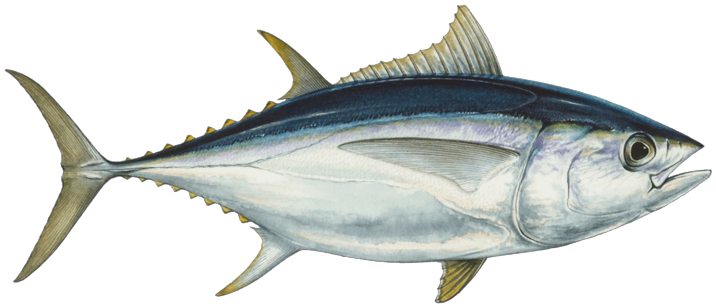
Tunas and large pelagics



Indian Ocean

Hand-operated pole-and-lines, Handlines and hand-operated pole-and-lines, Trolling lines, Floating object purse seine (FAD), Longlines (unspecified), Unassociated purse seine (non-FAD)

Seafood Watch Consulting Researcher

March 1, 2021

Seafood Watch Standard used in this assessment: Fisheries Standard v3

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Watch Assessment. Each assessment 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." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, 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 assessments 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 Watch assessments in any way they find useful.

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.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard. 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: Buy first; they're well managed and caught or farmed responsibly.

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

Avoid/Red: Take a pass on these for now; they're overfished, lack strong management or are caught or farmed 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 fisheries in the Indian Ocean for albacore tuna (*Thunnus alalunga*), southern bluefin tuna (*Thunnus maccoyii*), bigeye tuna (*Thunnus obesus)*, skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*) and swordfish (*Xiphias gladius*) caught in purse seines, longlines, gillnets, handlines, hand-operated pole and lines, and trolling lines, and blue sharks (*Prionace glauca*) and shortfin mako sharks (I*surus oxyrinchus*) caught in drifting longlines.

Populations of albacore, bigeye, and skipjack tuna, swordfish, and blue sharks are all healthy. Fishing mortality rates for swordfish and blue sharks are of low concern, but bigeye tuna and albacore tuna are subject to overfishing. Skipjack tuna might be undergoing overfishing, but there is some uncertainty regarding its status. Southern bluefin tuna populations are at very low levels but fishing mortality rates have decreased and are currently considered sustainable. Yellowfin tuna and shortfin mako sharks are overfished and subjected to overfishing. Yellowfin tuna are in a rebuilding plan that does not meet scientific advice to reduce catches and improve the stock status to levels above the target reference point by 2027.

We also have included other retained and discarded species that typically comprise 5% or more of the total catch or whose status, i.e., endangered or threatened, justifies their inclusion in this report based on the Seafood Watch criteria. Longline and gillnet fisheries capture a number of secondary target and bycatch species including other billfish, sharks, seabirds, and sea turtles. Purse seine fisheries that operate around fish aggregating devices (FADs) result in bycatch of other finfish and shark species. Non-target species also become entangled in the netting of FADs. Purse seine fisheries targeting free-swimming schools (unassociated purse seines) tend to have lower bycatch levels. Highly selective gears such as handline, pole and line, and trolling lines tend to have very little bycatch associated with them. However, some of these fisheries rely on live baitfish, the effect of the removal of these species on the ecosystem is unknown, and few baitfish fisheries are managed.

Two tuna Regional Fisheries Management Organizations manage these fisheries - the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) manages the Southern bluefin tuna fishery, while the Indian Ocean Tuna Commission (IOTC) manages all other Indian Ocean tuna fisheries.

These fishing gears fish on the surface and therefore do not negatively impact bottom habitats, but because they capture ecologically important target species such as tunas and sharks, there are potential impacts to the ecosystem.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Albacore | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.916	1.000	1.000	3.873	**Avoid (1.650)**
Bigeye tuna | Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Bigeye tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Bigeye tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Bigeye tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Bigeye tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Bigeye tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Blue shark | Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Blue shark | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Blue shark | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Shortfin mako shark | Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Shortfin mako shark | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Shortfin mako shark | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Skipjack tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	3.318	1.000	1.000	3.873	**Avoid (1.893)**
Skipjack tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)	3.318	1.000	1.000	3.873	**Avoid (1.893)**
Skipjack tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	3.318	1.000	1.000	3.873	**Avoid (1.893)**
Skipjack tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	3.318	1.000	1.000	3.873	**Avoid (1.893)**
Skipjack tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	3.318	1.000	1.000	3.873	**Avoid (1.893)**
Southern bluefin tuna | Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Southern bluefin tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	2.236	1.000	1.000	3.873	**Avoid (1.715)**
Swordfish | Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	5.000	1.000	1.000	3.873	**Avoid (2.098)**

Swordfish | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	5.000	1.000	1.000	3.873	**Avoid (2.098)**
Swordfish | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	5.000	1.000	1.000	3.873	**Avoid (2.098)**
Yellowfin tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Yellowfin tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Yellowfin tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Yellowfin tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	1.000	2.236	1.000	3.873	**Avoid (1.715)**
Yellowfin tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	1.000	2.236	1.000	3.873	**Avoid (1.715)**
Yellowfin tuna | Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	1.000	1.000	1.000	3.873	**Avoid (1.403)**

Summary

All fisheries in this report are rated as red/avoid. The tropical tuna longline and FAD purse seine fisheries score high concern (red) for C2 (bycatch) and ineffective (red) for bycatch management and management of retained stocks due to the inadequate rebuilding plan for yellowfin tuna and overages of the existing TACs. The temperate longline (termed longline in this report) and Southern bluefin tuna longline fisheries also score high concern (red) for C2 (bycatch) and bycatch management. The unassociated purse seine, trolling line, and handline/hand-operated pole and line recommendations for skipjack and bigeye tuna are red rated for C2 for catch of yellowfin tuna and ineffective (red) for management of retained stocks due to the inadequate rebuilding plan for yellowfin tuna and overages of the existing TACs. Albacore tuna and shortfin mako sharks score high concern (red) for impacts to the stock (C1), and all yellowfin tuna recommendations score high concern (red) for impacts to the stock (C1) and ineffective for management of retained species.

Scoring Guide

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

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

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

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

Introduction

Scope of the analysis and ensuing recommendation

This report focuses on fisheries in the Indian Ocean for albacore tuna (*Thunnus alalunga*), southern bluefin tuna (*Thunnus maccoyii*), bigeye tuna (*Thunnus obesus)*, skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*) and swordfish (*Xiphias gladius*) caught in purse seines, longlines, gillnets, handlines, hand-operated pole and lines, and trolling lines as well as blue sharks (*Prionace glauca*) and shortfin mako sharks (I*surus oxyrinchus*) caught in drifting longlines.

Species Overview

Bigeye, skipjack and yellowfin tuna are found in tropical and subtropical waters worldwide including in the Indian Ocean. These species are each assessed as single populations in the Indian Ocean. In the Pacific Ocean, there are two populations: Eastern Pacific, and Western and Central Pacific. In the Atlantic Ocean, there is one population of yellowfin and two of skipjack (Eastern and Western). Bigeye, skipjack and yellowfin tuna are highly migratory and are commonly found as juveniles schooling together below floating objects (IOTC 2018)(IOTC 2018d)(IOTC 2018a).

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 2017f). Longlines have historically captured the majority of albacore tuna worldwide {ISSF 2013b}.

Southern bluefin tuna are only found in the southern hemisphere, primarily in the Indian, Atlantic and Western Pacific Ocean and are uncommonly found in the Eastern Pacific Ocean. This species migrates from the southern coast of Australia and the central Indian Ocean as juveniles and remains in offshore waters as adults. There is only one known spawning location, south-east of Java, Indonesia in the Indian Ocean (CCSBT 2019d).

Swordfish is a highly migratory species found in all oceans and throughout the Indian Ocean. Juveniles inhabit mostly tropical and subtropical waters, moving to higher latitudes later in life. Swordfish remain in surface waters during the night and move to depths (800-1000 m) during the day. Swordfish are not typically found in schools like tuna but can be found in larger densities around seamounts and oceanic fronts (IOTC 2017d).

Blue sharks are highly migratory, found throughout the world's oceans in epipelagic and mesopelagic waters. They are considered the most widely distributed shark species and most abundant, with abundance increasing with latitude. They are an apex predator, consuming a variety of fish and squid species (IOTC 2018g), (Rice 2017), (IOTC 2018m). Blue sharks are viviparous meaning they give live birth, with a gestation of 9-12 months. Litter sizes in the Indian Ocean average 38 pups (IOTC 2018m). They mature slowly - minimum age of reproduction ranges from 4-7 years and males in the Indian Ocean can live up to 25 years (IOTC 2018m).

Like blue sharks, shortfin mako sharks are highly migratory and give birth to live young (9-14 pups per litter) but they have a longer gestation of 15-18 months and higher ages of maturity (7-15 years) and lifespans ranging from 29-32 years (Brunel et al. 2019), (IOTC 2018l), (IOTC 2016i). Shortfin mako sharks are fairly solitary and follow warm water masses (>16-degrees C) toward the poles in the summer

In the Indian Ocean, tuna are managed by the Indian Ocean Tuna Commission (IOTC). The southern bluefin tuna is managed by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT).

Production Statistics

Historically, the pole-and-line and trolling fisheries captured the majority of skipjack tuna in the Indian Ocean until the mid-

1980s, when purse seining was introduced. Since then, both fisheries have contributed far less to the overall catches in the region and skipjack is predominantly caught with purse seines (49%), gillnets (18%), and pole and line gear (16%) (IOTC 2019j). Total catches of skipjack tuna peaked in 2006 and again in 2018 at around 600,000 MT. In 2018, 33% of the catch was from 'other fisheries' (IOTC 2019j).

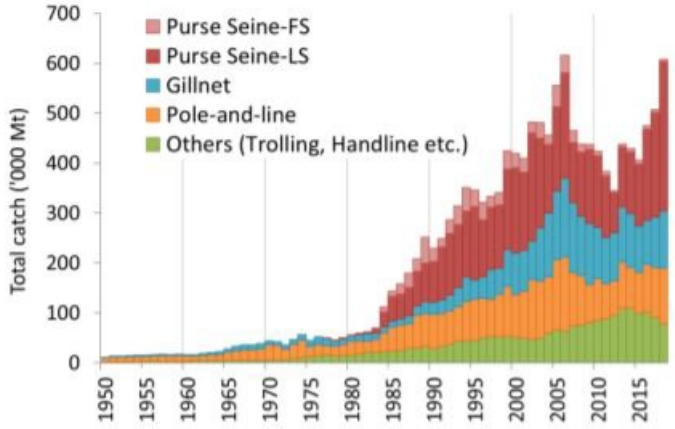

Figure 1: Annual catches of skipjack tuna by gear (1950-2018) (IOTC 2019j)

Total annual catches of yellowfin tuna have increased significantly since the 1980s due to the expansion of the purse seine, gillnet, and troll and pole fisheries. Total catches peaked in 2004 at 528,797 MT (20,929 MT troll and 4,631 MT handline). The stock is overfished and currently subject to overfishing. A rebuilding plan aims to reduce catches to below 2014/2015 levels, but total catches in 2018 were the highest in the most recent 10 years at nearly 424,000 MT, with 31% coming from purse seine, 21% longline, 20% gillnet and 28% coming from 'other fisheries' that include troll and pole and handline fisheries (IOTC 2019j).

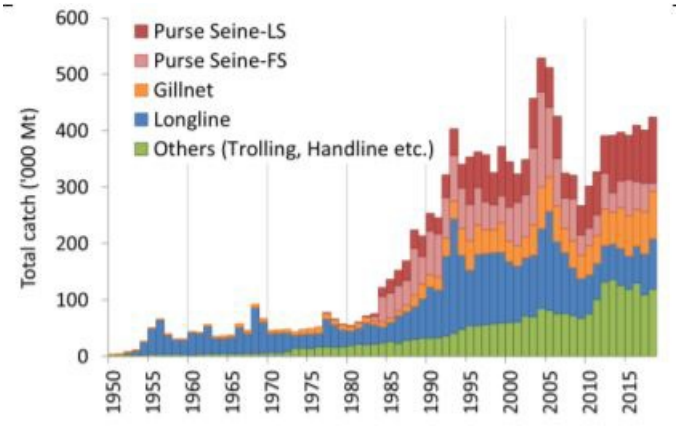

Figure 2: Annual catches of yellowfin tuna by gear (1950-2018) (IOTC 2019j)

Albacore tuna are primarily caught with longlines in the Indian Ocean, with a small percentage of the catch coming from purse seine and other fishing gears. After a stable trend in catches, total catches (all gears) increased during the 1980's, peaking around 30,000 t. However, this increase was largely due to the drift gillnet fishery, which was banned internationally by the United Nations in 1992 (IOTC 2017f). 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, with 38,347 t caught in 2017 (IOTC 2018e).

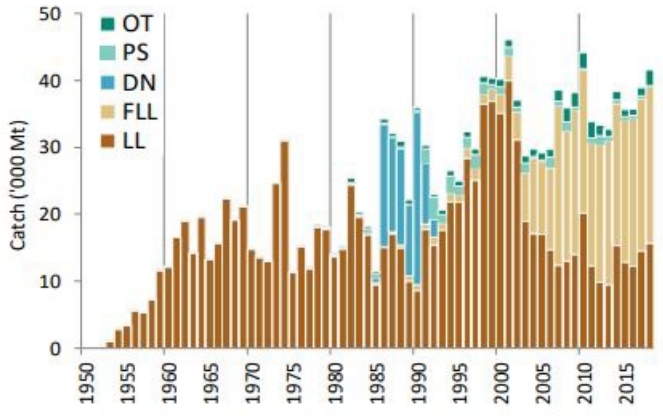

Figure 3: Albacore catches in the Indian Ocean by gear (1950-2018) (IOTC 2019e)

Nearly equal percentages of bigeye tuna are caught with longlines (~42%) and purse seines (~37%) (IOTC 2019j). Between 2014-2018, pole and line gear accounted for approximately 7% of total catch, while trolling line, gillnets, and artisanal fisheries combined accounted for about 9% of the total catch (IOTC 2019j). Over the last ten years, catches peaked in 2012 with nearly 125,000 MT. In 2018, roughly 93,500 MT of bigeye tuna were caught in the Indian Ocean.

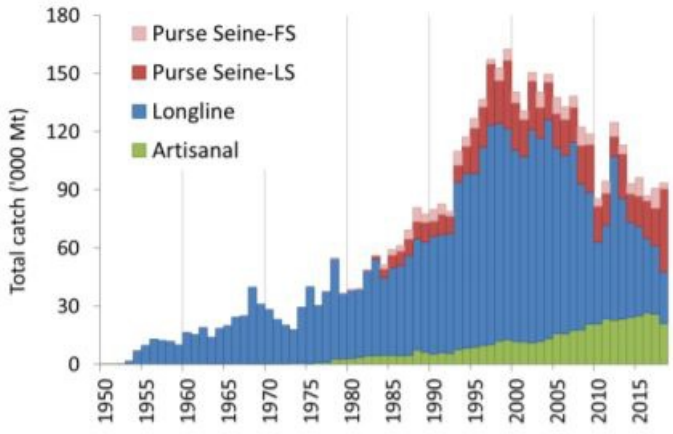

Figure 4: Bigeye tuna catches in the Indian Ocean by gear (1950-2018) (IOTC 2019j)

Southern bluefin tuna are primarily captured by longlines, followed by a smaller amount caught by purse seine fisheries, which support tuna ranching operations in Australia and are outside the scope of this report. Total catches peaked in the 1960's at around 82,000 t, with just under 80,000 t coming from the longline fishery. Catches have declined significantly since then, to around 20,000 t in 2018 (CCSBT 2019). Southern bluefin tuna are caught in all three oceans, but the majority is caught in the Indian Ocean (CCSBT 2019).

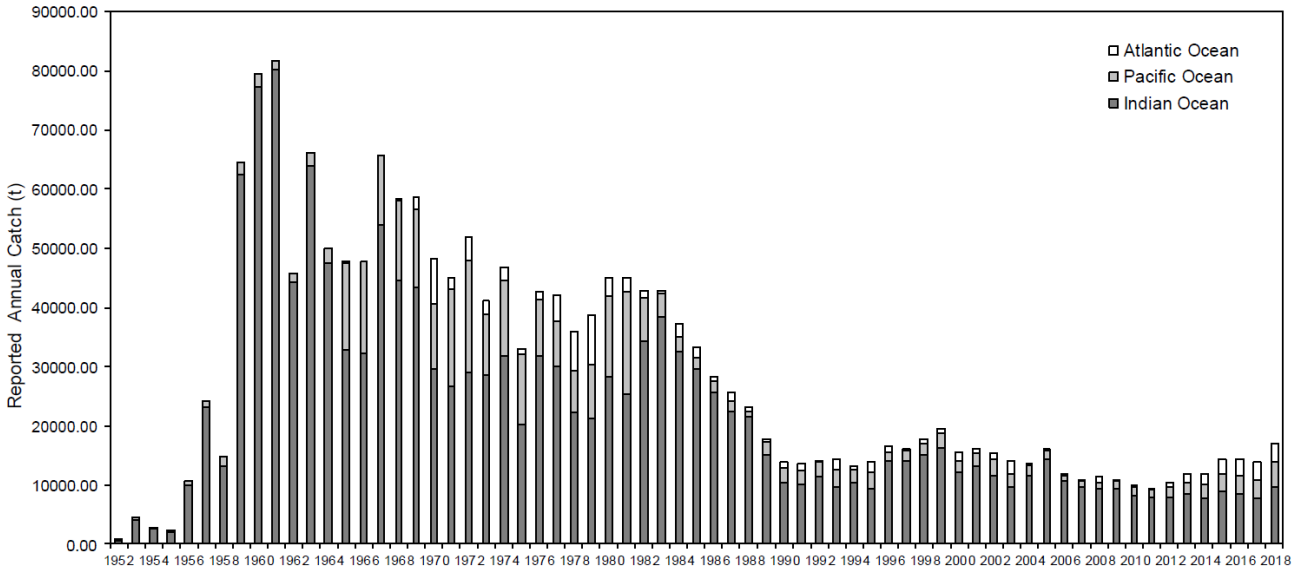

Figure 5: Southern bluefin tuna catches by ocean basin (1952-2018) (CCSBT 2019)

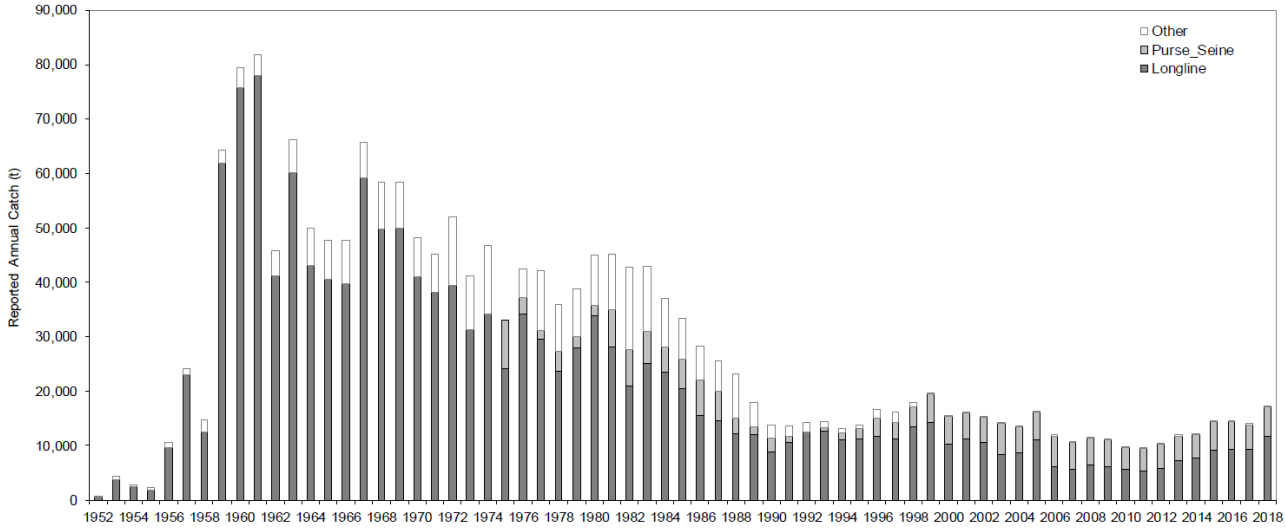

Figure 6: Southern bluefin tuna catches by fishing gear (1952-2018) (CCSBT 2019)

Approximately 70% of swordfish in the Indian Ocean is caught with longlines (IOTC 2019e). Between 2008-2017, highest catches were recorded in 2016 at 39,777 MT (IOTC 2017d). Catches decreased slightly in 2017 to 33,352 MT (IOTC 2019e). Nearly 60% of the catch is caught by four fleets - Taiwan, Sri Lanka, Spain, and Indonesia (IOTC 2019e).

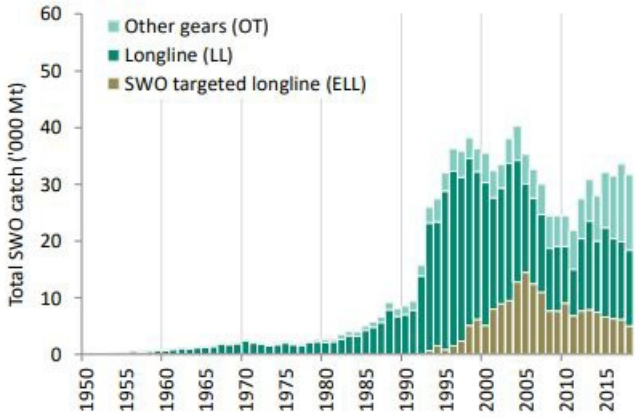

Figure 7: Swordfish catches in the Indian Ocean (1950-2018) (IOTC 2019e)

Catches of blue sharks in the Indian Ocean are often un- or under-reported (IOTC 2018m). When catch statistics are reported, they are often of dressed weight, not live weights. Therefore, any reported blue shark shark catches in the Indian Ocean are highly unreliable, which prompted the creation of catch reconstructions for the 2017 stock assessment (IOTC 2018m). Mean annual catch estimates ranged from 30,000-55,000 MT, depending on the model (IOTC 2018m).

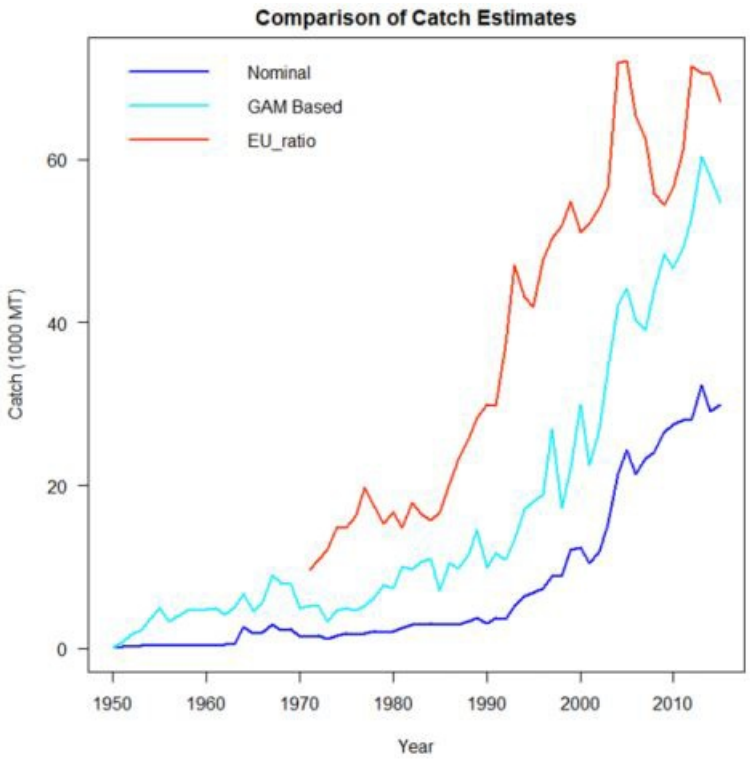

Figure 8: Estimated blue shark catches 1950-2015 (Rice 2017).

Similar to blue sharks, catches of shortfin mako sharks are un- or under-reported. Catch estimates between 2013-2015 ranged between roughly 1,300-1,700 MT (IOTC 2016i). However, in 2015, nearly 60,000 MT of unidentified sharks were estimated to have been caught in the Indian Ocean (IOTC 2016i). These are likely underestimates because usually only retained sharks or shark meat are reported (IOTC 2016i).

Importance to the US/North American market.

The United States imported around 30% of its skipjack tuna from Japan and Panama (each) during 2018. Other important countries included the Philippines (24%). The majority of yellowfin tuna were imported from Vietnam (12%) and Sri Lanka (9%). The United States imports around 10% of bigeye tuna from each of the following countries: French Polynesia, Surinam and the Marshal Islands. The majority of southern bluefin tuna is imported from Australia. Around 35% of swordfish are imported from Ecuador (NMFS 2019).

Common and market names.

In Hawaii, bigeye and yellowfin tuna are known as ahi, and skipjack as aku. Skipjack tuna, often together with smaller amounts of bigeye and yellowfin tuna, is canned as "light" tuna. 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 species are sold canned, in fresh and frozen form, and for the sushi and sashimi markets.

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. 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.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

ALBACORE			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	3.670: Low Concern	1.000: High Concern	Red (1.916)

BIGEYE TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)

BLUE SHARK			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	3.670: Low Concern	5.000: Low Concern	Green (4.284)

SHORTFIN MAKO SHARK			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	1.000: High Concern	1.000: High Concern	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000: High Concern	1.000: High Concern	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.000: High Concern	1.000: High Concern	Red (1.000)

SKIPJACK TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

SOUTHERN BLUEFIN TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.000: High Concern	5.000: Low Concern	Yellow (2.236)

SWORDFISH			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

YELLOWFIN TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000: High Concern	1.000: High Concern	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	1.000: High Concern	1.000: High Concern	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)	1.000: High Concern	1.000: High Concern	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	1.000: High Concern	1.000: High Concern	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	1.000: High Concern	1.000: High Concern	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	1.000: High Concern	1.000: High Concern	Red (1.000)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given*

the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.

- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Albacore

Factor 1.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

Low Concern

Albacore tuna was last assessed in the Indian Ocean in 2019 (IOTC 2019e). This updated assessment indicates the spawning biomass (SB) is higher than levels needed to produce the maximum sustainable yield (SB_{MSY}), (SB_{2017}/SB_{MSY} = 1.281 (0.574-2.071) and, the population was estimated to be around 26% of virgin levels {IOTC 2019e}. The stock is above both the interim target and limit reference points ($0.4*SB_{MSY}$), indicating the population is not overfished (IOTC 2019e). We have awarded a Low Concern score, rather than a Very Low Concern score, due to a large amount of uncertainty in the stock assessment results. (IOTC 2019e).

Factor 1.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

High Concern

Albacore tuna in the Indian Ocean were assessed during 2019 (IOTC 2019e). Fishing mortality rates in 2017 were 135% (59%-217% range) of those needed to produce the maximum sustainable yield (MSY) (IOTC 2019e). Current fishing mortality rates are above the target but below limit reference point ($1.4*F_{MSY}$) and therefore overfishing is occurring (IOTC 2019e). We have therefore awarded a high concern score.

Bigeye tuna

Factor 1.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Very Low Concern
The most recent stock assessment of bigeye tuna in the Indian Ocean was conducted during 2019 (IOTC 2019e). Two models were used in the assessment but the stock status was based on results of the Stock Synthesis 3 model (IOTC 2019e). Based on a grid analysis, the spawning stock biomass in 2018 (last year of the model) was 31%(21-34%) of virgin or unfished levels (SB_{2018}/SB_0) and 122% (82-181%) of maximum sustainable yield levels (SB_{2018}/SB_{MSY}) (IOTC 2016). The population is not overfished and we have awarded a very low concern score because there is a high probability (65.4%) the spawning stock biomass is above MSY levels (IOTC 2019e).

Factor 1.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

High Concern
Fishing mortality rates for bigeye tuna are estimated to be above the interim target levels needed to produce the maximum sustainable yield (F) but below the interim limit reference point (IOTC 2019e). Currently, fishing mortality is 120% (70%–205% range) of maximum sustainable yield (F_{2018}/F_{MSY}) levels or target reference point and 92% of the limit reference point ($1.3*F_{MSY}$) (IOTC 2019e). Average catches over the past five years (2014-2018) have remained within the range of estimated maximum sustainable yield levels (IOTC 2019e). Based on these assessment results, this population is subject to overfishing so we have awarded a high concern score.

Blue shark

Factor 1.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery

Low Concern
An assessment of blue sharks in the Indian Ocean was conducted in 2017 (IOTC 2018g)(Rice 2017). Progress in the assessment, including data sources and modelling approaches, has been made since the previous assessment. Four assessment models were used and all resulted in similar results (IOTC 2018g). The stock biomass in 2015 was estimated to be 1.50 (1.37-1.72) times that needed to produce the maximum sustainable yield (SB_{2015}/SB_{MSY}) (Rice 2017)(IOTC 2018g). The stock is not estimated to be overfished (IOTC 2018g). We have awarded a low concern score to account for the current status of blue sharks in the Indian Ocean.

Factor 1.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery

Low Concern
Fishing mortality rates for blue shark in the Indian Ocean were estimated during the 2017 assessment (IOTC 2018g) (Rice 2017). The fishing mortality rate in 2015 was estimated to be below the level needed to produce the maximum sustainable yield (F_{2015}/F_{MSY} = 0.90 (0.67 - 1.09)(IOTC 2018g)(Rice 2017). Fishing mortality rates are currently sustainable and overfishing is not occurring {IOTC 018g}. We have therefore awarded a low concern score.

Shortfin mako shark

Factor 1.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
The status of shortfin mako sharks in the Indian Ocean is currently unknown (IOTC 2019e) but a stock assessment is planned for 2020 (Brunel et al. 2019). A preliminary stock assessment was conducted during 2019, which indicated the biomass is right around maximum sustainable yield levels (Brunel et al. 2019). These results suggest shortfin mako sharks in the Indian Ocean are not currently overfished although stock trajectories showed trends towards an overfished state {Bruneil et al. 2019}. Globally shortfin mako sharks are considered Endangered by the International Union for the Conservation of Nature (IUCN), but the Indian Ocean segment has been assessed as Vulnerable (Rigby et al. 2019a). 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 2019d). We have assigned a high concern score due to its IUCN status, because the current assessment is preliminary in nature and no conclusion on stock status could be determined.

Factor 1.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
Shortfin mako sharks are caught as bycatch and targeted by fisheries in the Indian Ocean. The majority of the catch is taken as bycatch of industrial pelagic fleets but mako sharks are also captured in coastal longlines, gillnets, trammel nets, and sometimes trawls, particularly in areas with narrow continental shelves (Rigby et al. 2019a). However, fishing mortality rates for shortfin mako sharks in the Indian Ocean have historically been unknown because there is a general lack of information on catches due to under and un-reporting in the region (IOTC 2019e). A preliminary stock assessment conducted in 2019 indicated exploitation rates in 2015 were far above maximum sustainable yield levels {F_{2015}/F_{MSY} = 2.57} and that overfishing is currently occurring (Brunel et al. 2019). It is believed that maintaining or increasing current levels of fishing effort could lead to population declines or this species. A recent ecological risk assessment identified shortfin mako sharks as one of the most susceptible to longline capture in the Indian Ocean (Murua et al. 2018). We have awarded a high concern score because fishing mortality rates have historically been unknown and may lead to population declines.

Skipjack tuna

Factor 1.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Low Concern
Skipjack tuna populations in the Indian Ocean are considered healthy based on the 2017 stock assessment (IOTC 2017a). The spawning biomass is above the adopted limit reference point of 0.20 and at the target reference point of 0.40 of SB_0 (IOTC 2017a). Skipjack tuna are managed under a harvest control rule in the Indian Ocean (IOTC 2016).

The biomass is not currently overfished (IOTC 2017a)(IOTC 2018a). We have awarded a low and not very low concern because the spawning stock biomass is at and not above target levels currently (IOTC 2017a)(IOTC 2019e).

Factor 1.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Moderate Concern
Fishing mortality rates (F) in 2016 are estimated to be below both the target and limit reference points (IOTC 2017a). Catches levels in 2016 were below the estimated range of $C_{SB40\%}$ and the average catch over the previous five years (2012-16) also were below this range (IOTC 2017a). However, increases in skipjack catch between 2017 and 2018 was mainly due to increases of 43% in purse seine fishing (IOTC 2019e). Overfishing is not currently occurring on skipjack tuna in the Indian Ocean (IOTC 2017a)(IOTC 2018a). However, it should be noted the harvest control rule for skipjack tuna is not currently being followed (IOTC 2019e). We have awarded a moderate concern score due to the uncertainty in the assessment and catches exceeding the HCR by nearly 30%.

Southern bluefin tuna

Factor 1.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

High Concern
The current spawning biomass of southern bluefin tuna is a small fraction of virgin levels and well below the level needed to produce the maximum sustainable yield ($SB_{current}/SB_{MSY}$ = 0.13 (0.11-0.17)) and at 17% (15-21%) of unfished levels (CCSBT 2017). Despite this low level of SB, the biomass has increased since previous stock assessments (CCSBT 2017). In 2019, The Extended Scientific Committee suggested the spawning stock biomass in 2017 was 17% of the virgin biomass (CCSBT 2019). Positive trends in the catch per unit effort for Japan and Korea have been noted (CCSBT 2019). We have awarded a high concern score due to the low biomass compared to SBMSY.

Factor 1.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

Low Concern
Fishing mortality rates have decreased for southern bluefin tuna and are now below those needed to produce the maximum sustainable yield ($F_{current}/F_{MSY}$ = 0.55 (0.41-0.74)) (CCSBT 2019). In addition, reported catches are below the maximum sustainable yield (MSY) levels and current exploitation rates are considered moderate (CCSBT 2019). We have awarded a low concern score because fishing mortality rates are below reference points.
Justification:
Please note that the purse seine catch goes to supply aquaculture operations are outside the scope of this assessment.

Swordfish

Factor 1.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

Very Low Concern
The current biomass of swordfish has been reduced to around 26-43% of virgin levels and is above levels needed to produce the maximum sustainable yield ($SB_{current}/SB_{MSY}$ = 1.50 (1.05-2.45) and the spawning biomass is 31% (26-43%) of unfished levels (IOTC 2018j). The biomass is above the current provisional biomass based limit reference point (0.4*BMSY) and therefore swordfish are not considered overfished (IOTC 2018j). Current fishing mortality rates are not expected to reduce the population over the next decade (IOTC 2018j). We have awarded a very low concern score because this population is considered healthy.

Factor 1.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

Low Concern
The 2017 assessment indicated that fishing mortality rates for swordfish in the Indian Ocean are well below levels needed to produce the maximum sustainable yield (F_{2015}/F_{MSY} = 0.76 (0.41-1.04) (IOTC 2018j). Fishing levels are also below the provisional limit reference point ($1.4*F_{MSY}$) and the provisional target reference point (F_{MSY}) (although above maximum sustainable yield levels) and therefore overfishing is not occurring (IOTC 2018j). We have awarded a low concern score because overfishing is not occurring.

Yellowfin tuna

Factor 1.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

High Concern
According to the most recent assessment of yellowfin tuna in the Indian Ocean (2018), the ratio of the biomass in 2017 to that needed to produce the maximum sustainable yield was estimated to be below the provisional target level of 1 (SB_{2017} /SB_{MSY} = 0.83 (C.I. 0.74–0.97)). The spawning biomass in 2017 was estimated to be 30% of unfished levels (Fu et al. 2018). These results are similar to the previous 2016 assessment but are slightly more pessimistic (IOTC 2018d). Results of the assessment were surrounded by uncertainty concerning the data quality (Fu et al. 2018). Yellowfin tuna in the Indian Ocean remain overfished (Fu et al. 2018) and we have therefore awarded a high concern score.

Factor 1.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

High Concern
The current fishing mortality rates (2017) are estimated to be well above both the provisional target reference point of F_{2017} /F_{MSY} = 1.20 (1.00–1.71) and right around the limit reference point (1.4 × F_{MSY}), (Fu et al. 2018). The results of the assessment are surrounded by uncertainty due to data quality issues (IOTC 2018d). Catch levels have remained around maximum sustainable yield (MSY) levels over recent years (IOTC 2018). However, despite catch limits being set based on 2014/2015 catches in the recovery plan, the total catches of yellowfin in 2018 increased by around 9% from 2014/2015 levels (IOTC 2019e). Yellowfin tuna in the Indian Ocean are undergoing overfishing (Fu et al. 2018), (IOTC 2018d). We have therefore awarded a "high" concern score.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. 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. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait 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 is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

ALBACORE			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.000	1.000: < 100%	Red (1.000)

BIGEYE TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	1.000	1.000: < 100%	Red (1.000)

BLUE SHARK			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000	1.000: < 100%	Red (1.000)

SHORTFIN MAKO SHARK			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.000	1.000: < 100%	Red (1.000)

SKIPJACK TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	1.000	1.000: < 100%	Red (1.000)

SOUTHERN BLUEFIN TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.000	1.000: < 100%	Red (1.000)

SWORDFISH			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	1.000	1.000: < 100%	Red (1.000)

YELLOWFIN TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)	1.000	1.000: < 100%	Red (1.000)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	2.236	1.000: < 100%	Yellow (2.236)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	2.236	1.000: < 100%	Yellow (2.236)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	1.000	1.000: < 100%	Red (1.000)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

ANTARCTIC INDIAN OCEAN | DRIFTING LONGLINES | SOUTHERN BLUEFIN TUNA			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Giant petrels	1.000: High Concern	1.000: High Concern	Red (1.000)
Shortfin mako shark	1.000: High Concern	1.000: High Concern	Red (1.000)
White-capped albatross	1.000: High Concern	1.000: High Concern	Red (1.000)
Black-browed albatross	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Bigeye tuna	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Southern bluefin tuna	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Porbeagle	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Blue shark	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

INDIAN OCEAN | INDIAN OCEAN, EASTERN | INDIAN OCEAN, WESTERN | DRIFTING LONGLINES			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Shortfin mako shark	1.000: High Concern	1.000: High Concern	Red (1.000)
White-chinned petrel	1.000: High Concern	1.000: High Concern	Red (1.000)
Whitetip shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Black-browed albatross	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Albacore	3.670: Low Concern	1.000: High Concern	Red (1.916)
Southern bluefin tuna	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Blue shark	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

INDIAN OCEAN | INDIAN OCEAN, EASTERN | INDIAN OCEAN, WESTERN | DRIFTING LONGLINES | TROPICAL TUNA FISHERY

SUB SCORE: 1.000 | DISCARD RATE: 1.000 | **SCORE: 1.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Leatherback turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Shortfin mako shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
White-chinned petrel	1.000: High Concern	1.000: High Concern	Red (1.000)
Yellowfin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)
Black-browed albatross	2.330: Moderate Concern	1.000: High Concern	Red (1.526)
Bigeye tuna	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Blue shark	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Swordfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

INDIAN OCEAN | INDIAN OCEAN, EASTERN | INDIAN OCEAN, WESTERN | FLOATING OBJECT PURSE SEINE (FAD)

SUB SCORE: 1.000 | DISCARD RATE: 1.000 | **SCORE: 1.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Whitetip shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Yellowfin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)
Bigeye tuna	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Rainbow runner	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Skipjack tuna	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

INDIAN OCEAN | INDIAN OCEAN, EASTERN | INDIAN OCEAN, WESTERN | GILLNETS AND ENTANGLING NETS (UNSPECIFIED)

SUB SCORE: 1.000 | DISCARD RATE: 1.000 | **SCORE: 1.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Green turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Hawksbill turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Leatherback turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Loggerhead turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
Olive Ridley turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Scalloped hammerhead	1.000: High Concern	1.000: High Concern	Red (1.000)
Shortfin mako shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Whitetip shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Yellowfin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)
Blue marlin	3.670: Low Concern	1.000: High Concern	Red (1.916)
Black marlin	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Skipjack tuna	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

INDIAN OCEAN | INDIAN OCEAN, EASTERN | INDIAN OCEAN, WESTERN | HANDLINES AND HAND-OPERATED POLE-AND-LINES

SUB SCORE: 1.000 | DISCARD RATE: 1.000 | **SCORE: 1.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Yellowfin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)
Bigeye tuna	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Bullet tuna	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Frigate tuna	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Skipjack tuna	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

INDIAN OCEAN | INDIAN OCEAN, EASTERN | INDIAN OCEAN, WESTERN | TROLLING LINES			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Yellowfin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)
Bigeye tuna	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Bigeye tuna	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Bullet tuna	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Frigate tuna	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Skipjack tuna	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

INDIAN OCEAN | INDIAN OCEAN, EASTERN | INDIAN OCEAN, WESTERN | UNASSOCIATED PURSE SEINE (NON-FAD)			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Manta ray (unspecified)	1.000: High Concern	1.000: High Concern	Red (1.000)
Yellowfin tuna	1.000: High Concern	1.000: High Concern	Red (1.000)
Bigeye tuna	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Skipjack tuna	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

Bycatch in troll and pole fisheries is typically very low (Kelleher 2005). In the Indian Ocean troll and pole fisheries, the primary targets are skipjack and yellowfin tuna. In addition to these main species, bigeye tuna (29% of catch from artisanal fisheries including pole and troll) (IOTC 2018) are caught, and bullet (30% of catch from pole and troll)(IOTC 2018b) and frigate tuna (37% of catch from pole and troll)(IOTC 2018c). We have therefore included these additional three species as secondary species in this report.

Bycatch is typically higher in FAD-associated compared to unassociated purse seine fisheries. For this report we used catch data from the Indian Ocean Tuna Commission and published literature to identify bycatch species in these fisheries that represent 5% of the total catch or are Endangered, Threatened or Protected species that warrant inclusion. For the associated purse seine fishery, only two additional bycatch species are included in this report, silky sharks, which are the main shark species (79% of all sharks) {Amande et al. 2008} and rainbow runner (37% of fish bycatch) (Adrill et al. 2012). Manta rays warranted inclusion in the unassociated purse seine fishery. The worst scoring species in the associated purse seine fishery is the silky shark, due to the potentially low population size and large negative impacts from fishing. All three tuna species scored fairly well in the unassociated fishery.

Gillnet fisheries are known to incidentally capture a number of taxa including, billfish, sea turtles, sharks and marine mammals. Information on bycatch in gillnets operating in the Indian Ocean is scarce. We have included several species of sharks, sea turtles, billfish and a general marine mammal category based on catch records and limited bycatch data.

This report also focuses on tuna and swordfish longline fisheries operating in the Indian Ocean. Several species of sharks, sea turtles and sea birds are also incidentally captured in these fisheries. We have included such species that either make up at least 5% of the total catch and are considered "main species" according to the Seafood Watch criteria or are a stock of concern, endangered etc. Reported catches from the Indian Ocean Tuna Commission and the Commission for the Conservation of Southern Bluefin Tuna databases were used to determine the main species. CCSBT fisheries overlap with 18

albatross species and 7 species of petrels. "The level of interaction between seabirds and SBT fisheries is still a significant level of concern (p. 21)(CCSBT 2019b). Other species were identified through the literature, which is cited in the tables below. The worst scoring species in this report are the leatherback sea turtle, due to it's very high stock status concern and high fishing mortality concern.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Bigeye tuna

Factor 2.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Very Low Concern
The most recent stock assessment of bigeye tuna in the Indian Ocean was conducted during 2019 (IOTC 2019e). Two models were used in the assessment but the stock status was based on results of the Stock Synthesis 3 model (IOTC 2019e). Based on a grid analysis, the spawning stock biomass in 2018 (last year of the model) was 31%(21-34%) of virgin or unfished levels (SB_{2018}/SB_0) and 122% (82-181%) of maximum sustainable yield levels (SB_{2018}/SB_{MSY}) (IOTC 2016). The population is not overfished and we have awarded a very low concern score because there is a high probability (65.4%) the spawning stock biomass is above MSY levels (IOTC 2019e).

Factor 2.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

High Concern
Fishing mortality rates for bigeye tuna are estimated to be above the interim target levels needed to produce the maximum sustainable yield (F) but below the interim limit reference point (IOTC 2019e). Currently, fishing mortality is 120% (70%–205% range) of maximum sustainable yield (F_{2018}/F_{MSY}) levels or target reference point and 92% of the limit reference point ($1.3*F_{MSY}$) (IOTC 2019e). Average catches over the past five years (2014-2018) have remained within the range of estimated maximum sustainable yield levels (IOTC 2019e). Based on these assessment results, this population is subject to overfishing so we have awarded a high concern score.

Black marlin

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

Moderate Concern

A stock assessment of black marlin in the Indian Ocean was last conducted in 2018 (IOTC 2019e). The assessment estimated the current ratio of the biomass in 2017 to that needed to produce the maximum sustainable yield was 1.68 (B_{2017}/B_{MSY}= 1.68 (1.32-2.10) (IOTC 2019a). This indicates the biomass is currently healthy and not overfished, but there is a considerable amount of uncertainty surrounding these results (IOTC 2019a). The Scientific Committee considers the assessment results uncertain and we have therefore awarded a moderate concern score (IOTC 2019a).

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

Moderate Concern

According to the most recent 2018 stock assessment, the ratio of current (2017) fishing mortality rates to those needed to produce the maximum sustainable yield was 0.96 (F_{2017}/F_{MSY} = 0.96 (0.77-1.12). This estimate would indicate that overfishing is not occurring; however, their current status is considered highly uncertain (IOTC 2019a). The uncertainty is related to large increases in catches and conflicting information about the catch data (IOTC 2019a). The IOTC considers their status uncertain and we have therefore awarded a moderate concern score.

Black-browed albatross

Factor 2.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

Moderate Concern
The International Union for Conservation for Nature (IUCN) has classified black-browed albatross as Least Concern with an increasing population trend (BirdLife International 2018). This is a change from previous designations as Near Threatened with a decreasing population trend. The total population of mature birds is estimated to be 1,400,000 {Birdlife International 2018}. The status of black-browed albatross in the Indian Ocean has not been assessed. We have awarded a moderate concern score based on the population size and trend and change in IUCN listing.

Factor 2.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

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 2018f). Due to low observer coverage, there is very little information on bycatch rates within the Indian Ocean (IOTC 2018f). However, they are reported to be one of the three most commonly captured seabird species in the South African longline fishery, with combined catch rates (with white-capped albatross and white-chinned petrels) far higher than those suggested in the Food and Agriculture Organizations (FAO) International Plan of Action (IPA) (Adrill et al. 2012). Bycatch of seabirds is of big concern in waters south of 25 degrees S, where the largest densities of albatross and petrels are found (Wolfaardt et al. 2019). There are management measures in place to reduce the bycatch of seabirds in longline fisheries operating in the Indian Ocean south of 25 degrees South latitude (IOTC 2016d). While these do meet best practice guidance (ACAP 2019) , the effectiveness of these measures has yet to be measured due to a lack of information on compliance (IOTC 2016d). We have awarded a high concern score due to a lack of information combined with black-browed albatross's high overlap with longline fisheries operating in the Indian Ocean..

Blue marlin

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

Low Concern

The last stock assessment on blue marlin in the Indian Ocean was conducted in 2016 (IOTC 2019e). The assessment indicated that the ratio of the biomass in 2015 (last year of data) to that needed to produce the maximum sustainable yield (MSY) was 1.11 (B_{2015}/B_{MSY} = 1.11 (0.90-1.35)) (IOTC 2019e). This population is not considered to be overfished and we have therefore awarded a low concern score (IOTC 2019e). We have not awarded a very low concern score due to some uncertainty with the results.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern

The ratio of the fishing mortality rate in 2015 to that needed to produce the maximum sustainable yield (MSY) was estimated to be 1.18 (F_{2015}/F_{MSY} = 1.18 (0.80-1.71)). The indicates blue marlin in the Indian Ocean are subject to overfishing (IOTC 2019e). We have awarded a high concern score to account of overfishing.

Bullet tuna

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines

Moderate Concern
Bullet and frigate tuna are listed as species of Least Concern with a stable population trend by the International Union for the Conservation of Nature (IUCN), and are considered some of the most abundant juvenile tunas in the world (Collette et al. 2011a)(Collette et al. 2011b). The status of bullet and frigate tuna in the Indian Ocean is unknown and no assessments have been conducted due to a lack of data. Information on abundance from catch rate series is also lacking (IOTC 2018b)(IOTC 2018c). We have awarded a "moderate" concern score due to the lack of information for these species and their IUCN status.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines

Moderate Concern
Trolling line and pole and line fisheries are one of the main fisheries targeting bullet and frigate tuna in the Indian Ocean (IOTC 2018b)(IOTC 2018c). Fishing mortality rates for bullet and frigate tuna in the Indian Ocean are not available due to a lack of data (IOTC 2018b)(IOTC 2018c). We have awarded a moderate concern score because information on fishing mortality rates is not available.

Frigate tuna

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines

Moderate Concern
Bullet and frigate tuna are listed as species of Least Concern with a stable population trend by the International Union for the Conservation of Nature (IUCN), and are considered some of the most abundant juvenile tunas in the world (Collette et al. 2011a)(Collette et al. 2011b). The status of bullet and frigate tuna in the Indian Ocean is unknown and no assessments have been conducted due to a lack of data. Information on abundance from catch rate series is also lacking (IOTC 2018b)(IOTC 2018c). We have awarded a "moderate" concern score due to the lack of information for these species and their IUCN status.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines

Moderate Concern
Trolling line and pole and line fisheries are one of the main fisheries targeting bullet and frigate tuna in the Indian Ocean (IOTC 2018b)(IOTC 2018c). Fishing mortality rates for bullet and frigate tuna in the Indian Ocean are not available due to a lack of data (IOTC 2018b)(IOTC 2018c). We have awarded a moderate concern score because information on fishing mortality rates is not available.

Giant petrels

Factor 2.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna

High Concern
The CCSBT does not separate out seabird species in their bycatch reporting, but rather groups them taxonomically. Bycatch of giant petrels (Procellaria and Ardena spp.) reported by the CCSBT can include white-chinned petrels, grey petrels, and flesh-footed shearwaters among others. All three of these species are listed on the IUCN Red List of threatened species as near threatened with decreasing populations (BirdLife International 2020)(BirdLife International 2018d)(BirdLife International 2018c). We therefore have awarded a high concern for abundance for this taxonomic group based on their IUCN status and decreasing populations.

Factor 2.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna

High Concern
Between 2010-2018, nearly 700 giant petrels were killed in this fishery in the Indian Ocean as well as nearly 400 unidentified seabirds. Members of the CCSBT's Ecologically Related Species Working Group have determined that interactions between seabirds and Southern Bluefin Tuna fisheries continues to be of concern (CCSBT 2019b). The CCSBT requires 10% observer coverage on its longline fleet, which is not sufficient to accurately assess bycatch of ETP species (BirdLife International 2019b) Due to these concerns, we have rating fishing mortality of giant petrels in the Southern Bluefin tuna longline fishery as high concern.

Green turtle

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern

The IUCN has classified green sea turtles as Endangered with a decreasing population trend. Green sea turtles have been listed on the Convention on International Trade in Endangered Species (CITES) since 1975 and are currently listed on Appendix 1 because they are threatened with extinction and international trade is prohibited. The mean annual number of nesting turtles worldwide has decreased between 48% to 67% over the past 100-150 years (Seminoff 2004). Within the Indian Ocean, green sea turtles conservation priority ranges from low risk-low threat to low risk-high threat and includes some regions that are in critical need of data collection (Wallace et al. 2011) Green sea turtles receive a high concern score for abundance due their IUCN and ESA classifications.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern

A 2018 Ecological Risk Assessment (ERA) of sea turtles in the Indian Ocean suggests mortality levels associated with incidental capture in gillnet fisheries are substantial (Williams et al. 2018). The ESA estimated that as much as 11,400 to 47,500 turtles are caught in gillnets (Williams et al. 2018). Other reports suggest >5,000 to 16,000 turtles were incidentally captured by Indian, Sri Lanka and Madagascar (each) (IOTC 2018l). Green sea turtles appear to be the most impacted, with loggerhead, hawksbill, leatherback and olive ridley being impacted to different degrees, dependent on a number of variables (i.e. season, region) (IOTC 2018l). Mortality from gillnet fisheries is thought to have a larger population-level impact on turtles compared to gears such as longline and purse seine (IOTC 2018l). There are currently no mitigation measures used to prevent the incidental capture of sea turtles in gillnets (IOTC 2018l). We have awarded a high concern score due to the negative impact gillnet mortality has on sea turtle populations in this region.

Hawksbill turtle

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern

The International Union for Conservation of Nature (IUCN) has classified hawksbill turtles as Critically Endangered with a decreasing population trend (Mortimer and Donnelly 2008). Hawksbill turtles have been listed on CITES since 1977 and are currently listed on CITES Appendix 1, meaning they threatened with extinction and international trade is prohibited. Information on their status in the Indian Ocean is lacking (IOTC 2018l), however some analysis has suggest hawksbill's in northern Indian Ocean have a high-risk and high-threat to their population but a low risk-low threat in the southern region (Wallace et al. 2011). We have awarded a high concern score based on the IUCN listing.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern

A 2018 Ecological Risk Assessment (ERA) of sea turtles in the Indian Ocean suggests mortality levels associated with incidental capture in gillnet fisheries are substantial (Williams et al. 2018). The ESA estimated that as much as 11,400 to 47,500 turtles are caught in gillnets (Williams et al. 2018). Other reports suggest >5,000 to 16,000 turtles were incidentally captured by Indian, Sri Lanka and Madagascar (each) (IOTC 2018l). Green sea turtles appear to be the most impacted, with loggerhead, hawksbill, leatherback and olive ridley being impacted to different degrees, dependent on a number of variables (i.e. season, region) (IOTC 2018l). Mortality from gillnet fisheries is thought to have a larger population-level impact on turtles compared to gears such as longline and purse seine (IOTC 2018l). There are currently no mitigation measures used to prevent the incidental capture of sea turtles in gillnets (IOTC 2018l). We have awarded a high concern score due to the negative impact gillnet mortality has on sea turtle populations in this region.

Leatherback turtle

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
Leatherback sea turtles have been listed as Endangered by the United States Endangered Species Act (ESA) since 1970 (FR 1970). The International Union for Conservation of Nature (IUCN) classified leatherback turtles as Vulnerable globally with a decreasing population trend in 2000 but are Critically Endangered in the southwest Indian Ocean {Wallace et al. 2013a}. 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 if international trade is prohibited. Their status in the Indian Ocean is unknown due to a lack of data (IOTC 2018l) but they are considered to be at a high risk (low threat) (Wallace et al. 2011). We have awarded a high concern score based on their ESA, IUCN and CITES listings.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery

High Concern
According to a recent 2018 ecological risk assessment, leatherback turtles were classified as having a medium vulnerability to longline capture (Williams et al. 2018). Information on incidental captures of this species are lacking but information from the South African fleet indicate turtle bycatch is made up mostly of leatherback turtles and 47 leatherbacks were reported as incidentally captured between 1997 and 2000 around Reunion Island (IOTC 2016c). Average estimated catch rates of turtles range from 0.005 to 0.3 turtles per 1000 hooks (IOTC 2016c). A separate analysis also concluded leatherback sea turtles had a very high impact from longline bycatch in the southwest Indian Ocean {Wallace et al. 2013a}. We have therefore awarded a high concern score.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
A 2018 Ecological Risk Assessment (ERA) of sea turtles in the Indian Ocean suggests mortality levels associated with incidental capture in gillnet fisheries are substantial (Williams et al. 2018). The ESA estimated that as much as 11,400 to 47,500 turtles are caught in gillnets (Williams et al. 2018). Other reports suggest >5,000 to 16,000 turtles were incidentally captured by Indian, Sri Lanka and Madagascar (each) (IOTC 2018l). Green sea turtles appear to be the most impacted, with loggerhead, hawksbill, leatherback and olive ridley being impacted to different degrees, dependent on a number of variables (i.e. season, region) (IOTC 2018l). Mortality from gillnet fisheries is thought to have a larger population-level impact on turtles compared to gears such as longline and purse seine (IOTC 2018l). There are currently no mitigation measures used to prevent the incidental capture of sea turtles in gillnets (IOTC 2018l). We have awarded a high concern score due to the negative impact gillnet mortality has on sea turtle populations in this region.

Loggerhead turtle

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
The International Union for Conservation of Nature (IUCN) classified loggerhead turtles as Vulnerable globally with a decreasing population trend but Critically Endangered in the northern Indian Ocean and Near Threatened in the southern Indian Ocean (Casale and Tucker 2017). 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 (IOTC 2018l), although they are through to be at a high risk and high threat in the northern and south eastern Indian Ocean (Wallace et al. 2011). We have awarded a high concern score based on the IUCN and CITES listings.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

High Concern
According to a recent 2018 ecological risk assessment, loggerhead turtles in the northwest and northeast Indian Ocean are the most vulnerable turtle (all fisheries) (Williams et al. 2018). Loggerhead sea turtles from the Bay of Bengal are considered one of the most susceptible populations to longline capture in the Indian Ocean (IOTC 2013d). Average estimated catch rates of turtles in the Indian Ocean is estimated to range from 0.005 to 0.3 turtles per 1000 hooks (IOTC 2016c). We have awarded a high concern score due to their high vulnerability to fisheries in this region.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
A 2018 Ecological Risk Assessment (ERA) of sea turtles in the Indian Ocean suggests mortality levels associated with incidental capture in gillnet fisheries are substantial (Williams et al. 2018). The ESA estimated that as much as 11,400 to 47,500 turtles are caught in gillnets (Williams et al. 2018). Other reports suggest >5,000 to 16,000 turtles were incidentally captured by Indian, Sri Lanka and Madagascar (each) (IOTC 2018l). Green sea turtles appear to be the most impacted, with loggerhead, hawksbill, leatherback and olive ridley being impacted to different degrees, dependent on a number of variables (i.e. season, region) (IOTC 2018l). Mortality from gillnet fisheries is thought to have a larger population-level impact on turtles compared to gears such as longline and purse seine (IOTC 2018l). There are currently no mitigation measures used to prevent the incidental capture of sea turtles in gillnets (IOTC 2018l). We have awarded a high concern score due to the negative impact gillnet mortality has on sea turtle populations in this region.

Mammals

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern

There is a lack of data on bycatch in gillnet fisheries (IOTC 2019i). Information from some fisheries indicates species such as the Indo-Pacific bottlenose dolphin and Indian Ocean humpback dolphins are incidentally captured in gillnet fisheries off Zanzibar (Amir et al. 2002)(Amir 2010). Madagascar reports interactions with the Indian Ocean humpback, Indo-Pacific bottlenose, spinner and Frazer's dolphins along with humpback whales {Andrianarivel 2001} (Razafindrakoto et al. 2008). There has been a documented decline in cetacean bycatch, which suggests current levels of mortality are not sustainable (Anderson et al. 2020). We have awarded a high concern score because marine mammals are highly vulnerable to fisheries interactions.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern

Marine mammals are reported as bycatch in gillnet fisheries operating in the Indian Ocean (IOTC 2019i). High levels of bycatch have been reported in some fisheries such as the Sri Lankan gillnet fishery (IOTC 2019i). Some reports indicate as many as 12,000 cetaceans have been incidentally captured annually by the Pakistan gillnet fishery (Moazzam and Khan 2019). Information from Zanzibar suggests the bycatch of dolphins in gillnets is unsustainable (Amir et al. 2002) (Amir 2010). It is estimated that 0.17 dolphins per gillnet boat per year are incidentally captured in Zanzibar, although rates as high at 0.24 have been reported in some areas (Braulik et al. 2018). Using data from several fisheries (Australia, Sri Lanka, India and Pakistan), researchers estimated that cetacean bycatch peaked at around 100,000 individuals per year between 2004 and 2006 but has since declined by about 15% (Anderson et al. 2020)(Nawaz and Moazzam 2014)(Shahid et al. 2016). It is estimated that 4.1 million cetaceans were incidentally captured in gillnet fisheries operating in the Indian Ocean between 1950 and 2018 (Anderson et al. 2020). The following nine countries account for 96% of cetacean bycatch in gillnet fisheries: Iran, Indonesia, India, Sri Lanka, Pakistan, Oma n, Yemen, UAE and Tanzania (Anderson et al. 2020). We have awarded a high concern score because bycatch of cetaceans in gillnet fisheries is substantial and negatively impacting populations.

Manta ray (unspecified)

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

High Concern
Several species of large rays (e.g., devil fish, manta rays) are incidentally captured in Indian Ocean unassociated purse seine fisheries (Hall and Roman 2013). There are no population assessments of these species in the Indian Ocean. We have awarded a "high" concern score because the stock status is unknown but they have a high vulnerability to fishing.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

High Concern
Several species of large rays (e.g., devil ray) are incidentally captured in unassociated purse seine fisheries in the Indian Ocean (Delgado de Molina et al. 2005) (Hall and Roman 2013). There is no information on their fishing mortality rates. We have awarded a "high" concern score because fishing mortality rates are unknown and this species has a high vulnerability to fishing.

Olive Ridley turtle

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
The International Union for Conservation of Nature (IUCN) considers Olive Ridley sea turtles to be Vulnerable with a decreasing population trend {Abreu-Grobis and Plotkin 2008}. Olive Ridley turtles have been listed as Threatened on the United States Endangered Species Act (ESA) since 1978 {FR 1978}. Olive ridley's in the northern Indian Ocean are considered one of the 11 most endangered regional management units of turtles (Wallace et al. 2011). We have awarded a high concern score because of the IUCN listing.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
A 2018 Ecological Risk Assessment (ERA) of sea turtles in the Indian Ocean suggests mortality levels associated with incidental capture in gillnet fisheries are substantial (Williams et al. 2018). The ESA estimated that as much as 11,400 to 47,500 turtles are caught in gillnets (Williams et al. 2018). Other reports suggest >5,000 to 16,000 turtles were incidentally captured by Indian, Sri Lanka and Madagascar (each) (IOTC 2018l). Green sea turtles appear to be the most impacted, with loggerhead, hawksbill, leatherback and olive ridley being impacted to different degrees, dependent on a number of variables (i.e. season, region) (IOTC 2018l). Mortality from gillnet fisheries is thought to have a larger population-level impact on turtles compared to gears such as longline and purse seine (IOTC 2018l). There are currently no mitigation measures used to prevent the incidental capture of sea turtles in gillnets (IOTC 2018l). We have awarded a high concern score due to the negative impact gillnet mortality has on sea turtle populations in this region.

Porbeagle

Factor 2.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna

Moderate Concern

Multiple assessments of porbeagle sharks in the southern hemisphere are inconclusive about their abundance, but they indicate that the stock is not as depleted as the north Atlantic stock {Clarke 2017}. According to the IUCN (Rigby et al. 2019d), abundance of the southern hemisphere stock of porbeagle shark has declined by less than 20% over three generations, but due to much higher declines in the north Atlantic Ocean, the global population is listed as Vulnerable on the IUCN Red List (Rigby et al. 2019d). A 2016 status review under the US Endangered Species Act determined that the southern hemisphere stock of porbeagle sharks was stable or increasing, but there is uncertainty around that estimate (Curtis et al. 2016). Another study found that large, adult porbeagle sharks are found in higher latitudes outside of the southern bluefin tuna fishery. A 2017 stock assessment indicates that porbeagle sharks in the southern hemisphere are not overfished (Clarke 2017). Porbeagle sharks also are listed under Appendix II of the Convention on International Trade in Endangered Species (CITES) (Rigby et al. 2019d). Studies indicate the porbeagle shark population in the southern hemisphere is faring better than the one in the North Atlantic The stock status is unknown, but there are indications that the stock is stable and possibly increasing in some areas (Curtis et al. 2016) (Clarke 2017). Therefore, we have rated porbeagle sharks as moderate concern.

Factor 2.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna

Low Concern

Between 2010 and 2018, approximately 3,300 porbeagle sharks were killed in the Southern bluefin tuna longline fishery (CCSBT 2019c). A 2017 stock assessment indicates that fishing mortality is less than 18% of F_{msm} - the instantaneous fishing mortality of the maximum number of sharks that can be killed by fishing in the long-term (Clarke 2017). The study also calculated F relative to F_{crash} (instantaneous fishing mortality that will in theory lead to population extinction) and F_{lim} (instantaneous fishing mortality rate that corresponds to the limit biomass B_{lim}) (Clarke 2017). Between 2006-2014, all models indicate that fishing mortality has decreased.(Clarke 2017). We have awarded a low concern score for fishing mortality of porbeagle sharks because study results "indicate low fishing mortality rates in the three regions comprising the assessment area, and low risk from commercial pelagic longline fisheries to porbeagle shark over the spatial domain of the assessment (Clarke 2017) (p. 5)."

Rainbow runner

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)

Moderate Concern

No stock assessments have been conducted for rainbow runner in the Indian Ocean and information on their population status and trends is not available. The International Union for the Conservation of Nature (IUCN) has listed this species globally as a species of Least Concern (Smith-Vaniz et al. 2015). There is some suggestion this species can be locally impacted due to bycatch in purse seine fisheries, although there is no indication of actual population declines {Smith-Vaniz et al 2015}. We have awarded a moderate concern score due to the IUCN status.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)

Moderate Concern

Rainbow runner is a common bycatch species in purse seine floating object sets in the Indian Ocean, making up ~37% of the fish bycatch (Adrill et al. 2012). However, information on their fishing mortality rates is not available, so we have awarded a moderate concern score.

Scalloped hammerhead

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
Scalloped hammerhead sharks are listed as Critically Endangered with a decreasing population trend by the International Union for the Conservation of Nature (IUCN) (Rigby et al. 2019c). No stock assessment has been conducted in the Indian Ocean due to a lack of data (IOTC 2019h) but the IUCN analysis suggests some reductions in population from areas such as South Africa (Rigby et al. 2019c). The current status is considered unknown. We have awarded a high concern score due to the IUCN listing.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
Information on fishing mortality rates of scalloped hammerheads in the Indian Ocean is not available due to a lack of data (IOTC 2019h). The current status of this species is unknown in the Indian Ocean but they are considered to be very vulnerable to gillnet capture (IOTC 2019h). We have awarded a high concern score due to scalloped hammerheads' high vulnerability to this fishing gear.

Shortfin mako shark

Factor 2.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
The status of shortfin mako sharks in the Indian Ocean is currently unknown (IOTC 2019e) but a stock assessment is planned for 2020 (Brunel et al. 2019). A preliminary stock assessment was conducted during 2019, which indicated the biomass is right around maximum sustainable yield levels (Brunel et al. 2019). These results suggest shortfin mako sharks in the Indian Ocean are not currently overfished although stock trajectories showed trends towards an overfished state {Bruneil et al. 2019}. Globally shortfin mako sharks are considered Endangered by the International Union for the Conservation of Nature (IUCN), but the Indian Ocean segment has been assessed as Vulnerable (Rigby et al. 2019a). 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 2019d). We have assigned a high concern score due to its IUCN status, because the current assessment is preliminary in nature and no conclusion on stock status could be determined.

Factor 2.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
Shortfin mako sharks are caught as bycatch and targeted by fisheries in the Indian Ocean. The majority of the catch is taken as bycatch of industrial pelagic fleets but mako sharks are also captured in coastal longlines, gillnets, trammel nets, and sometimes trawls, particularly in areas with narrow continental shelves (Rigby et al. 2019a). However, fishing mortality rates for shortfin mako sharks in the Indian Ocean have historically been unknown because there is a general lack of information on catches due to under and un-reporting in the region (IOTC 2019e). A preliminary stock assessment conducted in 2019 indicated exploitation rates in 2015 were far above maximum sustainable yield levels {F_{2015}/F_{MSY} = 2.57} and that overfishing is currently occurring (Brunel et al. 2019). It is believed that maintaining or increasing current levels of fishing effort could lead to population declines or this species. A recent ecological risk assessment identified shortfin mako sharks as one of the most susceptible to longline capture in the Indian Ocean (Murua et al. 2018). We have awarded a high concern score because fishing mortality rates have historically been unknown and may lead to population declines.

Silky shark

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
The current status of silky sharks in the Indian Ocean is unknown, although there is some 'anecdotal' information suggesting the abundance of this species has declined over recent decades (IOTC 2018i). The IOTC recently conducted a preliminary stock assessment (Urbina et al. 2019). This preliminary assessment estimated the biomass in 2015 to be 1.03 of the maximum sustainable yield (MSY) but with a large amount of uncertainty surrounding the results (Urbina et al. 2019). These results would suggest silky sharks are not yet overfished in the Indian Ocean but their current status could not be determined due to the uncertainty and preliminary nature of this assesment (Urbina et al. 2019). In the eastern and western Indian Ocean, and globally, silky sharks are considered Vulnerable by the International Union for the Conservation of Nature (IUCN) (Rigby et al. 2017). Due to the preliminary nature of the current assessment combined with the high level of uncertainty and the IUCN status we have awarded a high concern score.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
Silky sharks are caught in a number of fisheries in the Indian Ocean, including purse seine, longline and gillnet fisheries (IOTC 2018i), where they are considered common (IOTC 2016e). A full stock assessment has not been conducted in the Indian Ocean and there is substantial uncertainty surrounding total catch estimates (IOTC 2018i). However, a preliminary stock assessment has recently been conducted in anticipation of a full assessment being completed in the near future (Urbina et al. 2019). Based on this preliminary assessment, catches have been above maximum sustainable yield levels since 1994 and the exploitation rate for 2015 was far above MSY levels (F_{2015}/F_{MSY}=2.07) (Urbina et al. 2019). Based on this prelimarny assessment, overfishing is currently occurring (Urbina et al. 2019). There is some evidence that entanglement mortality of silky sharks in drift fish aggregating devices (DFADs) may be substantial, 5-10 times current bycatch estimates of silky sharks in purse seine fisheries operating in the Indian Ocean (Filmalter et al. 2013). Silky sharks are assessed as the fifth most vulnerable species to purse seine gear according to a recent ecological risk assessment (Murua et al. 2018). Silky sharks are assessed as the second most vulnerable species to longline gear according to a recent ecological risk assessment (Murua et al. 2018).We have awarded a high concern score due to the uncertainty surrounding fishing mortality rates and total catches and because it is believed current levels of fishing are too high to maintain the population at a healthy size.

White-capped albatross

Factor 2.1 - Abundance

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna

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 2018b). This species is listed on CMS Appendix II and ACAP Annex I (BirdLife International 2018b). We have awarded a high concern score based on the IUCN classification.

Factor 2.2 - Fishing Mortality

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna

High Concern
White-capped albatross populations are negatively impacted by the incidental capture in longline fisheries (BirdLife International 2018b). White-capped albatross are found throughout the southern hemisphere in the Indian Ocean and are therefore susceptible to longline capture (IOTC 2016f). They have been reported as one of the three most commonly captured species by the South African longline fishery {Adrill et al. 2012}, with an estimated 7,000 to 11,000 total birds killed between 1998 and 2002. Catch rates of seabirds, including white-capped albatross, in the South African fleet are higher than those proposed in the Food and Agricultural Organizations (FAO) International Plan of Action (IPA) {Adrille et al. 2012}. Bycatch of seabirds is of big concern in waters south of 25 degrees S, where the largest densities of albatross and petrels are found {Wolfaart et al. 2019}. There are management measures in place to reduce the bycatch of seabirds in longline fisheries operating in the Indian Ocean, however, the effectiveness of these measures has yet to be measured due to a lack of information (IOTC 2016d). In addition, observer coverage in the Indian Ocean is very low (~1%) and too low to accurately determine the impact of bycatch on seabirds in the region (IOTC 2016f). We have awarded a high concern score due to a lack of information combined with white-capped albatross's high overlap with longline fisheries operating in the Indian Ocean.

White-chinned petrel

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

High Concern
The International Union for Conservation of Nature (IUCN), has listed white-chinned petrel as Vulnerable with a decreasing population trend (BirdLife International 2018c). The global population is estimated to have declined from 1,430,000 pairs in the 1980's to 1,200,000 pairs currently (BirdLife International 2018c). This species is listed on CMS Appendix and ACAP Annex i {BirdLife international 2018c}. We have awarded a high concern score based on the IUCN status.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

High Concern
White-chinned petrels have a high overlap with longline effort in the Indian Ocean, as much as 60% in some areas (IOTC 2016f). This species is one of the three most commonly captured, along with black-browed and white-capped albatross, in the South African longline fishery (Adrill et al. 2012). White-chinned petrels have been reported to make up 10-55% of the seabird bycatch in this fishery (Peterson et al. 2007). The combined catch rates of these three species is higher than recommended levels in the Food and Agriculture Organizations (FAO) International Plan of Action (IPA) {Adrill et al. 2012}. Rapid population declines have been attributed to very high rates of incidental mortality in longline fisheries. Bycatch of seabirds is of big concern in waters south of 25 degrees S, where the largest densities of albatross and petrels are found (Wolfaardt et al. 2019). There are management measures in place to reduce the bycatch of seabirds in longline fisheries operating in the Indian Ocean south of 25 degrees South latitude (IOTC 2016d). While these do meet best practice guidance (ACAP 2019), the effectiveness of these measures has yet to be measured due to a lack of information on compliance (IOTC 2016d). In addition, observer coverage levels are too low (~1%) to adequately assess the impact of bycatch on seabird populations (IOTC 2016e). We have awarded a high concern score due to a lack of information combined with white-chinned petrel's high overlap with longline fisheries operating in the Indian Ocean.

Whitetip shark

Factor 2.1 - Abundance

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
The status of oceanic whitetip sharks in the Indian Ocean is unknown due to a lack of information in the region and this is not expected to improve in the short to medium term (IOTC 2018k). There are several standardized catch rate series (Japan and EU/Spain) but they show conflicting trends (IOTC 2018k). An ecological risk assessment (ERA) was conducted in the Indian Ocean in 2018 and indicated the whitetip shark has a medium vulnerability and ranked no 9 for longline and 11 for purse seine gears, due to low productivity (IOTC 2018k). Whitetip sharks are listed as Critically Endangered by the International Union for the Conservation of Nature (IUCN) (Rigby et al. 2019b) and are listed on Appendix II of CITES (IOTC 2018k). We have awarded a high concern score due to their low productivity, IUCN and CITES listings.

Factor 2.2 - Fishing Mortality

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

High Concern
Information on fishing mortality rates for oceanic whitetip sharks, which are caught in purse seine, longline and gillnet fisheries in the Indian Ocean, are unknown (IOTC 2018k). The IOTC Scientific Committee mentions that maintaining or increasing fishing effort could result in declines in biomass, productivity and catch per unit effort (IOTC 2018k). There is an indication that mortality rates at capture (haul back) are high (50%) for this species when caught by longline and may be higher for purse seine and gillnet gear's (IOTC 2018k). This may negatively impact the current management measures that requires live release. The IOTC Scientific Committee notes current management measures need to be strengthened (IOTC 2018k). We have awarded a high concern score because fishing mortality rates are unknown and increasing them could lead to population declines.

Factor 2.3 - Discard Rate/Landings

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery

< 100%
Tuna longline fisheries have an average discard rate of 28.5%, although discard rates can range from 0-40% (Kelleher 2005). Updated analysis indicate an overall discard rate of 7.4% for all longline fisheries (not just tuna) (Perez et al. 2019). Observer records from the Indian Ocean indicate slightly lower discard rates of 14% of the total catch and 17% of the retained catch (Adrill et al. 2012).

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

< 100%
Purse seine fisheries have an average discard rate of 5%, although in the Indian Ocean discard rates may be even lower (Perez et al. 2019){Adrill et al 2012}. However, discard rates from FAD, vs. non FAD sets is higher (3.6% vs 0.88%) (Dagorn et al. 2013). For example, observer data from the French and Spanish fleets indicated that tunas made up the majority of the catch in both floating object and unassociated sets and that discard rates were virtually non-existent, although they may occur on smaller vessels. The highest discard rates were for bony fish and sharks, which typically make up the majority of the bycatch (Adrill et al. 2012). Additional analysis reported discard amounts of 3,700 t tropical tuna, 2,000 t minor tuna, 4,300 t bony fish, 1,300 t sharks and 200 t billfish from FAD sets between 2000 and 2009 (Fonteneau et al. 2013).

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

< 100%
Discard rates in gillnet fisheries can be substantial, ranging from 0-66% {Kehller 2005}. In pelagic driftnets, discard rates are 11.7% (7.4-19%) (Perez et al. 2019). Information on discard rates specific to Indian Ocean gillnet fisheries is lacking (Aranda 2017).

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines

< 100%
Troll and pole fisheries globally typically have low discard rates. For example, global estimates of 9.5% (6.4-14.4%) have been made for pole and line fisheries and handline (1.9-44.2%) (Perez et al. 2019). In the Indian Ocean, baitfish, which make up the majority of bycatch in this fishery, are consumed locally, so discard rates are very low (Adrill et al. 2012). An estimate from the Maldivian pole and line fishery suggests bycatch of non tuna was 0.65% of the total catch, with only 0.02% of that being discarded (Miller et al. 2017).

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

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 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	RESEARCH AND MONITORING	ENFORCEMENT	INCLUSION	SCORE
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	Moderately Effective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	Moderately Effective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	Ineffective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	Ineffective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)	Ineffective	Ineffective	N/A	N/A	N/A	**Red (1.000)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	Ineffective	Highly effective	Moderately Effective	Moderately Effective	Highly effective	**Red (1.000)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	Ineffective	Highly effective	N/A	N/A	N/A	**Red (1.000)**

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	Ineffective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	**Red (1.000)**

The United Nations Straddling and Highly Migratory Fish Stocks Agreement (1995) indicated that the management of straddling and highly migratory fish stocks should be carried out through Regional Fisheries Management Organizations (RFMOs). RFMOs are the only legally mandated fishery management body on the high seas and within EEZ waters. There are currently 18 RFMOs (www.fao.org) that cover nearly all of the world's waters. Member countries must abide by the management measures set forth by individual RFMOs in order to fish in their waters {Cullis-Suzuki and Pauly 2010}. Some RFMOs manage all marine living resources within their authority (e.g., General Fisheries Commission for the Mediterranean (GFCM)), while others manage a group of species such as tunas (e.g., Inter-American Tropical Tuna Commission (IATTC)). This report focuses on troll and pole fisheries for tuna in international waters within the Indian Ocean, which are managed by the Indian Ocean Tuna Commission (IOTC). In addition to the IOTC, the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is the intergovernmental organization tasked with the management of southern bluefin tuna throughout its distribution (Atlantic, Pacific and Indian Ocean).

The following countries are current members of the IOTC: Australia, Belize, China, Comoros, Eritrea, European Union, France, Guinea, India, Indonesia, Iran, Japan, Kenya, Republic of Korea, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Pakistan, Philippines, Seychelles, Sierra Leone, Somalia, South Africa, Sri Lanka, Sudan, Tanzania, Thailand, United Kingdom, and Yemen. In addition, Bangladesh, Djibouti, Liberia, and Senegal are Cooperating Non-Contracting Parties. For this report we have scored this section for IOTC and CCSBT management. The following countries are current members of the CCSBT: Australia, EU, Fishing entity of Taiwan, Indonesia, Japan, Republic of Korea, New Zealand and South Africa.

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - 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? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy
Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring
Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - 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.

Factor 3.5 - 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, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna

Moderately Effective

Management measures adopted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), 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 (MP), which the CCSBT uses to aid in the setting of the TAC. The MP has been in place since 2012. In addition, there is a meta-rule process that the CCSBT can use to deal with certain situations such as untested recruitment or abundance estimates or "substantial" improvements with regard to unknown or missing data (CCSBT 2019). 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, 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 2019).

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines

Moderately Effective

The Indian Ocean Tuna Commission (IOTC) has adopted several management measures that affect species caught in the longline fishery.

Tunas: Longline vessels targeting tuna are encouraged to take steps to ensure the safe release of non-targeted species and retain on board all dead non-target species fit for human consumption (IOTC 2019).

Swordfish: Swordfish are managed through several measures that are not species-specific but apply to target species. These include mandates to recording and reporting of information (IOTC 2015b), limiting fishing capacity (IOTC 2015d) and recording of active fishing vessels in the IOTC area (IOTC 2014b).

Southern bluefin tuna:
Management measures adopted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), 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 (MP), which the CCSBT uses to aid in the setting of the TAC. The MP has been in place since 2012. In addition, there is a meta-rule process that the CCSBT can use to deal with certain situations such as untested recruitment or abundance estimates or "substantial" improvements with regard to unknown or missing data (CCSBT 2019). 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, 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 2019).

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, there are target and limit reference points for albacore and bigeye tuna (IOTC 2015b), (IOTC 2018e). There are management recommendations to limit catch of albacore tuna to MSY levels (38,800 t), and reduce swordfish catch to MSY (31, 590 t) (IOTC 2018e), (IOTC 2018j)(IOTC 2018).

Because some management measures are in place but there is increased need for precaution and implementation of harvest control rules, we have scored this as moderately effective.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery

Ineffective

The Indian Ocean Tuna Commission (IOTC) has adopted several management measures that affect species caught in the longline fishery.

Tunas: Longline vessels targeting tuna are encouraged to take steps to ensure the safe release of non-targeted species and retain on board all dead non-target species fit for human consumption (IOTC 2019). The 2014 Resolution for tropical tunas asks countries to establish an allocation system or other measures based on IOTC recommendations for target species (IOTC 2014b). Yellowfin tuna is currently managed through an interim rebuilding plan (IOTC 2019). The plan was adopted in 2017, and updated in 2018 and 2019. The 2018 resolution required fisheries using purse seine, which reported more than 5000 t of yellowfin caught in 2014, to reduce their catches by 15% from 2014 levels (IOTC 2019). The 2017 and 2018 resolutions were determined to have been unsuccessful in reducing fishing mortality rates on yellowfin tuna (IOTC 2018d). The resolution adopted in 2019 does not meet advice to reduce catches by 20% in order to improve the stock status to levels above the target reference point by 2027 (IOTC 2018d). There are management recommendations to limit catch of albacore tuna to MSY levels (38,800 t) (IOTC 2018e). Currently, interim target and limit reference points are used in the IOTC to manage bigeye tuna (IOTC 2015b).

Swordfish: Swordfish are managed through several measures that are not species-specific but apply to target species. These include mandates to recording and reporting of information (IOTC 2015b), limiting fishing capacity (IOTC 2015d) and recording of active fishing vessels in the IOTC area (IOTC 2014b).There are management recommendations to reduce swordfish catch to MSY (31,590 t) (IOTC 2018j).

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 bigeye, skipjack, and yellowfin tuna (IOTC 2015b). There is a harvest control rule in place for skipjack tuna (IOTC 2016).

We have awarded an ineffective score because yellowfin tuna, which constitutes a large proportion of this fishery, is not managed according to the scientific advice and its population continues to be overfished. In addition, the low level of required observer coverage (5%) makes it difficult to assess the effectiveness of current management and recovery plans.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)

Ineffective

The Indian Ocean Tuna Commission adopted procedures on a Fish Aggregating Device (FAD) Management Plan in 2019 (IOTC 2019). The 2019 Resolution sets a maximum number of operational buoys at 300 and the number of instrumental buoys that can be obtained annually is limited to no more than 500 (IOTC 2019). Purse seines cannot have more than 500 instrumental buoys at one time and must report to their respective countries the number of instrumental buoys on board (IOTC 2019). There are also limits on the use of supply vessels (IOTC 2019). Vessels must report annually the number of operational buoys, those lost or transferred and submit a Management Plan for the use of FADs to the Commission (IOTC 2019). Non-entangling FADs are required and the promotion of biodegradable FADs is recommended (IOTC 2019). The use of artificial lights, aircraft and unmanned aerial vehicles are prohibited (IOTC 2016g)(IOTC 2016h).

Starting in 2014, all bigeye, skipjack and yellowfin tuna caught by purse seines must be retained and landed (IOTC 2019). In addition, other non-target species (other tuna, rainbow runner, dolphinfish, triggerfish, billfish, wahoo and barracuda), unless unfit to consume, must be retained onboard (IOTC 2019c). The 2014 Resolution for tropical tunas asks countries to establish an allocation system or other measures based on IOTC recommendations for target species (IOTC 2014b).

Yellowfin tuna is currently managed through an interim rebuilding plan (IOTC 2018). The plan was adopted in 2017, 2018 and 2019. The 2018 resolution required fisheries using purse seine, which reported more than 5000 t of yellowfin caught in 2014, to reduce their catches by 15% from 2014 levels. The 2017 and 2018 resolutions were determined to have been unsuccessful in reducing fishing mortality rates on yellowfin tuna (IOTC 2018d). The resolution adopted in 2019 does not meet advice to reduce catches by 20% in order to improve the stock status to levels above the target reference point by 2027 (IOTC 2018d).

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 bigeye, skipjack, and yellowfin tuna (IOTC 2015b). There is a harvest control rule in place for skipjack tuna (IOTC 2016), however the catch limits agreed on in this plan have been exceeded for the past two years due to large increases in purse seine catches (IOTC 2018a)

We have awarded an ineffective score because yellowfin tuna, which contributes a substantial proportion to this fishery, is not managed according to the scientific advice and its population continues to be overfished. The skipjack harvest control rule catch limits have been exceeded and poor observer coverage in this fishery limits proper assessment of management goals. In addition, although the IOTC has adopted some management measures for FADs, they do not all meet best practice standards (IOTC 2019b).

Justification:

Note that this report does not assess the management of the Southern bluefin tuna purse seine fishery because it supplies tuna ranches, which is outside the scope of this report.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

Ineffective

Large-scale driftnets are banned on the high seas in the Indian Ocean (IOTC 2012d)(IOTC 2017e). However, small scale gillnets that still capture a large number of species, both target and incidental are still authorized. The 2014 Resolution for tropical tunas asks countries to establish an allocation system or other measures based on IOTC recommendations for target species (IOTC 2014b). Because large-scale driftnets are still being used regularly with lengths in excess of 4,000 m (and up to 7,000 m) within the EEZs and that those used within the EEZ may sometimes drift onto the high seas in contravention of Resolution 12/12, the IOTC agreed to Res 17/07 on Driftnets (IOTC 2017e). However, Pakistan, one of the biggest users, objected and are exempt from this measure.

Yellowfin tuna is currently managed through an interim rebuilding plan (IOTC 2018). The plan was adopted in 2017, 2018 and 2019. The 2018 resolution required fisheries using gillnets, which reported more than 2000 t of yellowfin caught in 2014, to reduce their catches by 10% from 2014 levels. The 2017 and 2018 resolutions were determined to have been unsuccessful in reducing fishing mortality rates on yellowfin tuna (IOTC 2018d). The resolution adopted in 2019 does not meet advice to reduce catches by 20% in order to improve the stock status to levels above the target reference point by 2027 (IOTC 2018d).

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 bigeye, skipjack, and yellowfin tuna (IOTC 2015b). There is a harvest control rule in place for skipjack tuna (IOTC 2016).

We have awarded an ineffective score because yellowfin tuna, which contributes a substantial proportion to this fishery, is not managed according to the scientific advice and its population continues to be overfished.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines

Ineffective
The Indian Ocean Tuna Commission (IOTC) has adopted several management measures that affect species caught in troll and pole fisheries.

There is a harvest control rule in place for skipjack tuna (IOTC 2016) and interim target and limit reference points are used to determine the status of both yellowfin and skipjack tuna (IOTC 2015b). There are interim target and limit reference points in place for bigeye tuna in the Indian Ocean but not for frigate or bullet tuna (IOTC 2015b).

Yellowfin tuna is currently managed through an interim rebuilding plan (IOTC 2018). The plan was adopted in 2017, 2018 and 2019. The 2018 resolution required fisheries using troll and pole gears to reduce their catches by 5% from 2014 levels (IOTC 2018). The 2017 and 2018 resolutions were determined to have been unsuccessful in reducing fishing mortality rates on yellowfin tuna (IOTC 2018d). A new resolution was adopted in 2019 but this measure does not meet advice to reduce catches by 20% in order to improve the stock status to levels above the target reference point by 2027.

There are no management measures in place for albacore, bigeye, bullet or frigate tuna in the Indian Ocean.

We have awarded an ineffective score because the IOTC has failed to adopt adequate management measures to address overfished yellowfin tuna.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Ineffective

Starting in 2014, all bigeye, skipjack and yellowfin tuna caught by purse seines must be retained and landed (IOTC 2019). In addition, other non-target species (other tuna, rainbow runner, dolphinfish, triggerfish, billfish, wahoo and baraccuda), unless unfit to consume, must be retained onboard (IOTC 2019c). The 2014 Resolution for tropical tunas asks countries to establish an allocation system or other measures based on IOTC recommendations for target species (IOTC 2014b).

Yellowfin tuna is currently managed through an interim rebuilding plan (IOTC 2018). The plan was adopted in 2017, 2018 and 2019. The 2018 resolution required fisheries using purse seine, which reported more than 5000 t of yellowfin caught in 2014, to reduce their catches by 15% from 2014 levels. The 2017 and 2018 resolutions were determined to have been unsuccessful in reducing fishing mortality rates on yellowfin tuna (IOTC 2018d). The resolution adopted in 2019 does not meet advice to reduce catches by 20% in order to improve the stock status to levels above the target reference point by 2027 (IOTC 2018d).

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 bigeye, skipjack, and yellowfin tuna (IOTC 2015b). There is a harvest control rule in place for skipjack tuna (IOTC 2016), however the catch limits agreed on in this plan have been exceeded for the past two years due to large increases in purse seine catches (IOTC 2018a)

We have awarded an ineffective score because yellowfin tuna, which contributes a substantial proportion to this fishery, is not managed according to the scientific advice and its population continues to be overfished. In addition, the skipjack harvest control rule catch limits have been exceeded and poor observer coverage in this fishery limits proper assessment of management goals.

Factor 3.2 - Bycatch Strategy

Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna

Ineffective

Vessels that target southern bluefin tuna are required to adhere to IOTC regulations discussed herein.

The IOTC has adopted various management measures to address bycatch species, and IOTC countries have been tasked with developing and implementing a National Plan of Action (NPOA) for sharks, seabirds and sea turtles.

Marine mammals: Vessels must take reasonable steps to release any incidentally captured cetaceans and to report incidental captures (IOTC 2013).

Sharks: Oceanic whitetip sharks and thresher sharks are prohibited from retention, landing and trade and should be released if incidentally captured (IOTC 2013e)(IOTC 2012c). There are shark finning measures in place. For sharks landed fresh, fins cannot be removed on board, while sharks landed frozen must adhere to fins on board not being more than 5% of the weight of sharks on board. Countries are supposed to try and find ways to make fishing gear more selective and improve handling practices for releasing live sharks (IOTC 2017c).

Sea turtles: Any interactions between vessel 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. Longline vessels must carry line cutters and dehooking devices. Countries are also requested to conduct studies on the use of circle hooks and whole finfish bait, handling techniques and other mitigation measures (IOTC 2012).

Seabirds: 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 (IOTC 2012b). The CCSBT aims to reduce seabird interactions with longlines by 50% in three years and 95% in five years, but currently, the Ecologically Related Species Working Group believes that longline interactions with seabirds is still at a "significant level of concern" (p. 21, (CCSBT 2019b)).

Progress to date has been slow with most countries not having fully implemented NPOAs for all three species (IOTC 2019e). The CCSBT requires a low level (10%) of observer coverage to monitor interactions with bycatch species, which makes it difficult to estimate interactions with ETP species (CCSBT 2019b), (BirdLife International 2019b) . We have awarded an ineffective score because these bycatch mitigation measures do not all meet best practice guidance for many taxa and effectiveness of the seabird mitigation measures is unknown due to the low observer coverage {Morgan and Pickerel 2018}.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery

Ineffective
The IOTC has adopted various management measures to address bycatch species. IOTC countries have been tasked with developing and implementing a National Plan of Action (NPOA) for sharks, seabirds and sea turtles.

Marine mammals: Vessels must take reasonable steps to release any incidentally captured cetaceans and to report incidental captures (IOTC 2013).

Sharks: Oceanic whitetip sharks and thresher sharks are prohibited from retention, landing and trade and should be released if incidentally captured (IOTC 2013e)(IOTC 2012c). There are shark finning measures in place. For sharks landed fresh, fins cannot be removed on board, while sharks landed frozen must adhere to fins on board not being more than 5% of the weight of sharks on board. Due to a lack of reporting, the effectiveness of these measures cannot be assessed (Clarke 2018). Countries are supposed to try to find ways to make fishing gear more selective and improve handling practices for releasing live sharks (IOTC 2017c).

Sea turtles: Any interactions between vessel 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. Longline vessels must carry line cutters and dehooking devices. Countries are also requested to conduct studies on the use of circle hooks and whole finfish bait, handling techniques and other mitigation measures (IOTC 2012).

Seabirds: 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 (IOTC 2012b).

Progress to date has been slow with most countries not having fully implemented NPOAs for all three species (IOTC 2019e). The IOTC requires a low level (5%) of observer coverage to monitor interactions with bycatch species (IOTC 2011). We have awarded an ineffective score because these bycatch mitigation measures do not all meet best practice guidance and there is no information on the effectiveness of the measures that have been implemented {Morgan and Pickerel 2018}.
Justification:
Vessels that target southern bluefin tuna are required to adhere to IOTC regulations.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)

Ineffective

Because large-scale driftnets are still being used regularly with lengths in excess of 4,000 m (and up to 7,000 m) within the EEZs and that those used within the EEZ may sometimes drift onto the high seas in contravention of Resolution 12/12, the IOTC agreed to Res 17/07 on Driftnets (IOTC 2017e). Pakistan, one of the biggest users objected and are exempt from this measure.There are management measures in place in the Indian Ocean to mitigate the incidental capture of bycatch species in purse seine fisheries. For example, vessels are not allowed to intentionally set a purse seine net around cetaceans, sea turtles, mobulids or whale sharks (IOTC 2013)(IOTC 2012)(IOTC 2013b)(IOTC 2019a).

Sea turtles: Any interactions between a vessel 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 (IOTC 2012).

Sharks: Oceanic whitetip sharks are prohibited from capture, landing and should be released if incidentally captured (IOTC 2013c). There are shark finning measures in place. For sharks landed fresh, fins cannot be removed on board, while sharks landed frozen must adhere to fins on board not being more than 5% of the weight of sharks on board. Countries are supposed to try and find ways to make fishing gear more selective and improve handling practices for releasing live sharks (IOTC 2017c). There is also a ban on retention, intentionally setting on and trade of mobulid rays (IOTC 2019f).

In addition, purse seine gear can become lost and turn into ghost gear (lost or abandoned gear that continues to fish), which can allow the gear to continue to incidentally capture species for long periods of time (Angiolillo 2019).

We have assigned an ineffective score because bycatch mitigation measures do not protect all species (i.e. silky sharks (Filmalter et al. 2013) adequately and poor observer coverage rates (IOTC 2011) make it difficult to fully determine the impact of the fishery on bycatch species.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

Ineffective

Small scale gillnets that capture a large number of species, both target and incidental are still authorized. The 2014 Resolution for tropical tunas asks countries to establish an allocation system or other measures based on IOTC recommendations for target species (IOTC 2014b). Because large-scale driftnets are still being used regularly with lengths in excess of 4,000 m (and up to 7,000 m) within the EEZs and that those used within the EEZ may sometimes drift onto the high seas in contravention of Resolution 12/12, the IOTC agreed to Res 17/07 on Driftnets (IOTC 2017e). However, Pakistan, one of the biggest users, objected and are exempt from this measure.

The IOTC has adopted various management measures to address bycatch species including banning the use of large scale driftnets in the IOTC Convention Area (IOTC 2017e). IOTC countries have been tasked with developing and implementing a National Plan of Action for sharks and sea turtles. Progress to date has been slow with most countries not having fully implemented NPOAs for sharks and sea turtles (IOTC 2019e). However, there are no bycatch mitigation measures mandated for gillnet fisheries.

Marine mammals: Vessels must take reasonable steps to release any incidentally captured cetaceans and to report incidental captures (IOTC 2013).

Sharks: Oceanic whitetip sharks and thresher sharks are prohibited from capture, landing and should be released if incidentally captured (IOTC 2013c).

Sea turtles: Any interactions between a vessel 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.

We have awarded an ineffective score because gillnet fisheries interact with a number of bycatch species and there are no measures in place specific to gillnet gear and one of the largest users of gillnets, Pakistan, is exempt from Resolution 17/07 that prohibits fishing with drift gillnets on the high seas.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines

Highly effective

We have awarded a highly effective score because all species are retained.

Justification:

Information on discards in this fishery can be found in section 2.3.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Moderately Effective

Bycatch is very low in this fishery and there are virtually no tuna discards (Adrill et al. 2012). There are management measures in place in the Indian Ocean to mitigate the potential incidental capture of bycatch species in purse seine fisheries. For example, vessels are not allowed to intentionally set a purse seine net around cetaceans, sea turtles, mobulids or whale sharks (IOTC 2013)(IOTC 2012)(IOTC 2013b)(IOTC 2019a). Any interactions between a vessel 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 (IOTC 2012). In addition, oceanic whitetip sharks are prohibited from capture, landing and should be released if incidentally captured (IOTC 2013c). There are shark finning measures in place. For sharks landed fresh, fins cannot be removed on board, while sharks landed frozen must adhere to fins on board not being more than 5% of the weight of sharks on board. Countries are supposed to try and find ways to make fishing gear more selective and improve handling practices for releasing live sharks (IOTC 2017c).

Bycatch is low in this fishery, but they do capture manta rays and some sea turtles. However, there are some measures in place for bycatch species, so we have awarded a moderately effective score.

Justification:

Discussion of discards is addressed in C2.3. This report does not assess purse seine fisheries targeting southern bluefin tuna because the catch goes to tuna ranching operations and is outside the scope of this report.

Factor 3.3 - Scientific Research And Monitoring

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

N/A

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines

Moderately Effective
Stock assessments for key tuna species are conducted on a regular basis but assessments for bullet and frigate tuna are hampered due to a lack of data. Logbook data on catch and effort in the troll and pole fishery are required to be submitted to the Commission (IOTC 2013e). Member countries are required to record and report catch and effort data by species and gear. Troll and pole fisheries must report data by a 1-degree grid area and month strata. In addition, size data must be provided and countries must have a random size sampling scheme in place. If an observer program is in place, this can serve as the sampling scheme {OTC 2013e}. In addition, bigeye tuna shipments into contracting countries must be accompanied by a Bigeye Tuna Statistical Document that includes import and export information, information on where the fish was caught, the product form, and what type of gear was used to capture it (IOTC 2013e). But 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 2013i}. We have therefore awarded only a "moderately effective" score.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Moderately Effective
Stock assessments for key tuna species are conducted on a regular basis but assessments for shark species are not currently conducted due to a lack of data. There are specific logbooks requirements for use with both drifting (DFAD) and artificial (AFAD) FADS (IOTC 2013l). Member countries are required to record and report catch and effort data by species and gear. purse seine fisheries must report data by a 1 degree grid area and month strata. In addition, size data must 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. Information on supply vessels used with FADs must also be provided (number of vessels, number of days at sea, total number and type of FADs per quarter) by individual countries. In addition, bigeye tuna shipments into contracting countries must be accompanied by a Bigeye Tuna Statistical Document that includes import and export information, and information on where the fish was 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 only awarded a moderately effective score.

Factor 3.4 - Enforcement Of Management Regulations

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

N/A

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Moderately Effective

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

The IOTC has a Compliance Committee that verifies compliance by countries with regard to implementing and following adopted management measures (IOTC 2016b). The Committee meets prior to the annual Commission meeting to assess compliance and enforcement of management measures by individual countries. According to information provided during the 2016 meeting, compliance with providing a record of authorized vessels increased from 30% in 2010 to 60% in 2015. Compliance with the Bigeye Tuna Statistical Document Program increased steadily since 2010 (13%) through 2014 (60%), decreasing slightly during 2015 (54%). Compliance with observing transshipments at sea was 64% in 2015. Compliance with the regional observer program has remained fairly poor over time, at just 20% during 2015. Reporting of mandatory statistics had a 43% compliance rate in 2015 for target species. Compliance with limiting fishing capacity had a 65% compliance rate in 2015, up from only 27% in 2010 (IOTC 2016b). The Committee is responsible for reporting its recommendations to the Commission. The Committee also discusses problems related to the implementation of management measures and provides the Commission with advice on how to address these issues. The Committee has also been tasked with developing incentives and sanctions to encourage compliance with adopted measures (IOTC 2013e).

But the Committee considers only compliance with a measure, not quality or completeness of data submitted. In addition, although the Committee will let countries know through a formal letter that they are not in compliance, it does not necessarily inform them on how to comply with the measures (IOTC 2013h). The IOTC is currently assessing and reviewing compliance issues with regard to the implementation of management measures, to help strengthen compliance and to provide technical support to developing nations (IOTC 2013h). Information on compliance with measures, such as the observer scheme, is reported in publicly accessed reports (IOTC 2012) (IOTC 2013i) (IOTC 2013k). Individual country compliance reports are also produced (IOTC 2013s). But it has been noted that many countries fail to provide all the information necessary to monitor compliance (Pillai and Satheeshkumar 2012). Though there have been strong improvements in both compliance with IOTC regulations and reducing IUU fishing in recent years, some concerns remain, leading to a score of "moderately effective."

Factor 3.5 - Stakeholder Inclusion

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

N/A

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

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 2012).

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 (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 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***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	SCORE
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna	5	0	Moderate Concern	**Green (3.873)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines	5	0	Moderate Concern	**Green (3.873)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery	5	0	Moderate Concern	**Green (3.873)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)	5	0	Moderate Concern	**Green (3.873)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)	5	0	Moderate Concern	**Green (3.873)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines	5	0	Moderate Concern	**Green (3.873)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines	5	0	Moderate Concern	**Green (3.873)**
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)	5	0	Moderate Concern	**Green (3.873)**

Criterion 4 Assessment

SCORING GUIDELINES

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

Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - 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. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*

- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

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

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

5
Fishing gears such as trolling line and pole and line, pelagic longline, gillnet and purse seine rarely impact bottom habitats. This scores a 5 according the the Seafood Watch Standard for Fisheries.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

0
Not applicable due to the fishing gear not coming into contact with the bottom habitat.

Factor 4.3 - Ecosystem-based Fisheries Management

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines
Antarctic Indian Ocean | Drifting longlines | Southern Bluefin Tuna
Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Drifting longlines | Tropical tuna fishery

Moderate Concern

Tuna longline fisheries operating in the Indian Ocean catch ecologically important species including other tunas, billfish and sharks. In particular, sharks are considered top predators in many ecosystems and play a critical role in how these ecosystems are structured and function (Piraino et al. 2002)(Stevens et al. 2000). The loss of these predators can cause many changes such as to prey abundances, which can lead to a cascade of other effects (Myers et al. 2007)(Duffy 2003)(Ferretti et al. 2010)(Schindler et al. 2002) and behavioral changes (Heithaus et al. 2007). Longline fisheries could cause other indirect effects that are not well understood, such as changing prey available to seabirds due to the removal of tunas, reducing optimal school sizes or reducing the fitness of individuals in a school (Chuenpagdee et al. 2003). In addition, longline gear can become lost and turn into ghost gear (lost or abandoned gear that continues to fish), which can allow the gear to continue to incidentally capture species for long periods of time (Angiolillo 2019).

The IOTC has a Working Party on Ecosystems and Bycatch (WPEB) that analyzes technical problems related to the management goals, identifies research priorities and indicates data and information requirements that are needed. In addition, it provides advice on management measures (IOTC 2017b). 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. 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 moderate concern score instead of high concern score.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Floating object purse seine (FAD)

Moderate Concern

Purse seine fisheries in the Indian Ocean catch several ecologically important groups including tunas and sharks. In particular, sharks are considered top predators in many ecosystems and play a critical role in how these ecosystems are structured and function (Piraino et al. 2002)(Stevens et al. 2000). The loss of these predators as well as removal of tuna can cause many changes such as to prey abundances, which can lead to a cascade of other effects (Myers et al. 2007)(Duffy 2003)(Ferretti et al. 2010)(Schindler et al. 2002) and behavioral changes (Heithaus et al. 2007). In addition, purse seine gear can become lost and turn into ghost gear (lost or abandoned gear that continues to fish), which can allow the gear to continue to incidentally capture species for long periods of time (Angiolillo 2019).

The use of FADs can also impact the surrounding ecosystems. Juvenile tuna, specifically bigeye and yellowfin, are often associated with FADs and this could lead to growth and recruitment overfishing (Freon and Dagorn 2000)(Bromhead et al. 2003). In addition, increases in the biomass of tunas under FADs, reduced free-school abundance, changes in school movement patterns and structure and differences between the age and size of free and FAD associated schools had been associated with the introduction of FAD fisheries (Fonteneau et al. 2000)(Menard et al. 2000).

The IOTC has a Working Party on Ecosystems and Bycatch (WPEB) that analyzes technical problems related to the management goals, identifies research priorities and indicates data and information requirements that are needed. In addition, it provides advice on management measures (IOTC 2017b). 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.

The Commission has adopted management measures specific to bycatch species in purse seine fisheries such as sharks but the effectiveness of these measures is not always clear. We have therefore awarded a moderate concern score.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Gillnets and entangling nets (unspecified)

Moderate Concern

Tuna gillnet fisheries operating in the Indian Ocean catch ecologically important species including sea turtles, marine mammals 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 effects (Myers et al. 2007)(Duffy 2003)(Ferretti et al. 2010)(Schindler et al. 2002) and behavioral changes (Heithaus et al. 2007).

The IOTC has a Working Party on Ecosystems and Bycatch (WPEB) that analyzes technical problems related to the management goals, identifies research priorities and indicates data and information requirements that are needed. In addition, it provides advice on management measures (IOTC 2017b). 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. In addition, the Commission has adopted management measures specific to bycatch species such as sharks, sea birds and sea turtles. However, the success of all of these measures on reducing impacts to the ecosystem is not fully understood. We have therefore awarded a moderate concern score.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Handlines and hand-operated pole-and-lines

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Trolling lines

Moderate Concern

Trolling line and pole and line fisheries target tuna, which are top predators and considered "exceptional species." In addition to tuna, troll and pole fisheries rely on live baitfish, which could include other "exceptional species" such as anchovy or sardines. The effect of the removal of these species on the ecosystem is unknown, and few baitfish fisheries are managed (Gillett 2012), (FAO 2014). The IOTC has a Working Party on Ecosystems and Bycatch (WPEB) that analyzes technical problems related to the management goals, identifies research priorities and indicates data and information requirements that are needed. In addition, it provides advice on management measures (IOTC 2017b). 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. We have awarded a "moderate concern" score because this fishery impacts exception species but there are some efforts through the IOTC to address ecosystem issues but their success is not fully understood.

Indian Ocean | Indian Ocean, Eastern | Indian Ocean, Western | Unassociated purse seine (non-FAD)

Moderate Concern

The unassociated purse seine fishery does capture "exceptional species" such as tunas but these species are monitored and assessed. Interactions with other "exceptional species" common in associated purse seine fisheries, such as sharks, are minimal in the unassociated fishery. The IOTC has a Working Party on Ecosystems and Bycatch (WPEB) that analyzes technical problems related to the management goals, identifies research priorities and indicates data and information requirements that are needed. In addition, it provides advice on management measures (IOTC 2017b). 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. In addition, the Commission has adopted management measures specific to bycatch species in purse seine fisheries such as sharks.

The Commission has adopted management measures specific to bycatch species in purse seine fisheries such as sharks. We have therefore awarded a moderate concern score instead of high concern score.

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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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