005–2010 (IOTC 2013c). Overfishing of skipjack tuna is not occurring and we have therefore awarded a “very low” concern score.</td>
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</table>

**YELLOWFIN TUNA**

**Factor 1.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
<th>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</th>
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</thead>
<tbody>
<tr>
<td><strong>Medium</strong></td>
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<tr>
<td>FishBase assigned a moderate vulnerability score of 46 out of 100 (Froese and Pauly 2013). Yellowfin tuna reaches sexual maturity around 100 cm in size and 3–5 years in age. A maximum length of 240 cm in size can be attained and it can live 8–9 years. It is a broadcast spawner and high-level predator in the ecosystem (Froese and Pauly 2014) (IOTC 2013d). These life history characteristics also support a moderate level of vulnerability and a score of “medium” concern.</td>
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**Factor 1.2 - Abundance**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
<th>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</th>
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</thead>
<tbody>
<tr>
<td><strong>High Concern</strong></td>
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</table>
According to the most recent assessment of yellowfin tuna in the Indian Ocean (2015), the ratio of the biomass in 2014 to that needed to produce the maximum sustainable yield was estimated to be well below the provisional target level of 1 ($SB_{2014}/SB_{MSY} = 0.66$ (C.I. 0.58–0.74)), although the biomass is above the provisional limit reference point ($0.4 \times SB_{MSY}$). Therefore, yellowfin tuna is currently considered overfished, which is a change from the 2012 assessment results (IOTC 2015). We have awarded a “high” concern score based on the overfished status.

**Factor 1.3 - Fishing Mortality**

| INDIAN OCEAN, FLOATING OBJECT PURSE SEINE |
| INDIAN OCEAN, UNASSOCIATED PURSE SEINE |

**High Concern**

The current fishing mortality rates are estimated to be well above both the provisional target reference point of $F_{2014}/F_{MSY} = 1.34$ (1.02–1.67) and right around the limit reference point ($1.4 \times F_{MSY}$). The 2012 assessment results were unclear if the status of yellowfin tuna was moving toward overfishing occurring, because catches in recent years had exceeded previous maximum sustainable yield estimates (IOTC 2013d). Based on the 2014 assessment, it is clear that the population is undergoing overfishing (IOTC 2015). We have therefore awarded a “high” concern score.
**Criterion 2: Impacts on other species**

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. Seafood Watch® defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing.

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

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

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

**Criterion 2 Summary**

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

### BIGEYE TUNA - INDIAN OCEAN - FLOATING OBJECT PURSE SEINE

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellowfin tuna</td>
<td>2.00:Medium</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.414)</td>
</tr>
<tr>
<td>Silky shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.414)</td>
</tr>
<tr>
<td>Rainbow runner</td>
<td>2.00:Medium</td>
<td>3.00:Moderate Concern</td>
<td>2.33:Moderate Concern</td>
<td>Yellow (2.644)</td>
</tr>
<tr>
<td>Skipjack tuna</td>
<td>2.00:Medium</td>
<td>5.00:Very Low Concern</td>
<td>5.00:Very Low Concern</td>
<td>Green (5.000)</td>
</tr>
</tbody>
</table>

### SKIPJACK TUNA - INDIAN OCEAN - FLOATING OBJECT PURSE SEINE

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellowfin tuna</td>
<td>2.00:Medium</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.414)</td>
</tr>
<tr>
<td>Silky shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.414)</td>
</tr>
<tr>
<td>Rainbow runner</td>
<td>2.00:Medium</td>
<td>3.00:Moderate Concern</td>
<td>2.33:Moderate Concern</td>
<td>Yellow (2.644)</td>
</tr>
<tr>
<td>Bigeye tuna</td>
<td>2.00:Medium</td>
<td>5.00:Very Low Concern</td>
<td>5.00:Very Low Concern</td>
<td>Green (5.000)</td>
</tr>
</tbody>
</table>

### SKIPJACK TUNA - INDIAN OCEAN - UNASSOCIATED PURSE SEINE

<table>
<thead>
<tr>
<th>Species</th>
<th>Inherent Vulnerability</th>
<th>Abundance</th>
<th>Fishing Mortality</th>
<th>Subscore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellowfin tuna</td>
<td>2.00:Medium</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.414)</td>
</tr>
<tr>
<td>Silky shark</td>
<td>1.00:High</td>
<td>2.00:High Concern</td>
<td>1.00:High Concern</td>
<td>Red (1.414)</td>
</tr>
<tr>
<td>Rainbow runner</td>
<td>2.00:Medium</td>
<td>3.00:Moderate Concern</td>
<td>2.33:Moderate Concern</td>
<td>Yellow (2.644)</td>
</tr>
<tr>
<td>Bigeye tuna</td>
<td>2.00:Medium</td>
<td>5.00:Very Low Concern</td>
<td>5.00:Very Low Concern</td>
<td>Green (5.000)</td>
</tr>
</tbody>
</table>
Bycatch is typically higher in associated compared to unassociated purse seine fisheries. For this report, we used catch data from the Indian Ocean Tuna Commission and published literature to identify bycatch species that represent 5% of the total catch in these fisheries or are Endangered, Threatened, or Protected species that warrant inclusion. For the associated purse seine fishery, only two additional bycatch species are included in this report: silky sharks, which are the main shark species (79% of all shark bycatch) (Amande et al. 2008), and rainbow runner (37% of fish bycatch) (Ardill et al. 2012). The total estimated percentage bycatch in the floating object fishery between 2003 and 2007 was 5.3% (Ardill et al. 2012). One additional species, large rays, warranted inclusion in the unassociated purse seine fishery. The percentage of bycatch in this fishery between 2003 and 2007 was only 1.17% (Ardill et al. 2012). The worst scoring species in the associated purse seine fishery is the silky shark, due to the potentially low population size and large negative impacts from fishing. All three tuna species scored fairly well in the unassociated fishery.

**Criterion 2 Assessment**

**SCORING GUIDELINES**

**Factor 2.1 - Inherent Vulnerability**

*(same as Factor 1.1 above)*

**Factor 2.2 - Abundance**

*(same as Factor 1.2 above)*
**Factor 2.3 - Fishing Mortality**
*(same as Factor 1.3 above)*

**Silky shark**

**Factor 2.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
</tr>
</tbody>
</table>

FishBase assigned a very high vulnerability score of 79 out of 100 (Froese and Pauly 2013). Silky shark reaches sexual maturity around 228 cm in size and 8–12 years of age. It reaches a maximum size of 350 cm and 25 years of age (Froese and Pauly 2013).

**Factor 2.2 - Abundance**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Concern</strong></td>
</tr>
</tbody>
</table>

The status of silky sharks in the Indian Ocean is uncertain. In the eastern and western Indian Ocean, along with globally, silky sharks are considered Near Threatened by the International Union for the Conservation of Nature (IUCN) (Bonfil et al. 2009). No qualitative assessment has been conducted in the Indian Ocean, due to a lack of information. The information that does exist indicates that significant declines in abundance have occurred over time, and silky shark is considered one of the most vulnerable shark species in the Indian Ocean (IOTC 2012) (IOTC 2013g). We have awarded a “high” concern score based on the IUCN classification.

**Factor 2.3 - Fishing Mortality**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Concern</strong></td>
</tr>
</tbody>
</table>

Silky sharks are caught in a number of fisheries in the Indian Ocean, including purse seine fisheries. A qualitative assessment has not been conducted in the Indian Ocean, and there is substantial uncertainty surrounding total catch estimates. Current fishing mortality rates are unknown but it is generally thought that maintaining or increasing fishing effort will likely cause the biomass to decline (IOTC 2013g). There is some evidence that entanglement mortality of silky sharks in drift fish aggregating devices (DFADs) may be substantial: 5 to 10 times the current bycatch estimates of silky sharks in purse seine fisheries operating in the Indian Ocean (Filmalter et al. 2013). Although other gears have higher bycatch rates of silky sharks (e.g., gillnet and longline), we have still awarded a “high” concern score because of the uncertainty surrounding fishing mortality rates, the lack of effective management measures in place, and because it is believed current levels of fishing are too high to maintain the population at a healthy size.

**Factor 2.4 - Discard Rate**

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20%</td>
</tr>
</tbody>
</table>
Purse seine fisheries have an average discard rate of 5%, although in the Indian Ocean discard rates may be even lower (Kelleher 2005) (Adrill et al. 2012). For example, observer data from the French and Spanish fleets indicated that tunas made up the majority of the catch in both floating object and unassociated sets and that discard rates were virtually non-existent, although they may occur on smaller vessels. The highest discard rates in these fisheries are for sharks, which typically make up the majority of the bycatch (Adrill et al. 2012).

**Manta ray (unspecified)**

**Factor 2.1 - Inherent Vulnerability**

<table>
<thead>
<tr>
<th>Source</th>
<th>Status</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</strong></td>
<td>High</td>
<td>Fishbase has assigned a very high vulnerability score of 78 out of 100 (Froese and Pauly 2013).</td>
</tr>
</tbody>
</table>

**Factor 2.2 - Abundance**

<table>
<thead>
<tr>
<th>Source</th>
<th>Status</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</strong></td>
<td>High Concern</td>
<td>Several species of large rays (e.g., devil fish, manta rays) are incidentally captured in Indian Ocean unassociated purse seine fisheries (Hall and Roman 2013). There are no population assessments of these species in the Indian Ocean. We have awarded a “high” concern score because the stock status is unknown but they have a high vulnerability to fishing.</td>
</tr>
</tbody>
</table>

**Factor 2.3 - Fishing Mortality**

<table>
<thead>
<tr>
<th>Source</th>
<th>Status</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</strong></td>
<td>High Concern</td>
<td>Several species of large rays (e.g., devil ray) are incidentally captured in unassociated purse seine fisheries in the Indian Ocean (Delgado de Molina et al. 2005) (Hall and Roman 2013). There is no information on their fishing mortality rates. We have awarded a “high” concern score because fishing mortality rates are unknown and this species has a high vulnerability to fishing.</td>
</tr>
</tbody>
</table>

**Factor 2.4 - Discard Rate**

<table>
<thead>
<tr>
<th>Source</th>
<th>Status</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</strong></td>
<td>&lt; 20%</td>
<td>Purse seine fisheries have an average discard rate of 5%, although in the Indian Ocean discard rates may be even lower (Kelleher 2005) (Adrill et al. 2012). For example, observer data from the French and Spanish fleets indicated that tunas made up the majority of the catch in both floating object and unassociated sets and that discard rates were virtually non-existent but may occur on smaller vessels. The highest discard rates in these fisheries are for sharks, which typically make up the majority of the bycatch (Adrill et al. 2012).</td>
</tr>
</tbody>
</table>
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 $\leq 3.2$ = Yellow or Moderate Concern
- Score $\leq 2.2$ or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern

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

Criterion 3 Summary

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Harvest Strategy</th>
<th>Bycatch Strategy</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian Ocean / Floating object purse seine</td>
<td>3.000</td>
<td>1.000</td>
<td>Red (1.732)</td>
</tr>
<tr>
<td>Indian Ocean / Unassociated purse seine</td>
<td>3.000</td>
<td>3.000</td>
<td>Yellow (3.000)</td>
</tr>
</tbody>
</table>

Factor 3.1: Harvest Strategy

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

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

Factor 3.1: Harvest Strategy

Factor 3.1 Summary
The United Nations Straddling and Highly Migratory Fish Stocks Agreement (1995) indicated that the management of straddling and highly migratory fish stocks should be carried out through Regional Fisheries Management Organizations (RFMOs). RFMOs are the only legally mandated fishery management body on the high seas and within EEZ waters. There are currently 18 RFMOs (www.fao.org) that cover nearly all of the world’s waters. Member countries must abide by the management measures set forth by individual RFMOs in order to fish in their waters (Cullis-Suzuki and Pauly 2010). Some RFMOs manage all marine living resources within their authority (e.g., General Fisheries Commission for the Mediterranean (GFCM)), while others manage a group of species such as tunas (e.g., Inter-American Tropical Tuna Commission (IATTC)). This report focuses on purse seine fisheries for tuna in international waters within the Indian Ocean, which are managed by the Indian Ocean Tuna Commission (IOTC). The following countries are current members of the IOTC: Australia, Belize, China, Comoros, Eritrea, European Community, France, Guinea, India, Indonesia, Iran, Japan, Kenya, Republic of Korea, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Pakistan, Philippines, Seychelles, Sierra Leone, Somalia, South Africa, Sri Lanka, Sudan, Tanzania, Thailand, United Kingdom, and Yemen. In addition, Bangladesh, Djibouti, Liberia, and Senegal are Cooperating Non-Contracting Parties. For this report we have scored this section for IOTC management.

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.

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Strategy</th>
<th>Recovery</th>
<th>Research</th>
<th>Advice</th>
<th>Enforce</th>
<th>Track</th>
<th>Inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian Ocean / Floating object purse seine</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Highly Effective</td>
</tr>
<tr>
<td>Indian Ocean / Unassociated purse seine</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Highly Effective</td>
</tr>
</tbody>
</table>
The Indian Ocean Tuna Commission has management measures in place specific to purse seine fisheries. Countries must have a fish aggregating device (FAD) management plan submitted to the Commission by the end of 2013. The plan must include information on the fleet, number of drifting FADs (DFADs), ways to reduce incidental bycatch, institutional arrangements for the management plan, construction requirements for DFADs, monitoring and review plans, and DFAD logbooks (recorded for any visit to a DFAD). For anchored FADs (AFADs), information on the vessel types, number of beacons to be deployed, reporting procedures for deployment, distance between AFADs, policies to reduce bycatch, inventories of AFADs deployed, institutional arrangements for management of the plan, AFAD construction specifications, and use of an AFAD logbook must also be included in the FAD management plan (IOTC 2013l). These plans must also have initiatives or surveys included to minimize the capture of small bigeye and yellowfin tuna. Starting in 2015, all AFADs will be required to be marked according to a marking scheme to be adopted in 2014 (IOTC 2013l). The number of instrumental buoys used on FADs will be restricted starting in 2017, and the use of artificial lights and aircraft or unmanned aerial vehicles will be prohibited (IOTC 2016). Starting in 2014, all bigeye, skipjack, and yellowfin tuna caught by purse seine must be retained and landed; in addition, the Commission encourages that other nontargeted species be retained (e.g., rainbow runner, other tuna) (IOTC 2013l).

Previously, in 2005, countries were required to limit their catches of bigeye tuna to recent levels, and Taiwan and China were asked to limit their catches to 35,000 MT. This measure was to be readdressed in 2006 but this does not appear to have yet occurred (this measure is still considered active) (IOTC 2013l). In addition, bigeye tuna shipments into contracting countries must be accompanied by a Bigeye Tuna Statistical Document that includes import and export information, and information on where the fish was caught, the product form, and what type of gear was used to capture it (IOTC 2013l). There is also a time/area closure in place for purse seine vessels from November to December, and fishing around data buoys is prohibited (IOTC 2013l). But the scientific committee has indicated that the current closure is likely to be ineffective due to fishing effort being redistributed to other areas (IOTC 2012b). Yellowfin catches from purse seine vessels that caught 5,000 MT or more during 2014 must be reduced by 15% starting in 2017 (IOTC 2016).

In addition to these management measures, the IOTC adopted a measure to implement the precautionary approach in 2012, which included the use of stock-specific reference points, associated harvest control rules, the ability to enact emergency measures in the face of natural phenomena having a negative impact on resources, and the ability to assess the performance of reference points and potential harvest control rules through a management strategy evaluation (IOTC 2013l). Currently, interim target and limit reference points are used in the IOTC for bigeye and yellowfin tuna (IOTC 2013l). A harvest control rule and reference points have been formally adopted by the Commission for skipjack tuna (IOTC 2016).

In 2009, a performance review of the IOTC identified several areas of the current conservation and management plans that needed to be addressed. These included modification of the timing of data reporting; any noncompliance should be monitored and identified at the member level; causes of noncompliance need to be identified; data quality (catch, effort, and size) needs to be improved; a scientific observer program should be established; a statistical committee should be developed; the list of shark species should be expanded to include five additional species and applied to all gear types; alternative reporting means (e.g., port sampling) should be explored; assessment methods for data-deficient species should be developed; and measures such as catch limits and total allowable catches (TACs) should be explored. Various degrees of work have been implemented since 2009 to address these issues (IOTC 2013q).

We have awarded a “moderately effective” score because the IOTC is taking the initiative to define target and limit reference points and has a transparent plan in place to assess and deal with compliance issues.

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.

**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.*

**Moderately Effective**

Yellowfin tuna was recently assessed as overfished in the Indian Ocean (IOTC 2015b). Managers have adopted measures to address the status of yellowfin tuna (IOTC 2016) but it is too early to determine their effectiveness. It should be noted that management measures enacted in 2010 to address overfishing of this species (based on the 2008 assessment) were successful at rebuilding the population for a short period. We have therefore awarded a "moderately effective" score.

**Subfactor 3.1.4 – Management Record of Following Scientific Advice**

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

**Moderately Effective**

Stock assessments for key tuna species are conducted on a regular basis. There are specific logbook requirements for use with both drifting (DFAD) and anchored (AFAD) FADs (IOTC 2013l). Member countries are required to record and report catch and effort data by species and gear. Purse seine fisheries must report data by a 1-degree grid area and month strata. In addition, size data must be provided and countries must have a random size sampling scheme in place. If an observer program is in place, this can serve as the sampling scheme. Information on supply vessels used with FADs must also be provided (number of vessels, number of days at sea, total number and type of FADs per quarter) by individual countries. In addition, bigeye tuna shipments into contracting countries must be accompanied by a Bigeye Tuna Statistical Document that includes import and export information, information on where the fish was caught, the product form, and what type of gear was used to capture it (IOTC 2013l). But the Compliance Committee indicated that reporting of mandatory statistics is generally poor, due to incomplete and/or poorly documented data. We have therefore awarded a “moderately effective” score.
The Indian Ocean Tuna Commission's Scientific Committee provides advice to the Commission. In 2016, the IOTC implemented a harvest control rule for skipjack in line with scientific advice (IOTC 2016). Otherwise, no specific advice was provided for bigeye or skipjack tuna besides monitoring skipjack tuna catches (IOTC 2013b) (IOTC 2013c). In 2015, it was advised that future catches of yellowfin tuna should be 80% or less of current levels to allow the population to rebuild (IOTC 2015). In 2016, the Commission adopted a new measure for yellowfin tuna. This measure included a requirement (for vessels that caught more than 5,000 MT of yellowfin during 2014) to reduce purse seine catches by 15% of 2014 levels. In addition, the new measure restricts the number of active and required instrumental buoys along with the number of supply vessels (IOTC 2016). In 2013, the Commission adopted a resolution that addresses some of the scientific advice with regard to sharks (IOTC 2013l). We have awarded a "moderately effective" score to account for the IOTC’s mixed record of adhering to scientific advice.

**Subfactor 3.1.5 – Enforcement of Management Regulations**

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

**INDIAN OCEAN, FLOATING OBJECT PURSE SEINE**

**INDIAN OCEAN, UNASSOCIATED PURSE SEINE**

**Moderately Effective**
The IOTC maintains a record of fishing vessels larger than 24 m in length, and all vessels (purse seine, longline, gillnet, pole and line, handline, and trolling) authorized to fish must have in place a data recording system (all vessels over 24 m, and under 24 m if fishing outside EEZs). This includes logbooks (paper or electronic) that collect information (each fishery has specific required catch and effort data) (IOTC 2013l). Information on Illegal, Unreported, and Unregulated (IUU) vessels is required to be reported by individual countries to the Commission (IOTC 2013l). Vessel monitoring systems (VMS) are required on all vessels larger than 15 m in length, and compliance with the time/area closure must be monitored by individual countries through methods such as VMS; these records must be provided to the Commission (IOTC 2013l). In addition, countries must inspect at least 5% of landings or transshipments in their ports per year (IOTC 2013l). There are no total allowable catches (TACs) currently in place that need enforcement. IUU fishing continues to be a problem in the Indian Ocean. In 2016, the Commission took further action to address IUU fishing (IOTC 2016).

The IOTC has a Compliance Committee that verifies compliance by countries with regard to implementing and following adopted management measures (IOTC 2016b). The Committee meets prior to the annual Commission meeting to assess compliance and enforcement of management measures by individual countries. According to information provided during the 2016 meeting, compliance with providing a record of authorized vessels increased from 30% in 2010 to 60% in 2015. Compliance with the Bigeye Tuna Statistical Document Program increased steadily since 2010 (13%) through 2014 (60%), decreasing slightly during 2015 (54%). Compliance with observing transshipments at sea was 64% in 2015. Compliance with the regional observer program has remained fairly poor over time, at just 20% during 2015. Reporting of mandatory statistics had a 43% compliance rate in 2015 for target species. Compliance with limiting fishing capacity had a 65% compliance rate in 2015, up from only 27% in 2010 (IOTC 2016b).

The Committee is responsible for reporting their recommendations to the Commission. The Committee also discusses problems related to the implementation of management measures and provides the Commission with advice on how to address these issues. The Committee has also been tasked with developing incentives and sanctions to encourage compliance with adopted measures (IOTC 2013l). But the Committee considers only compliance with a measure, not quality or completeness of data submitted. In addition, although the Committee will let countries know through a formal letter that they are not in compliance, it does not necessarily inform them on how to comply with the measures (IOTC 2013o). The IOTC is currently assessing and reviewing compliance issues with regard to the implementation of management measures, to help strengthen compliance and to provide technical support to developing nations (IOTC 2013o). Information on compliance with measures, such as the observer scheme, is reported in publicly accessed reports (IOTC 2012b) (IOTC 2013p) (IOTC 2013r). Individual country compliance reports are also produced (IOTC 2013s). But it has been noted that many countries fail to provide all the information necessary to monitor compliance (Pillai and Satheeshkumar 2012).

Though there have been substantial improvements in compliance with regulations and reductions in IUU fishing in recent years, some concern remains, leading to a score of “moderately effective.”

**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 over time.*

*INDIAN OCEAN, FLOATING OBJECT PURSE SEINE*  
*INDIAN OCEAN, UNASSOCIATED PURSE SEINE*

**Moderately Effective**
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.

The Indian Ocean Tuna Commission has been successful in maintaining healthy populations of bigeye, skipjack, and yellowfin tuna. It should be noted that the scientific committee did recommend that catches of yellowfin tuna should remain under 300,000 MT, but catches were higher than this during both 2011 and 2012 (IOTC 2013d). We have therefore awarded only a “moderately effective” score.

Indian Ocean, Floating Object Purse Seine
Indian Ocean, Unassociated Purse Seine
Highly Effective

The IOTC allows for the inclusion of stakeholders in developing management objectives through participation in countries' delegations and allows for accredited observers to attend Commission meetings (IOTC 2012b).

Factor 3.2: Bycatch Strategy

SCORING GUIDELINES

Four subfactors are evaluated: Management Strategy and Implementation, Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.' Unless reason exists to rate Scientific Research and Monitoring, Record of Following Scientific Advice, and Enforcement of Regulations differently, these rating are the same as in 3.1.

- 5 (Very Low Concern)—Rated as 'highly effective' for all four subfactors considered
- 4 (Low Concern)—Management Strategy rated ‘highly effective’ and all other subfactors rated at least ‘moderately effective.’
- 3 (Moderate Concern)—All subfactors rated at least ‘moderately effective.’
- 2 (High Concern)—At minimum, meets standards for ‘moderately effective’ for Management Strategy but some other factors rated ‘ineffective.’
- 1 (Very High Concern)—Management exists, but Management Strategy rated ‘ineffective.’
- 0 (Critical)—No bycatch management even when overfished, depleted, endangered or threatened species are known to be regular components of bycatch and are substantially impacted by the fishery

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>All Kept</th>
<th>Critical</th>
<th>Strategy</th>
<th>Research</th>
<th>Advice</th>
<th>Enforce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian Ocean / Floating object purse seine</td>
<td>No</td>
<td>No</td>
<td>Ineffective</td>
<td>Ineffective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
</tr>
<tr>
<td>Indian Ocean / Unassociated purse seine</td>
<td>No</td>
<td>No</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
<td>Moderately Effective</td>
</tr>
</tbody>
</table>
Subfactor 3.2.2 – Management Strategy and Implementation

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

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ineffective</td>
</tr>
</tbody>
</table>

There are management measures in place in the Indian Ocean to mitigate the incidental capture of bycatch species in purse seine fisheries. For example, vessels are not allowed to intentionally set a purse seine net around cetaceans, sea turtles, or whale sharks. Any interactions between a vessel and sea turtles must be reported to the Commission, and fishers are required to attempt proper mitigation measures, aid in recovery when necessary, and release all incidentally captured sea turtles. In addition, oceanic whitetip sharks are prohibited from capture and landing, and should be released if incidentally captured (IOTC 2013). Countries are also requested to conduct studies on the use of alternative fish aggregating device (FAD) designs, handling techniques, and other mitigation measures to reduce the incidental capture of bycatch. In addition, a new resolution has recently been adopted that will require a gradual change to non-entangling FADs (IOTC 2013). Countries have been asked to develop National Plans of Action (NPOAs) for sharks, but few countries have followed through with this (IOTC 2013). In addition, there are no bycatch catch limits in place, and ghost fishing of sharks continues to be a major concern in this fishery (Filmanter et al. 2013). An analysis of RFMOs performance with regard to bycatch management found the IOTC to score in the lower third of the range (Gilman et al. 2013). We have therefore awarded an “ineffective” score.

<table>
<thead>
<tr>
<th>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderately Effective</td>
</tr>
</tbody>
</table>

There are management measures in place in the Indian Ocean to mitigate the incidental capture of bycatch species in purse seine fisheries. For example, vessels are not allowed to intentionally set a purse seine net around cetaceans, sea turtles, or whale sharks. Any interactions between a vessel and sea turtles must be reported to the Commission, and fishers are required to attempt proper mitigation measures, aid in recovery when necessary, and release all incidentally captured sea turtles. In addition, oceanic whitetip sharks are prohibited from capture and landing, and should be released if incidentally captured (IOTC 2013). Countries have been asked to develop National Plans of Action (NPOAs) for sharks, but few countries have followed through with this (IOTC 2013). In addition, there are no bycatch catch limits in place, but bycatch levels are much less than those in associated purse seine fisheries. An analysis of RFMOs performance with regard to bycatch management found the IOTC to score in the lower third of the range (Gilman et al. 2013). We have therefore awarded a “moderately effective” score because there are some management measures in place and bycatch levels are low in this fishery.

Subfactor 3.2.3 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documente 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.

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ineffective</td>
</tr>
</tbody>
</table>


Subfactor 3.2.4 – Management Record of Following Scientific Advice

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

INDIAN OCEAN, UNASSOCIATED PURSE SEINE

Moderately Effective

The Indian Ocean Tuna Commission (IOTC) requires at least 5% observer coverage on all vessels (regardless of gear) over 24 m in length operating within the Convention Area (IOTC 2013l). Observers aboard purse seine vessels must also monitor catches during off-loading to determine the composition of bigeye catches, unless the country already has a sampling scheme in place (IOTC 2013l). But the Working Party on Ecosystems and Bycatch has recommended that the Compliance Committee address the lack of implementation of this program by member countries (IOTC 2013o). For example, only 13 countries have submitted a list of accredited observers to the Commission, and only 7 countries have submitted observer data for a total of 82 observed trips between 2010 and 2013 (December) (IOTC 2013o). In addition, only two or three countries have yet achieved the required 5% observer coverage (both fisheries) (IOTC 2013o). Therefore, information on important bycatch species such as silky sharks may be lacking. In addition, reporting of sea turtle bycatch is very low and often poorly documented (IOTC 2013p), so we have awarded an “ineffective” score.

INDIAN OCEAN, UNASSOCIATED PURSE SEINE

Moderately Effective

In terms of sharks, the Scientific Committee has recommended that the Commission develop ways to improve compliance with regard to reporting shark data and recommended that mitigation measures to reduce the bycatch of oceanic whitetip sharks be developed (IOTC 2012b). Oceanic whitetip sharks have since been prohibited from being retained. It has also been recommended (by the Working Party on Ecosystems and Bycatch) that the Commission should add additional shark species to the current resolution on recording catch and effort data (IOTC 2013o). This has not been completely addressed. We have therefore awarded a “moderately effective” score.

Subfactor 3.2.5 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management

INDIAN OCEAN, FLOATING OBJECT PURSE SEINE

INDIAN OCEAN, UNASSOCIATED PURSE SEINE

Moderately Effective

The Indian Ocean Tuna Commission (IOTC) requires at least 5% observer coverage on all vessels (regardless of gear) over 24 m in length operating within the Convention Area (IOTC 2013l). Observers aboard purse seine vessels must also monitor catches during off-loading to determine the composition of bigeye catches, unless the country already has a sampling scheme in place (IOTC 2013l). But the Working Party on Ecosystems and Bycatch has recommended that the Compliance Committee address the lack of implementation of this program by member countries (IOTC 2013o). For example, only 13 countries have submitted a list of accredited observers to the Commission, and only 7 countries have submitted observer data for a total of 82 observed trips between 2010 and 2013 (December) (IOTC 2013o). In addition, only two or three countries have yet achieved the required 5% observer coverage (both fisheries) (IOTC 2013o). Therefore, information on important bycatch species such as silky sharks may be lacking. In addition, reporting of sea turtle bycatch is very low and often poorly documented (IOTC 2013p), so we have awarded a “moderately effective” score.
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.

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</td>
</tr>
</tbody>
</table>

**Moderately Effective**

The IOTC maintains a record of fishing vessels larger than 24 m in length, and all vessels (purse seine, longline, gillnet, pole and line, handline, and trolling) authorized to fish must have in place a data recording system (all vessels over 24 m, and under 24 m if fishing outside EEZs). This includes logbooks (paper or electronic) that collect information (each fishery having specific required catch and effort data) (IOTC 2013l). Information on Illegal, Unreported, and Unregulated (IUU) vessels is required to be reported by individual countries to the Commission (IOTC 2013l). Vessel monitoring systems (VMS) are required on all vessels larger than 15 m in length, and compliance with the time/area closure must be monitored by individual countries through methods such as VMS; these records must be provided to the Commission (IOTC 2013l). Compliance with mandatory reporting of bycatch statistics has increased from 29% in 2010 to 48% in 2012 and 45% in 2013 (IOTC 2014b). We have awarded a “moderately effective” score because there are enforcement measures in place and reporting of bycatch species has improved over time.
**Criterion 4: Impacts on the habitat and ecosystem**

This Criterion assesses the impact of the fishery on seafloor habitats, and increases the 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 $\leq 3.2=$ Yellow or Moderate Concern
- Score $\leq 2.2=$ Red or High Concern

Rating cannot be Critical for Criterion 4.

**Criterion 4 Summary**

<table>
<thead>
<tr>
<th>Region / Method</th>
<th>Gear Type and Substrate</th>
<th>Mitigation of Gear Impacts</th>
<th>EBFM</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indian Ocean / Floating object purse seine</td>
<td>4.00: Very Low Concern</td>
<td>0.00: Not Applicable</td>
<td>1.00: Very High Concern</td>
<td>Red (2.000)</td>
</tr>
<tr>
<td>Indian Ocean / Unassociated purse seine</td>
<td>5.00: None</td>
<td>0.00: Not Applicable</td>
<td>3.00: Moderate Concern</td>
<td>Green (3.873)</td>
</tr>
</tbody>
</table>

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

**Criterion 4 Assessment**

SCORING GUIDELINES

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

- **5 (None)** - Fishing gear does not contact the bottom
- **4 (Very Low)** - Vertical line gear
- **3 (Low)**—Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally
- **2 (Moderate)**—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand
- **1 (High)**—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)
- **0 (Very High)**—Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)

Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.
Factor 4.2 - Mitigation of Gear Impacts

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

Factor 4.3 - Ecosystem-Based Fisheries Management

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

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

<table>
<thead>
<tr>
<th>INDIAN OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Low Concern</strong></td>
</tr>
<tr>
<td>Although purse seine fishing typically does not result in the nets coming in contact with the bottom, anchored FADs could result in contact with the bottom (Beverly et al. 2012)(Seafood Watch 2013).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INDIAN OCEAN, UNASSOCIATED PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>None</strong></td>
</tr>
<tr>
<td>Unassociated purse seine sets do not typically come in contact with the bottom.</td>
</tr>
</tbody>
</table>
**Factor 4.3 - Ecosystem-Based Fisheries Management**

**INDIAN OCEAN, FLOATING OBJECT PURSE SEINE**

**Very High Concern**

Purse seine fisheries in the Indian Ocean catch several ecologically important groups including other tunas and sharks. In particular, sharks are considered top predators in many ecosystems and play a critical role in how these ecosystems are structured and function (Piraino et al. 2002) (Stevens et al. 2000). The loss of these predators can cause many changes, such as to prey abundances, which can lead to a cascade of other affects (Myers et al. 2007) (Duffy 2003) (Ferretti et al. 2010) (Schindler et al. 2002) and behavioral changes (Heithaus et al. 2007).

The use of FADs in the Indian 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 are difficult to evaluate due to insufficient qualitative data (Fonteneau et al. 2000), so additional research should be undertaken to determine the potential effects of FADs on the ecosystem, including monitoring the number of FADs being used (Dagorn et al. 2012). Recently, the Indian Ocean Tuna Commission (IOTC) required individual countries to provide a management plan for FADs to be submitted to the Commission in 2013. Within this plan, countries must identify designs and deployment options that will reduce the incidental capture of sharks, marine turtles, or other bycatch species (IOTC 2013).

The IOTC has a Working Party on Ecosystems and Bycatch (WPEB). Working Parties (WP) in the IOTC analyze technical problems related to the management goals, identify research priorities, and indicate data and information requirements that are needed. In addition, they provide advice on management measures (IOTC 2013). This WP meets annually and presents a final report of the meeting, which includes information on the outcomes of the Scientific Committee, progress on recommendations from the WPEB, review of information available on ecosystems and bycatch (including any new information), a review of national bycatch issues, and information on sharks and rays, marine turtles, seabirds, marine mammals, and other bycatch species when necessary (IOTC 2013). In addition, the Commission has adopted management measures specific to bycatch species such as sharks in purse seine fisheries.

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

**INDIAN OCEAN, UNASSOCIATED PURSE SEINE**

**Moderate Concern**
The unassociated purse seine fishery does capture “exceptional species” such as tunas but these species are monitored and assessed. Interactions with other “exceptional species” common to associated purse seine fisheries (such as sharks) are minimal in the unassociated fishery. It should be mentioned that the Indian Ocean Tuna Commission (IOTC) has a Working Party on Ecosystems and Bycatch (WPEB). Working Parties (WP) in the IOTC analyze technical problems related to the management goals, identify research priorities, and indicate data and information requirements that are needed. In addition, they provide advice on management measures (IOTC 2013t). This WP meets annually and presents a final report of the meeting, which includes information on the outcomes of the Scientific Committee, progress on recommendations from the WPEB, review of information available on ecosystems and bycatch (including any new information), a review of national bycatch issues, and information on sharks and rays, marine turtles, seabirds, marine mammals, and other bycatch species when necessary (IOTC 2013o). In addition, the Commission has adopted management measures specific to bycatch species such as sharks in purse seine fisheries. We have awarded a “moderate” concern score because “exceptional species” are caught and there is effort underway to assess the ecosystem impact of this loss and the IOTC is working to incorporate ecosystem effects into management plans.
Acknowledgements

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

Seafood Watch would like to thank several anonymous reviewers for graciously reviewing this report for scientific accuracy.
References


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Pillai, N.G. and Satheeshkumar, P. 2012. Biology, fishery, conservation and management of Indian Ocean


## Appendix A: Extra By Catch Species

### Rainbow runner

#### Factor 2.1 - Inherent Vulnerability

<table>
<thead>
<tr>
<th>INDIA N OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medium</strong></td>
</tr>
<tr>
<td>Fishbase assigned a moderate vulnerability score of 41 out of 100 (Froese and Pauly 2013). Age and size at sexual maturity is unknown. Rainbow runner reach a maximum size of 180 cm and live up to 6 years (Froese and Pauly 2013).</td>
</tr>
</tbody>
</table>

#### Factor 2.2 - Abundance

<table>
<thead>
<tr>
<th>INDIA N OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate Concern</strong></td>
</tr>
<tr>
<td>No stock assessments have been conducted for rainbow runner in the Indian Ocean and information on their population status and trends is not available. We have awarded a &quot;moderate&quot; concern score due to the unknown status.</td>
</tr>
</tbody>
</table>

#### Factor 2.3 - Fishing Mortality

<table>
<thead>
<tr>
<th>INDIA N OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate Concern</strong></td>
</tr>
<tr>
<td>Rainbow runner is a common bycatch species in purse seine floating object sets in the Indian Ocean, making up ~37% of the fish bycatch (Adrille et al. 2012). But information on its fishing mortality rates is not available, so we have awarded a &quot;moderate&quot; concern score.</td>
</tr>
</tbody>
</table>

#### Factor 2.4 - Discard Rate

<table>
<thead>
<tr>
<th>INDIA N OCEAN, FLOATING OBJECT PURSE SEINE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>&lt; 20%</strong></td>
</tr>
<tr>
<td>Purse seine fisheries have an average discard rate of 5%, although in the Indian Ocean discard rates may be even lower (Kelleher 2005) (Adrill et al. 2012). For example, observer data from the French and Spanish fleets indicated that tunas made up the majority of the catch in both floating object and unassociated sets and that discard rates were virtually non-existent, although they may occur on smaller vessels. The highest discard rates in these fisheries are for sharks, which typically make up the majority of the bycatch (Adrill et al. 2012).</td>
</tr>
</tbody>
</table>
Appendix B: Update Summary

This report was updated during August 2016 to incorporate a new stock assessment for yellowfin tuna that was published in November 2015 and new management measures adopted in May of 2016. The status change for yellowfin resulted in a change to the Criterion 1 score from green to red and a change in the overall recommendation for skipjack tuna caught by unassociated purse seine from Good Alternative to Avoid. The recommendation for unassociated purse seine caught bigeye tuna was removed due to low volume.