Monterey Bay Aquarium Seafood Watch®

Blue shark *(Prionace glauca)*
Shortfin mako shark *(Isurus oxyrinchus)*
Silky shark *(Carcharhinus falciformis)*
Swordfish *(Xiphias gladius)*

Indian Ocean

Pelagic longline, Shallow-set longline, Deep-set longline

Fisheries Standard Version F2

July 11, 2016 (updated November 7, 2016)

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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.

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

Summary

This report focuses on four general longline fisheries in the Indian Ocean that target tuna but also capture blue shark *(Prionace glauca)* and shortfin mako shark *(Isurus oxyrinchus)*. These targeted tunas include: 1. albacore tuna *(Thunnus alalunga)* (termed the Indian Ocean––longline, deep-set fishery in this report); 2. southern bluefin tuna *(Thunnus maccoyii)* (termed the southern Indian Ocean––longline, pelagic fishery in this report); 3. tropical tunas (bigeye tuna *[Thunnus obesus]* and yellowfin tuna *[Thunnus albacares]*) (termed the Indian Ocean––longline, pelagic fishery in this report); and 4. swordfish *(Xiphias gladius)* (termed the Indian Ocean––longline, shallow-set fishery in this report); along with the Sri Lankan yellowfin longline fishery, which also captures silky shark *(Carcharhinus falciformis)* and swordfish. The tuna species targeted in these fisheries have been assessed in separate Seafood Watch reports.

The status of blue, shortfin mako, and silky sharks in the Indian Ocean is uncertain. Due to a lack of data, no comprehensive stock assessment has been conducted. Based on ecological risk assessments, it is likely that fisheries operating in the Indian Ocean are affecting these species' populations to some degree. The Indian Ocean swordfish population is healthy but there is concern over potential localized depletion within the Southwest Indian Ocean.

The longline fisheries that target these species also capture a number of secondary target and bycatch species. We have included species that are typically reported as 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. Bycatch is a high concern for all fisheries covered in the report, because they all may have substantial impacts on threatened, endangered, and vulnerable species.

Management strategy for retained species is moderately effective, but concerns with inadequate monitoring, compliance and, in some cases, failure to comply with scientific advice lead to a high concern for management of retained species. Management of bycatch is also a high concern, because strategies are not adequate to constrain and minimize bycatch of threatened, endangered, and depleted species.

Longlines do not typically come in contact with bottom habitats but do capture "exceptional species," and management takes this into account to some degree.

These species are managed by the Indian Ocean Tuna Commission (IOTC) and by the Ministry of Fisheries and Aquatic Sciences in Sri Lanka.

Final Seafood Recommendations

SPECIES/FISHERY	CRITERION 1: IMPACTS ON THE SPECIES	CRITERION 2: IMPACTS ON OTHER SPECIES	CRITERION 3: MANAGEMENT EFFECTIVENESS	CRITERION 4: HABITAT AND ECOSYSTEM	OVERALL RECOMMENDATION
Swordfish Sri lanka Indian Ocean, Pelagic longline	Green (3.873)	Red (0.950)	Red (1.414)	Green (3.873)	**Avoid (2.118)**
Silky shark Sri lanka Indian Ocean, Pelagic longline	Red (1.414)	Red (0.950)	Red (1.414)	Green (3.873)	**Avoid (1.646)**
Blue shark Indian Ocean, Pelagic longline, Tropical tuna fishery	Red (1.414)	Red (1.000)	Red (1.414)	Green (3.873)	**Avoid (1.668)**
Shortfin mako shark Indian Ocean, Pelagic longline, Tropical tuna fishery	Red (1.414)	Red (1.000)	Red (1.414)	Green (3.873)	**Avoid (1.668)**
Blue shark Southern Indian Ocean, Pelagic longline, Bluefin fishery	Red (1.414)	Red (1.414)	Red (1.414)	Green (3.873)	**Avoid (1.819)**
Shortfin mako shark Southern Indian Ocean, Pelagic longline, Bluefin fishery	Red (1.414)	Red (1.414)	Red (1.414)	Green (3.873)	**Avoid (1.819)**
Blue shark Indian Ocean, Longline, shallow-set, Swordfish fishery	Red (1.414)	Red (1.414)	Red (1.414)	Green (3.873)	**Avoid (1.819)**
Shortfin mako shark Indian Ocean, Longline, shallow-set, Swordfish fishery	Red (1.414)	Red (1.414)	Red (1.414)	Green (3.873)	**Avoid (1.819)**

Blue shark Indian Ocean, Longline, deep-set, Albacore fishery	Red (1.414)	Red (1.414)	Red (1.414)	Green (3.873)	**Avoid (1.819)**
Shortfin mako shark Indian Ocean, Longline, deep-set, Albacore fishery	Red (1.414)	Red (1.414)	Red (1.414)	Green (3.873)	**Avoid (1.819)**

Summary

All species and fisheries have an overall recommendation of "Avoid".

Scoring Guide

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

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

- **Best Choice/Green** = Final Score >3.2, and no Red Criteria, and no Critical scores
- **Good Alternative/Yellow** = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores
- **Avoid/Red** = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

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

Introduction

Scope of the analysis and ensuing recommendation

This report focuses on four general longline fisheries in the Indian Ocean that target tuna but also capture blue shark *(Prionace glauca)* and shortfin mako shark *(Isurus oxyrinchus)*. These targeted tunas include: 1. albacore tuna *(Thunnus alalunga)* (termed the Indian Ocean - longline, deep-set fishery in this report); 2. southern bluefin tuna *(Thunnus maccoyii)* (termed the southern Indian Ocean - longline, pelagic fishery in this report); 3. tropical tunas (bigeye tuna *(Thunnus obesus)* and yellowfin tuna *(Thunnus albacares)*) (termed the Indian Ocean - longline, pelagic fishery in this report); and 4. swordfish *(Xiphias gladius)* (termed the Indian Ocean-longline, shallow-set fishery in this report), along with the Sri Lankan yellowfin longline fishery, which also captures silky shark *(Carcharhinus falciformis)* and swordfish. The tuna species targeted in these fisheries have been assessed in separate Seafood Watch reports.

Species Overview

Blue shark is a highly migratory species of shark found throughout the world's oceans in epipelagic and mesopelagic waters. It is considered the most widely distributed shark species and most abundant, with abundance increasing with latitude. Blue shark is an apex predator, consuming a variety of fish and squid species (IOTC 2013h).

Shortfin mako shark is a highly migratory species found in coastal and oceanic epipelagic waters worldwide. Shortfin mako shark is found from 20° S to 40° N in the Pacific Ocean. This species is an apex predator feeding on fish and cephalopods, among other prey (Froese and Pauly 2015).

In the Indian Ocean, swordfish and tuna are managed by the Indian Ocean Tuna Commission (IOTC). The southern bluefin tuna is also managed by the Commission for the Conservation of Southern Bluefin Tuna. In Sri Lanka, the Ministry of Fisheries and Aquatic Resource Development is in charge of managed marine resources such as tuna.

Silky shark is a highly migratory species found throughout the world's oceans. Silky shark is found in a number of habitats, including along the continental shelf and open ocean. Silky shark is often found associated with schools of tuna, making them susceptible to bycatch in tuna fisheries. Silky sharks feed on fish, squid and some invertebrates (Froese and Pauly 2015).

Swordfish is a billfish species found globally from 50° N to 50° S, and throughout the Atlantic Ocean as well as the Mediterranean Sea. Spawning occurs in tropical and subtropical waters of the Western Atlantic. There are three management units for swordfish: North Atlantic, South Atlantic, and Mediterranean. There is some genetic evidence that these units are distinct populations, although mixing between the populations likely occurs. Longlines capture the majority of swordfish worldwide (ISSF 2013).

These species are managed by the Indian Ocean Tuna Commission (IOTC).

Production Statistics

Information on shark catches in the Indian Ocean over time is uncertain. Detailed catch data has only been provided by five Contracting Parties to the Commission. Catch estimates for blue shark were 26,361 t in 2011, 21,901 t in 2012, and 23,187 t in 2013. The majority of blue shark is caught in longline fisheries (IOTC 2013h). Shortfin mako catches are also mostly from longline fisheries and were 1,489 t in 2011, 1,426 in 2012, and 1,572 in 2013 (IOTC 2013i). Silky shark is not commonly taken by longline fisheries. Total catches in the Indian Ocean were 4,490 t in 2011, 4,177 t in 2012, and 3,573 t in 2013 (IOTC 2013j).

The Sri Lankan longline fishery has been expanding in recent years and is the top country in the Indian Ocean region catching yellowfin tuna with longlines (IOTC 2013c). The main tuna fishery occurs in offshore waters stretching to the end of the Exclusive Economic Zone (EEZ) and into high seas waters. Swordfish is primarily taken by longline fisheries (90%) in the Indian Ocean. It had been primarily a bycatch species in tuna fisheries prior to the early 1990s. Longline catches have decreased from a peak of 37,234 t in 2004, due to a decrease in longline effort (primarily by the Taiwanese ?eet) to 23,375 t in 2012 (IOTC 2013f).

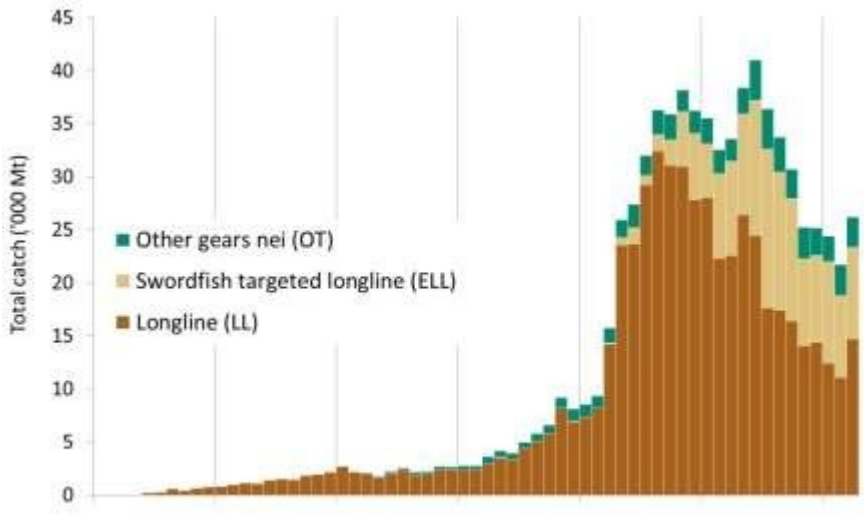

Figure 1 Swordfish catches in the Indian Ocean, 1950-20120 (IOTC 2013f).

Importance to the US/North American market.

The United States imports the majority of its swordfish from Ecuador (24%) (NMFS 2014b). Species-specific information on imports and exports of sharks is not available through the National Marine Fisheries Service. During 2014, imports of fresh shark primarily came from Mexico, with smaller amounts imported from Canada, China, Costa Rica, and Spain. Shark fins were imported from New Zealand and China (NMFS 2015).

Common and market names.

Blue and silky sharks are also known as “shark,” and shortfin mako shark as “mako.” Swordfish is also known as broadbilled swordfish, broadbill, espada, and emperado.

Primary product forms

Blue, silky, and shortfin mako sharks and swordfish are sold in fresh and frozen forms.

Assessment

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

Criterion 1: Impacts on the species under assessment

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

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

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

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

Criterion 1 Summary

BLUE SHARK				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Indian Ocean Pelagic longline	High	2.00: High Concern	1.00: High Concern	Red (1.414)
Southern Indian Ocean Pelagic longline	High	2.00: High Concern	1.00: High Concern	Red (1.414)
Indian Ocean Longline, shallow-set	High	2.00: High Concern	1.00: High Concern	Red (1.414)
Indian Ocean Longline, deep-set	High	2.00: High Concern	1.00: High Concern	Red (1.414)

SHORTFIN MAKO SHARK				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Indian Ocean Pelagic longline	High	2.00: High Concern	1.00: High Concern	Red (1.414)
Southern Indian Ocean Pelagic longline	High	2.00: High Concern	1.00: High Concern	Red (1.414)
Indian Ocean Longline, shallow-set	High	2.00: High Concern	1.00: High Concern	Red (1.414)

Indian Ocean Longline, deep-set	High	2.00: High Concern	1.00: High Concern	Red (1.414)

SILKY SHARK				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Sri lanka/Indian Ocean Pelagic longline	High	2.00: High Concern	1.00: High Concern	Red (1.414)

SWORDFISH				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Score**
Sri lanka/Indian Ocean Pelagic longline	Medium	3.00: Moderate Concern	5.00: Very Low Concern	Green (3.873)

Although no stock assessments have been conducted, there is concern over the status of shark species, including blue, shortfin mako, and silky, in the Indian Ocean. This is because their life history characteristics make many shark species susceptible to fishing pressure. Swordfish in the Indian Ocean are not overfished; however, the swordfish in the Southwest Indian Ocean may be susceptible to localized depletion.

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 is 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.*

BLUE SHARK

Factor 1.1 - Inherent Vulnerability

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High

FishBase assigned a high vulnerability score of 67 out of 100 (Froese and Pauly 2013). Blue shark reaches sexual maturity between 4 and 7 years of age and between 173 and 221 cm in size. The maximum size attained is around 380 cm. Blue shark gives birth to live young every 1–2 years (IOTC 2013h).

Factor1.2 - Abundance

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High Concern

The status of blue shark in the Indian Ocean is unknown, although globally it is classified as Near Threatened by the International Union for the Conservation of Nature (IUCN). Indices of abundance from Japanese and Portuguese fleets operating in the Indian Ocean indicate fairly stable abundance with slightly increasing trends over time. No population assessment has been conducted (IOTC 2013h). An ecological risk assessment conducted in the Indian Ocean found blue shark had one of the highest productivity levels (IOTC 2012); however, it had a high vulnerability to fishing. We have therefore awarded a “high” concern score.

Factor 1.3 - Fishing Mortality

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High Concern

Fishing mortality rates for blue shark are not known in the Indian Ocean but it is considered one of the most susceptible species to longline capture (IOTC 2012). Blue shark is both targeted and caught as bycatch in longline fisheries operating in the Indian Ocean. Information on catches and catch rates is highly uncertain and makes conducting a stock assessment di□cult. It is believed that maintaining or increasing current catch levels will likely result in population declines (IOTC 2013h). We have awarded a “high” concern score because fishing mortality rates are unknown, there is the potential that they are high enough to cause population declines, and there are no e□ective management measures in place.

SHORTFIN MAKO SHARK

Factor 1.1 - Inherent Vulnerability

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High

FishBase assigned a very high vulnerability score of 86 out of 100 (Froese and Pauly 2013). Shortfin mako shark reaches sexual maturity between 18 and 19 years of age and 190 to 270 cm in length. The maximum size reached is 400 cm. Shortfin mako shark gives birth to live young every 2–3 years (IOTC 2013i).

Factor 1.2 - Abundance

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High Concern

The status of shortfin mako shark in the Indian Ocean is uncertain. Catch rate series from Japanese fleets operating in the region show fluctuations in abundance with no real trends from 1994 to 2010. Similar fluctuations in abundance indices from Portuguese fleets between 1999 and 2012 have also occurred, although slight increases in abundance have occurred during the last few years. Overall there is a lack of information available. Globally, shortfin mako shark is considered Vulnerable by the International Union for the Conservation of Nature (IUCN), but the Indian Ocean segment has not been individually assessed. According to a recent ecological risk assessment, shortfin mako shark has one of the lowest productivity levels of assessed shark species in the Indian Ocean and is considered the most vulnerable species (IOTC 2012). We have assigned a “high” concern score based on the uncertain status of this species, its high vulnerability to fishing, and the IUCN classification (IOTC 2013i).

Factor 1.3 - Fishing Mortality

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High Concern

Shortfin mako shark is caught as bycatch and targeted by fisheries in the Indian Ocean. Fishing mortality rates for shortfin mako shark in the Indian Ocean are unknown because there is a general lack of information on catches, due to underreporting and non-reporting in the region. It is believed that maintaining or increasing current levels of fishing e□ort could lead to population declines for this species. In addition, a recent ecological risk assessment identified shortfin mako shark as one of the species most susceptible to longline capture in the Indian Ocean (IOTC 2012). We have awarded a “high” concern score because fishing mortality rates are unknown but may lead to population declines and because there are only general management measures in place for sharks (i.e., reporting requirements) and no species-specific measures are currently in place (IOTC 2013i).

SILKY SHARK

Factor 1.1 - Inherent Vulnerability

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

High

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

Factor 1.2 - Abundance

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

High Concern

The status of silky shark in the Indian Ocean is uncertain. In the Eastern and Western Indian Ocean as well as globally, silky shark is considered Near Threatened by the International Union for the Conservation of Nature (IUCN). 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 2013e). We have awarded a “high” concern score based on the IUCN classification.

Factor 1.3 - Fishing Mortality

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

High Concern

Silky shark is 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 e□ort will likely cause the biomass to decline. Piracy in the Indian Ocean has displaced parts of the longline fleet, although not the target fishery of this report, and this could cause localized depletions (IOTC 2013e). We have awarded a “high” concern score due to the uncertainty surrounding fishing mortality rates and total catches; it is believed current levels of fishing are too high to maintain the population at a healthy size; and even though a National Plan of Action for Sharks has been developed and is expected to be put into place in 2014, it is unclear how e□ective it will be in managing silky sharks.

SWORDFISH

Factor 1.1 - Inherent Vulnerability

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

Medium

FishBase assigned a high to very high vulnerability of 72 out of 100 (Froese and Pauly 2013). But the life history characteristics of swordfish indicate a lower vulnerability to fishing. For example, swordfish reaches sexual maturity around 120–170 cm in size and around 1–3 and 6–7 years (males and females, respectively). Swordfish reaches a maximum length of 455 cm and lives more than 30 years. It is a broadcast spawner and top predator (IOTC 2013f). This is more indicative of a moderate vulnerability to fishing and we have adjusted the score accordingly.

Factor 1.2 - Abundance

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

Moderate Concern

The current biomass of swordfish is estimated to have been reduced to around 30%–53% of virgin levels and is slightly above the levels needed to produce the maximum sustainable yield ($SB_{current}/SB_{MSY}$ = 1.07–1.59). The biomass is above the current provisional biomass-based limit reference point (0.4 × B_{MSY}) and therefore swordfish is not considered overfished. There is a very low risk of the population becoming overfished in the future, even if catches are increased (IOTC 2013f). But in the Southwest Indian Ocean, swordfish has been subjected to localized depletion even though this is not a genetically distinct population. The biomass in this area is below levels needed for the maximum sustainable yield ($SB_{current}/SB_{MSY}$ = 0.73–1.44) and is therefore overfished (IOTC 2013f). We have awarded a “moderate concern” score.

Factor 1.3 - Fishing Mortality

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

Very Low Concern

Fishing mortality rates for swordfish in the Indian Ocean are estimated to be well below the levels needed to produce the maximum sustainable yield (F_{2009}/F_{MSY} = 0.50–0.63). Fishing levels are also below the provisional limit reference point (1.4 × F_{MSY}) and therefore overfishing is not occurring. In addition, recent catches of swordfish have been below the maximum sustainable yield. Fishing mortality rates in the Southwest Indian Ocean (see stock status for details) are also well below levels needed to produce the maximum sustainable yield (F_{2009}/F_{MSY} = 0.64–1.19) (IOTC 2013f). We have awarded a “very low” concern score.

Criterion 2: Impacts on other species

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

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

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

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

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.

BLUE SHARK - INDIAN OCEAN - LONGLINE, DEEP-SET					
Subscore:	**1.414**	**Discard Rate:**	**1.00**	**Score:**	**1.414**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Shortfin mako shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	
white-chinned petrel	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	
black-browed albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	
Loggerhead turtle	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)	
Albacore tuna	2.00:Medium	4.00:Low Concern	3.67:Low Concern	Green (3.831)	

BLUE SHARK - INDIAN OCEAN - LONGLINE, SHALLOW-SET					
Subscore:	**1.414**	**Discard Rate:**	**1.00**	**Score:**	**1.414**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Shortfin mako shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	
black-browed albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	

white-chinned petrel	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Loggerhead turtle	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)
Swordfish	2.00:Medium	3.00:Moderate Concern	5.00:Very Low Concern	Green (3.873)

BLUE SHARK - INDIAN OCEAN - PELAGIC LONGLINE

Subscore:	**1.000**	**Discard Rate:**	**1.00**	**Score:**	**1.000**

Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**
Leatherback turtle	1.00:High	1.00:Very High Concern	1.00:High Concern	Red (1.000)
Shortfin mako shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
white-chinned petrel	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Yellowfin tuna	2.00:Medium	2.00:High Concern	1.00:High Concern	Red (1.414)
black-browed albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Loggerhead turtle	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)
Bigeye tuna	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)

BLUE SHARK - SOUTHERN INDIAN OCEAN - PELAGIC LONGLINE

Subscore:	**1.414**	**Discard Rate:**	**1.00**	**Score:**	**1.414**

Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**
Shortfin mako shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
white-chinned petrel	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
black-browed albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
white-capped albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Loggerhead turtle	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)
Southern bluefin tuna	1.00:High	1.00:Very High Concern	3.67:Low Concern	Red (1.916)
Bigeye tuna	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)

SHORTFIN MAKO SHARK - INDIAN OCEAN - LONGLINE, DEEP-SET					
Subscore:	**1.414**	**Discard Rate:**	**1.00**	**Score:**	**1.414**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Blue shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
white-chinned petrel	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
black-browed albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Loggerhead turtle	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)
Albacore tuna	2.00:Medium	4.00:Low Concern	3.67:Low Concern	Green (3.831)

SHORTFIN MAKO SHARK - INDIAN OCEAN - LONGLINE, SHALLOW-SET					
Subscore:	**1.414**	**Discard Rate:**	**1.00**	**Score:**	**1.414**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Blue shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
black-browed albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
white-chinned petrel	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Loggerhead turtle	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)
Swordfish	2.00:Medium	3.00:Moderate Concern	5.00:Very Low Concern	Green (3.873)

SHORTFIN MAKO SHARK - INDIAN OCEAN - PELAGIC LONGLINE					
Subscore:	**1.000**	**Discard Rate:**	**1.00**	**Score:**	**1.000**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
Leatherback turtle	1.00:High	1.00:Very High Concern	1.00:High Concern	Red (1.000)
Blue shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
white-chinned petrel	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Yellowfin tuna	2.00:Medium	2.00:High Concern	1.00:High Concern	Red (1.414)
black-browed albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Loggerhead turtle	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)

Bigeye tuna	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)

SHORTFIN MAKO SHARK - SOUTHERN INDIAN OCEAN - PELAGIC LONGLINE					
Subscore:	**1.414**	**Discard Rate:**	**1.00**	**Score:**	**1.414**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Blue shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	
white-chinned petrel	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	
black-browed albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	
white-capped albatross	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)	
Loggerhead turtle	1.00:High	1.00:Very High Concern	2.33:Moderate Concern	Red (1.526)	
Southern bluefin tuna	1.00:High	1.00:Very High Concern	3.67:Low Concern	Red (1.916)	
Bigeye tuna	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)	

SILKY SHARK - SRI LANKA/INDIAN OCEAN - PELAGIC LONGLINE					
Subscore:	**1.000**	**Discard Rate:**	**0.95**	**Score:**	**0.950**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Turtles	1.00:High	1.00:Very High Concern	1.00:High Concern	Red (1.000)	
Yellowfin tuna	2.00:Medium	2.00:High Concern	1.00:High Concern	Red (1.414)	
Swordfish	2.00:Medium	3.00:Moderate Concern	5.00:Very Low Concern	Green (3.873)	
Bigeye tuna	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)	

SWORDFISH - SRI LANKA/INDIAN OCEAN - PELAGIC LONGLINE					
Subscore:	**1.000**	**Discard Rate:**	**0.95**	**Score:**	**0.950**
Species	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**	
Turtles	1.00:High	1.00:Very High Concern	1.00:High Concern	Red (1.000)	

Yellowfin tuna	2.00:Medium	2.00:High Concern	1.00:High Concern	Red (1.414)
Silky shark	1.00:High	2.00:High Concern	1.00:High Concern	Red (1.414)
Bigeye tuna	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	Green (5.000)

This report focuses on tuna and swordfish longline fisheries operating in the Indian Ocean and the Sri Lankan yellowfin tuna fishery that also capture other large pelagic species including blue, shortfin mako, and silky sharks, along with swordfish (Sri Lanka).

Several species of sea turtles and seabirds are also incidentally captured in the Indian Ocean longline fishery. We have included species that either make up at least 5% of the total catch and are considered “main species” according to the Seafood Watch criteria or are a stock of concern, endangered, etc. Targeted tuna species are included as other “main species” in this report and assessed in separate Seafood Watch reports. Reported catches from the Indian Ocean Tuna Commission database were used to determine the main species. Other species were identified through the literature, which is cited in the tables below. The worst scoring species in the albacore and swordfish fisheries are the black-browed albatross and white-chinned petrel, due to their stock status. In the southern bluefin tuna fishery, black-browed albatross, white-capped albatross, and white-chinned petrel were the worst scoring species due to their stock status. In the tropical tuna fishery, leatherback sea turtle was the worst scoring species due to its stock status.

Information on bycatch in the Sri Lankan fishery is limited. Information on seabird interactions in Sri Lankan fisheries is not available. But two small studies have been conducted during which no seabird interactions were observed. Sri Lanka has therefore determined that no mitigation measures are needed and no National Plan of Action is needed. Interactions between the longline fishery and sea turtles also appear to be low. A comprehensive study is currently underway to determine the impact of Sri Lankan fisheries on sea turtles. Currently Sri Lanka does offer protection to sea turtles through the Fauna and Flora Protection Act and through the Convention on the International Trade of Endangered Species (CITES). Similarly, marine mammal interactions, although not currently reported, are thought to be rare in the longline fishery. Marine mammals are currently protected in Sri Lanka through the Fisheries and Aquatic Resources Act and the Fauna and Flora Protection Act {Hewapathirana and Maldeniya 2013}. We have included yellowfin, bigeye, and skipjack tuna, swordfish, and turtles in this report. Of these, the turtles scored the lowest due to their stock status.

Albacore - deep set

Albacore	Target	IOTC catch d
Loggerhead turtle	36% of turtles	Adrille et al.
White-chinned petrel	one of three most common bird species	Adrille et al.

Black-browed albatross	one of three most common bird species	Adrille et al.

Swordfish - shallow set		
Loggerhead turtle	36% of turtles	Adrille et al.
Leatherback turtle	30% of turtles	Adrille et al.
White-chinned petrel	one of three most common bird species	Adrille et al.
Black-browed albatross	one of three most common bird species	Adrille et al.

Tropical Tuna - Indian Ocean		
Bigeye tuna	Target	IOTC catch d
Yellowfin tuna	Target	IOTC catch d
Loggerhead turtle	36% of turtles	Adrille et al.
Leatherback turtle	30% of turtles	Adrille et al.
White-chinned petrel	one of three most common bird species	Adrille et al.
Black-browed albatross	one of three most common bird species	Adrille et al.

Southern bluefin - Southern Indian Ocean		
Southern bluefin tuna	Target	IOTC catch d
Bigeye tuna	Target	IOTC catch d
Loggerhead turtle	36% of turtles	Adrille et al.
White-capped albatross	one of three most common bird species	Adrille et al.
White-chinned petrel	one of three most common bird species	Adrille et al.
Black-browed albatross	one of three most common bird species	Adrille et al.

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)

TURTLES

Factor 2.1 - Inherent Vulnerability

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

High

Turtles have a high vulnerability due to their life history characteristics that include a late age at maturity, long life, and low reproductive output (Seafood Watch 2013).

Factor 2.2 - Abundance

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

Very High Concern

There are six species of turtles found in the Indian Ocean: flatback, green, hawksbill, leatherback, loggerhead, and olive ridley. Of these, the flatback is considered Data Deficient, green and loggerhead are considered Endangered, olive ridley is Vulnerable, and hawksbill and leatherback are considered Critically Endangered by the International Union for the Conservation of Nature (IOTC 2013g). Information on which species are captured in the Sri Lankan longline fishery is not readily available, and data on interactions does not appear to be provided to the Indian Ocean Tuna Commission (IOTC 2013g). We have awarded a “very high” concern score due to the IUCN classifications.

Factor 2.3 - Fishing Mortality

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

High Concern

Longline fisheries operating in the Indian Ocean incidentally capture sea turtles, although these fisheries’ impact is not as great as those using other gear types, such as gillnets. An Ecological Risk Assessment estimated that around 3,500 turtles are caught in the Indian Ocean by longliners annually. Information on sea turtle interactions is not currently available from the majority of longline fleets operating in the Indian Ocean, including the Sri Lankan fishery. A study conducted in the Bay of Bengal and other areas around India estimated 0.303 turtles per 1,000 hooks were caught, the highest rate of the study. This is largely due to an olive ridley nesting ground on the east coast of India (IOTC 2013g). Wallace et al. (2013) considers leatherback turtle to be at a high risk and high bycatch impact; loggerhead turtle in the southwest Indian Ocean to be at a high risk but low impact from longline fisheries; while hawksbill turtles in the Southeast and Southwest Indian Ocean are at a low risk and low bycatch impact. There are no mandated turtle bycatch mitigation measures at the international Indian Ocean Tuna Commission level, or at the domestic Sri Lankan level. We have therefore awarded a “high” concern score.

Factor 2.4 - Discard Rate

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

20-40%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% {Kelleher 2005). Within the Indian Ocean, discard rates are reported to be less than the average, around 9% {Kelleher et al. 2005). Attempts to determine actual discard rates in the Sri Lankan tuna fishery have been unsuccessful {O'Meara et al. 2011). We have awarded a score of 20%–40% because there is no indication that discards in the Sri Lankan tuna fishery are higher or lower than the normal global range.

WHITE-CHINNED PETREL

Factor 2.1 - Inherent Vulnerability

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High

Seabirds have a high level of vulnerability due to their life history characteristics that include late age at sexual maturity, long life, and low number of young (Seafood Watch 2013).

Factor 2.2 - Abundance

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High Concern

The International Union for Conservation of Nature (IUCN) has listed white-chinned petrel as Vulnerable with a decreasing population trend. The global population is estimated to have declined from 1,430,000 pairs in the 1980s to 1,200,000 pairs currently (BirdLife International 2012d). We have awarded a "high" concern score based on the IUCN status.

Factor 2.3 - Fishing Mortality

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High Concern

White-chinned petrel has a high overlap with longline e□ort in the Indian Ocean, as much as 60% in some areas (IOTC 2013k). This species is very vulnerable to incidental fishing mortality in the southern hemisphere (ACAP 2014). This species is one of the three most commonly captured—along with black-browed and white-capped albatross (Southern Indian Ocean)—in the South African tuna and swordfish longline fisheries (Ardill et al. 2012). White-chinned petrel has been reported to make up 10%–55% of the seabird bycatch in pelagic and demersal fisheries of South Africa (Petersen et al. 2007). Rapid population declines have been attributed to very high rates of incidental mortality in longline fisheries. There are mitigation measures in place in the Indian Ocean, which appear to be reducing longline interactions (Ardill et al. 2012) (IOTC 2013k). We have therefore awarded a “high” concern and not critical concern score.

Factor 2.4 - Discard Rate

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

BLACK-BROWED ALBATROSS

Factor 2.1 - Inherent Vulnerability

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High

Seabirds have a high level of vulnerability due to their life history characteristics that include late age at sexual maturity, long life, and low number of young (Seafood Watch 2013).

Factor 2.2 - Abundance

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High Concern

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species

classifies black- browed albatross as Near Threatened with a decreasing population trend. The total population size worldwide is estimated to be 700,000 breeding birds or 2.1 million individual birds (BirdLife International 2013a). The IUCN upgraded the status from Endangered to Near Threatened in 2013, because it was thought the population was no longer undergoing very rapid population declines. The status of black-browed albatross in the Indian Ocean has not been assessed. We have awarded a “high” concern score based on its IUCN status.

Factor 2.3 - Fishing Mortality

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High Concern

Black-browed albatross has a high (88%) overlap with some areas of the Indian Ocean Tuna Commission’s (IOTC) convention area, and there is some evidence that longline fisheries have contributed to population declines (IOTC 2013k). Due to low observer coverage and poor reporting by many member countries, there is very little information on bycatch rates within the Indian Ocean (IOTC 2013k). Reported interactions north of 20° S for any bird species are sparse because observer coverage is low (IOTC 2013k). But black-browed albatross is reported to be one of the three most commonly captured seabird species in the South African longline tuna and swordfish fisheries (Ardill et al. 2012). There are management measures in place that appear to have reduced the bycatch of seabirds in longline fisheries operating in the Indian Ocean (Ardill et al. 2012). We have therefore awarded a “high” concern and not very high concern score.

Factor 2.4 - Discard Rate

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

LEATHERBACK TURTLE

Factor 2.1 - Inherent Vulnerability

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High

Sea turtles have a high level of vulnerability due to their life history characteristics that include late age at sexual maturity and long life span (Seafood Watch 2013).

Factor 2.2 - Abundance

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY

Very High Concern

The International Union for Conservation of Nature (IUCN) classified leatherback turtle as Critically Endangered with a decreasing population trend in 2000 (Martinez 2000). In addition, leatherback turtle has been listed on the Convention on International Trade of Endangered Species (CITES) since 1975 and is currently listed on CITES Appendix I, meaning that it is threatened with extinction and that international trade is prohibited. Its status in the Indian Ocean is unknown due to a lack of data. We have awarded a “very high” concern score based on the IUCN and CITES listings.

Factor 2.3 - Fishing Mortality

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY

High Concern

According to a recent ecological risk assessment, leatherback turtle represented about 10% of all reported sea turtle interactions in the Indian Ocean over a 24-year period and su□ered a 38% mortality rate, the highest of all turtle species in this region (IOTC 2013j). Leatherback from the Southwestern Indian Ocean is the most susceptible to longline capture and is considered one of the most vulnerable to longline capture (IOTC 2013j). A separate analysis also concluded that leatherback sea turtle had a very high impact from longline bycatch in the Southwest Indian Ocean (Wallace et al. 2013). Some fleets, but likely not all, do use mitigation measures to reduce the incidental capture of sea turtles, so we have awarded a “high” concern and not very high concern score.

Factor 2.4 - Discard Rate

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

WHITE-CAPPED ALBATROSS

Factor 2.1 - Inherent Vulnerability

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High

Seabirds have a high level of vulnerability due to their life history characteristics that include late age at sexual maturity, long life, and low number of young (Seafood Watch 2013).

Factor 2.2 - Abundance

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

High Concern

White-capped albatross is considered Near Threatened by the International Union for the Conservation of Nature (IUCN). The population trend is uncertain and not well understood but the IUCN has listed this species as having a decreasing population trend. There are an estimated 200,000 mature birds (BirdLife International 2013b). We have awarded a “high” concern score based on the IUCN classification.

Factor 2.3 - Fishing Mortality

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

High Concern

White-capped albatross populations are negatively affected by the incidental capture in longline fisheries (BirdLife International 2013b). White-capped albatross is found throughout the Southern Hemisphere in the Indian Ocean and are therefore susceptible to longline capture (IIOTC 2013k). It has been reported as one of the three most commonly captured species by the South African longline fishery (Ardill et al. 2012), with an estimated 7,000 to 11,000 total birds killed between 1998 and 2000 (Ryan et al. 2002). Catch rates of seabirds, including white-capped albatross, in the South African fleet are higher than those proposed in the Food and Agricultural Organization’s (FAO) International Plan of Action (IPA) (Ardill et al. 2012). There are mitigation measures in place in the Indian Ocean (IOTC 2013k). We have therefore awarded a “high” concern and not very high concern score.

Factor 2.4 - Discard Rate

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can

range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

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	Harvest Strategy	Bycatch Strategy	Score
Indian Ocean / Pelagic longline Tropical tuna fishery	2.000	1.000	Red (1.414)
Indian Ocean / Longline, shallow-set Swordfish fishery	2.000	1.000	Red (1.414)
Indian Ocean / Longline, deep-set Albacore fishery	2.000	1.000	Red (1.414)
Southern Indian Ocean / Pelagic longline Bluefin fishery	2.000	1.000	Red (1.414)
Sri lanka / Indian Ocean / Pelagic longline	2.000	1.000	Red (1.414)

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1: Harvest Strategy

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

- 5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered
- 4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'
- 3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'
- 2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'
- 1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of

Species of Concern rated 'ineffective.'

- 0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.

Factor 3.1 Summary

FACTOR 3.1: MANAGEMENT OF FISHING IMPACTS ON RETAINED SPECIES							
Region / Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Indian Ocean / Pelagic longline Tropical tuna fishery	Moderately Effective	N/A	Moderately Effective	Ineffective	Ineffective	Moderately Effective	Highly Effective
Indian Ocean / Longline, shallow-set Swordfish fishery	Moderately Effective	N/A	Moderately Effective	Ineffective	Ineffective	Moderately Effective	Highly Effective
Indian Ocean / Longline, deep-set Albacore fishery	Moderately Effective	N/A	Moderately Effective	Ineffective	Ineffective	Moderately Effective	Highly Effective
Southern Indian Ocean / Pelagic longline Bluefin fishery	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Ineffective	Moderately Effective	Highly Effective
Sri lanka / Indian Ocean / Pelagic longline	Moderately Effective	N/A	Moderately Effective	Ineffective	Moderately Effective	Moderately Effective	Highly Effective

The United Nations Law of the Sea 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 high seas. 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., International Commission for the Conservation

of Atlantic Tunas (ICCAT)). This report focuses on longline fisheries for swordfish and tuna in international waters within the Indian Ocean, which are managed by the Indian Ocean Tuna Commission (IOTC) and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). The Ministry of Fisheries and Aquatic Sciences is in charge of managing Sri Lanka's fisheries. The following countries are current members of the IOTC: Australia, Belize, China, Comoros, Eritrea, European Union, 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 and CCSBT 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.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Moderately Effective

The Indian Ocean Tuna Commission (IOTC) has adopted several management measures that affect species caught in the longline fishery but there are no management measures in place for blue or shortfin mako sharks. For example, the IOTC has requested countries to provide information on the number of licensed vessels larger than 24 m in length (under 24 m if fishing outside of their EEZ). Countries are also required to introduce a Fleet Development Plan for capacity control (IOTC 2013l). 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 t. In addition, there is a time/area closure in place for longline vessels (through 2014) between February and March (IOTC 2013l). Starting in 2017, longline vessels are required to reduce their catches of yellowfin tuna by 10% of 2014 levels (IOTC 2016). The only species-specific management measure that applies to swordfish is an effort limitation capping the fishing capacity to 2007 levels. Management measures (only relevant to the Southern Indian Ocean aspect of this report) adopted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), which is responsible for the management of southern bluefin tuna throughout its range, include a total allowable catch (TAC) (which is set on a 3-year cycle divided between eight countries and the European Community) and a Management Procedure (which the CCSBT uses to aid in the setting of the TAC). The Management Procedure, a pre-defined set of rules that indicate how changes to the TAC can be made, has been in place since 2012. The goal of the Management Procedure is to allow a 70% probability of rebuilding the stock by 2035 to the interim rebuilding target reference point, which is 20% of the virgin biomass. Under this Management Procedure, the minimum and maximum amounts the TAC can

change are 100 t and 3,000 t, respectively. In addition, there is a meta-rule process that the CCSBT can use to deal with “exceptional circumstances” in the southern bluefin tuna fishery. The meta-rule process outlines the process of determining whether an exception circumstance exists, and the process for action (CCSBT 2010) (CCSBT 2014).

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 to evaluate the performance of reference points and potential harvest control rules through management strategy evaluation (IOTC 2013l). Currently, interim target and limit reference points are used in the IOTC for albacore, bigeye, and yellowfin tuna, and swordfish; the IOTC Scientific Committee is to advise the Commission on target and limit reference points for albacore tuna by the end of 2014 (IOTC 2013l). A harvest control rule and reference points have been formally adopted for skipjack tuna (IOTC 2016). In addition, the Scientific Committee is to provide management advice for albacore tuna based on the use of Management Strategy Evaluation by the end of 2014 (IOTC 2013l).

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, non-compliance should be monitored and identified at the member level, causes of non-compliance 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 means of reporting (i.e., port sampling) should be explored, assessment methods for data-deficient species should be developed, and catch limits, TACs, etc. 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 due to the fact the IOTC is taking initiatives to define target and limit reference points and has management in place for some individual species.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Moderately Effective

The Ministry of Fisheries and Aquatic Sciences is in charge of fisheries management in Sri Lanka. Sri Lanka instituted the Fisheries and Aquatic Resources Act in 1996, which helps Sri Lanka develop fisheries management plans. Under this Act are several orders including the development of a fisheries and aquatic resources advisory council, designated fishery management areas, management authorities, and required licenses for all fishing gear (MFAR 2007). In 2012, an operational license for fishing on the high seas was instituted (Herath and Maldenlya 2013). In addition, the Ministry of Fisheries and Aquatic Sciences of Sri Lanka developed a Ten Year Development Policy Framework in 2007, which aims to develop oceanic fisheries (MFAR 2007). There are currently no quotas, catch limits, etc. for yellowfin tuna and

there is no tuna-specific management plan in place that is specific to Sri Lanka (Joeseph 2003), although measures including a harvest control rule for skipjack tuna are in place for the Indian Ocean region. In terms of silky shark, Sri Lanka has developed a National Plan of Action for Sharks and a data collection program (Herath and Maldenlya 2013). Sri Lanka is a cooperating member of the Indian Ocean Tuna Commission and must comply with those management measures as well, so we have awarded a "moderately effective" score.

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.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY

N/A

No target species are overfished.

INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

N/A

There is concern over the status of blue and shortfin mako sharks, although no comprehensive stock assessment has been conducted. Other species (e.g., tuna and billfish) are not overfished.

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Moderately Effective

Southern bluefin tuna is overfished but there are management measures in place to aid in its recovery, so we have awarded a "moderately effective" score. In addition, there is concern over the status of blue and shortfin mako sharks.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

N/A

Yellowfin and bigeye tuna are not overfished, so no recovery plan is needed.

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.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Moderately Effective

Stock assessments for key tuna species are conducted on a regular basis. Logbook data on catch and effort in the longline fishery are required to be submitted to the Commission (IOTC 2013l). Assessments of blue and shortfin mako sharks have not been conducted (IOTC 2013h) (IOTC 2013i). Member countries are required to record and report catch and effort data by species and gear. Longline fisheries must report data by a 5° grid area and month strata. In addition, size data must also 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 (IOTC 2013l). The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) has a Catch Document Scheme in place for southern bluefin tuna that tracks and validates the flow of southern bluefin tuna from catch to sale (CCSBT 2014b). 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). The Compliance Committee indicated that reporting of mandatory statistics is generally poor, due to incomplete and/or poorly documented data, although an improvement was noted in 2012 (IOTC 2013p). We have therefore awarded only a "moderately effective" score.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Moderately Effective

Stock assessments for key tuna species are conducted by the Indian Ocean Tuna Commission (IOTC) on a regular basis, but assessments for shark species are not currently conducted due to a lack of data. Logbook data on catch and effort in the longline fishery is required to be submitted to the Commission (IOTC 2013l). Member countries are required to record and report catch and effort data by species and gear. Longline fisheries must report data by a 5° grid area and month strata. In addition, size data must also be provided and countries must have a random-size sampling scheme in place (IOTC 2013l). The (IOTC) Compliance Committee indicated that reporting of mandatory statistics is generally poor, due to incomplete and/or poorly documented data, although an improvement was noted in 2012 (IOTC 2013p) and Sri Lanka was highlighted in the assessment for providing poor quality effort data for the longline fishery (IOTC 2013d). 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.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

Ineffective

The Indian Ocean Tuna Commissions Scientific Committee provides advice to the Commission. The most recent advice for albacore tuna was that fishing mortality should be reduced or catch levels capped at levels from 2012 to maintain the spawning stock biomass at maximum sustainable yield levels (IOTC 2015b). But this advice has not been followed. No specific advice was provided for bigeye tuna other than continued monitoring and data collection (IOTC 2013b). In 2015, it was advised that future catches of yellowfin tuna should be 80% or less of current levels in order to allow the population to rebuild (IOTC 2015). In 2016, the Commission adopted a requirement to reduce longline catches by only 10% and not 20% of 2014 levels (IOTC 2016). The only advice provided for swordfish in the Indian Ocean was for the Commission to continue monitoring and improving data collection, and catches should not exceed the current maximum sustainable yield estimate of 29,900–34,200 t (IOTC 2013f). The IOTC has not adopted any new management measures to improve monitoring and there is no total allowable catch (TAC) in place. Regarding blue and shortfin mako sharks, it has been advised that maintaining or increasing effort will likely lead to population declines (IOTC 2013h) (IOTC 2013i). No effort limits have been adopted by the Commission. We have awarded an “ineffective” score because advice (e.g., for albacore and swordfish) has not been followed for the main species in this fishery.

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Moderately Effective

The Indian Ocean Tuna Commission’s Scientific Committee provides advice to the Commission. The most recent advice for albacore tuna was that fishing mortality rates need to be reduced by at least 20% to maintain the spawning stock biomass at maximum sustainable yield levels (IOTC 2013a). But this advice has not been followed. No specific advice was provided for bigeye tuna other than continued monitoring and data collection (IOTC 2013b). In 2012, it was advised that catches of yellowfin tuna should not exceed 300,000 t (IOTC 2013d). The only advice provided for swordfish in the Indian Ocean was for the Commission to continue monitoring and improving data collection, and catches should not exceed the current maximum sustainable yield estimate of 29,900–34,200 t (IOTC 2013f). The IOTC has not adopted any new management measures to improve monitoring and there is no total allowable catch (TAC) in place. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) (only relevant to the Southern Indian Ocean section of this report) has adhered to scientific advice and utilizes a Management Procedure in setting a total allowable catch level that will ensure that the biomass reaches the current interim rebuilding target for southern bluefin tuna (CCSBT 2011). Regarding blue and shortfin mako sharks, it has been advised that maintaining or increasing effort will likely lead to population declines (IOTC 2013h) (IOTC

2013i). No effort limits have been adopted by the Commission. We have awarded a "moderately effective" score because some but not all advice (e.g., for albacore and swordfish) has been followed.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Ineffective

Sri Lanka has created a National Plan of Action for Sharks, based on the advice of the Indian Ocean Tuna Commission (IOTC). Sri Lanka also has improved onsite sampling so that all species of sharks are sampled, per the recommendation of the IOTC. Sri Lanka enforces the ban on shark finning and on the catching, retaining, etc. of thresher shark. Sri Lanka has taken legal action against fishers who violated the ban on catching thresher shark (Herath and Maldenlya 2013). In 2012, the IOTC Scientific Committee advised that catches of yellowfin tuna should not exceed 300,000 t (for all countries) but updated data for 2013 is not yet available (IOTC 2013d). The only advice provided by the IOTC Scientific Commission with regard to swordfish was for the Commission to continue monitoring and improving data collection, and catches should not exceed the current maximum sustainable yield estimate of 29,900–34,200 t (IOTC 2013f). We have awarded an "ineffective" score because scientific advice has not always been followed for target species in this fishery.

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, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Ineffective

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, compliance with the time/area closure must be monitored by individual countries through methods such as VMS, and 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 TACs currently in place that need enforcement. IUU fishing appears to continue to occur (IOTC 2014a). 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 2013l). 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 2014 meeting, compliance with providing a record of authorized vessels increased slightly from 30% in 2010 to 38% in 2013. Compliance with the Bigeye Tuna Statistical Document Program increased steadily since 2010 (13%) through 2013 (45%). Compliance with observing transshipments at sea was 60% in 2013 and compliance with the regional observer program was 31% in 2013. Reporting of mandatory statistics had a 39% compliance rate in 2013 for target species and 45% for bycatch species. Compliance with limiting fishing capacity occurred at a rate of 59% in 2013 (IOTC 2014b).

The Committee is responsible for reporting its 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 only considers compliance with a measure, not quality or completeness of data submitted. Although the Committee will let countries know that they are not in compliance through a formal letter, 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). It has recently adopted additional measures to strengthen compliance (IOTC 2016). 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 many countries fail to provide all the information necessary to monitor compliance (Pillai and Satheeshkumar 2012).

The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) also has a compliance plan that lays out a framework to achieve full compliance over time. Within the plan is a 3-year action plan aimed at priority issues with regard to compliance. In addition, the CCSBT has three Compliance Policy guidelines: minimum performance requirements, corrective actions policy and monitoring, and control and surveillance collection and sharing. Within the CCSBT, a Quality Assurance Review program provides information to individual member countries on how well they are complying and provides recommendations on ways to improve in the development of management strategies (CCSBT 2014b).

We have awarded an “ineffective” score because there are compliance issues with regard to IUU fishing and individual countries reporting data to the IOTC.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Moderately Effective

The Department of Fisheries and Aquatic Resources (DFAR) is in charge of law enforcement in

Sri Lanka. Sri Lanka is currently undertaking efforts to implement a vessel monitoring system (VMS) in their fleet. A pilot program was to be undertaken in 2013 but it is unclear if this has yet occurred (Herath and Maldenlya 2013).

In 2012, a logbook recording program for "multiday" fishing vessels was instituted. Though the logbook is gear specific, initial data reporting was considered poor due to the lack of understanding with regard to completing the forms. The Department of Fisheries and Aquatic Resources is currently conducting work to improve the data entry through monitoring and awareness programs (Herath and Maldenlya 2013). Sri Lanka has provided a list of authorized longline vessels to the IOTC (IOTC 2014) and developed a National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported, and Unregulated (IUU) Fishing (Hearth and Maldenlya 2013). Sri Lanka has been compliant (current status) with the majority of IOTC regulations (IOTC 2014c). We have awarded a "moderately effective" score to account for Sri Lanka taking action to improve data recording and reporting and for being compliant with most IOTC management measures.

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.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

Moderately Effective

The Indian Ocean Tuna Commission has been mostly successful in maintaining healthy populations; however, currently fishing mortality rates are too high for albacore and yellowfin tuna, and there are concerns about the status of key shark species. We have therefore awarded a "moderately effective" score.

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Moderately Effective

The Indian Ocean Tuna Commission has been mostly successful in maintaining healthy populations; however, current fishing mortality rates are too high for albacore tuna. In addition, the Commission for the Conservation of Southern Bluefin Tuna has not been able to maintain the stock status of southern bluefin tuna and there are concerns about the status of key shark species. We have therefore awarded only a "moderately effective" score.

Subfactor3.1.7 – StakeholderInclusion

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.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

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).

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

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). Sri Lanka appears to include stakeholder input when developing management plans. For example, stakeholder input was utilized in the development of the National Plan of Action for Sharks (Herath and Maldenlya 2013). We have therefore awarded a "highly effective" score.

Factor 3.2: Bycatch Strategy

SCORING GUIDELINES

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

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

FACTOR 3.2: BYCATCH STRATEGY						
Region / Method	**All Kept**	**Critical**	**Strategy**	**Research**	**Advice**	**Enforce**
Indian Ocean / Pelagic longline Tropical tuna fishery	No	No	Ineffective	Ineffective	Moderately Effective	Ineffective
Indian Ocean / Longline, shallow-set Swordfish fishery	No	No	Ineffective	Ineffective	Moderately Effective	Ineffective
Indian Ocean / Longline, deep-set Albacore fishery	No	No	Ineffective	Ineffective	Moderately Effective	Ineffective
Southern Indian Ocean / Pelagic longline Bluefin fishery	No	No	Ineffective	Ineffective	Moderately Effective	Ineffective
Sri lanka / Indian Ocean / Pelagic longline	No	No	Ineffective	Ineffective	Moderately Effective	Moderately Effective

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.).

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Ineffective

Longline fisheries operating in the Indian Ocean incidentally capture other species such as sharks, sea turtles, and seabirds. The Indian Ocean Tuna Commission has instituted some management measures aimed at these species. For example, vessels must take reasonable steps to release any incidentally captured cetaceans and to report incidental captures (IOTC 2013l). Oceanic whitetip shark and thresher shark are prohibited from being retained and landed, and any incidentally captured sharks should be released if still alive (IOTC 2013l).

Interactions between vessels 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, longline vessels must carry line cutters and dehooking devices used to release incidentally captured sea turtles. Countries are also requested to conduct studies on the use of circle hooks and whole finfish bait, handling techniques, and other mitigation measures to reduce the incidental capture of sea turtles (IOTC 2013l). The Working Party on Ecosystems and Bycatch has recommended that these measures be strengthened and that countries should also report total estimated levels of incidental turtle catches by species (IOTC 2013o). All interactions with seabirds must be

recorded and countries must provide information on how they are implementing observer programs to aid in the recording and reporting of these interactions. Mitigation measures are required. South of 25° S two pre-approved mitigation measures must be used, but mitigation methods in other areas must be used as well. The success of these measures will be re-evaluated in 2016 (IOTC 2013l). Though countries have been asked to develop National Plans of Action (NPOAs) for sharks and seabirds, few countries have followed through with this (IOTC 2013o). In addition, there are no bycatch catch limits in place for any species, and best-practice bycatch mitigation measures are not used to reduce the incidental capture of sea turtles or sharks.

An analysis of Regional Fishery Management Organizations' (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.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Ineffective

Sri Lanka has taken a number of steps to protect sharks in its fisheries. For example, it has instituted a ban on catching, retaining, or selling thresher sharks and has banned shark finning, requiring sharks to be landed with their fins naturally attached. There is also an on-site sampling program, which was recently updated to account for all species of sharks (Herath and Maldenlya 2013). In addition, during 2013, Sri Lanka completed the development of its National Plan of Action for Sharks (Herath and Maldenlya 2013). Sea turtles are protected in Sri Lankan waters, but there are no bycatch mitigation measures in place to minimize interactions with longline fisheries (Herath and Maldenlya 2013). We have therefore awarded an "ineffective" score.

Subfactor 3.2.3 – 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

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Ineffective

The IOTC requires at least 5% observer coverage on all vessels, regardless of gear, over 24 m in length operating in the Convention Area (IOTC 2013l). 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). Only 2 or 3 countries have yet achieved the required 5% observer coverage (both fisheries) (IOTC 2013o). In addition, reporting of seabird and sea turtle bycatch is very low and often poorly documented (IOTC 2013p), so we have awarded an "ineffective" score.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Ineffective

Sri Lanka has an on-site sampling program, which among other things allows for the collection of data specific to all shark species landed. Though there is no observer program, this sampling program monitors the catch and also provides information on effort. Observers are not used because the current fleet is made up of vessels that are too small. Sri Lanka has stated that if the fleet expanded to larger vessels, it would implement an observer program. Sri Lanka reports to the PELAGOS database, which has recently been updated to include additional shark species. Sri Lanka has awareness programs in place with regard to the prohibition on catching thresher shark (Herath and Maldenlya 2013). In addition, Sri Lanka is taking proactive measures to aid fishers in understanding the ban on catching thresher shark. But the observer program is not in place, leading to a loss of information on bycatch species (seabirds, sea turtles, etc.). Because of Sri Lanka's known issues with data reporting, and a high potential for bycatch impacts on several vulnerable species, this lack of data is a concern. We have therefore awarded an "ineffective" score.

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, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Moderately Effective

See the Harvest Strategy section 3.1.4 for more details.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Moderately Effective

See the Harvest Strategy section 3.1.4 for details.

Subfactor 3.2.5 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen's compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Ineffective

There has been a lack of compliance with regard to bycatch management measures, so we have awarded an "ineffective" score.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Moderately Effective

See the Harvest Strategy section 3.1.5 for details.

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	Score
Indian Ocean / Pelagic longline Tropical tuna fishery	5.00: None	0.00: Not Applicable	3.00: Moderate Concern	Green (3.873)
Indian Ocean / Longline, shallow-set Swordfish fishery	5.00: None	0.00: Not Applicable	3.00: Moderate Concern	Green (3.873)
Indian Ocean / Longline, deep-set Albacore fishery	5.00: None	0.00: Not Applicable	3.00: Moderate Concern	Green (3.873)
Southern Indian Ocean / Pelagic longline Bluefin fishery	5.00: None	0.00: Not Applicable	3.00: Moderate Concern	Green (3.873)
Sri lanka / Indian Ocean / Pelagic longline	5.00: None	0.00: Not Applicable	3.00: Moderate Concern	Green (3.873)

Although pelagic longline gears do not typically come in contact with bottom habitats, they do affect a number of ecologically important species and the consequence of this varies by region. Mitigation measures to reduce the impact of pelagic longlines on bottom habitats are not generally needed.

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

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

None

Although pelagic longlines are surface fisheries, contact with the seabed can occur in shallow-set fisheries (Passfield and Gilman 2010). These effects are still considered to be a low risk to bottom habitats (Gilman et al. 2013) (Seafood Watch 2013), so we have awarded a no impact score.

Factor 4.2 - Mitigation of Gear Impacts

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Not Applicable

Factor 4.3 - Ecosystem-Based Fisheries Management

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Moderate Concern

Tuna longline fisheries operating in the Indian Ocean catch ecologically important species including other tunas, billfish, and sharks. These species are considered top predators in many ecosystems and therefore 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, that can lead to a cascade of other effects (Myers et al. 2007) (Duffy 2003) (Ferretti et al. 2010) (Schindler et al. 2002) and behavioral changes (e.g., predator avoidance) (Heithaus et al. 2007).

The IOTC has a Working Party on Ecosystems and Bycatch (WPEB), which is tasked with analyzing technical problems related to the management goals, identifying research priorities, and indicating data and information requirements that are needed. In addition, it provides advice on management measures (IOTC 2013t). This Working Party 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 and 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 2000, the IOTC agreed to a 5-year program initiated by Japan to investigate marine mammal and shark depredation events in longline fisheries, in order to explore implications for the ecosystem approach to management (IOTC 2009). Information on the results of this initiative is unknown at this point. In addition, the Commission has adopted management measures specific to bycatch species such as sharks, seabirds, and sea turtles. We have therefore awarded a “moderate” concern score instead of high concern score.

SRI LANKA / INDIAN OCEAN, PELAGIC LONGLINE

Moderate Concern

Tuna longline fisheries catch ecologically important species including other tunas, billfish, 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, that can lead to a cascade of other effects (Myers et al. 2007) (Duffy 2003) (Ferretti et al. 2010) (Schindler et al. 2002) and behavioral changes (Heithaus et al. 2007).

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 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 and 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 2000, the IOTC agreed to a 5-year program initiated by Japan to investigate marine mammal and shark depredation events in longline fisheries, in order to explore implications for the ecosystem approach to management (IOTC 2009). In addition, the Commission has adopted management measures specific to bycatch species such as sharks, seabirds, and sea turtles.

Sri Lanka has three main fisheries Acts, which take into account ecosystem and bycatch issues. The acts are the Fauna and Flora Protection Act, Fisheries and Aquatic Resources Act, and the National Environment Act of Sri Lanka. Within these acts, Sri Lanka has prohibited the possession of marine mammals and sea turtles, prohibited the use of fishing gears on coral reefs, enacted a law that requires sharks to be landed with their fins attached, and prohibited

the export of threatened species. In addition, Sri Lanka's National Plan of Action for Sharks aims to protect the ecosystem (Herath and Maldenlya 2013). We have therefore awarded a "moderate" concern and not high concern score.

Acknowledgements

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

Seafood Watch would like to thank one anonymous reviewer for graciously reviewing this report for scientific accuracy.

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Appendix A: Extra By Catch Species

YELLOWFIN TUNA

Factor 2.1 - Inherent Vulnerability

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE
INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY

Medium

FishBase assigned a moderate vulnerability score of 46 out of 100 (Froese and Pauly 2013).

Factor 2.2 - Abundance

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE
INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY

High Concern

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 × 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 2.3 - Fishing Mortality

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE
INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY

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 × F_{MSY}). The 2012 assessment results were unclear if the status of yellowfin tuna was moving toward overfishing occurring, because catches in recent years have 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.

Factor 2.4 - Discard Rate

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

20-40%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can

range from 0%–40% {Kelleher 2005). Within the Indian Ocean, discard rates are reported to be less than the average, around 9% {Kelleher et al. 2005). Attempts to determine actual discard rates in the Sri Lankan tuna fishery have been unsuccessful {O'Meara et al. 2011). We have awarded a score of 20%–40% because there is no indication that discards in the Sri Lankan tuna fishery are higher or lower than the normal global range.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

BIGEYE TUNA

Factor 2.1 - Inherent Vulnerability

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE
INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Medium

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.

Factor 2.2 - Abundance

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE
INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Very Low Concern

According to the most recent assessment, the biomass is currently estimated to 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.

Factor 2.3 - Fishing Mortality

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE
INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Very Low Concern

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 affect the population (IOTC 2013b), so we have awarded a “very low” concern score.

Factor 2.4 - Discard Rate

SRI LANKA/INDIAN OCEAN, PELAGIC LONGLINE

20-40%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% {Kelleher 2005). Within the Indian Ocean, discard rates are reported to be less than the average, around 9% {Kelleher et al. 2005). Attempts to determine actual discard rates in the Sri Lankan tuna fishery have been unsuccessful {O’Meara et al. 2011). We have awarded a score of 20%–40% because there is no indication that discards in the Sri Lankan tuna fishery are higher or lower than the normal global range.

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

LOGGERHEAD TURTLE

Factor 2.1 - Inherent Vulnerability

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

High

Sea turtles have a high level of vulnerability due to their life history characteristics that include late age at sexual maturity and long life span (Seafood Watch 2013).

Factor 2.2 - Abundance

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

Very High Concern

The International Union for Conservation of Nature (IUCN) classified loggerhead turtle as Endangered in 1996, although it has been suggested that this classification needs to be updated (MTSG 2006). Loggerhead is also listed on Appendix I of the Convention on International Trade of Endangered Species (CITES). The status of loggerhead turtles in the Indian Ocean is unknown. But loggerhead from the Arabian Gulf is considered one of the most productive turtle species in the Indian Ocean (IOTC 2013j). We have awarded a “very high” concern score due to the IUCN rating.

Factor 2.3 - Fishing Mortality

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

Moderate Concern

In the southeast Indian Ocean, loggerhead sea turtle bycatch in the longline fishery is considered to have only a low impact to loggerheads but is considered a high risk to the population (Wallace et al. 2013). Overall, data on sea turtle interactions are lacking throughout the Indian Ocean (IOTC 2013j). But loggerhead sea turtle from the Bay of Bengal is considered one of the most susceptible populations to longline capture in the Indian Ocean (IOTC 2013j). There are mitigation measures in place for some but not all fleets to reduce the incidental capture of sea turtles in longline fisheries operating in the Indian Ocean. Despite the low bycatch impact, we have awarded a “moderate concern” score because e□ective management is not in place throughout its range in the Indian Ocean.

Factor 2.4 - Discard Rate

INDIAN OCEAN, PELAGIC LONGLINE TROPICAL TUNA FISHERY
SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY
INDIAN OCEAN, LONGLINE, SHALLOW-SET SWORDFISH FISHERY
INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

SOUTHERN BLUEFIN TUNA

Factor 2.1 - Inherent Vulnerability

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

High

FishBase assigned a high to very high vulnerability score of 67 out of 100 (Froese and Pauly 2013). Southern bluefin tuna's life history characteristics suggest a high vulnerability to fishing pressure. For example, southern bluefin tuna reaches sexual maturity after at least 8 years of age and at a size of 155 cm in length, but perhaps not until 15 years of age. It reaches a total length of 2 m and can live up to 42 years (IOTC 2013e). Southern bluefin tuna is a top predator and considered a broadcast spawner (Froese and Pauly 2013).

Factor 2.2 - Abundance

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Very High Concern

The current spawning biomass of southern bluefin tuna is estimated to be a small fraction of virgin levels and well below the level needed to produce the maximum sustainable yield ($SB_{current}/SB_{MSY}$ = 0.229 (0.146–0.320)). But at current catch levels, the population is expected to increase. Catch rates from the Japanese longline fishery have been increasing since 2007 for some age classes, and aerial surveys have indicated a recent increase in abundance in 2013, the second-highest in history (IOTC 2013e). But catch rate series can provide biased results (Maunder et al. 2006). The International Union for the Conservation of Nature (IUCN) has listed southern bluefin tuna as Critically Endangered (Collette et al. 2011c). We have awarded a "very high" concern score based on the current low biomass levels and IUCN status.

Factor 2.3 - Fishing Mortality

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

Low Concern

Fishing mortality rates are estimated to have decreased for southern bluefin tuna and are now below those needed to produce the maximum sustainable yield ($F_{current}/F_{MSY}$ = 0.76 (0.52–1.07)). In addition, reported catches are below the maximum sustainable yield (MSY) levels and current exploitation rates are considered moderate (IOTC 2013e). We have therefore awarded a "low" concern instead of very low concern score because of the high level of uncertainty surrounding the assessment results.

Factor 2.4 - Discard Rate

SOUTHERN INDIAN OCEAN, PELAGIC LONGLINE BLUEFIN FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

ALBACORE TUNA

Factor 2.1 - Inherent Vulnerability

INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

Medium

FishBase assigned a high vulnerability score of 58 out of 100 for albacore tuna (Froese and Pauly 2013). But the life history characteristics of albacore suggest only a medium vulnerability to fishing. For example, albacore reaches sexual maturity between 5 and 6 years of age and reaches a maximum age of 10+ years (IOTC 2013a). It is a broadcast spawner and top predator (Froese and Pauly 2013). Based on these life history characteristics, we have awarded a medium score.

Factor 2.2 - Abundance

INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

Low Concern

Albacore tuna was last assessed in the Indian Ocean in 2014. At that time, the spawning biomass (SB) was estimated to be slightly higher than levels needed to produce the maximum sustainable yield (SB_{MSY}), which is the interim target reference point (SB_{2012}/SB_{MSY} = 1.09 (0.34–2.20)). The longline vulnerable population is only around 47% of virgin levels. Since the population size is estimated above both the interim target and limit reference points, the population is not overfished (IOTC 2015b). We have awarded a “low” concern and not very low concern score because the population is close to the target reference point and not substantially above it and there is some uncertainty surrounding the results.

Factor 2.3 - Fishing Mortality

INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

Low Concern

Albacore tuna in the Indian Ocean were assessed as undergoing overfishing in 2014. Fishing mortality rates in 2012 were estimated to be 69% (23%–139% range) of those needed to produce the maximum sustainable yield (MSY), indicating that overfishing is not occurring. Catches have increased since 2007 and recent catches are likely higher than MSY levels. Maintaining or increasing e□ort in the future is likely to lead to a decrease in the population (IOTC 2015b). We have therefore awarded a “low" and not "very low" concern score.

Factor 2.4 - Discard Rate

INDIAN OCEAN, LONGLINE, DEEP-SET ALBACORE FISHERY

< 20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0%–40% (Kelleher 2005). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Ardill et al. 2012).

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. There were no changes to the overall recommendations.