Albacore Tuna, Bigeye Tuna, Southern Bluefin Tuna, Swordfish, Yellowfin Tuna

Thunnus alalunga, *Thunnus obesus*, *Thunnus maccoyii, Xiphias gladius, Thunnus albacares*

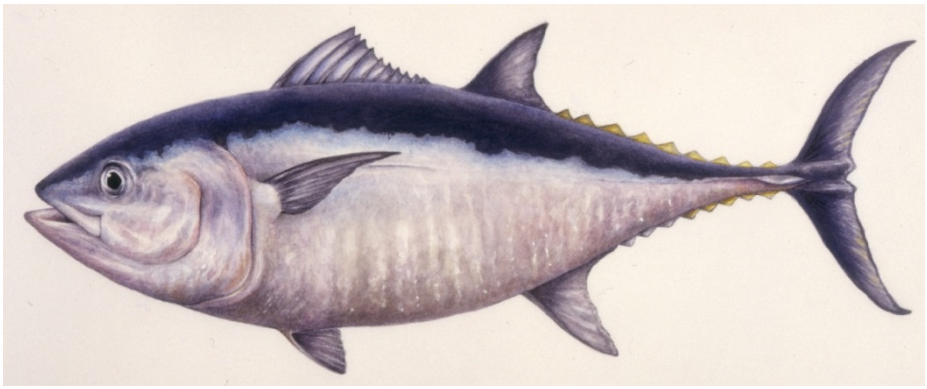

Image © Monterey Bay Aquarium

Indian Ocean

Longline

December 8, 2014

Alexia Morgan, Consulting Researcher

Disclaimer

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

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 wild-catch fisheries for consumers and businesses. These criteria are:

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

Each criterion includes:

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

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

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

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

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

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

Summary

This report focuses on four general longline fisheries in the Indian Ocean for 1. albacore tuna (*Thunnus alalunga*) (termed Indian Ocean—longline, deep-set in this report), 2. southern bluefin tuna (*Thunnus maccoyii*) (termed southern Indian Ocean—longline, pelagic in this report) fishery, 3. tropical tunas (bigeye tuna (*Thunnus obesus)*, yellowfin tuna (*Thunnus albacares*)) (termed Indian Ocean—longline, pelagic in this report) fishery and 4. swordfish (*Xiphias gladius*) (termed Indian Ocean—longline, shallow-set in this report), along with the Sri Lankan yellowfin longline fishery.

Populations of bigeye and yellowfin tuna are all healthy and fishing mortality rates are low. Southern bluefin tuna populations are at very low levels, but fishing mortality rates have decreased and are currently considered sustainable. Swordfish populations in the southeast Indian Ocean are healthy, but in the southwest region they are below levels needed to produce the maximum sustainable yield. Fishing mortality rates, however, are sustainable. Albacore tuna is the only species that is currently undergoing overfishing but are not overfished.

The longline fisheries that target these species also capture a number of secondary target and bycatch species. We have included species that typically represent 5% or more of the total catch or whose status (i.e., endangered or threatened) justifies their inclusion in this report per the Seafood Watch criteria.

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 as well as by the Commission for the Conservation of Southern Bluefin Tuna in waters within the Indian Ocean, and in Sri Lanka they are managed by the Ministry of Fisheries and Aquatic Sciences.

Table of Conservation Concerns and Overall Recommendations

Stock / Fishery	Impacts on the Stock	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Bigeye Tuna Indian Ocean - Longline, Pelagic	Green (5.00)	Red (1.00)	Red (1.41)	Green (3.87)	**Avoid (2.288)**
Yellowfin Tuna Indian Ocean - Longline, Pelagic	Green (4.28)	Red (1.00)	Red (1.41)	Green (3.87)	**Avoid (2.201)**

Southern Bluefin Tuna Southern Indian Ocean - Longline, Pelagic	Red (1.92)	Red (1.41)	Red (1.41)	Green (3.87)	**Avoid (1.963)**
Swordfish Indian Ocean - Longline, Shallow-Set	Green (3.87)	Red (1.41)	Red (1.41)	Green (3.87)	**Avoid (2.340)**
Albacore Tuna Indian Ocean - Longline, Deep-Set	Red (2.00)	Red (1.41)	Red (1.41)	Green (3.87)	**Avoid (1.984)**
Bigeye Tuna Southern Indian Ocean - Longline, Pelagic	Green (5.00)	Red (1.41)	Red (1.41)	Green (3.87)	**Avoid (2.494)**
Yellowfin Tuna Sri Lanka Indian Ocean - Longline, Pelagic	Green (4.28)	Red (1.00)	Red (1.41)	Green (3.87)	**Avoid (2.201)**
Bigeye Tuna Sri Lanka Indian Ocean - Longline, Pelagic	Green (5.00)	Red (1.00)	Red (1.41)	Green (3.87)	**Avoid (2.288)**

Scoring Guide

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

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

- **Best Choice/Green** = Final Score >3.2, **and** no Red Criteria, **and** no Critical scores
- **Good Alternative/Yellow** = Final score >2.2, **and** neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern,[2] **and** no more than one Red Criterion, **and** no Critical scores, **and** does not meet the criteria for Best Choice (above)
- **Avoid/Red** = Final Score <=2.2, **or** either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern,[2] **or** two or more Red Criteria, **or** one or more Critical scores.

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

Table of Contents

Introduction

Scope of the analysis and ensuing recommendation

This report focuses on four general longline fisheries in the Indian Ocean for 1. albacore tuna (*Thunnus alalunga*) (termed Indian Ocean— deep-set in this report), 2. southern bluefin tuna (*Thunnus maccoyii*), 3. tropical tunas (bigeye tuna (*Thunnus obesus)*, yellowfin tuna (*Thunnus albacares*)) and 4. swordfish (*Xiphias gladius*) (termed Indian Ocean— shallow-set in this report), along with the Sri Lankan yellowfin longline fishery.

Overview of the species and management bodies

Albacore tuna are widely distributed in temperate and tropical waters in all oceans, including the Indian Ocean. Albacore tuna biology is not well understood in the Indian Ocean. In other oceans, there are two populations (northern and southern) of albacore tuna, but in the Indian Ocean only one southern population is thought to exist. Albacore tuna migrate long distances and it is possible they move between the Indian and Atlantic Oceans (IOTC 2013a). Longlines have historically captured the majority of albacore tuna worldwide (ISSF 2013b).

Bigeye, and yellowfin tuna are found in tropical and subtropical waters worldwide, including the Indian Ocean where they are all assessed as single populations. There are two populations living in the eastern, western and central Pacific Ocean, and one population of bigeye and yellowfin in the Atlantic Ocean. Bigeye and yellowfin tuna are highly migratory and are commonly found as juveniles schooling together below floating objects (IOTC 2013b)(IOTC 2013c)(IOTC 2013d).

Southern bluefin tuna are found only in the southern hemisphere, primarily in the Indian, Atlantic and western Pacific Oceans and are found infrequently in the eastern Pacific Ocean. This species migrates from the south coast of Australia and the central Indian Ocean as juvenile and remain in offshore waters as adults. There is only one known spawning location, south-east of Java, Indonesia in the Indian Ocean (IOTC 2013e).

Globally, longlines are the most common method used to capture swordfish, southern bluefin, albacore and bigeye tuna. Purse seines are the primary gear used to capture yellowfin tuna. Albacore catches have increased since the 1950s remaining around 400,000 t over the past decade. Bigeye and yellowfin tuna catches have all increased substantially over time, peaking in the early 2000s for bigeye and yellowfin tuna (ISSF 2013b).
In the Indian Ocean, swordfish and tuna are managed by the Indian Ocean Tuna Commission. 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 manages marine resources such as tuna.

Production Statistics

Albacore tuna are caught primarily with longlines in the Indian Ocean. Within the Indian Ocean, the majority of longline catches are made (in decreasing order) by: Taiwan, Indonesia, Japan, China, Malaysia and the Seychelles. After a stable trend in catches, total catches (all gears) increased during the 1980s, peaking around 30,000 t. However, this increase was due largely to the drift gillnet fishery, which was banned in 1992. Catches initially decreased after this ban but increased again between 1993 and 2001, when they peaked at 46,000 t (all gears, longline represented around 40,000 t). Since 2001, catches have remained high, although slightly less than peak levels in 2012 (~34,000 t all gears, 30,000 t longlines) (IOTC 2013a).

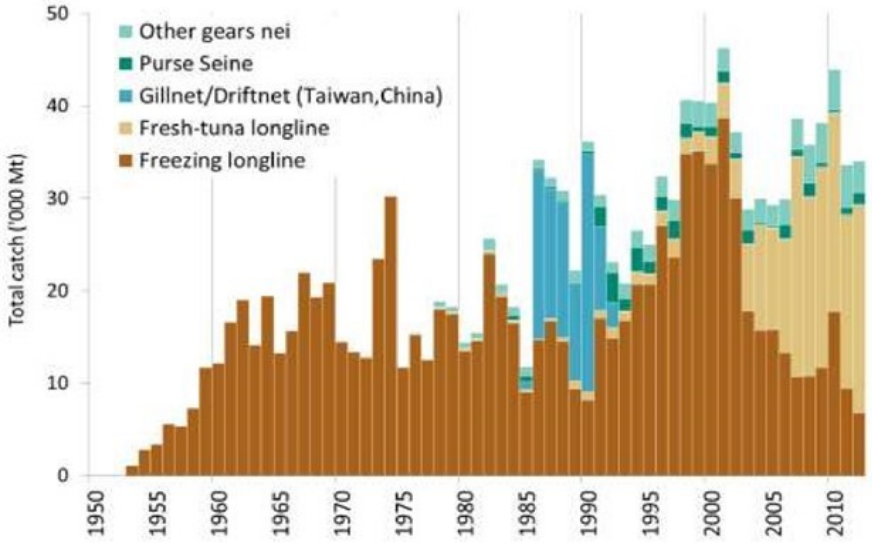

Figure 1: Albacore tuna annual catches, 1950-2012, Indian Ocean (IOTC 2013a)

The majority (80%) of southern bluefin tuna are caught in the Indian Ocean and primarily by longline fisheries. Total catches (all oceans) peaked in the 1960s at around 82,000 t, with just under 80,000 t coming from the longline fishery. Catches have declined significantly since then, being only around 10,000 t in 2012, with around half of that coming from the longline fleet. Catches from the Indian Ocean have declined from 45,000 t in 1968 to 8,000 t (IOTC 2013e).

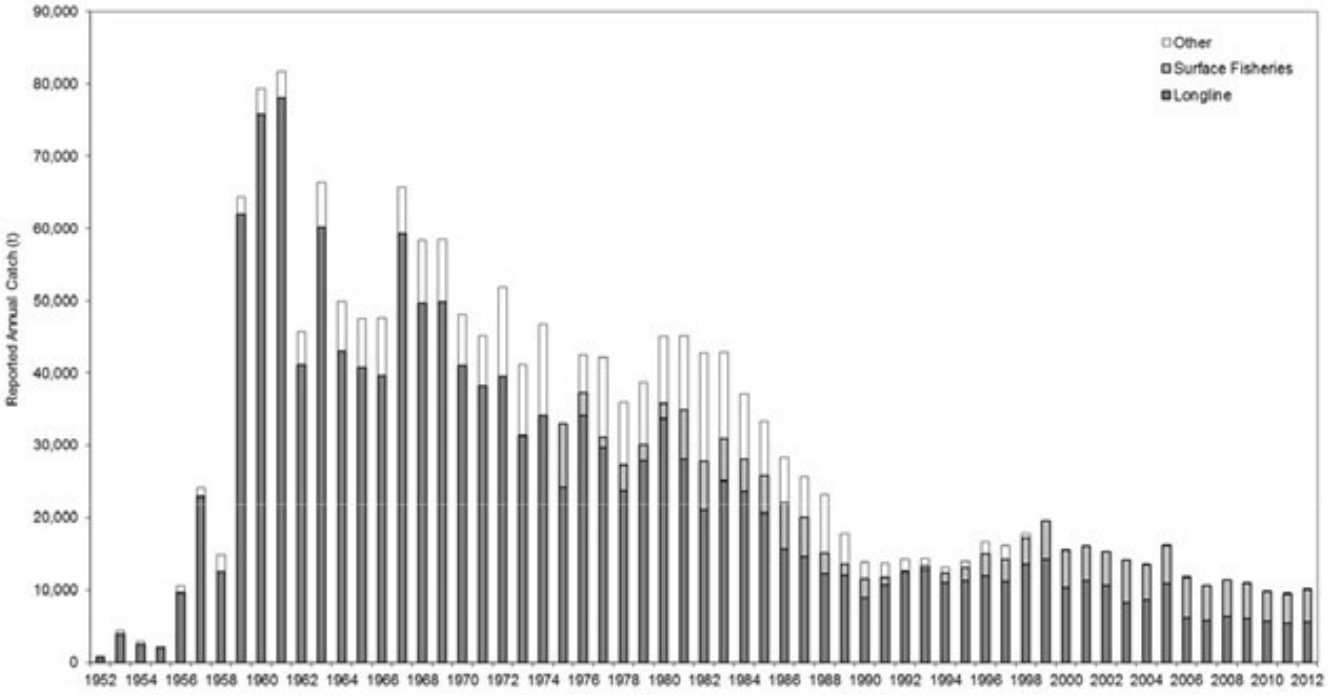

Figure 2: Southern bluefin tuna annual catches, 1952-2012, in the Indian Ocean (IOTC 2013e).

Longlines are the primary gear used to capture bigeye tuna in the Indian Ocean, representing 70% of the catch in 2012. After steady increases in total catches between 1950 and 1999 (160,000 t total catches), catches in more recent years have decreased 115,000 t (total catches 76,089 t longline) in 2012. This decrease in catches is most likely due to piracy in the northwest Indian Ocean, which has subsequently reduced longline effort in this region. The top fishing nations for bigeye tuna in the Indian Ocean include (in decreasing order): Taiwan, Indonesia, Seychelles, Japan and India (IOTC 2013b).

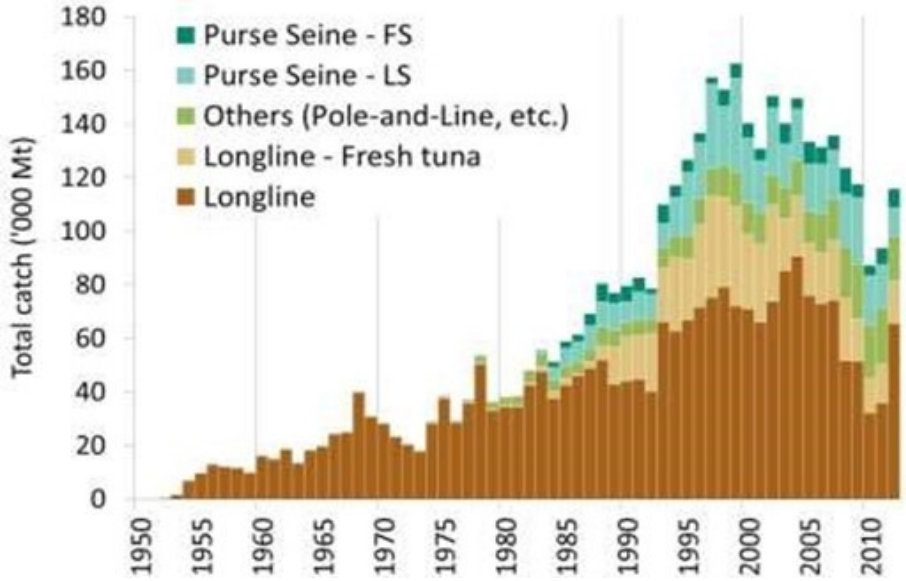

Figure 3: Bigeye tuna annual catches, 1950-2012, in the Indian Ocean (IOTC 2013b)

Longline gear is one of many gears targeting yellowfin tuna in the Indian Ocean. During the early years of commercial fishing in the region (1950-1980s), longlines made up the majority of catches. Total annual catches have increased significantly since the 1980s due to the expansion of the purse seine, handline, trolling and gillnet fisheries. Total catches peaked in 2004 (528,797 t) but have since dropped, with total catches in 2012 being 370,000 t (~107,000 t from the longline fleet). The longline fleet takes mostly large yellowfin tuna and catches for this fleet peaked in 1993 (200,000 t) but have since declined, due in part to increased piracy in the northwest Indian Ocean. The top countries (in decreasing order) catching yellowfin tuna with longlines include: Sri Lanka, Indonesia, Maldives and India (IOTC 2013d).

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 and into high seas waters. Yellowfin tuna catches increased 8% between 2011 and 2012 with the expansion of the yellowfin tuna longline fishery. In 2012, total yellowfin tuna catches in Sri Lanka were 28,376 t, with 7,627 t coming from the tuna longline fishery. Other gears that target this species include gillnet or a combination of gillnet and longlines.

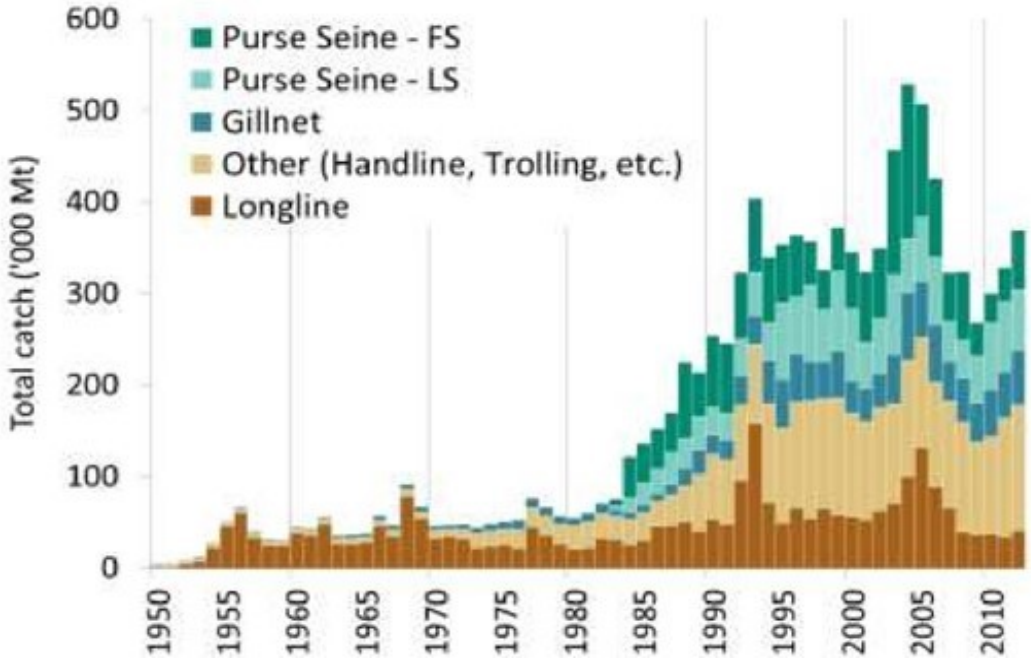

Figure 4: Yellowfin tuna annual catches, 1950-2012, in the Indian Ocean (IOTC 2013d)

Swordfish are taken primarily (90%) by longline fisheries in the Indian Ocean. They were primarily a bycatch species in tuna fisheries prior to the early 1990s. The Taiwanese, Australian, Reunion Island, Seychelles and Mauritius fleets began targeting swordfish in the early 1990s along with some European fleets (Portugal, Spain, France (Reunion Island) and the UK) that began fishing in the Indian Ocean. Between 2009 and 2012, the top nine identified (in terms of total catch) fishing nations for swordfish (longline only (bycatch and target) were in descending order: Taiwan, Spain, Sri Lanka, Indonesia, France (Reunion Island), Portugal, Seychelles, Tanzania and Indian. Overall catches of swordfish increased from the 1950s to 1980s along with tuna longline fishing effort. Longline catches have decreased from a peak of 37,234 t in 2004, due to a decrease in longline effort, primarily by the Taiwanese fleet, to 23,375 t in 2012 (IOTC 2013f).

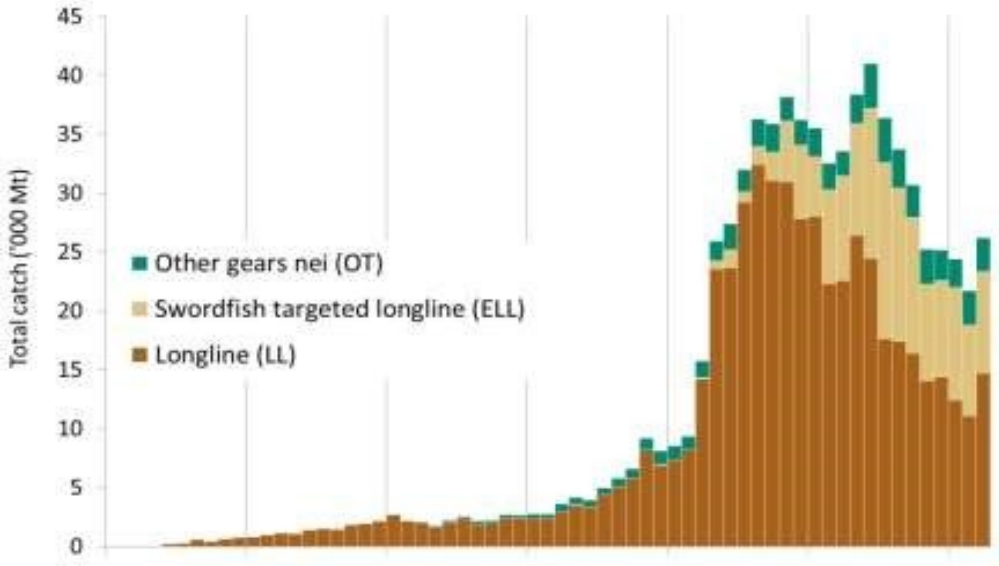

Figure 5: Swordfish catches in the Indian Ocean, 1950-20120 (IOTC 2013f)

Importance to the US/North American market

During 2013, the United States imported most (39%) of its albacore tuna from Thailand. Other countries the United States imports large amounts of albacore from include Vietnam (20%) and Indonesia (16%) (NMFS 2014).

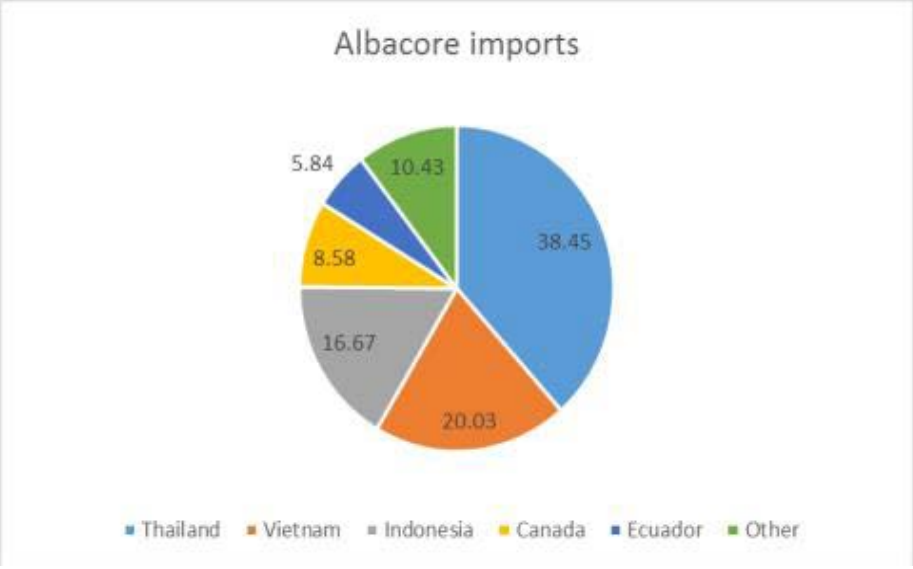

Figure 6: Major contributors to US albacore tuna imports (%) all countries and region (country of origin) ({NMFS 2014)

During 2013, the United States imported around 19% of its annual bigeye tuna from Ecuador, 16% from the Marshall Islands and 14% from Sri Lanka (NMFS 2014).

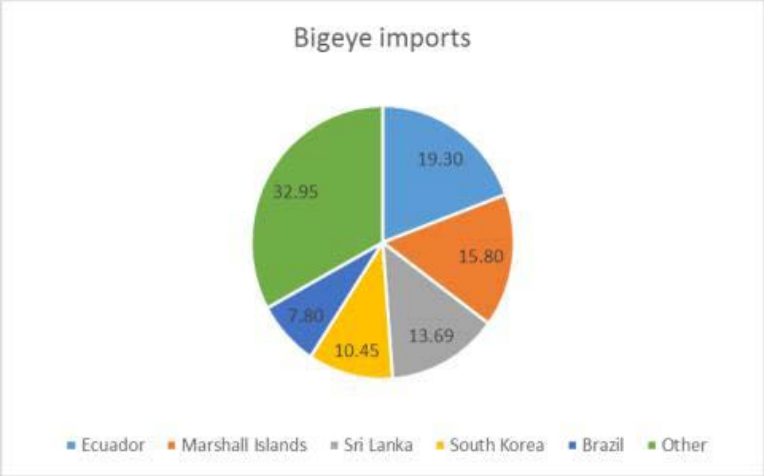

Figure 7: Major contributors to US bigeye tuna imports (%) all countries and regions (country of origin) (NMFS 2014)

In 2013, the majority of yellowfin tuna (49%) were imported from Trinidad and Tobago (49%). Smaller amounts were imported from the Philippines (7%), Vietnam (6%) and Indonesia (5%) (NMFS 2014).

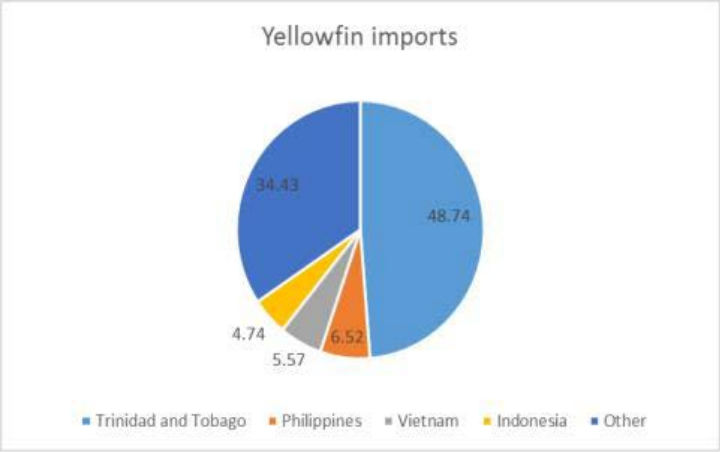

Figure 8: Major contributors to US yellowfin tuna imports (%) all countries and regions (country of origin) (NMFS 2014)

During 2013, swordfish imports into the United States were primarily from Ecuador (23%), Canada (14%) and Costa Rica and Singapore (11%).

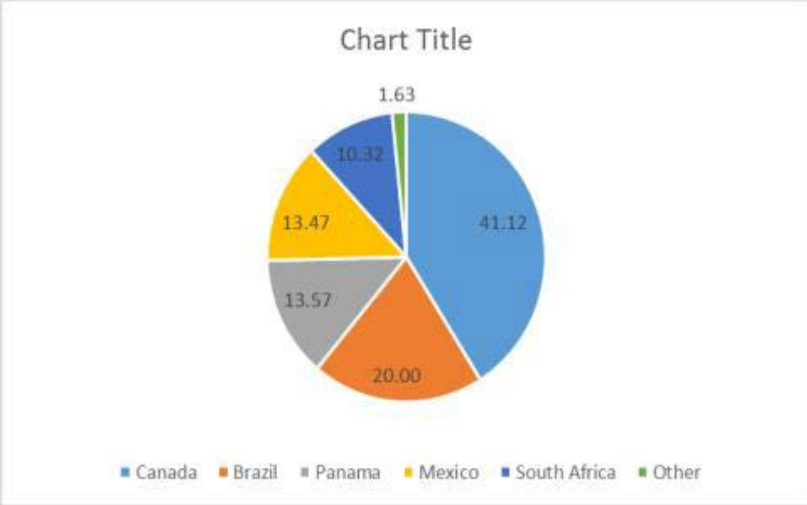

Figure 9: Major contributors to US swordfish imports (%) all countries (country of origin) (NMFS 2014)

The US imports the majority of its annual southern bluefin tuna from New Zealand (47%), followed by Japan (33%)

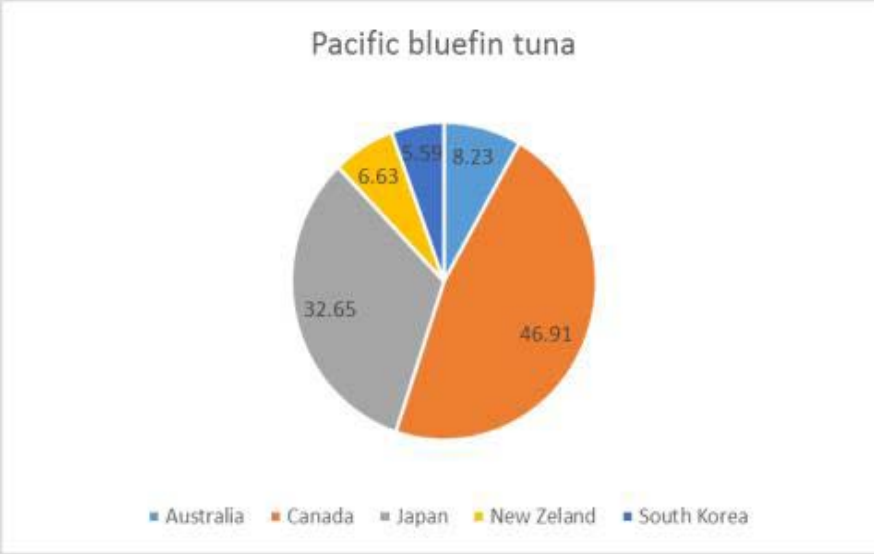

Figure 10: Southern bluefin tuna imports (percentage), 2013, for all countries and regions (country of origin) (NMFS 2014)

Common and market names

In Hawaii, bigeye and yellowfin tuna are known as ahi. Swordfish are also known as broadbilled swordfish, broadbill, espada and emperado. Southern bluefin tuna are also known as southern tunny or tunny and albacore tuna are known as longfinned tuna, germon or albecor.

Primary product forms

These longline caught species are sold in fresh and frozen form and for the sushi and sashimi markets. Albacore tuna is also sold in canned form.

Assessment

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

Criterion 1: Stock for which you want a recommendation

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2=Red or High Concern*
  Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Criterion 1 Summary

ALBACORE TUNA				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**
Indian Ocean Longline, Deep-Set	2.00:Medium	4.00:Low Concern	1.00:High Concern	**Red (2.000)**

BIGEYE TUNA				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**
Indian Ocean Longline, Pelagic	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	**Green (5.000)**
Southern Indian Ocean Longline, Pelagic	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	**Green (5.000)**
Sri Lanka Indian Ocean Longline, Pelagic	2.00:Medium	5.00:Very Low Concern	5.00:Very Low Concern	**Green (5.000)**

SOUTHERN BLUEFIN TUNA				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**
Southern Indian Ocean Longline, Pelagic	1.00:High	1.00:Very High Concern	3.67:Low Concern	**Red (1.916)**

SWORDFISH				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**
Indian Ocean Longline, Shallow-Set	2.00:Medium	3.00:Moderate Concern	5.00:Very Low Concern	**Green (3.873)**

YELLOWFIN TUNA				
Region / Method	**Inherent Vulnerability**	**Abundance**	**Fishing Mortality**	**Subscore**
Indian Ocean Longline, Pelagic	2.00:Medium	5.00:Very Low Concern	3.67:Low Concern	**Green (4.284)**
Sri Lanka Indian Ocean Longline, Pelagic	2.00:Medium	5.00:Very Low Concern	3.67:Low Concern	**Green (4.284)**

Populations of bigeye and yellowfin tuna are all healthy and fishing mortality rates are low. Southern bluefin tuna populations are at very low levels, but fishing mortality rates have decreased and are currently considered sustainable. Swordfish populations in the Indian Ocean are healthy, but in the southwest region they are below levels needed to produce the maximum sustainable yield. Fishing mortality rates, however, are sustainable. Albacore tuna is the only species that is currently undergoing overfishing but is not overfished.

Criterion 1 Assessment

ALBACORE TUNA

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make 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.

Indian Ocean, Longline, Deep-Set

Medium

FishBase assigned a high vulnerability score of 58 out of 100 for albacore tuna (Froese and Pauly 2013). However, the life history characteristics of albacore suggest only a medium vulnerability to fishing. For example, albacore reach sexual maturity between 5 and 6 years of age and reach a maximum age of 10+ years (IOTC 2013a). They are broadcast spawners, and top predators (Froese and Pauly 2013). Based on these life history characteristics we have awarded a score of 'medium.'

Factor 1.2 - Abundance

Scoring Guidelines

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

Indian Ocean, Longline, Deep-Set

Low Concern

Albacore tuna were last assessed in the Indian Ocean in 2011. At that time, the spawning biomass (SB) was estimated to be slightly higher than levels needed to produce the maximum sustainable yield (SBMSY), which is the interim target reference point, (SB2010/SBMSY = 1.05 (0.54-1.56)); however, the population was only around 29% of virgin levels. The population was above both the interim target and limit reference points, indicating the was not overfished (IOTC 2013a). Abundance indices have been somewhat variable since the early 1980s, with several showing increasing trends in recent years (IOTC 2013a). We have awarded a score of 'low concern' and not 'very low concern' because the population is close to the target reference point and not substantially above it, and there is some uncertainty surrounding the results.

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 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.*

Indian Ocean, Longline, Deep-Set

High Concern

Albacore tuna in the Indian Ocean were assessed as undergoing overfishing in 2011. Fishing mortality rates in 2010 were estimated to be 133% (90%–176% range) of those needed to produce the maximum sustainable yield (MSY), indicating overfishing is occurring. Recent catches appear to be only slightly higher than MSY levels, but maintaining or increasing effort in the future is likely to lead to a decrease in the population (IOTC 2013a). We have therefore awarded a score of 'high concern.'

BIGEYE TUNA

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*

- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make 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.

Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Pelagic

Sri Lanka Indian Ocean, Longline, Pelagic

Medium

FishBase assigned a high to very high vulnerability of 72 out of 100 for bigeye tuna (Froese and Pauly 2013). However, bigeye tuna's life history characteristics suggest a medium vulnerability to fishing. For example, bigeye tuna reach sexual maturity around 100 cm or 3 years of age, reach a maximum size of 200 cm and live around 15 years (IOTC 2013b). They are broadcast spawners and top predators (Froese and Pauly 2013). Based on these life history characteristics, we have awarded a score of 'medium.'

Factor 1.2 - Abundance

Scoring Guidelines

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

Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Pelagic

Sri Lanka Indian Ocean, Longline, Pelagic

Very Low Concern

According to the most recent assessment, the biomass is estimated to be well above target levels which produce the maximum sustainable yield (SB2012/SBMSY=1.44 (0.87-2.22)). The current biomass is around 40% of virgin levels (IOTC 2013b). We have awarded a score of 'very low concern' because the biomass is well above target levels.

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 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.*

Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Pelagic

Sri Lanka Indian Ocean, Longline, Pelagic

Very Low Concern

Fishing mortality rates are estimated to be below the provisional target levels needed to produce the maximum sustainable yield (FMSY), 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 five years have been below MSY levels. Maintaining catches at the current level should not negatively impact the population (IOTC 2013b), and so we have awarded a score of 'very low concern.'

SOUTHERN BLUEFIN TUNA

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make 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.

Southern Indian Ocean, Longline, Pelagic

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 reach 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. They can reach a total length of 2 m and can live up to 42 years (IOTC 2013e). Southern bluefin tuna are a top-predator and are considered broadcast spawners (Froese and Pauly 2013).

Factor 1.2 - Abundance

Scoring Guidelines

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

Southern Indian Ocean, Longline, Pelagic

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)). However, 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 (2013) have indicated a recent increase in abundance—the second highest in history (IOTC 2013e). However, catch rate series 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 score of 'very high concern' based on the current low biomass levels and IUCN status.

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 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.*

Southern Indian Ocean, Longline, Pelagic

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 (Fcurrent/FMSY = 0.76 (0.52-1.07)). In addition, reported catches are below the MSY levels and current exploitation rates are considered moderate (IOTC 2013e). We have therefore awarded a score of 'low concern' instead of 'very low concern' because of the high level of uncertainty surrounding the assessment results.

SWORDFISH

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make 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.

Indian Ocean, Longline, Shallow-Set

Medium

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

Factor 1.2 - Abundance

Scoring Guidelines

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

Indian Ocean, Longline, Shallow-Set

Moderate Concern

The current biomass of swordfish is estimated to have been reduced to around 30%–53% of virgin levels and is slightly above levels needed to produce the maximum sustainable yield (SBcurrent/SBMSY = 1.07-1.59). The biomass is above the current provisional biomass based limit reference point (0.4*BMSY) and therefore swordfish are not considered overfished. There is a very low risk of the population becoming overfished in the future, even if catches are increased (IOTC 2013f). However, in the southwest Indian Ocean, although this is not a genetically distinct population, swordfish have been subjected to localized depletion. The biomass in this area is below levels needed for the maximum sustainable yield (SBcurrent/SBMSY = 0.73-1.44) and is therefore overfished (IOTC 2013f). We have therefore awarded a score of ‘moderate.’

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 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.*

Indian Ocean, Longline, Shallow-Set

Very Low Concern

Fishing mortality rates for swordfish in the Indian Ocean are estimated to be well below levels needed to produce the maximum sustainable yield (F2009/FMSY = 0.50-0.63). Fishing levels are also below the provisional limit reference point (1.4*FMSY) 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 (F2009/FMSY = 0.64-1.19) (IOTC 2013f). We have awarded a score of 'very low concern.'

YELLOWFIN TUNA

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing).*

- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make 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.

Indian Ocean, Longline, Pelagic

Sri Lanka Indian Ocean, Longline, Pelagic

Medium

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

Factor 1.2 - Abundance

Scoring Guidelines

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

Indian Ocean, Longline, Pelagic

Sri Lanka Indian Ocean, Longline, Pelagic

Very Low Concern

The population of yellowfin tuna in the Indian Ocean is estimated to be healthy and at 38% of virgin

levels. The ratio of the biomass (in 2010) to that needed to produce the maximum sustainable yield was well above the provisional target level of 1 (SB_{2010}/SB_{MSY} = 1.24 (0.91-1.40)). The biomass is also above the provisional limit reference point (0.4*SBMSY) and therefore yellowfin tuna are not overfished (IOTC 2013d). Seafood Watch has awarded a score of 'very low concern.'

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 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.*

Indian Ocean, Longline, Pelagic

Sri Lanka Indian Ocean, Longline, Pelagic

Low Concern

The current fishing mortality rates are estimated to be below both the provisional target reference point of 1 (0.69 (0.59-0.90)) and limit reference point (1.5*FMSY). However, it is unclear if the status is moving toward overfishing occurring, and catches in recent years have exceeded previous maximum sustainable yield estimates (IOTC 2013d). We have therefore awarded a score of 'low concern' and not 'very low concern.'

Criterion 2: Impacts on Other Species

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

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

Criterion 2 Summary

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

Albacore Tuna: Indian Ocean, Longline, Deep-Set

Subscore: 1.414 **Discard Rate: 1.00** **C2 Rate: 1.414**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLACK-BROWED ALBATROSS	High	2.00: High Concern	1.00: High Concern	**1.414**
BLUE SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
SHORTFIN MAKO SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
WHITE-CHINNED PETREL	High	2.00: High Concern	1.00: High Concern	**1.414**
LOGGERHEAD TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
ALBACORE TUNA	Medium	4.00: Low Concern	1.00: High Concern	**2.000**

Bigeye Tuna: Indian Ocean, Longline, Pelagic

Subscore: 1.000 **Discard Rate:** 1.00 **C2 Rate:** 1.000

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
LEATHERBACK TURTLE	High	1.00: Very High Concern	1.00: High Concern	**1.000**
BLACK-BROWED ALBATROSS	High	2.00: High Concern	1.00: High Concern	**1.414**
BLUE SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
SHORTFIN MAKO SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
WHITE-CHINNED PETREL	High	2.00: High Concern	1.00: High Concern	**1.414**
LOGGERHEAD TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	3.67: Low Concern	**4.284**
BIGEYE TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Bigeye Tuna: Southern Indian Ocean, Longline, Pelagic

Subscore: 1.414 **Discard Rate:** 1.00 **C2 Rate:** 1.414

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLACK-BROWED ALBATROSS	High	2.00: High Concern	1.00: High Concern	**1.414**
BLUE SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
SHORTFIN MAKO SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
WHITE-CAPPED ALBATROSS	High	2.00: High Concern	1.00: High Concern	**1.414**
WHITE-CHINNED PETREL	High	2.00: High Concern	1.00: High Concern	**1.414**
LOGGERHEAD TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
SOUTHERN BLUEFIN TUNA	High	1.00: Very High Concern	3.67: Low Concern	**1.916**
BIGEYE TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Bigeye Tuna: Sri Lanka Indian Ocean, Longline, Pelagic

Subscore: 1.000 **Discard Rate:** 0.95 **C2 Rate:** 1.000

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
TURTLES	High	1.00: Very High Concern	1.00: High Concern	**1.000**
SILKY SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
SWORDFISH	Medium	3.00: Moderate Concern	5.00: Very Low Concern	**3.873**
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	3.67: Low Concern	**4.284**
BIGEYE TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SKIPJACK TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Southern Bluefin Tuna: Southern Indian Ocean, Longline, Pelagic

Subscore: 1.414 **Discard Rate:** 1.00 **C2 Rate:** 1.414

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLACK-BROWED ALBATROSS	High	2.00: High Concern	1.00: High Concern	**1.414**
BLUE SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
SHORTFIN MAKO SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
WHITE-CAPPED ALBATROSS	High	2.00: High Concern	1.00: High Concern	**1.414**
WHITE-CHINNED PETREL	High	2.00: High Concern	1.00: High Concern	**1.414**
LOGGERHEAD TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
SOUTHERN BLUEFIN TUNA	High	1.00: Very High Concern	3.67: Low Concern	**1.916**
BIGEYE TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Swordfish: Indian Ocean, Longline, Shallow-Set

Subscore: 1.414 **Discard Rate:** 1.00 **C2 Rate:** 1.414

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
BLACK-BROWED ALBATROSS	High	2.00: High Concern	1.00: High Concern	**1.414**
BLUE SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
SHORTFIN MAKO SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
WHITE-CHINNED PETREL	High	2.00: High Concern	1.00: High Concern	**1.414**
LOGGERHEAD TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
SWORDFISH	Medium	3.00: Moderate Concern	5.00: Very Low Concern	**3.873**

Yellowfin Tuna: Indian Ocean, Longline, Pelagic

Subscore: 1.000 **Discard Rate:** 1.00 **C2 Rate:** 1.000

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
LEATHERBACK TURTLE	High	1.00: Very High Concern	1.00: High Concern	**1.000**
BLACK-BROWED ALBATROSS	High	2.00: High Concern	1.00: High Concern	**1.414**
BLUE SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
SHORTFIN MAKO SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
WHITE-CHINNED PETREL	High	2.00: High Concern	1.00: High Concern	**1.414**
LOGGERHEAD TURTLE	High	1.00: Very High Concern	2.33: Moderate Concern	**1.526**
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	3.67: Low Concern	**4.284**
BIGEYE TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

Yellowfin Tuna: Sri Lanka Indian Ocean, Longline, Pelagic				
Subscore:	**1.000**	**Discard Rate:**	**0.95**	**C2 Rate:**	**1.000**

Species	Inherent Vulnerability	Abundance	Fishing Mortality	Subscore
TURTLES	High	1.00: Very High Concern	1.00: High Concern	**1.000**
SILKY SHARK	High	2.00: High Concern	1.00: High Concern	**1.414**
SWORDFISH	Medium	3.00: Moderate Concern	5.00: Very Low Concern	**3.873**
YELLOWFIN TUNA	Medium	5.00: Very Low Concern	3.67: Low Concern	**4.284**
BIGEYE TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**
SKIPJACK TUNA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

This report focuses on tuna and swordfish longline fisheries operating in the Indian Ocean and on the Sri Lankan yellowfin tuna fishery.

Several species of sharks, sea turtles and sea birds 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, are endangered or are a stock of concern. 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, white-chinned petrel, and blue and shortfin mako sharks due to their stock status. In the southern bluefin tuna fishery, black-browed albatross, white-capped albatross, white-chinned petrel and blue and shortfin mako sharks were the worst scoring species; all due to their stock statuses. In the tropical tuna fishery leatherback sea turtles were the worst scoring species due to their stock status.

Information on bycatch in the Sri Lankan fishery is limited and information on sea bird interactions is not available. However, two small studies have been conducted, during which no sea bird 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 appears to be low. A comprehensive study is 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).

Albacore - deep-set		
Albacore	Target	IOTC catch data
Blue shark	Most commonly reported shark species	IOTC catch data; Adrille et al. 2012
Shortfin mako shark	second most common shark species in catch	IOTC catch data; Adrille et al. 2012
Loggerhead	36% of turtles	Adrille et al. 2012
White-chinned petrel	one of three most common bird species	Adrille et al. 2012
Black-browed albatross	one of three most common bird species	Adrille et al. 2012
Swordfish - shallow-set		
Swordfish	Target	IOTC catch data
Blue shark	Most commonly reported shark species	IOTC catch data; Adrille et al. 2012
Shortfin mako shark	second most common shark species in catch	IOTC catch data; Adrille et al. 2012
Loggerhead	36% of turtles	Adrille et al. 2012
Leatherback	30% of turtles	Adrille et al. 2012
White-chinned petrel	one of three most common bird species	Adrille et al. 2012
Black-browed albatross	one of three most common bird species	Adrille et al. 2012
Tropical Tuna - Indian Ocean		

Bigeye	Target	IOTC catch data
Yellowfin	Target	IOTC catch data
Blue shark	Most commonly reported shark species	IOTC catch data; Adrille et al. 2012
Shortfin mako shark	second most common shark species in catch	IOTC catch data; Adrille et al. 2012
Loggerhead	36% of turtles	Adrille et al. 2012
Leatherback	30% of turtles	Adrille et al. 2012
White-chinned petrel	one of three most common bird species	Adrille et al. 2012
Black-browed albatross	one of three most common bird species	Adrille et al. 2012
Southern bluefin - Southern Indian Ocean		
Southern bluefin	Target	IOTC catch data
Bigeye	Target	IOTC catch data
Blue shark	Most commonly reported shark species	IOTC catch data; Adrille et al. 2012
Shortfin mako shark	second most common shark species in catch	IOTC catch data; Adrille et al. 2012
Loggerhead	36% of turtles	Adrille et al. 2012
White-capped albatross	one of three most common bird species	Adrille et al. 2012
White-chinned petrel	one of three most common bird species	Adrille et al. 2012
Black-browed albatross	one of three most common bird species	Adrille et al. 2012

We have included bigeye and skipjack tuna, swordfish, turtles and silky sharks in this report. Of these, the turtles scored the lowest due to their stock status.

Criterion 2 Assessment

SILKY SHARK

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Sri Lanka Indian Ocean, Longline, Pelagic

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Sri Lanka Indian Ocean, Longline, Pelagic

High Concern

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

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Sri Lanka Indian Ocean, Longline, Pelagic

High Concern

Silky sharks are caught in a number of fisheries in the Indian Ocean, including longline fisheries. A qualitative assessment has not been conducted in the Indian Ocean and there is substantial uncertainty surrounding total catch estimates as well. Current fishing mortality rates are unknown, but it is

generally thought that maintaining or increasing fishing effort will likely cause the biomass to decline. Piracy in the Indian Ocean has displaced parts of the longline fleet to non-traditional fishing locations and this could cause localized depletions (IOTC 2013e). We have awarded a score of 'high concern' because of the uncertainty surrounding fishing mortality rates and total catches, and because it is believed that current levels of fishing are too high to maintain the population at a healthy size. Additionally, although a national plan of action for sharks has been developed, it is unclear how effective it will be in managing silky sharks.

Factor 2.4 - Discard Rate

Sri Lanka Indian Ocean, Longline, Pelagic

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% (Kellher 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.

SKIPJACK TUNA

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Sri Lanka Indian Ocean, Longline, Pelagic

Medium

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Sri Lanka Indian Ocean, Longline, Pelagic

Very Low Concern

Skipjack tuna populations in the Indian Ocean are considered healthy. The ratio of the biomass in 2011 to that needed to produce the maximum sustainable yield (SB2011/SBMSY) was well above the interim target reference point of 1 (1.20 (1.01-1.40)) and was also above the limit reference point, both indicating the population is not overfished. In addition, there is a low probability of the biomass falling below the limit reference point (0.4*BMSY) over the next 3 to 10 years (IOTC 2013b). We have therefore awarded a score of 'very low concern' based on these results.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Sri Lanka Indian Ocean, Longline, Pelagic

Very Low Concern

Total catches of skipjack tuna in the Indian Ocean have been declining over time and were well below the maximum sustainable yield (MSY) (478,000 t) in 2011. Fishing mortality rates (F2011) in 2011 were 80% (68%–92%) of those needed to produce the maximum sustainable yield (FMSY)—the provisional target reference point—and were also below the provisional limit reference point (1.5*FMSY) (IOTC 2013b). There is a low probability that fishing mortality rates will exceed the limit reference point in 3 to 10 years. In addition, even if catches are maintained at current levels or increased slightly to levels from 2005 to 2010, there is a low risk of catches exceeding MSY levels (IOTC 2013b). Overfishing of skipjack tuna is not occurring and we have therefore awarded a score of 'very low concern.'

Factor 2.4 - Discard Rate

Sri Lanka Indian Ocean, Longline, Pelagic

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 around 9%, which is less than the average (Kellher 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.

SWORDFISH

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Sri Lanka Indian Ocean, Longline, Pelagic

Medium

Fishbase assigned a high to very high vulnerability of 72 out of 100 (Froese and Pauly 2013). However, the life history characteristics of swordfish indicate a lower vulnerability to fishing. For example, swordfish reach sexual maturity around 120-170 cm in size and around 1-3 (males) to 6-7 years (females) of age. Swordfish reach a maximum length of 455 cm and live more than 30 years. They are broadcast spawners and are top predators (IOTC 2013f). This is more indicative of a moderate vulnerability to fishing and we have adjusted the score accordingly.

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Sri Lanka Indian Ocean, Longline, Pelagic

Moderate Concern

The current biomass of swordfish is estimated to have been reduced to around 30%–53% of virgin levels and is slightly above levels needed to produce the maximum sustainable yield (SBcurrent/SBMSY = 1.07-1.59). The biomass is above the current provisional biomass based limit reference point (0.4*BMSY) and therefore swordfish are not considered overfished. There is very low risk of the population becoming overfished in the future, even if catches are increased (IOTC 2013f). However, although this is not a genetically distinct population, swordfish have been subjected to localized depletion in the southwest Indian Ocean. The biomass in this area is below levels needed for the maximum sustainable yield (SBcurrent/SBMSY = 0.73-1.44) and is therefore overfished (IOTC 2013f). We have therefore awarded a score of ‘moderate concern.’

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Sri Lanka Indian Ocean, Longline, Pelagic

Very Low Concern

Fishing mortality rates for swordfish in the Indian Ocean are estimated to be well below levels needed to produce the maximum sustainable yield (F2009/FMSY = 0.50-0.63). Fishing levels are also below the provisional limit reference point (1.4*FMSY) 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 Abundance for details) are also well below levels needed to produce the maximum sustainable yield (F2009/FMSY = 0.64-1.19) (IOTC 2013f). We have awarded a score of 'very low concern.'

Factor 2.4 - Discard Rate

Sri Lanka Indian Ocean, Longline, Pelagic

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 around 9%—less than the average (Kellher 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.

TURTLES

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Sri Lanka Indian Ocean, Longline, Pelagic

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

Scoring Guidelines (same as Factor 1.2 above)

Sri Lanka Indian Ocean, Longline, Pelagic

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 endangered, olive ridley are 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 do not appear to be provided to the Indian Ocean Tuna Commission (IOTC 2013g). We have awarded a score of 'very high concern' due to the IUCN classifications.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Sri Lanka Indian Ocean, Longline, Pelagic

High Concern

Longline fisheries operating in the Indian Ocean incidentally capture sea turtles, although their impact is not as great as 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 1000 hooks were caught, the highest of the study. This is due largely to an olive ridley nesting ground on the east coast of India (IOTC 2013g). Wallace et al. (2013) considers leatherback turtles to be at a high risk and high bycatch impact, loggerhead turtles 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 score of 'high concern.'

Factor 2.4 - Discard Rate

Sri Lanka Indian Ocean, Longline, Pelagic

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 around 9%; less than the average (Kellher 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.

Criterion 3: Management effectiveness

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

The final score for this criterion is the geometric mean of the two scores. The Criterion 3 rating is determined as follows:

- *Score >3.2=Green or Low Concern*
- *Score >2.2 and <=3.2=Yellow or Moderate Concern*
- *Score <=2.2 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*
  Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Region / Method	Management of Retained Species	Management of Non-Retained Species	Overall Recommendation
Indian Ocean Longline, Deep-Set	2.000	1.000	Red(1.414)
Indian Ocean Longline, Pelagic	2.000	1.000	Red(1.414)
Indian Ocean Longline, Shallow-Set	2.000	1.000	Red(1.414)
Southern Indian Ocean Longline, Pelagic	2.000	1.000	Red(1.414)
Sri Lanka Indian Ocean Longline, Pelagic	2.000	1.000	Red(1.414)

Factor 3.1: Harvest Strategy

Scoring Guidelines

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

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered.*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*

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

Factor 3.1 Summary

Factor 3.1: Management of fishing impacts on retained species							
Region / Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Indian Ocean Longline, Deep-Set	Moderately Effective	N/A	Moderately Effective	Ineffective	Ineffective	Moderately Effective	Highly Effective
Indian Ocean Longline, Pelagic	Moderately Effective	N/A	Moderately Effective	Ineffective	Ineffective	Moderately Effective	Highly Effective
Indian Ocean Longline, Shallow-Set	Moderately Effective	N/A	Moderately Effective	Ineffective	Ineffective	Moderately Effective	Highly Effective
Southern Indian Ocean Longline, Pelagic	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Ineffective	Moderately Effective	Highly Effective
Sri Lanka Indian Ocean Longline, Pelagic	Moderately Effective	N/A	Moderately Effective	Ineffective	Moderately Effective	Moderately Effective	Highly Effective

The United Nation's 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 there are currently 18 RFMOs (www.fao.org) that cover nearly all of the world's high seas. Countries must abide by the management measures set forth by individual RFMOs in order to fish in their waters (Cullis-Suzuki and Pauly 2010). Some RFMOs manage all marine living resources within their authority (i.e., General Fisheries Commission for the Mediterranean (GFCM)), while others manage a group of species such as tunas (i.e., 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 Community, Djibouti France, Guinea, Indonesia, Iran, Japan, Kenya, Republic of Korea,

Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Pakistan, Philippines, Seychelles, Sierra Leone, Somalia, Sri Lanka, Sudan, Tanzania, Thailand, United Kingdom, Vanuatu and Yemen. In addition, Senegal and South African and 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, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Moderately Effective

The Indian Ocean Tuna Commission (IOTC) has adopted several management measures that affect species caught in the longline fishery. For example, the IOTC has requested countries provide information on the number of licensed vessels larger than 24 m in length (under 24 m if fishing outside of their exclusive economic zone (EEZ)). Countries are also required to introduce a fleet development plan for capacity control (IOTCC 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 was a time/area closure in place for longline vessels (through 2014) between February and March (IOTC 2013l). The only species specific management measure that applies to swordfish is an effort limitation capping the fishing capacity to 2007 levels. Management measures adopted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) (only relevant to the southern Indian Ocean aspect of this report), which is responsible for the management of southern bluefin tuna throughout their range, include a total allowable catch (TAC) set on a three-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% or the virgin biomass. Under this management procedure, the minimum and maximum amount the TAC can change is 100 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 outlines the process of determining whether an exceptional 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, skipjack, yellowfin tuna and swordfish and 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). In addition, the Scientific Committee is to provide management advice for albacore tuna based on the use of a 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 areas included: modifying the timing of data reporting, monitoring and identifying non-compliance at the member level, identifying causes of non-compliance, improving data quality (catch, effort and size), establishing a scientific observer program, developing a statistical committee, expanding the list of shark species to include five additional species applied to all gear types, exploring alternative reporting means (i.e., port sampling), developing assessment methods for data deficient species, and exploring catch limits and TACs. Various degrees of work have been implemented since 2009 to address these issues (IOTC 2013q).

We have awarded a score of 'moderate concern' due to the fact the IOTC is taking initiative to define target and limit reference points and has management in place for some individual species.

Sri Lanka Indian Ocean, Longline, Pelagic

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 that 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 2007, the Ministry of Fisheries and Aquatic Sciences of Sri Lanka developed a Ten Year Development Policy Framework, 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 (Joeseph 2003). Sri Lanka is a cooperating member of the Indian Ocean Tuna Commission and must comply with those management measures as well, and so we have awarded a score of 'moderately effective.'

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, Longline, Deep-Set

N/A

Target species are not depleted.

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

N/A

No target species are overfished.

Southern Indian Ocean, Longline, Pelagic

Moderately Effective

Southern bluefin tuna are overfished but there are management measures in place to aid in their recovery, so we have awarded a score of 'moderately effective.'

Southern Indian Ocean, Longline, Shallow-Set

N/A

Target species are not depleted.

Sri Lanka Indian Ocean, Longline, Pelagic

N/A

Yellowfin and bigeye tuna are not overfished and 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, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Moderately Effective

Stock assessments for key tuna species are conducted on a regular basis. 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 degree 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 were caught, the product form and what type of gear was used to capture it (IOTC 2013l). However, 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 a score of only 'moderately effective.'

Sri Lanka Indian Ocean, Longline, Pelagic

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 degree 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 (IOT 2013d). We have therefore awarded a score of 'moderately effective.'

Subfactor 3.1.4 – Management Record of Following Scientific Advice

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

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Ineffective

The Indian Ocean Tuna Commissions 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). However, 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 the biomass reaches the current interim rebuilding target for southern bluefin tuna (CCSBT 2011). We have awarded a score of 'ineffective' because advice (i.e., albacore and swordfish) has not been followed for the main species in this fishery.

Southern Indian Ocean, Longline, Pelagic

Moderately Effective

The Indian Ocean Tuna Commissions 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). However, 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 the biomass reaches the current interim rebuilding target for southern bluefin tuna (CCSBT 2011). We have awarded a score of 'moderate concern' because some but not all advice (i.e., albacore and swordfish) has been followed.

Southern Indian Ocean, Longline, Shallow-Set

Ineffective

The Indian Ocean Tuna Commissions 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). However, 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 the biomass reaches the current interim rebuilding target for southern bluefin tuna (CCSBT 2011). We have awarded a score of 'ineffective' because advice (i.e., albacore and swordfish) has not been followed for the main species in this fishery.

Sri Lanka Indian Ocean, Longline, Pelagic

Ineffective

Sri Lanka has created a national plan of action for sharks, based on the advice of the Indian Ocean Tuna Commission (IOTC). They have also improved onsite sampling so that all species of sharks are sampled, per the recommendation of the IOTC. Sri Lanka also enforces the ban on shark finning and on catching, retaining etc., thresher sharks. Sri Lanka has taken legal action against fishermen who violated the ban on catching thresher sharks (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 a score of 'ineffective' 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, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

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, handling and trolling) authorized to fish must have a data recording system in place (including all vessels over 24 m and under 24 m, if fishing outside EEZs). This includes logbooks (paper or electronic) that collect information (each fishery having specific required catch and effort data) (IOTC 2013l). Information on illegal, unreported and unregulated (IUU) vessels is required to be reported by individual countries to the commission (IOTC 2013l). Vessel monitoring systems (VMS) are required on all vessels larger than 15 m in length and compliance with the time/area closure must be monitored by individual countries through methods such as VMS, 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 each year (IOTC 2013l). There are no TACs currently in place that need enforcement. It appears that IUU fishing continues to occur (IOTC 2014a).

In terms of compliance with management measures, the IOTC has a compliance committee that verifies compliance by each country with regards 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 from 2010 (13%) through 2013 (45%). Compliance with the regional observer program (transshipment at sea) was at 60% and the regional observer program compliance was at 31% during 2013. In 2013, reporting of mandatory statistics had a 39% compliance rate for target species and 45% for bycatch species. The compliance rate for Limiting fishing capacity was 59% in 2013 (IOTC 2014b).

The committee is responsible for reporting their recommendations to the commission. The committee also discusses problems related to the implementation of management measures and provides the commission with advice on how to address these issues. The committee has also been tasked with developing incentives and sanctions to encourage compliance with these adopted measures (IOTC 2013l). However, the committee considers only compliance with a measure and not quality or completeness of data submitted. In addition, while the committee will let countries know (through a formal letter) they are not in compliance, they do 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 in an effort to help strengthen compliance and to provide technical support to developing nations (IOTC 2013o). Information on compliance with measures, such as the observer scheme, are reported in publicly accessed reports (IOTC 2012b) (IOTC 2013p)(IOTC 2013r). Individual country compliance reports are also produced (IOTC 2013s). However, it has been noted that many countries fail to provide all of 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 three-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 is a quality assurance review program that 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 a score of ‘ineffective’ because there are compliance issues with regard to IUU fishing and the reporting of data to the IOTC from individual countries .

Sri Lanka Indian Ocean, Longline, Pelagic

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 vssel monitoring system in their fleet. A pilot program was to be undertaken in 2013, but it is unclear if this occurred (Herath and Maldenlya 2013). In 2012, a logbook recording program for "multiday" fishing vessels was instituted. While the logbook is gear specific, initial data reporting was considered poor due to the lack of understanding with regards 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). We have awarded a score of 'moderately effective' to account for Sri Lanka taking action to improve data recording and reporting.

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, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

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. We have therefore awarded a score of 'moderately effective.'

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Sri Lanka Indian Ocean, Longline, Pelagic

Moderately Effective

The Indian Ocean Tuna Commission has been mostly successful in maintaining healthy populations; however, current fishing mortality rates are too high for species such as 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. We have therefore awarded a score of only 'moderately effective.'

Subfactor 3.1.7 – Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent and includes stakeholder input.

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

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, Longline, Pelagic

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 score of 'highly effective.'

Bycatch Strategy

Factor 3.2: Management of fishing impacts on bycatch species						
Region / Method	**All Kept**	**Critical**	**Strategy**	**Research**	**Advice**	**Enforce**
Indian Ocean Longline, Deep-Set	No	No	Ineffective	Ineffective	Moderately Effective	Ineffective
Indian Ocean Longline, Pelagic	No	No	Ineffective	Ineffective	Moderately Effective	Ineffective
Indian Ocean Longline, Shallow-Set	No	No	Ineffective	Ineffective	Moderately Effective	Ineffective
Southern Indian Ocean Longline, Pelagic	No	No	Ineffective	Ineffective	Moderately Effective	Ineffective
Sri Lanka Indian Ocean Longline, Pelagic	No	No	Ineffective	Ineffective	Moderately Effective	Moderately Effective

Subfactor 3.2.1 – Management Strategy and Implementation

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

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Ineffective

Longline fisheries operating in the Indian Ocean incidentally capture other species such as sharks, sea turtles and sea birds. 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 sharks and thresher sharks 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 fishermen 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 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). However, 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 (ITOC 2013o). All interactions with sea birds 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 degrees, 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). While countries have been asked to develop national plans of action (NPOAs) for sharks and seabirds, very few countries have followed through with this (IOTC 2013o). In addition, there are no bycatch catch limits in place for any species and best practices 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 regards to bycatch management found the IOTC to score in the lower third of the range (Gilman et al. 2013). We have therefore awarded a score of 'ineffective.'

Sri Lanka Indian Ocean, Longline, Pelagic

Ineffective

Sri Lanka has taken a number of steps to protect sharks in their fisheries. For example, they have instituted a ban on catching, retaining or selling thresher sharks and have banned shark finning, requiring sharks to be landed with their fins naturally attached. There is also an onsite 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 their 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 a score of 'ineffective.'

Subfactor 3.2.2 – Scientific Research and Monitoring

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

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Ineffective

The IOTC requires at least 5% observer coverage on all vessels over 24 m in length (regardless of gear) operating in the Convention Area (IOTC 2013l). However, the working party on ecosystems and bycatch has recommended that the Compliance Committee address the lack of implementation of this program by member countries (IOTC 2013o). For example, only 13 countries have submitted a list of accredited observers to the commission and only 7 countries have submitted observer data for a total of 82 observed trips between 2010 and 2013 (December) (IOTC 2013o). In addition, only 2-3 countries have yet achieved the required 5% observer coverage (both fisheries) (IOTC 2013o). Because of this and the fact that Reporting of seabird and sea turtle bycatch is very low and often poorly documented (IOTC 2013p), we have awarded a score of 'ineffective.'

Sri Lanka Indian Ocean, Longline, Pelagic

Ineffective

Sri Lanka has an onsite sampling program, which among other things allows for the collection of data specific to all shark species landed. While 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 if the fleet expanded to larger vessels they 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 sharks (Herath and Maldenlya 2013). In addition, Sri Lanka is taking proactive measures to aid fishermen in understanding the ban on catching thresher sharks. However, because the observer program is not in place, leading to a loss of information on bycatch species and due to Sri Lanka's known issues with data reporting, as well as a high potential for bycatch impacts on several vulnerable species, this lack of data is a concern. We have therefore awarded a score of 'ineffective.'

Subfactor 3.2.3 – Management Record of Following Scientific Advice

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

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Moderately Effective

See harvest strategy section for more details.

Sri Lanka Indian Ocean, Longline, Pelagic

Moderately Effective

See harvest strategy section for details.

Subfactor 3.2.4 – Enforcement of Management Regulations

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

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Ineffective

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

Sri Lanka Indian Ocean, Longline, Pelagic

Moderately Effective

See harvest strategy section 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	Overall Recomm.
Indian Ocean Longline, Deep-Set	5.00:None	0.00:Not Applicable	3.00:Moderate Concern	**Green (3.873)**
Indian Ocean Longline, Pelagic	5.00:None	0.00:Not Applicable	3.00:Moderate Concern	**Green (3.873)**
Indian Ocean Longline, Shallow-Set	5.00:None	0.00:Not Applicable	3.00:Moderate Concern	**Green (3.873)**
Southern Indian Ocean Longline, Pelagic	5.00:None	0.00:Not Applicable	3.00:Moderate Concern	**Green (3.873)**
Sri Lanka Indian Ocean Longline, Pelagic	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 impact 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.

Justification of Ranking

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

Scoring Guidelines

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

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Sri Lanka Indian Ocean, Longline, Pelagic

None

Although pelagic longlines are surface fisheries, contact with the seabed can occur in shallow-set fisheries (Passfield and Gilman 2010). However, 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 score of 'no impact.'

Factor 4.2 – Mitigation of Gear Impacts

Scoring Guidelines

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage to seafloor and modifications shown to be effective at reducing damage, or an effective combination of 'moderate' mitigation measures.*

- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced.*
- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats.*

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Sri Lanka Indian Ocean, Longline, Pelagic

Not Applicable

Factor 4.3 – Ecosystem-Based Fisheries Management

Scoring Guidelines

- *5 (Very Low Concern)—Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators).*
- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.*

- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*
- *1 (Very High Concern)—Use of hatchery supplementation or 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.*

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

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 as top predators play a critical role in how these ecosystems are structured and function (Piraino et al. 2002) (Stevens et al. 2000). The loss of these predators can cause many changes such as to prey abundances, which can lead to a cascade of other affects (Myers et al. 2007)(Duffy 2003)(Ferretti et al. 2010) (Schindler et al. 2002) and behavioral changes (i.e., 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, as well as identifying research priorities and indicating 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 five year program initiated by Japan to investigate marine mammal and shark depredation events in longline fisheries, and 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, sea birds and sea turtles. We have therefore awarded a score of 'moderate concern' instead of 'high concern.'

Sri Lanka Indian Ocean, Longline, Pelagic

Moderate Concern

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

The 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 five year program initiated by Japan to investigate marine mammal and shark depredation events in longline fisheries, and 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, sea birds 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 score of ‘moderate concern’ and not high concern.

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

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References

Abreu-Grobois, A Plotkin, P. (IUCN SSC Marine Turtle Specialist Group) 2008. Lepidochelys olivacea. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2.

ACAP. 2014. white-chinned petrel Procellaria aequinoctialis. Agreement on the Conservation of Albatrosses and Petrels.

Ardill, D., Itano, D. and Gillett, R. 2012. A review of bycatch and discard issues in Indian Ocean tuna fisheries. Smartfish Working Papers No 00X.

BirdLife International 2013. Thalassarche steadi. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2.

BirdLife International. 2013a. Thalassarche melanophrys. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2.

BirdLife International. 2012a. Puffinus carneipes. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2.

BirdLife International. 2012b. Procellaria cinerea. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2.

BirdLife International. 2012c. Diomedea epomophora. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2.

BirdLife International. 2012d. Procellaria aequinoctialis. In: IUCN 2012. IUCN Red List of Threatened Species.

Bonfil, R., Amorim, A., Anderson, C., Arauz, R., Baum, J., Clarke, S.C., Graham, R.T., Gonzalez, M., Jolón, M., Kyne, P.M., Mancini, P., Márquez, F., Ruíz, C. Smith, W. 2009. Carcharhinus falciformis. The IUCN Red List of Threatened Species. Version 2014.3.

CCSBT. 2014b. Monitoring, control and surveillance. Commission for the Conservation of Southern Bluefin Tuna. Available at: http://www.ccsbt.org/site/monitoring_control_surceillance.php

CCSBT. 2014. Total Allowable Catch. Commission for the Conservation of Southern Bluefin Tuna. Available at: http://www.ccsbt.org/site/conservation_and_management.php

CCSBT. 2011. Report of the eighth meeting of the Commission. Commission for the Conservation of the Southern Bluefin Tuna. 10-13 October 2011, Bali, Indonesia.

CCSBT. 2010. Report of the fifteenth meeting of the scientific committee. Commission for the Conservation of Southern Bluefin Tuna, 11 September 2010, Narita, Japan.

Collette, B., Acero, A., Amorim, A.F., Boustany, A., Canales Ramirez, C., Cardenas, G., Carpenter, K.E., de Oliveira Leite Jr., N., Di Natale, A., Fox, W., Fredou, F.L., Graves, J., Guzman-Mora, A., Viera Hazin, F.H., Juan Jorda, M., Kada, O., Minte Vera, C., Miyabe, N., Montano Cruz, R., Nelson, R., Oxenford, H., Salas, E., Schaefer, K., Serra, R., Sun, C., Teixeira Lessa, R.P., Pires Ferreira Travassos, P.E., Uozumi, Y. Yanez, E. 2011. Auxis thazard. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Collette, B., Acero, A., Amorim, A.F., Boustany, A., Canales Ramirez, C., Cardenas, G., Carpenter, K.E., de Oliveira Leite Jr., N., Di Natale, A., Fox, W., Fredou, F.L., Graves, J., Guzman-Mora, A., Viera Hazin, F.H., Juan Jorda, M., Kada, O., Minte Vera, C., Miyabe, N., Montano Cruz, R., Nelson, R., Oxenford, H., Salas, E., Schaefer, K., Serra, R., Sun, C., Teixeira Lessa, R.P., Pires Ferreira Travassos, P.E., Uozumi, Y. Yanez, E. 2011b. Auxis rochei. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1.

Collette, B., Chang, S.-K., Di Natale, A., Fox, W., Juan Jorda, M., Miyabe, N., Nelson, R., Uozumi, Y. Wang, S. 2011c. Thunnus maccoyii. The IUCN Red List of Threatened Species. Version 2014.3.

Duffy, J.E. 2003. Biodiversity loss, trophic skew and ecosystem functioning. Ecology Letters 6:680-687.

Ferretti, F., B. Worm, G.L. Britten, M.R. Heithaus, H.K. and Lotze. 2010. Patterns and ecosystem consequences of shark declines in the ocean. Ecology Letters, 13: 1055– 1071.

Gilman, E., Passfield, K. and Nakamura, K. 2013. Performance of regional fisheries management organizations: ecosystem-based governance of bycatch and discards. Fish and Fisheries DOI:10.1111/faf.12021.

Herath, H.L.N.S. and Maldenlya, R. 2013. Status of shark fishery in Sri Lanka. IOTC-2013-WPEB09-18

IOTC. 2014. IOTC. 2014a. Report of the eleventh session of the Compliance Committee. Indian Ocean Tuna Commission IOTC-2014-CoC11-R[E].

IOTC. 2014b. Summary report on the level of compliance. Indian Ocean Tuna Commission IOTC-2014-CoC11-03 Rev1[E].

IOTC. 2013a. Status of the Indian Ocean albacore (ALB: Thunnus alalunga) resource. IOTC-2013-SC16-ESo1[E]. Available at: http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES01[E].pdf

IOTC. 2013b. Status of the Indian Ocean bigeye tuna (BET: Thunnus obesus) resource. IOTC-2013-SC16-ES02[E]. Available at: http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES02[E].pdf

IOTC. 2013c. Status of the Indian Ocean skipjack tuna (SKJ: Katsuwonus pelamis) resource. IOTC-2013-SC16-ES03[E]. Available at: http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES03[E].pdf

IOTC. 2013d. Status of the Indian Ocean yellowfin tuna (YFT: Thunnus albacares) resource. IOTC-2013-SC16-ES04[E]. Available at: http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES04[E].pdf

IOTC. 2013e. Report on biology, stock status and management of southern bluefin tuna: 2013. IOTC-2013-SC16-ES05[E]. Available at:http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES05[E].pdf

IOTC. 2013f. Status of southwest Indian Ocean swordfish (SWO: Xiphias gladius) resource. IOTC-2013-SC16-ES16[E]. Available at: http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES16[E].pdf

IOTC. 2013g. Status of the Indian Ocean silky shark (FAL: Carcharhinus falciformis). IOTC-2013-SC16-ES21[E]. Available at: http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES21[E].pdf

IOTC. 2013h. Status of the Indian Ocean blue shark (BSH: Prionace glauca). IOTC-2013-SC16-ES17[E]. Available at: http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES17[E].pdf

IOTC. 2013i. Status of the Indian Ocean shortfin mako shark (SMA: Isurus oxyrinchus). IOTC-2013-SC16-ES20[E]. Available at:http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES20[E].pdf

IOTC. 2013j. Ecological risk assessment (ERA) and productivity - susceptibility analysis (PSA) of sea turtles overlapping with fisheries in the IOTC region. IOTC-2012-SC15-INFO9. Available at: http://www.iotc.org/files/proceedings/2012/sc/IOTC-2012-SC15-INF09%20Rev_1.pdf

IOTC. 2013k. Status of seabirds in the Indian Ocean. IOTC-2013-SC16-ES25. Available at: http://www.iotc.org/files/proceedings/2013/sc/IOTC-2013-SC16-ES25[E].pdf

IOTC. 2013l. Compendium of active [and pending] conservation and management measures for the Indian Ocean Tuna Commission. Last updated: 15 September, 2013.

IOTC. 2013m. Status of the Indian Ocean bullet tuna (BLT: Auxis rochei) resource. IOTC-2013-SC16-ES06[E].

IOTC. 2013o. Report of the ninth session of the IOTC Working Party on Ecosystems and Bycatch. IOTC-2013-WPEB09-R[E].

IOTC. 2013p. Summary report on the level of compliance. IOTC-2013-CoC10-03.

IOTC. 2013q. Performance review update (Resolution 09/01 - on the performance review follow-up). IOTC-2013-CoC10-06.

IOTC. 2013r. Summary report on possible infractions observed under the regional observer programme. IOTC-2013-CoC10-08c Rev 1[E].

IOTC. 2013s. IOTC compliance report for: Australia. IOTC-2013-CoC10-CR01

IOTC. 2013t. Working parties. Indian Ocean Tuna Commission.

IOTC. 2013n. Status of the Indian Ocean frigate tuna (FRI: Auxis thazard) resource. IOTC-2013-SC16-ES07[E].

IOTC. 2012b. Report of the fiteenth session of the IOTC Scientific Committee. IOTC-2012-SC15-R[E], Mahe, Seychelles, 10-15 December 2012.

IOTC. 2012. Preliminary ecological risk assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC). IOTC-2012-WPEB08-31 Rev_2. Available at: http://www.iotc.org/files/proceedings/2012/wpeb/IOTC-2012-WPEB08-31%20Rev_2.pdf

IOTC. 2009. Predation survey of longline-caught fish. Indian Ocean Tuna Commission.

International Seafood Sustainability Foundation (ISSF). 2013a. ISSF stock status ratings 2013 status of the world fisheries for tuna. ISSF Technical Report 2013-4, April 2013

Kelleher, K. 2005. Discards in the world's marine fisheries. An update. FAO Fisheries Technical Paper No. 470. Rome, FAO. 131 p.

Maunder, M., Sibert, J., Fonteneau, A., Hampton, J., Kleiber, P., and Harley, S. 2006. Interpreting catch per unit effort data to assess the status of individual stocks and communities. ICES Journal of Marine Science, 63: 1373–1385. Sibert, J., Hampton, J., Kleiber, P., and Maunder, M. 2006. Biomass, Size, and Trophic Status of Top Predators in the Pacific Ocean. Science, 314: 1773–1776

Myers, R.A., Baum, J.K., Shepherd, T.D., Powers, S.P. and Peterson, C.H. 2007. Cascading effects of the loss of apex predatory sharks from a coastal. Science 315:1846-1850.

National Marine Fisheries Service (NMFS). 2013. Us Foreign trade. NOAA Office of Science and Technology.

O.'Meara, D., Harper, S., Perear, N. and Zeller, D. 2011. Reconstruction of Sri Lanka's Fisheries Catches: 1950:2008. Fisheries catch reconstructions: Islands, Part II. pp. 85-

Passfield, K., Gilman, E. (2010) Effects of Pelagic Longline Fishing on Seamount Ecosystems based on Interviews with Pacific Island Fishers. Technical Report produced under the Global Environment Facility Oceanic Fisheries Management Project. International Union for the Conservation of Nature, Gland, Switzerland.

Petersen, S.; Nel, D.; Omardien, A. 2007. Towards an ecosystem approach to longline fisheries in the Benfuela: an assessment of impacts on seabirds, sea turtles and sharks.

Pillai, N.G. and Satheeshkumar, P. 2012. Biology, fishery, conservation and management of Indian Ocean Fisheries. Ocean Science Journal 47:411-433

Piraino, S., Fanelli, G., Boero, F. 2002. Variability of species roles in marine communities: change of paradigms for conservation priorities. Marine Biology 140:1067-1074.

Ryan, P. G.; Keith, D. G.; Kroese, M. 2002. Seabird bycatch by tuna longline fisheries off southern Africa, 1998-2000. South African Journal of Marine Science 24: 103.

Schindler, D.E., Essington, T.E., Kitchell, J.F., Boggs, C. and Hilborn, R. 2002. Sharks and tunas: fisheries impacts on predators with contrasting life histories. Ecological Applications 12:735-748.

Seafood Watch. 2013. Seafood Watch. 2013. Seafood Watch criteria for fisheries. Monterey Bay Aquarium Seafood Watch Version January 18, 2013. 82 p.

Stevens, J.D., Bonfil, R., Dulvy, N.K. and Walker, P.A. 2000. The effects of fishing on sharks, rays, and chimaeras (chondrichthuyans), and the implications for marine ecosystems. ICES Journal of Marine Science 57:476-494.

Wallace, B.P., Kot, C.Y., MiMatteo, A.D., Lee, T., Crowder, L.B. and Lewison, R.L. 2013. Impacts of fisheries bycatch on marine turtle populations worldwide: toward conservation and research priorities. Ecosphere 4:40.http://dx.doi.org/10.1980/ES12-00388.1

Appendix A

BLACK-BROWED ALBATROSS

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

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 their 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 score of 'high concern' based on their IUCN status.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-et

Southern Indian Ocean, Longline, Pelagic

High Concern

Black-browed albatross have a high (88%) overlap in some areas of the Indian Ocean Tuna Commissions (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). However, they are reported to be one of the three most commonly captured seabird species caught in the South African longline tuna and swordfish fisheries (Ardill et al. 2012). There are management measures in place, which 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 score of 'high concern' and not 'very high concern.'

Factor 2.4 - Discard Rate

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

<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).

BLUE SHARK

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High

FishBase assigned a high vulnerability score of 67 out of 100 (Froese and Pauly 2013). Blue sharks reach 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 sharks give birth to live young every 1-2 years (IOTC 2013h).

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High Concern

The status of blue sharks in the Indian Ocean is unknown, although globally they are 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 trends slightly increasing over time. However, no population assessment has been conducted (IOTC 2013h). An ecological risk assessment conducted in the Indian Ocean found blue sharks had one of the highest productivity levels (IOTC 2012); however, they have a high vulnerability to fishing. We have therefore awarded a score of 'high concern.'

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High Concern

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

Factor 2.4 - Discard Rate

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

<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

Scoring Guidelines (same as Factor 1.1 above)

Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

Very High Concern

The International Union for Conservation of Nature (IUCN) classified leatherback turtles as Critically Endangered with a decreasing population trend in 2000 (Martinez 2000). In addition, leatherback turtles have been listed on the Convention on International Trade of Endangered Species (CITES) since 1975 and are currently listed on CITES Appendix 1, meaning they are threatened with extinction and international trade is prohibited. Their status in the Indian Ocean is unknown due to a lack of data. We have awarded a score of 'very high concern' based on their IUCN and CITES listings.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

High Concern

According to a recent ecological risk assessment, leatherback turtles represented about 10% of all reported sea turtle interactions in the Indian Ocean over a 24 year period, and suffered a 38% mortality rate, the highest of all turtle species in this region (IOTC 2013j). Leatherbacks from the southwestern Indian Ocean are the most susceptible to longline capture and are considered one of the most vulnerable to longline capture (IOTC 2013j). A separate analysis also concluded leatherback sea turtles had a very high impact from longline bycatch in the southwest Indian Ocean (Wallace et al. 2013). Some but likely not all fleets do use mitigation measures to reduce the incidental capture of sea turtles, and so

we have awarded a score of 'high concern' and not 'very high concern.'

Factor 2.4 - Discard Rate

Indian Ocean, Longline, Pelagic

Southern Indian Ocean, Longline, Shallow-Set

<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

Scoring Guidelines (same as Factor 1.1 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

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

Scoring Guidelines (same as Factor 1.2 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Very High Concern

The International Union for Conservation of Nature (IUCN) classified loggerhead turtles as Endangered in 1996, although it has been suggested that this classification needs to be updated (MTSG 2006). Loggerheads are also listed on Appendix 1 of the Convention on International Trade of Endangered Species (CITES). The status of loggerhead turtles in the Indian Ocean is unknown. However, loggerheads from the Arabian Gulf are considered one of the most productive turtle species in the Indian Ocean (IOTC 2013j). We have awarded a score of 'very high concern' due to the IUCN rating.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

Moderate Concern

In the southeast Indian Ocean, loggerhead sea turtle bycatch in 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). However, loggerhead sea turtles from the Bay of Bengal are 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. We have awarded a score of 'moderate concern' because, despite the low bycatch impact, effective management is not in place throughout their range in the Indian Ocean.

Factor 2.4 - Discard Rate

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

<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).

SHORTFIN MAKO SHARK

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High Concern

The status of shortfin mako sharks 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. However, overall, there is a lack of information available. Globally, shortfin mako sharks are 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 sharks have 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 score of 'high concern' based on the uncertain status of this species, its high vulnerability to fishing and the IUCN classification (IOTC 2013i).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High Concern

Shortfin mako sharks are caught as bycatch and targeted by fisheries in the Indian Ocean. However, fishing mortality rates for shortfin mako sharks in the Indian Ocean are unknown because there is a general lack of information on catches, due to under and un-reporting in the region. It is believed that maintaining or increasing current levels of fishing effort could lead to population declines for this species. In addition, a recent ecological risk assessment identified shortfin mako sharks as one of the most susceptible sharks to longline capture in the Indian Ocean (IOTC 2012). We have awarded a score of 'high concern' 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).

Factor 2.4 - Discard Rate

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

<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

Scoring Guidelines (same as Factor 1.1 above)

Southern Indian Ocean, Longline, Pelagic

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Southern Indian Ocean, Longline, Pelagic

High Concern

White-capped albatross are 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 score of 'high concern' based on the IUCN classification.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Southern Indian Ocean, Longline, Pelagic

High Concern

White-capped albatross populations are negatively impacted by the incidental capture in longline

fisheries (BirdLife International 2013b). White-capped albatross are found throughout the southern hemisphere in the Indian Ocean and are therefore susceptible to longline capture (IIOTC 2013k). They have 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 by the South African fleet, including white-capped albatross, 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 score of 'high concern' and not 'very high concern.'

Factor 2.4 - Discard Rate

Southern Indian Ocean, Longline, Pelagic

<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-CHINNED PETREL

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High

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

Factor 2.2 - Abundance

Scoring Guidelines (same as Factor 1.2 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

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 score of 'high concern' based on the IUCN status.

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

High Concern

White-chinned petrels have a high overlap with longline effort 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 (Ardrill et al. 2012). White-chinned petrels have 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 score of 'high concern' and not 'critical concern.'

Factor 2.4 - Discard Rate

Indian Ocean, Longline, Deep-Set

Indian Ocean, Longline, Pelagic

Indian Ocean, Longline, Shallow-Set

Southern Indian Ocean, Longline, Pelagic

<20%

Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0% to 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).