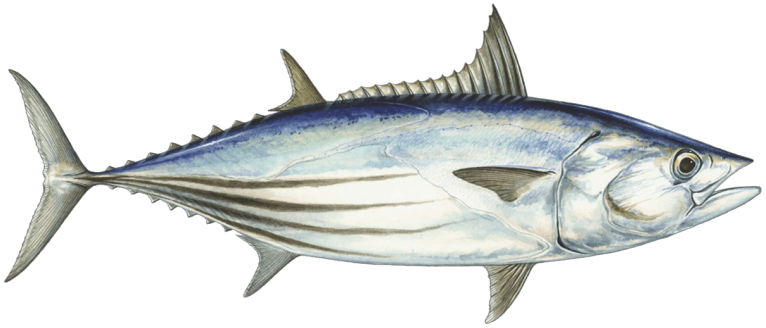
Tunas and large pelagics



Eastern Central Pacific

Floating object purse seine (FAD), Dolphin set purse seine, Unassociated purse seine (non-FAD), Longlines (unspecified)

Seafood Watch Consulting Researcher

Updated: December 6, 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 environmental 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. 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.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

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, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides 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 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 the following fisheries in the Eastern Pacific Ocean: 1) the longline fishery targeting swordfish (*Xiphias gladius*), albacore tuna (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus)*, and yellowfin tuna (*Thunnus albacares*), and 2) three purse seine fisheries (unassociated sets, associated sets, dolphin sets) targeting yellowfin, bigeye, and skipjack tuna (*Katsuwonus pelamis*). We have included ratings for blue sharks (*Prionace glauca*), dolphinfish (*Coryphaena hippurus)*, silky sharks (*Carcharhinus falciformis)*, and wahoo (*Acanthocybium solandri)* that also are caught in these fisheries.

Skipjack and albacore tuna are fairly robust, and fishing mortality rates are within biological reference points. Recent updates to the yellowfin assessment in 2020 indicate that yellowfin tuna stock status and fishing mortality is most likely within reference points, however, there is a high degree of uncertainty in the stock and risk assessments for yellowfin tuna. Bigeye tuna and swordfish abundance is likely within reference points, however, there is uncertainty regarding fishing mortality rates, and overfishing may be occurring for swordfish in particular. A high degree of uncertainty surrounds all assessed tuna species in the Eastern Pacific Ocean. Silky sharks and blue sharks are slow growing species that reach sexual maturity later in life and produce a small number of young. Mahi mahi and wahoo grow quickly, reaching sexual maturity at a young age and producing a large number of young. The status of dolphinfish populations in the Eastern Pacific Ocean is currently unknown, as is the status of wahoo. Although silky shark populations are currently being assessed, there is a large degree of uncertainty surrounding their status.

The three purse seine fisheries have different levels of bycatch; the associated fishery has the highest. Sharks, primarily silky and oceanic whitetip, bony fish and other tuna are incidentally captured in the associated fishery. The unassociated purse seine fishery typically has relatively lower bycatch; however, both manta rays and silky sharks are reported as incidental takes and both species are of high concern. The dolphin set fishery historically had issues with dolphin bycatch, but this had been reduced considerably since the 1990's due mostly to the Agreement of the International Dolphin Conservation Program.

Tuna, large pelagics, and swordfish in the EPO are managed by the Inter-American Tropical Tuna Commission (IATTC). Measures to mitigate the negative impacts of the increasing number of associated sets in the purse seine fishery have not been effective for a number of target and non-target species due to the lack of compliance with scientific advice and lack of bycatch catch limits. Management measures specific to the longline fishery also are insufficient to account for uncertainty and over-exploitation risk to both target and bycatch species. In addition to target species, the Eastern Pacific Ocean longline fishery also captures a number of secondary target and bycatch species, including vulnerable/endangered turtles, shark species, finfish and false killer whales. There are no management measures in place for mahi mahi or wahoo. Although some measures are in place for sharks (for example, prohibiting shark finning), there are no catch limits or other measures in place.

The IATTC takes ecosystem-based fisheries management considerations into account, and measures are in place to minimize adverse impacts to turtles and sharks. The efficacy of these measures, however, is unknown due to limited observer coverage, especially in the longline fishery. The IATTC is currently working to improve ecosystem management of longline and purse seine fisheries by developing Ecological Risk Assessments. Purse seine and longline gears typically have little contact with bottom habitats, although associated/fish aggregating device gear can be anchored to the bottom.

Unassociated and dolphin sets targeting skipjack and yellowfin tuna in the Eastern Pacific Ocean purse seine fishery receives a "yellow" or "good alternative" rating, which includes dolphinfish. All other tuna purse seine (object associated) and longline fisheries in the Eastern Pacific Ocean receive a a "red" or "avoid" rating. This also includes ratings for blue shark, silky shark, dolphinfish, and wahoo caught in these gears.

This assessment was originally published in March 2021. It was reviewed for significant changes in the fishery in May 2021 and updated accordingly. Please see Appendix 1 for details of the update.

Final Seafood Recommendations

SPECIES | FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Albacore | Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Albacore | Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Bigeye tuna | Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	2.644	1.000	1.000	3.873	**Avoid (1.789)**
Bigeye tuna | Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	2.644	1.000	1.000	3.873	**Avoid (1.789)**
Bigeye tuna | Eastern Central Pacific | Floating object purse seine (FAD)	2.644	1.000	1.000	3.162	**Avoid (1.700)**
Blue shark | North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Blue shark | South Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Dolphinfish | Eastern Central Pacific, Northeast Pacific | Drifting longlines	2.644	1.000	1.000	3.873	**Avoid (1.789)**
Dolphinfish | Eastern Central Pacific, Southeast Pacific | Drifting longlines	3.413	1.000	1.000	3.873	**Avoid (1.907)**
Dolphinfish | Eastern Central Pacific | Floating object purse seine (FAD)	2.644	1.000	1.000	3.162	**Avoid (1.700)**
Dolphinfish | Eastern Central Pacific | Unassociated purse seine (non-FAD)	2.644	1.000	3.000	3.873	**Good Alternative (2.354)**
Silky shark | Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Silky shark | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000	1.000	3.873	**Avoid (1.403)**
Silky shark | Eastern Central Pacific | Floating object purse seine (FAD)	1.000	1.000	1.000	3.162	**Avoid (1.333)**
Skipjack tuna | Eastern Central Pacific | Dolphin set purse seine	3.318	1.000	3.000	3.873	**Good Alternative (2.492)**
Skipjack tuna | Eastern Central Pacific | Floating object purse seine (FAD)	3.318	1.000	1.000	3.162	**Avoid (1.800)**

Skipjack tuna | Eastern Central Pacific | Unassociated purse seine (non-FAD)	3.318	1.000	3.000	3.873	**Good Alternative (2.492)**
Swordfish | Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.916	1.000	1.000	3.873	**Avoid (1.650)**
Swordfish | Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.916	1.000	1.000	3.873	**Avoid (1.650)**
Wahoo | Eastern Central Pacific | Floating object purse seine (FAD)	2.644	1.000	1.000	3.162	**Avoid (1.700)**
Yellowfin tuna | Eastern Central Pacific | Dolphin set purse seine	4.284	1.000	3.000	3.873	**Good Alternative (2.656)**
Yellowfin tuna | Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Yellowfin tuna | Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	4.284	1.000	1.000	3.873	**Avoid (2.018)**
Yellowfin tuna | Eastern Central Pacific | Floating object purse seine (FAD)	4.284	1.000	1.000	3.162	**Avoid (1.918)**
Yellowfin tuna | Eastern Central Pacific | Unassociated purse seine (non-FAD)	4.284	1.000	3.000	3.873	**Good Alternative (2.656)**

Summary

This report focuses on the following fisheries in the Eastern Pacific Ocean: 1) the longline fishery targeting swordfish, albacore tuna, bigeye tuna, and yellowfin tuna, and 2) three purse seine fisheries (unassociated sets, associated sets, dolphin sets) targeting yellowfin, bigeye and skipjack tuna. Unassociated and dolphin sets targeting skipjack and yellowfin tuna in the Eastern Pacific Ocean purse seine fishery receives a "yellow" or "good alternative" rating. These ratings also apply to dolphinfish and wahoo caught in unassociated (non-FAD) purse seines. All other tuna purse seine and longline fisheries in the Eastern Pacific Ocean receive a a "red" or "avoid" rating. These avoid ratings also apply to blue sharks, dolphinfish, silky sharks, and wahoo that are caught in these gears.

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 longline and purse seine fisheries in the Eastern Pacific Ocean (EPO). Main species of tuna caught with purse seine gear reviewed include skipjack tuna (*Katsuwonus pelamis*), bigeye tuna (*Thunnus obesus)*, and yellowfin tuna (*Thunnus albacares*). This report also assesses dolphinfish (*Coryphaena hippurus)*, silky sharks (*Carcharhinus falciformis)*, and wahoo (*Acanthocybium solandri)* caught in purse seines. In addition, this report assesses longline-caught northern and southern albacore tuna (*Thunnus alalunga*), bigeye tuna, yellowfin tuna, northern and southern swordfish (*Xiphias gladius*), northern and southern Pacific blue sharks (*Prionace glauca*), dolphinfish, and silky sharks.

Fishing gear and landings data are broken down into three primary purse seine categories based on set type - dolphin sets, Fish Aggregating Device (FAD/associated) sets, and unassociated (sometimes called school) sets. Dolphin sets occur when fishers, primarily targeting yellowfin tuna, set their gear around a pod of dolphins (and associated tuna) and then backdown the net from the surface to allow the dolphins to escape prior to completing the haul. FADs are associated with relatively dense fish aggregations, and with this strategy fishers set purse seine gear around the FAD. Examples of FADs include kelp or plant material, dead animals, wooden artifacts, and man-made FAD devices, etc. Unassociated or school sets are not associated with dolphins or FADs (Hall & Ramon 2013). Longline landings data are reviewed separately in this report.

Species Overview

Skipjack, bigeye, yellowfin and albacore tuna are found in tropical and subtropical waters throughout the Pacific Ocean. There are six populations of albacore tuna - North and South Pacific Ocean, North and South Atlantic Ocean, Indian Ocean and Mediterranean Sea (ISC 2011). There are four populations of yellowfin and bigeye and five of skipjack as follows: Western and Central Pacific Ocean, EPO, Atlantic (eastern and western for skipjack) and Indian Ocean. Juvenile yellowfin and bigeye tuna tend to form schools with skipjack tuna that are mostly found in surface waters. Larger tunas are found in subsurface waters where they also form schools (ISSF 2017).

Swordfish are a widely distributed billfish species, found globally from 50-degrees N to 50-degrees S and at all longitudes in the Pacific Ocean. Swordfish are assessed as two populations in the North Pacific (Western and Central and Eastern Pacific), a single population in the Southwest Pacific, two populations in the Atlantic (South and North), and a single population in both the Indian Ocean and Mediterranean Sea (ISC 2014).

Dolphinfish (mahi mahi) are highly migratory and found worldwide in tropical and subtropical waters. Mahi mahi is typically found in pelagic habitats, where it forms schools and is commonly found associated with floating objects. This species is a top predator, feeding on small fish and squid (Froese and Pauly 2020).

Blue sharks are highly migratory found throughout the world's oceans in epipelagic and mesopelagic waters. It is considered the most widely distributed shark species and the most abundant, with abundance increasing with latitude. Blue shark is an apex predator, consuming a variety of fish and squid species {ISCSWG 2014}.

Silky sharks also are highly migratory and are found throughout the world's oceans. Silky sharks occupy a

number of habitats, including along the continental shelf and open ocean. They are often associated with schools of tuna, making them susceptible to bycatch in tuna fisheries. Silky sharks feed on fish, squid, and some invertebrates (Froese and Pauly 2020).

Wahoo are found in tropical and subtropical waters worldwide. It is an epipelagic scombrid species that is typically found alone, although while small they may form small groups. Wahoo preys primarily on fish and squid (Froese and Pauly 2020).

Longlines also are the most common method globally used to capture swordfish, albacore and bigeye tuna while purse seines are the primary gear used to capture yellowfin and skipjack tuna (Hall & Ramon 2013). Albacore catches have increased since the 1950's fluctuating between 200,000 and 250,000 t over the past decade. Bigeye, skipjack and yellowfin tuna catches have all increased substantially over time, peaking in the early 2000's, after which catches stabilized (ISSF 2017). Swordfish catches have varied over time (IATTC 2018c).

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 legally mandated fishery management body on the high seas and within EEZ waters. There are currently 18 RFMOs that cover nearly all of the world's waters. The Inter-American Tropical Tuna Commission (IATTC) is the RFMO responsible for managing the EPO tuna fisheries. IATTC Member countries must abide by the management measures set forth by individual RFMOs in order to fish in their waters. IATTC members include: Belize, Canada, China, Colombia, Costa Rica, Ecuador, El Salvador, European Union, France, Guatemala, Japan, Kiribati, Korea, Mexico, Nicaragua, Panama, Peru, Chinese Taipei, United States, Vanuatu, Venezuela (IATTC 2018c).

Production Statistics

Purse seine

Catches of skipjack tuna in the EPO (primarily purse seine) are significantly less than those from the Western and Central Pacific Ocean. During 2002-2016 the annual retained catch averaged 255,000 t (range 147,000 to 338,000 t). The preliminary estimate of the retained skipjack catch in 2017, 326,000 t, is 28% greater than the average for 2002-2016, and 3% lower than the record catch of 2016 (IATTC 2018c) (Figure A).

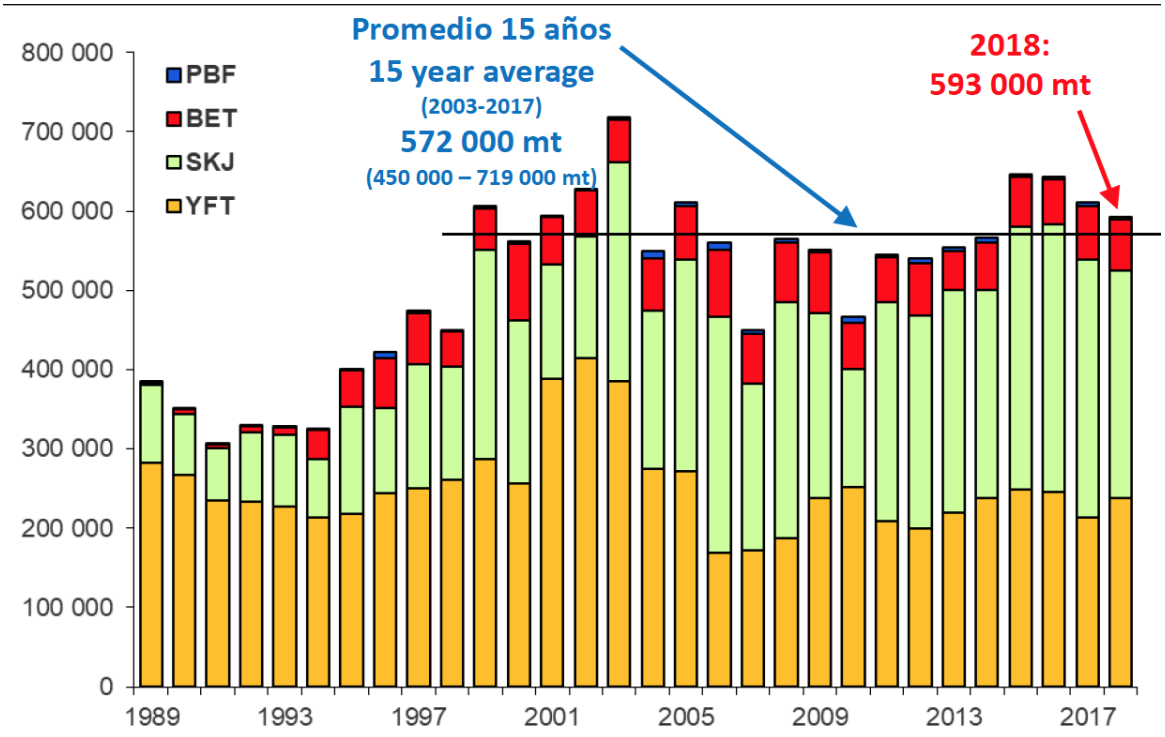

Figure 1: EPO retained catches for all gear types for bluefin (PBF), Bigeye (BET), Skipjack (SKJ), and yellowfin (YFT) tuna (IATTC 2019g).

Purse seines catch the majority of yellowfin tuna in the EPO, and over the years catches have been variable. Yellowfin tuna catches peaked in 2002 at 443,458 t and have since decreased to just under 210,000 t in 2017. The average annual retained catch during 2002-2016 was 247,000 t (range: 167,000 to 413,000 t). The retained yellowfin catch in 2017, 210,000 t, was 13% less than that of 2016, and 15% less than the average for 2002-2016 (IATTC 2018c). The majority of yellowfin caught in the EPO purse seine fishery occurs with dolphin sets (Figure B).

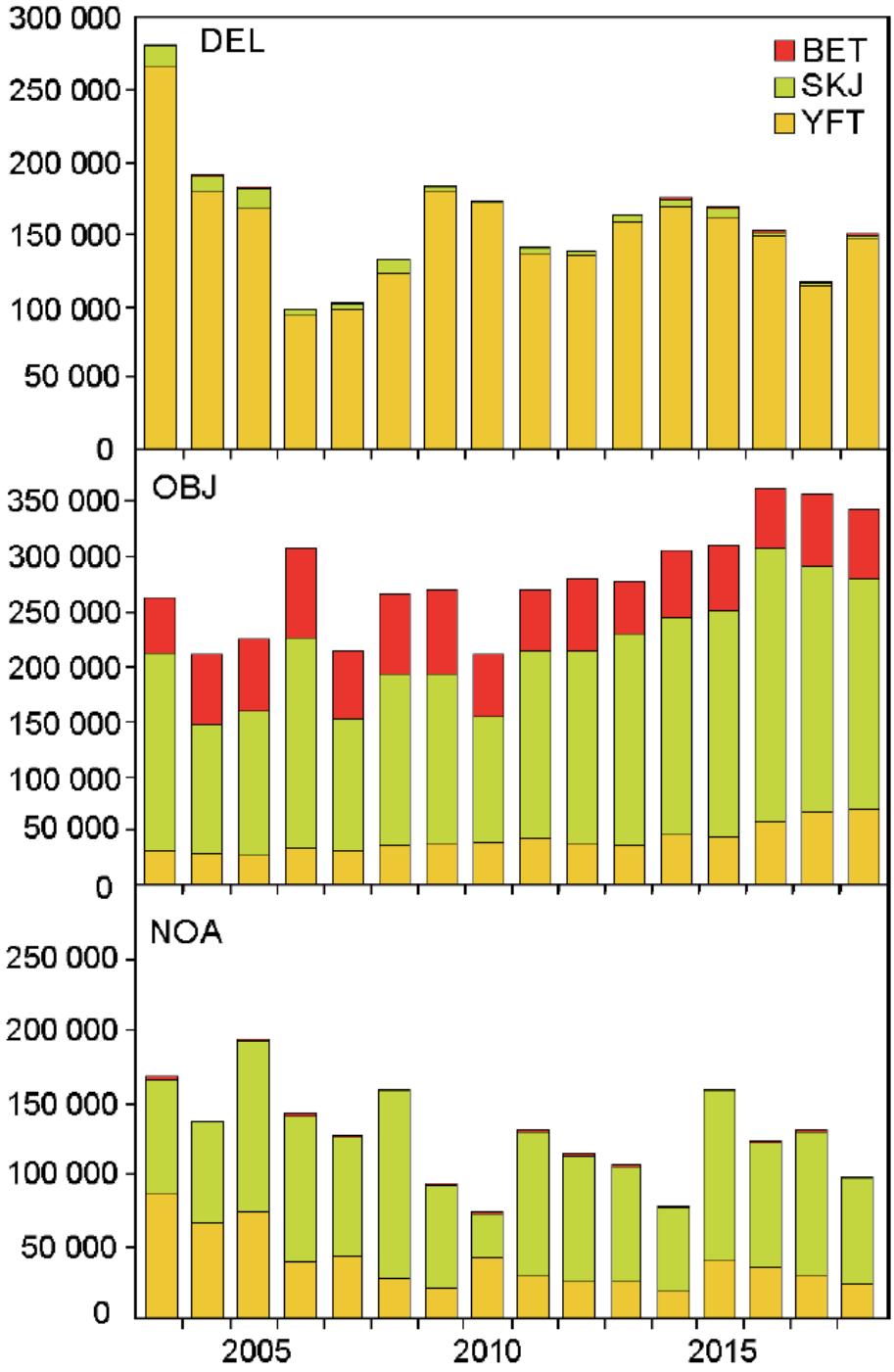

Figure 2: Purse-seine catches of tunas by species and set type2003-2018 (IATTC 2019h).

Purse seines catch the majority of bigeye tuna in the region (mostly associated fisheries). Total catches of bigeye tuna in the EPO also have varied over time, peaking during the early 1990's and reaching their highest level (148,557 t) in 2000. In the EPO, the average catch between 1988 and 2017 was 104,000 t. The number of associated/FAD sets increased dramatically in the early 1990s, and this led to a sudden and

dramatic increase in the purse-seine catches of bigeye. The retained purse seine, bigeye tuna catch in 2017 was approximately 66,000 t (IATTC 2018c).

Of the nearly 615,000 t of tunas caught in 2017, 47% were caught by Ecuadorian vessels, and 18% by Mexican vessels. Other countries with significant catches of tunas and bonitos in the EPO included Panama (11%), Colombia (6%), United States (6%) and Venezuela (4%).

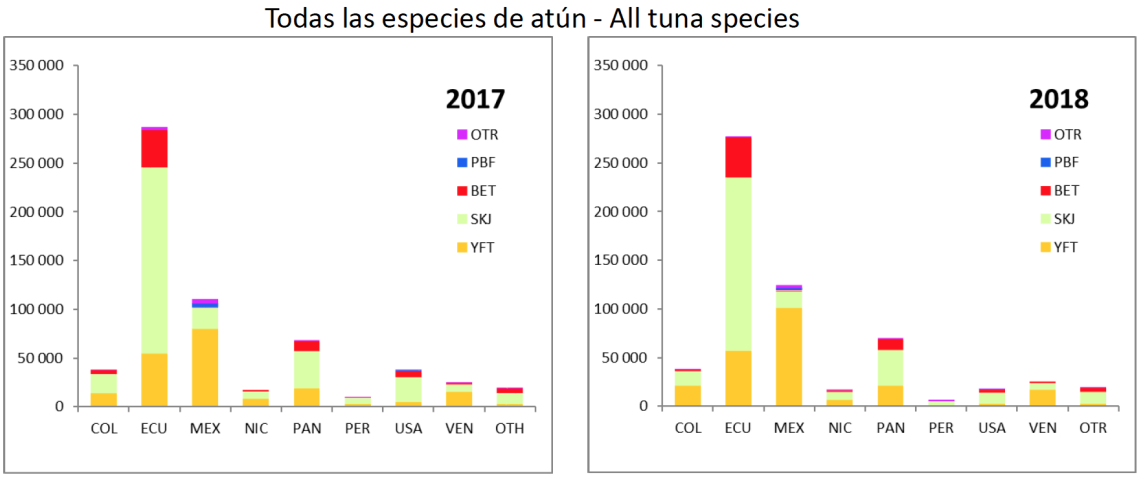

Figure 3: EPO purse seine fleet catches by country (IATTC 2019g).

Longline

The primary gear used to catch albacore tuna are drifting longlines. In 2017, the total catch of albacore tuna in the southern and northern EPO was 35,561 t. The longline fishery accounted for for roughly 25,991 t in 2017. Albacore catches across all gears peaked in 2014 at 48,668 t (Figure C,D)(IATTC 2019).

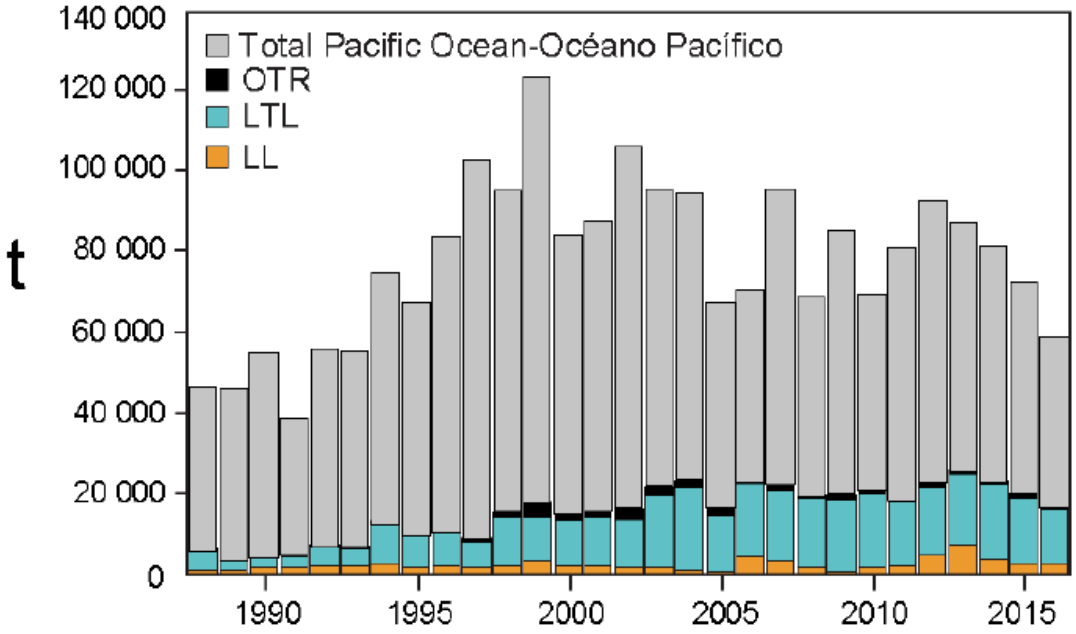

Figure 4: Retained catches of North Pacific albacore. The catches from the EPO are broken down by gear (LL/longline; LTL/pole and line; OTR/ other){IATTC 2018).

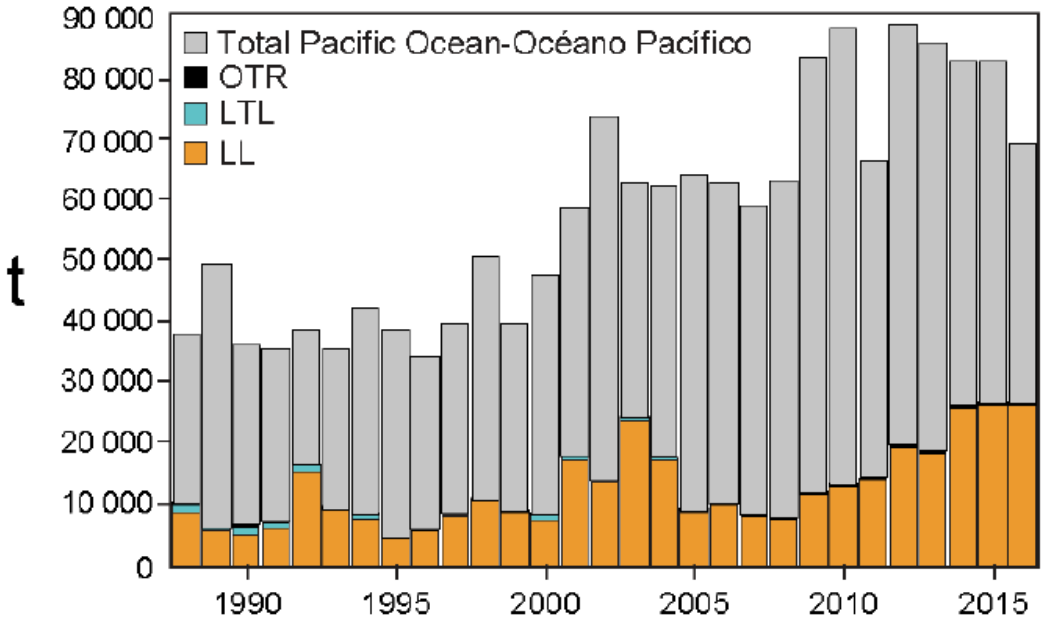

Figure 5: Retained catches of South Pacific albacore. The catches from the EPO are broken down by gear (LL/longline; LTL/pole and line; OTR/ other){IATTC 2018).

Yellowfin tuna catches in the EPO peaked in 2002 at 443,458 t and have since decreased to just under 239,000 t in 2018. The 2018 EPO catch is less than the average for the previous 5-year period (244,000 t). Purse seines catch the majority of yellowfin tuna in the EPO. In the WCPO, the catches of yellowfin tuna reached a record high of 676,000 t in 2017 (Figure C)(IATTC 2019).

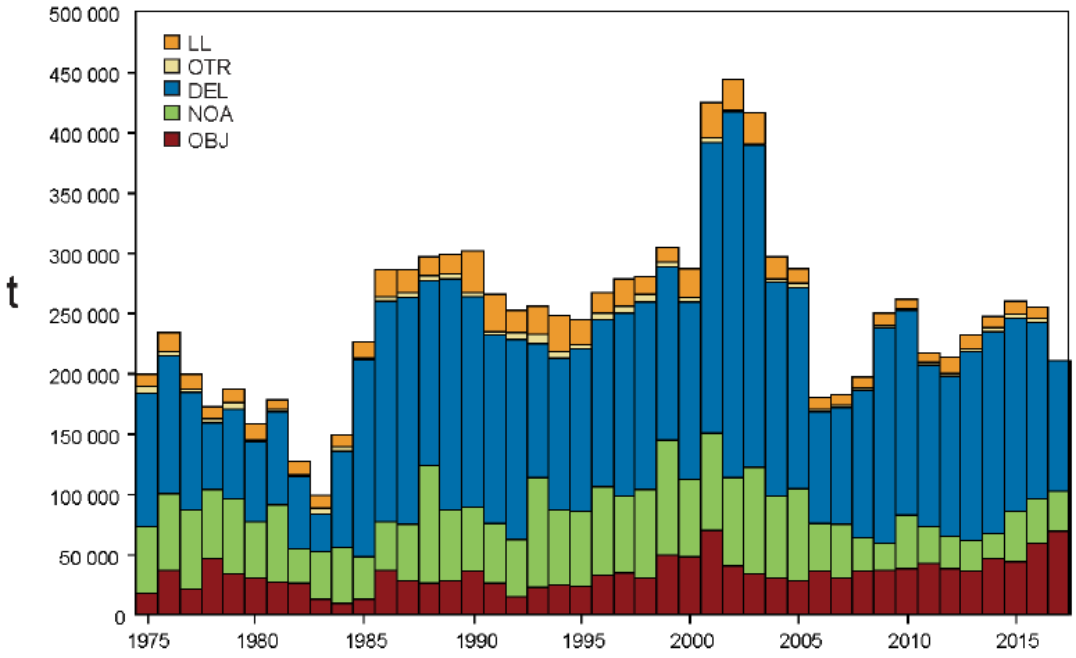

Figure 6: Total catches (retained catches plus discards) for the purse-seine fisheries (DEL, NOA, OBJ), and retained catches for the pole-and-line (OTR) and longline fisheries (LL), of yellowfin tuna in the eastern Pacific Ocean, 1975- 2017. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2017 catch data are preliminary (IATTC 2017).

Catches of mahi mahi by longliners operating in the Eastern Pacific Ocean (EPO) were very low during the early 1990s but increased rapidly from 43 MT in 1996 to 6,866 MT in 1997. Reported catches of dolphinfish in the EPO by all gears have declined from a high of 71,000 t in 2009 to 14,000 t in 2016 (IATTC 2018c).

Silky shark catches in the EPO were around 15,000 MT in 1994. Catches decreased through the late 1990s into the early 2000s. Since 2009, catches have been increasing. In 2016, over 340,000 silky sharks were reported caught in EPO longline and purse seine fisheries (Clarke et al. 2018). IATTC(2018c) reported 711 t silky sharks caught in purse seines in 2017 and 452 t caught with longlines in 2016 (IATTC 2018c).

In the North Pacific, catches of blue sharks peaked between 1976 and 1989 (113,000 t in 1981). Catches have since declined. Over the most recent 10 years (2005-2015), average annual catches are around 41,000 t but have begun decreasing since 2011. The majority of blue sharks are caught by longlines (ISCSWG 2017). IATTC(2018c) reported 1,816 t blue sharks were caught with longlines in 2016 (IATTC 2018c).

Wahoo catches reported to IATTC are typically combined with other unidentified tuna and tuna-like species. The amount of retained "unidentified tunas" has fluctuated somewhat over time but generally been much less than the amount discarded. Discards have declined overall since 2008 (1,380 MT) (IATTC 2018c). Wahoo catches were specifically reported for 2017 (purse seines) and 2016 (longlines) (IATTC 2018c). In 2017, 368 t wahoo were reported caught in FAD purse seines and in 2016, 243 t were caught in longline

fisheries (IATTC 2018c).

Importance to the US/North American market.

In 2017, the U.S imported 150,469 t of fresh and frozen tuna, down 19,850 tons (11.7%) from 2016 but the value of fresh and frozen tuna imports increased by 2.2% to $1.0 billion. Imports of canned tuna were 141,480 tons, up 8,882 tons (6.7%) from 2016. The value of canned tuna imports also increased by $108.9 million (20.8%) from 2016. Tuna is also re-exported from the US (1,066 tons valued at $7.4 million) as fresh and frozen products (NMFS 2017a). Bigeye tuna within the IATTC Convention Area are primarily imported from Panama and Ecuador (33% each). Skipjack tuna are primarily imported from Mexico (99%). The majority of yellowfin tuna were imported from Mexico (31%) and Venezuela (28%) (NMFS 2017).

In 2019, the US imported approximately 13,700 t of dolphinfish primarily from Peru, Ecuador, Taiwan, Costa Rica, and Vietnam. Species-specific information on import and exports of sharks is not available through the National Marine Fisheries Service (NMFS). During 2019, imports of fresh shark primarily came from Canada and Mexico, with smaller amounts imported from Ecuador and Spain {NMFS 2020}. Shark fins were imported from Brazil and China {NMFS 2020}. Information on import and exports of other species included in this report is not available through the NOAA Fisheries.

In 2017, US fishermen landed 475 million pounds of tuna at ports in United States, American Samoa, other US territories and foreign ports, which was valued at almost $427.3 million — an increase of 507,000 pounds (less than 1%) but a decrease of $5.5 million (over 1%) compared with 2016. The average ex-vessel price per pound of all species of tuna in 2017 was $0.90 compared with $0.91 in 2016. Bigeye landings in 2017 increased by 10% from 2016 at 26.2 million pounds. The average ex-vessel price per pound was $2.99 in 2017 compared to $3.44 in 2016. Skipjack landings in 2017 were more than 25,000 pounds (7%) less than those in 2016. The average ex-vessel price per pound was $0.63 in 2017 compared to $0.66 in 2016. Yellowfin landings were 75.8 million pounds — an increase of 30.4 million pounds (67%) compared with 2016. The average ex-vessel price per pound was $1.04 in 2017 compared with $1.06 in 2016 (Figure A, B).

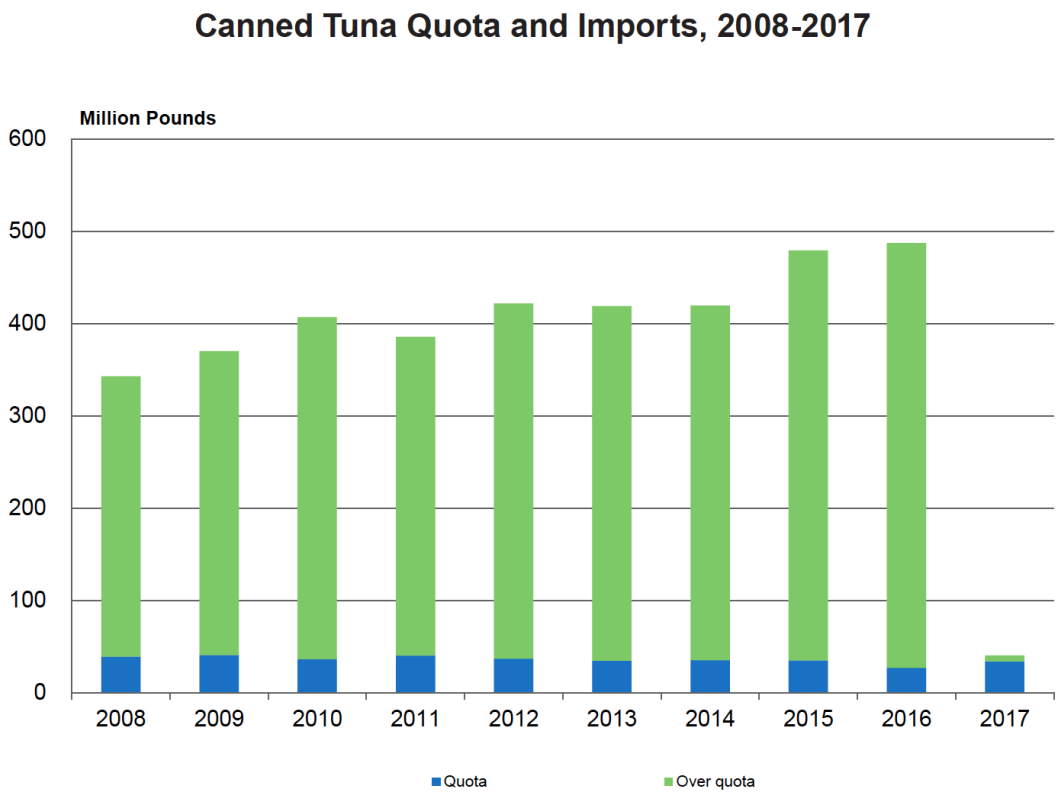

Figure 7: US supply of fresh and frozen tuna, 2008-2018 (NMFS 2017b).

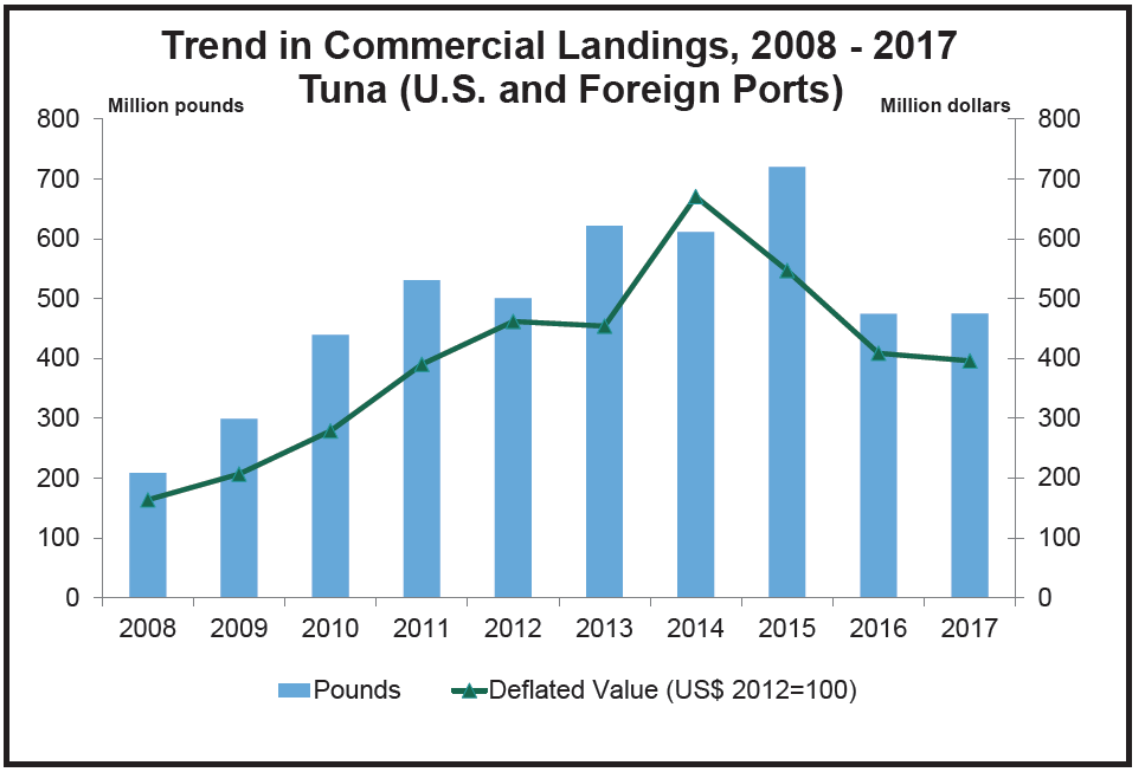

Figure 8: Trends in commercial tuna landings, 2008-2017 (NMFS 2017b).

Common and market names.

Table 1. Common, market and primary product forms of tuna and swordfish (FDA 2019).

Tuna species	Common/Market Name	Product forms
Skipjack tuna	Bonito, lesser tuna, Aku	Fresh, frozen, canned, filet, rounds
Bigeye tuna	Bigeye, Ahi	Fresh, sashimi, frozen, canned, filet, rounds
Yellowfin tuna	Ahi	Fresh, frozen, canned, filet, rounds
Albacore tuna	Germon, Longfinned tuna, Tombo ahi	Fresh, frozen, canned, filet, rounds
Swordfish	Broadbill, Espada, Emperado	Fresh, frozen, filet, rounds
Blue shark	Shark, Mano	Fresh, frozen, filet
Dolphinfish	Mahi mahi, Dorado	Fresh, frozen, filet
Silky shark	Shark	Fresh, frozen, filet
Wahoo	Ono	Fresh, frozen, filet

Primary product forms

See Table 1 above.

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**
Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)

BIGEYE TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Eastern Central Pacific | Floating object purse seine (FAD)	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

BLUE SHARK			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
South Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000: High Concern	1.000: High Concern	Red (1.000)

DOLPHINFISH			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific, Northeast Pacific | Drifting longlines	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Eastern Central Pacific, Southeast Pacific | Drifting longlines	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Eastern Central Pacific | Floating object purse seine (FAD)	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Eastern Central Pacific | Unassociated purse seine (non-FAD)	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

SILKY SHARK			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000: High Concern	1.000: High Concern	Red (1.000)
Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000: High Concern	1.000: High Concern	Red (1.000)
Eastern Central Pacific | Floating object purse seine (FAD)	1.000: High Concern	1.000: High Concern	Red (1.000)

SKIPJACK TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific | Dolphin set purse seine	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Eastern Central Pacific | Floating object purse seine (FAD)	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Eastern Central Pacific | Unassociated purse seine (non-FAD)	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)

SWORDFISH			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	3.670: Low Concern	1.000: High Concern	Red (1.916)
Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	3.670: Low Concern	1.000: High Concern	Red (1.916)

WAHOO			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific | Floating object purse seine (FAD)	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

YELLOWFIN TUNA			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Central Pacific | Dolphin set purse seine	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Eastern Central Pacific | Floating object purse seine (FAD)	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Eastern Central Pacific | Unassociated purse seine (non-FAD)	3.670: Low Concern	5.000: Low Concern	Green (4.284)

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

Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines

Low Concern

The most recent stock assessment for albacore tuna in the eastern North Pacific Ocean (NEPO) was conducted in 2020 using data through 2018 and a length-based, sex-structured modeling approach. It is important to note that this assessment includes eastern and western North Pacific. The population of albacore in the north Pacific has not dropped below the WCPFC-adopted limit reference point (LRP; 20% of the current spawning stock biomass (SSB) when F=0) since 1993. The SSB has been relatively stable since 2000, and the SSB_{2018} was estimated to be 58,858 t, which is 2.3 times larger than the WCPFC LRP threshold of 25,573 t and 3.01 times larger than SSB_{MSY} (ISC 2020). The estimated 2015-2017 spawning potential ratio (SPR; equilibrium spawning stock biomass per recruit that would result from the current year's pattern and intensity of fishing mortality) was 0.50 (ISC 2020). A consistent stock assessment schedule and stable SSB trends yield a "low concern" score for the NEPO albacore tuna abundance despite uncertainties.

Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines

Low Concern

Albacore tuna in the South Pacific was last assessed in 2015. According to the model, the SSB of albacore tuna has been reduced to around 41% (33%–55%) of unfished levels. However, it was concluded that the stock was most likely above both the level corresponding to the MSY and the WCPFC-adoped LRP 20% of the SSB (SSB in the absence of fishing ($20\%SSB_{F=0}$)(Harley et al. 2017)(IATTC 2018c). Additionally, a more recent review by the WCPFC estimated SB_{2015}/SBF=0 = 0.52 with a probable range of 0.37 to 0.63, and there were no individual models where ($SB_{2015}/SB_{F=0}$) < 0.2, which indicated that the probability that recent SSB was below the LRP was zero (WCPFC 2018). While the stock assessment schedule and LRPs are limited for SEPO albacore, extant stock assessment data suggest the stock is not in an overfished state, and SEPO albacore receive a "low concern" score for abundance.

Factor 1.2 - Fishing Mortality

Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines

Low Concern

NEPO albacore are taken in longline, troll and pole-and-line fisheries. The ratio of $F_{2015\text{-}2017}$:F_{MSY} was 0.60 and was at or below all potential F-based reference points, suggesting that that overfishing is not occurring for NEPO albacore (ISC 2020). NEPO albacore therefore receive a "low concern" score for fishing mortality in the longline fishery.

Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines

Low Concern

Over 90% of catches of albacore in the southern Pacific Ocean are taken by the longline fishery (IATTC 2018c). According to the most recent stock assessment of the southern stock (2015), SEPO albacore fishing mortality (F) has generally been increasing over time, and the ratio of the current F to F_{MSY} was less than 1 ($F_{2009\text{-}2012}/F_{MSY}$ = 0.39 (0.20-0.59)(Harley et al. 2017). It is not likely that overfishing is occurring (IATTC 2018c). A recent review by the WCPFC noted that there was a 0% probability (0 out of 72 models) that the recent F had exceeded F_{MSY} (WCPFC 2018). Despite data limitations, the SEPO albacore stock receives a "low concern" for fishing mortality.

Bigeye tuna

Factor 1.1 - Abundance

Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

Moderate Concern

In 2020, a benchmark assessment for bigeye was updated to better account for model uncertainty. This new form of assessment cycle for the IATTC includes a standard assessment approach and a separate risk analyses that considers different model runs (and weights them based on biological feasibility) to create management advice based on risk or management strategy evaluations (IATTC 2020). For all models combined in the risk assessment, bigeye SB_{2020} is 9% above SB_{MSY}, and there is a 47% chance that SB_{MSY} is exceeded. However, there is only a 6% chance that SB_{LIMIT} is exceeded by the estimated SB_{2020} (IATTC 2020b).

It's important to note that there are considerable discrepancies in results depending on selected model attributes. According to the 44 converged reference model runs for 2020 bigeye assessment, the spawning biomass of bigeye at the beginning of 2020 ranged from 51% - 532% of the spawning biomass at the LRP level (IATTC 2020). All short-term models and two environment models estimate that at the beginning of 2020 the bigeye stock is overfished (IATTC 2020). However, the models in the aggregate risk analyses suggest this population is likely not overfished (IATTC 2020b). While the EPO bigeye stock is currently not considered overfished, the significant variations between model estimates and high uncertainty yield a "moderate concern" score for stock status.

Justification:

According to the last full assessment of bigeye tuna in the Eastern Pacific Ocean (2016), 2005-2009 saw a recovering trend for bigeye in the EPO (likely due in part to to IATTC tuna conservation resolutions initiated in 2004). Although the resolutions have continued since 2009, the rebuilding

trend was not sustained during 2010-2013, and the spawning biomass ratio (SBR) gradually declined to a historically low level of 0.16 at the start of 2013. The spawning biomass ratio subsequently increased to 0.21 at the start of 2017 (Aires-da-Silva et al. 2017)(IATTC 2018a). Indicators (CPUE, weight, fleet capacity) were used to assess bigeye tuna in 2019 while the revised stock assessment was conducted, and all bigeye indicators suggested reduced bigeye abundance in the EPO at that time (IATTC 2019b).

Factor 1.2 - Fishing Mortality

Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

Moderate Concern
As with stock status estimates, there is a significant degree of uncertainty surrounding the most recent bigeye assessment fishing mortality estimates (2020). The 2020 risk analysis for management suggests that bigeye F_{2019} is 7% greater than F_{MSY} (50% probability) but does not exceed the F_{LRP} (fishing mortality threshold that should be avoided because fishing harder could endanger the sustainability of the stock). The risk assessment (based on multiple model runs) concludes there is a 5% chance that $F_{2019} > F_{LRP}$ (IATTC 2020).

The 2020 benchmark standard assessment indicates that fishing mortality of bigeye in 2017-2019 ranged from 51% - 223% of the F_{MSY} (roughly half of the model runs suggest that the fishing mortality of bigeye in 2017-2019 is higher than the MSY level). Estimates of F_{2019} of bigeye in 2017-2019 ranged from 32% - 114% of the F_{LRP} (IATTC 2020), and overfishing is unlikely to be occurring (only 3 of 44 models predicted overfishing) (IATTC 2019). Bigeye tuna receive a "moderate concern" for fishing mortality because F is likely fluctuating around F_{MSY}, but there is a very low probability that overfishing is occurring despite uncertainty within the current assessment and risk analyses approach.

Justification:
A partial assessment in in 2019 the IATTC assessed bigeye proxy indicators (catch per day, fleet capacity, etc.), which all suggested exploitation rates were increasing and were likely at or above their reference levels (IATTC 2019b).

Blue shark

Factor 1.1 - Abundance

North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines

Low Concern
The north Pacific stock of blue shark was assessed in 2017. Within the Pacific Ocean, blue sharks are found in both hemispheres, with no genetic evidence of distinct hemispheric populations (ISC

2017b). According to the assessment, the biomass has remained near an all time high since 2005. The SSB in 2015 was 71% above levels needed to produce the MSY (SB_{2015}/SB_{MSY}) (ISC 2017b).

The population of blue shark in the north Pacific is therefore not overfished and receives a "low concern" score for abundance per Seafood Watch Criteria.

South Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern

A stock assessment for blue sharks in the southern Pacific was conducted in 2016 (Takeuchi et al. 2016). However, due to a lack of data, poor model fit and high uncertainty, the authors do not recommend that management decisions rely on the stock status estimates (Takeuchi et al. 2016). Assessments are based on tagging data, differences in abundance, and evidence of pregnant females in high latitudes (in both the North and South Pacific Ocean). The population in the South Pacific is likely a separate population from the North Pacific (Kleiber et al. 2009). The International Union for the Conservation of Nature (IUCN) considers blue sharks to be "Near Threatened" globally (Rigby et al. 2019). We have awarded a score of "high" concern based on the "Near Threatened" IUCN status and high inherent vulnerability of sharks to fishing.

Factor 1.2 - Fishing Mortality

North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines

Low Concern

Blue sharks are widely distributed throughout the North Pacific and dominate shark catches in that region. The primary source of known blue shark fishing mortality is oceanic longline fisheries targeting swordfish and tuna, including mostly shallow-set longline fisheries in temperate waters, and deep-set longline fisheries in more tropical area. Sharks are targeted less often than tunas and swordfish, although new Asian shark markets have been developing for over a decade (Clarke et al. 2014)(ISC 2017b). The last assessment for blue sharks in the North Pacific was conducted in 2016. Fishing mortality rates were estimated to be well below levels needed to produce the maximum sustainable yield ($F_{2012\text{-}2014}/F_{MSY}$ was approximately 37%) (ISC 2017b). Overfishing is likely not occurring for blue sharks, and they receive a "low concern" score for fishing mortality in the EPO longline fishery.

South Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern

Blue sharks are widely distributed throughout the Eastern Central Pacific Ocean including in the South Pacific region. A stock assessment for blue sharks in the southern Pacific was conducted in 2016 (Takeuchi et al. 2016). However, due to a lack of data, poor model fit and high uncertainty, the authors do not recommend that management decisions rely on the stock status estimates (Takeuchi et al. 2016). Some trends in catch rates for various fisheries have been analyzed. We have awarded a score of "high" concern because there is little information on fishing mortality, they are highly susceptible to longline capture, and there are no management measures in place.

Justification:

In the South Pacific, catch rates declined until 2003 and have since increased to mid-1990's levels.

There has been no trend in the size or sex of blue sharks in any part of the WCPO over time (Walsh et al. 2009),(Clarke 2011). Some information on catch levels is available. In the EPO, blue shark catch in longlines increased in 2011 to near 10,000 t and has fluctuated near that value ever since (IATTC 2019k). There was no distinction between southern or northern stock. The 2017 preliminary blue shark catch estimates in the EPO were around 6,900 t (IATTC 2019k).

Dolphinfish

Factor 1.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Moderate Concern
An exploratory stock assessment was conducted on mahi mahi (also known as dorado, dolphinfish) from the southern EPO in 2016. The spawning stock biomass remained fairly stable since 2007, with a slight decrease during 2010. Some common reference points used for species such as tuna were assessed for mahi mahi. The spawning biomass ratio to that of the unfished stock averaged 0.20 for the time series (IATTC 2016g). The IUCN assessed mahi mahi as a species of Least Concern (Collette et al. 2011a). There is a high degree uncertainty surrounding reference points for dolphinfish (especially in the western Pacific), however the IUCN rates this species as Least Concern; therefore, dolphinfish receive a moderate concern score for abundance due to data limitations.

Factor 1.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Moderate Concern
Fishing mortality rates for mahi mahi in the Eastern Pacific Ocean compared to reference points are unknown. However, the Inter-American Tropical Tuna Commission (IATTC) conducted an exploratory stock assessment which suggests that fishing mortality rates have decreased slightly since 2007 and the fishing mortality needed to produce the maximum sustainable yield is two times more than current levels {Aires da Silva et al 2016}. However, according to (Aires da Silva et al. 2016), the geographic range of the exploratory stock assessment includes the "core" region of the EPO stock, but there is uncertainty in areas north of the Equator (Aires da Silva et al. 2016).

Mahi mahi are caught as bycatch and targeted in longline fisheries in the Eastern Pacific Ocean. The IUCN does not consider there to be any major threats to mahi mahi from commercial fishing (Collette et al. 2011a). Preliminary analysis shows variable, but somewhat steady, catch per unit effort trends in abundance. Commercial fishing does not appear to be a major threat, the catch per unit effort has been somewhat stable over time, and the preliminary stock assessment states that

current fishing mortality rates of 50% of the maximum sustainable yield. However, due to the uncertainty levels in areas north of the Equator, we have awarded a score of moderate concern.

Eastern Central Pacific, Southeast Pacific | Drifting longlines

Low Concern

According to an exploratory stock assessment in 2016, dolphinfish fishing mortality rates have decreased slightly since 2007, and the analysis suggests that the fishing mortality is roughly 50% of MSY (IATTC 2016g). Another study from Guatemala estimated a fishing mortality rate of 4.53 for mahi mahi (Bran 2010) and an exploitation rate (artisanal fishery) of 0.36 in 2008 (Ixquiac and Juarez 2014). Preliminary analyses show variable but steady CPUE (IATTC 2016g). We have therefore awarded a "low concern" score because commercial fishing does not appear to be a major threat and CPUE has been somewhat stable over time.

Justification:

Dolphinfish are caught as bycatch and target in longline fisheries and purse seine fisheries (IATTC 2013). From 1993-2018, the average annual total catch of mahi mahi in purse seine fisheries was roughly 442,000 individuals (primarily taken in FAD sets)(IATTC 2019d). Reported catches of dolphinfish have declined, from a high of 71,000 t in 2009 to 14,000 t in 2016 (IATTC 2018c). The International Union for Conservation of Nature (IUCN) does not consider there to be any major threats to mahi mahi/dolphinfish from commercial fishing (Collette et al. 2011a).

Silky shark

Factor 1.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

High Concern

Silky sharks are assessed as "Vulnerable" with a decreasing population trend by the IUCN (Rigby et al. 2017), and they therefore receive a "high concern" score based on their IUCN rating and unknown population status.

Justification:

Due to data limitations and uncertainty, the IATTC has been unable to conduct a full silky shark assessment specific to the EPO, however a more recent assessment explored a Pacific-wide silky shark stock assessment. Results suggest that the biomass of silky sharks has declined significantly in the last 20 years, although there is much uncertainty and these values are not adequate for regulatory action (IATTC 2018e).

In 2014, the IATTC proposed a suite of possible stock status indicators, including standardized bycatch-per-set (BPS) indices from the purse-seine fishery, that could be considered for managing the silky shark regionally. As a proxy for abundance, the BPS of silky sharks caught in purse seine

sets made on floating objects decreased dramatically in the EPO in late 1990's and has been slightly increasing to stable in recent years (not approaching historic levels)(Figure A) (IATTC 2019e).

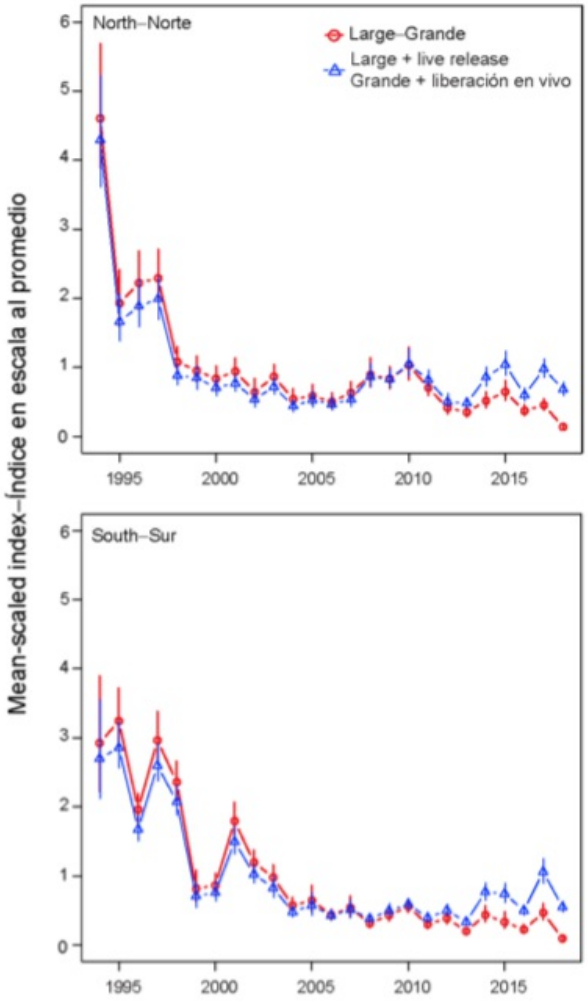

Figure 9: Mean-scaled standardized silky shark bycatch-per-set (BPS; in numbers of sharks per set) in sets on floating objects for large sharks, with and without live release, in the north (top) and south (bottom) EPO. Vertical bars indicate pointwise approximate 95% confidence intervals (IATTC 2019e).

Purse seine indices of abundance were updated in 2019, which indicated a decrease in silky sharks (index) in 2018 compared to 2017 in both areas (IATTC 2019e). Recent research suggests a correlation between north EPO silky shark indices and oceanographic condition variability (e.g. El Nino), especially for small and medium sharks (IATTC 2019e)(Lennert-Cody et al. 2019).

Factor 1.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines

Eastern Central Pacific, Southeast Pacific | Drifting longlines

Eastern Central Pacific | Floating object purse seine (FAD)

High Concern

Silky sharks are caught as bycatch in purse seine and longline fisheries operating in the Eastern Pacific Ocean but are also targeted, in small amounts, in some longline fisheries (IATTC 2013g). Fishing pressure from longline and purse seine fisheries targeting tunas and swordfish is high, and it is the main shark species caught in fisheries using FADs as well as longline fisheries in the eastern Pacific. Research suggests that silky shark diet composition parallels FAD-associated prey items, and silky sharks may be modifying their behavior to target FAD sets. This could in turn increase silky shark fishing mortality in FAD-associated sets, where it is already likely very high (IATTC 2019e) (IATTC 2018e)(Rigby et al. 2017).

The most recent attempt at a stock assessment for this species indicated that the current fishing mortality rates are unknown but that they have likely increased significantly in the last 20 years (IATTC 2018e). The IUCN assessment indicates that incidental capture in purse seine fisheries is a major threat to this species (Rigby et al. 2017), and therefore, cumulative fishing mortality of silky sharks is "high concern".

Skipjack tuna

Factor 1.1 - Abundance

Eastern Central Pacific | Dolphin set purse seine

Eastern Central Pacific | Floating object purse seine (FAD)

Eastern Central Pacific | Unassociated purse seine (non-FAD)

Low Concern

Due to the complexity associated with skipjack tuna stock assessments (neither biomass or fishing mortality reference points are available), the latest skipjack tuna assessment is based on indicators to assess relative trends in biomass. According to the indicators tracked and associated simplistic stock assessment, both skipjack biomass and recruitment have been increasing over the past 20 years, and were above their respective upper reference levels in 2015 and 2016. However, the average skipjack weight was at or below its lower reference level 2015-2017. A high degree of uncertainty exists with regards to stock status, however, most indicators and model-estimates suggest the skipjack population is moderately stable (it does not appear to be any indication the population is overfished) (IATTC 2019c), and skipjack tuna receives a "low concern" score for abundance.

Justification:

Skipjack tuna are a challenging species to assess due to high and variable productivity (annual recruitment is a large proportion of total biomass) and challenges around estimating the impacts of fishing mortality (IATTC 2019c). In response, the IATTC evaluates eight indicators to track skipjack tuna biomass and recruitment relative to historic levels. Indicators include: skipjack catch, standardized effort (sum of days of fished for FAD and NOA fisheries), catch per unit effort (CPUE).

A simple stock assessment is also used to estimate proxies of biomass, recruitment and exploitation rates (IATTC 2019c).

Factor 1.2 - Fishing Mortality

Eastern Central Pacific | Dolphin set purse seine
Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Moderate Concern
Similar to biomass for skipjack tuna, fishing mortality is tracked via a suite of indicators (including catch, days fished) to assess exploitation rates. The standardized effort indicator of exploitation rate increased starting in the early 1990s and has been above the average level since about 2000. The most recent skipjack stock indicator assessment (2019) suggests the long-term pattern in reduced average skipjack weight may be "due to increasing fishing mortality resulting from the increasing number of sets." However, it is unknown if the current fishing mortality levels are appropriate because there are no reference points for skipjack tuna in the EPO (IATTC 2019c). The report goes on to add that any continued decline in average length is a concern with regards to fishing mortality. Recruitment and biomass indicators used to determine the status of skipjack tuna in the EPO have not generally indicated significant negative effects to the population from increased fishing (Maunder 2017), however, due to the high degree of uncertainty and increasing exploitation rates, skipjack tuna in the EPO receive a "moderate concern" score for fishing mortality.

Swordfish

Factor 1.1 - Abundance

Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines

Low Concern
An assessment for swordfish in the North Pacific was conducted in 2018. Although there are no agreed-upon reference points, the female biomass in 2016 was estimated to be 29,403 mt, which is around 87% above the maximum sustainable yield (MSY) level (ISC 2018b). The spawning potential ratio of the stock is currently estimated at 45% (ISC 2018a)(IATTC 2018c). Model sensitivity analysis revealed a few runs that indicated the stock was overfished and the assessment does not incorporate model uncertainty (ISC 2018a). Swordfish in the north Pacific likely are not overfished, but because the base case model does not incorporate uncertainty and there is a lack of reference points, we score abundance as low concern rather than very low concern.

Justification:
The IATTC considers two populations of swordfish, one in the Western and Central Pacific (subregion 1), which includes part of the Eastern Pacific Ocean and one population in the Eastern Pacific (subregion 2). The EPO population is further broken out into two stocks in the northeastern

Pacific Ocean (NEPO) and the southeastern Pacific Ocean (SEPO: south of about 5°S) based on extant genetic and fishery data (IATTC 2016f).

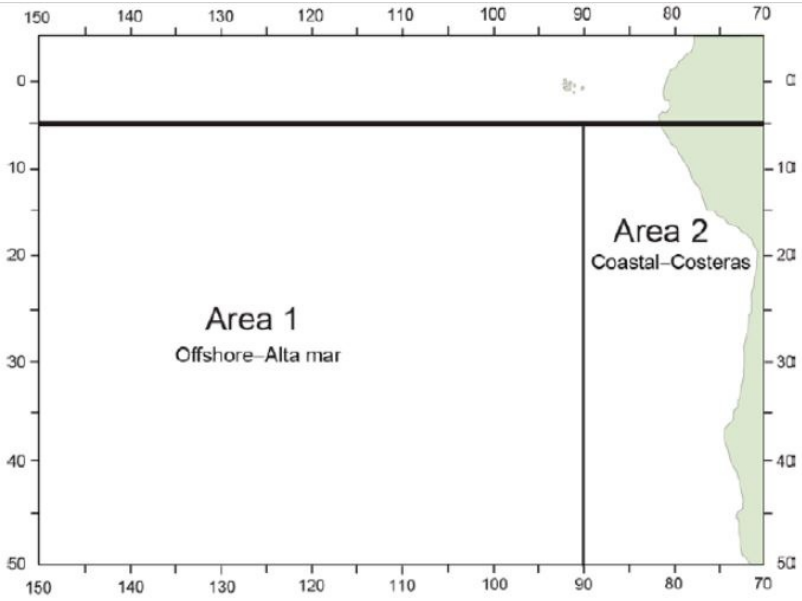

FIGURE 2.1. Area stratification for analysis of swordfish stocks in the eastern Pacific Ocean.

Figure 10: Area stratification for analysis of swordfish stocks in the eastern Pacific Ocean (IATTC 2011a).

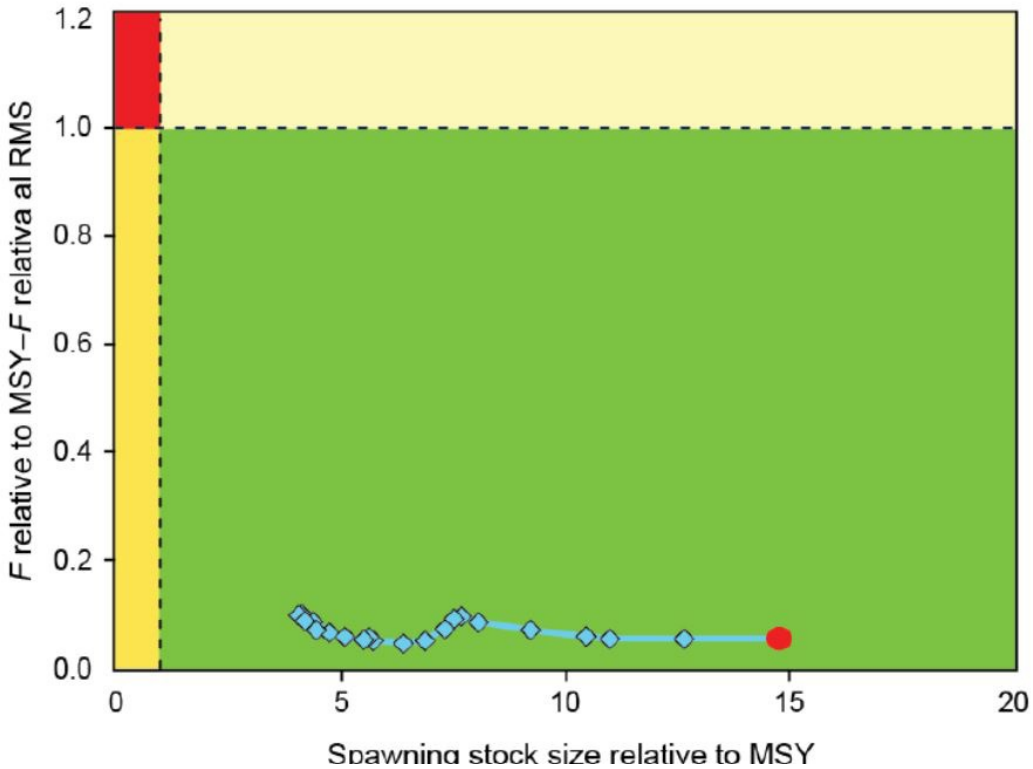

Figure 11: The relationship between spawning stock biomass relative to maximum sustainable yield (MSY) and fishing mortality rate (F) to MSY (IATTC 2011a).

Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines

Low Concern

The EPO swordfish population is generally recognized as two stocks: 1) in the NEPO, and 2) in the southeastern Pacific Ocean (SEPO: south of about 5°S) based on extant genetic and fishery data (IATTC 2016f). The most recent assessment of the stock of swordfish in the SEPO (2011 data) suggested that the swordfish stock in the SEPO is not overfished, the spawning biomass ratio was estimated at roughly 1.45, indicating that the SSB is about 50 percent above the carrying capacity, and substantially above the level which is expected to produce catch at the MSY level (IATTC 2018c). In light of high recruitment years and other stock assessment findings, the SEPO swordfish stock receives a "low concern" score for abundance despite the outdated stock assessment.

Factor 1.2 - Fishing Mortality

Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines

High Concern

With updated catch data considered and no new stock assessment, it likely that overfishing is occurring in recent years. The recent average yield of roughly 23,000 mt is almost four times higher than the 2014-estimated MSY (5,490 mt)(ISC 2014). It unknown whether fishing mortality rates are sustainable in the long term, and NEPO swordfish therefore receives a "high concern" score for

fishing mortality.

Justification:
Based on the most recent assessment (2014) of NEPO swordfish using a sex-specific age-structured assessment method, at the current level of fishing effort, there is negligible risk of the spawning biomass decreasing to less than 40% of its unfished level (IATTC 2018c). However, catches across the EPO (including the southern region) have increased dramatically since that time. During 1999-2008 the longline catch averaged 12,000 t, but during 2014-2016 this almost doubled, to over 23,000 t. The cause of this dramatic increase is unknown; it could be due to increased abundance of swordfish, increased effort directed toward the species, increased reporting, or a combination of all of these (IATTC 2019h).

Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
Swordfish are primarily caught by longline fishing gear in the EPO. In the southern EPO, swordfish catches have been steadily increasing since about 2005, and recent average annual catches over the past 5 years (27,098 t) exceed the estimated MSY (IATTC 2018c). In light of the limited assessment schedule and observer coverage, catches exceeding MSY in the past five years, and increased fishing effort, SEPO swordfish receive a "high concern" score for fishing mortality.

Justification:
While exploitation rates in this region are considered sustainable because there is no indication of a significant impact of fishing on this stock, the results of the assessment did suggest an expansion of the fishery onto components of the stock that were previously not, or were only lightly, exploited. And this has been confirmed; longline effort increased from 111 million hooks in 2008 to 174 million hooks in 2016 (IATTC 2018c).

Wahoo

Factor 1.1 - Abundance

Eastern Central Pacific | Floating object purse seine (FAD)

Moderate Concern
Wahoo are listed as a species of "Least Concern" by the IUCN (Collette et al. 2011c). They are widespread in the EPO, and there are no targeted fisheries for them, but they are caught as bycatch and are increasingly retained (Hall & Ramon 2013). No population assessments have been conducted in this region. Data limitations coupled with an IUCN "Least Concern" rating yield a "moderate concern" score for wahoo in the EPO.

Factor 1.2 - Fishing Mortality

Eastern Central Pacific | Floating object purse seine (FAD)

Moderate Concern

Although no targeted fisheries occur for wahoo in the EPO, they are caught as bycatch in several fisheries including purse seine and longline fisheries and are increasingly retained. Catches of wahoo the region have been increasing over the past 20 years, with a particularly sharp uptick around 2006. Higher catches of wahoo are likely related to changes in longline data reporting and an increasing number of floating object purse seine sets (Collette et al. 2011c)(IATTC 2018c). Roughly 368 t and 243 t of wahoo were caught in 2017 in purse seine and longline fisheries, respectively (IATTC 2018c). Fishing mortality is unknown for this species, and wahoo therefore receive a "moderate concern" score for fishing mortality in longline and purse seine fisheries.

Yellowfin tuna

Factor 1.1 - Abundance

Eastern Central Pacific | Dolphin set purse seine
Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Low Concern

Annual recruitment of yellowfin has been near or below average since 2003 (IATTC 2019)(IATTC 2019a)(IATTC 2018c). The 2020 full assessment for yellowfin tuna estimated that SB_{2020} ranged from 49% - 219% of the target reference point SB_{MSY}. The probability that the spawning biomass at the beginning of SB_{2020} is lower than SB_{MSY} is 50% or less for 13/48 models. The risk analyses for yellowfin with model estimates aggregated indicate there is a 12% chance overall that SB_{2020} is lower than SB_{MSY} (IATTC 2020b), and the probability that the SB_{2020} is below the SB_{LRP} ranges from 0% - 2% (IATTC 2020c).

Similar, to bigeye tuna, there are considerable discrepancies in results depending on selected model attributes and the steepness of the stock-recruit curve. Additional uncertainty relates to spatial structure and differing trends by fishery (longline, purse seine type, etc.) There are still models that estimate the yellowfin stock may be overfished {IATTC 2019c), however most model runs in aggregate indicate this is highly unlikely {IATTC 2020b; IATTC 2020c}. In summary, there is some conflicting information about stock status; however the majority of models indicate this stock is not overfished, and yellowfin tuna receive a "low concern" score for abundance in the EPO.

Justification:

Yellowfin tuna in the eastern Pacific Ocean were last fully assessed during the 2017 cycle (IATTC

2018c). At that time, there was a high degree uncertainty concerning recent and future recruitment and biomass levels, with the potential for three different regimes since 1975 (IATTC 2018c). In 2019, the IATTC was unable to reconcile the trend data for the full assessment model, so the assessment and management for 2019/20 yellowfin tuna abundance is based on a set of proxy indicators for the most recent year. Indicators from 2019 of relative abundance (CPUE across gear types, length) have been at low levels since 2010, however the average length of fish has increased (IATTC 2019).

Factor 1.2 - Fishing Mortality

Eastern Central Pacific | Dolphin set purse seine
Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Low Concern

The average fishing mortality rate has been increasing for all age classes of yellowfin tuna since 2009 (IATTC 2019a), in large part due to increasing effort from object associated fisheries. The point estimate of the fishing mortality in 2017-2019 ranged from 40% - 168% of the F_{MSY} (IATTC 2020c). The probability that the fishing mortality of yellowfin in 2017-2019 is higher than the F_{MSY} level is 50% or more for only 14/48 models. The risk analyses with aggregated model runs indicates that there is only 9% chance that $F>F_{MSY}$(IATTC 2020b). Additionally, the point estimate of the $F_{2017\text{-}2019}$ ranged from 22% - 65% of the LRP (IATTC 2020c). The probability that the fishing $F_{2017\text{-}2019} > F_{LRP}$ was estimated to be zero for all models (IATTC 2020b). In summary, the majority of models indicate that F is within target and limit reference points, and yellowfin tuna receive a "low concern" score for fishing mortality.

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**
Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)

BIGEYE TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)

BLUE SHARK			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
South Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)

DOLPHINFISH			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific | Unassociated purse seine (non-FAD)	1.000	1.000: < 100%	Red (1.000)

SILKY SHARK			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)

SKIPJACK TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Central Pacific | Dolphin set purse seine	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific | Unassociated purse seine (non-FAD)	1.000	1.000: < 100%	Red (1.000)

SWORDFISH			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)

WAHOO			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)

YELLOWFIN TUNA			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Central Pacific | Dolphin set purse seine	1.000	1.000: < 100%	Red (1.000)
Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific | Floating object purse seine (FAD)	1.000	1.000: < 100%	Red (1.000)
Eastern Central Pacific | 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.

EASTERN CENTRAL PACIFIC | DOLPHIN SET PURSE SEINE			
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)
Spinner dolphin	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Hawksbill turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Olive Ridley turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Pantropical spotted dolphin	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Skipjack tuna	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Yellowfin tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)

EASTERN CENTRAL PACIFIC | FLOATING OBJECT PURSE SEINE (FAD)			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Pacific bluefin tuna	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)
East Pacific green sea turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Loggerhead turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Olive Ridley turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Bigeye tuna	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Dolphinfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Rainbow runner	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Wahoo	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Yellowtail amberjack	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Skipjack tuna	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Yellowfin tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)

EASTERN CENTRAL PACIFIC | 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)
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Dolphinfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Rainbow runner	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Yellowtail amberjack	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Skipjack tuna	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Yellowfin tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)

EASTERN CENTRAL PACIFIC, NORTHEAST PACIFIC | DRIFTING LONGLINES			
SUB SCORE: 1.000	DISCARD RATE: 1.000		**SCORE: 1.000**
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Laysan albatross	1.000: High Concern	1.000: High Concern	Red (1.000)
Black-footed albatross	1.000: High Concern	1.000: High Concern	Red (1.000)
East Pacific green sea turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
False killer whale	1.000: High Concern	1.000: High Concern	Red (1.000)
Hawksbill turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Whitetip shark	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)
Silky shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Olive Ridley turtle	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Swordfish	3.670: Low Concern	1.000: High Concern	Red (1.916)
Bigeye tuna	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Wahoo	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Dolphinfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Sailfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Shortfin mako shark	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Blue marlin	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Blue shark	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Yellowfin tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)

EASTERN CENTRAL PACIFIC, SOUTHEAST PACIFIC | DRIFTING LONGLINES			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Laysan albatross	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)
Loggerhead 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)
Whitetip 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)
False killer whale	1.000: High Concern	1.000: High Concern	Red (1.000)
Hawksbill turtle	1.000: High Concern	1.000: High Concern	Red (1.000)
Blue shark	1.000: High Concern	1.000: High Concern	Red (1.000)
Black-footed albatross	1.000: High Concern	1.000: High Concern	Red (1.000)
Olive Ridley turtle	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Swordfish	3.670: Low Concern	1.000: High Concern	Red (1.916)
East Pacific green sea turtle	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Wahoo	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Sailfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Bigeye tuna	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Dolphinfish	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Albacore	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Blue marlin	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Yellowfin tuna	3.670: Low Concern	5.000: Low Concern	Green (4.284)

Purse Seine Fisheries

EPO purse seine fisheries target tunas but also catch incidental species such as sharks, bony fish and marine mammals. Bycatch composition depends on the type of purse seine fishery (unassociated, dolphin or floating object). IATTC catch and discard data by fishery 1993-2017 were used to identify main species included in this report (IATTC 2019f) . Most main species were included because the EPO tuna purse seine fishery likely constitutes greater than 20% of the total fishing mortality for the species (wahoo, rainbow runner, bluefin tuna, dolphinfish, yellowtail) or are highly vulnerable and/or threatened (silky shark, whitetip shark, spinner dolphin, spotted dolphin, rays).

Silky sharks limited the C2 score for all purse seine fisheries due to their "Vulnerable" IUCN status, decreasing population trend (Rigby et al. 2017) and likely increasing fishing mortality rates. Additional C2 limiting species for the floating object associated fishery included Pacific bluefin tuna (due to their overfished status and high fishing mortality rates) and oceanic whitetip sharks due to their ESA "Threatened" status and historical overexploitation. Rays also limited the C2 score for the unassociated

fishery due to their inherent vulnerability and limited data.

Sea turtle mortalities in the purse seine fisheries are relatively rare. In 2017 a total of 590 interactions occurred involving purse seine and sea turtle interactions and 4 total mortalities. Sea turtles were included in the purse seine review if any mortalities occurred for a given species 2013-2017. Because mortalities are so rare and comprise a negligible percentage of overall fishing mortality for turtles, purse seine fishery C2 scores were not limited by sea turtle interactions.

Longline Fisheries

EPO longline fisheries target tunas and swordfish but also incidentally captures billfish, sharks, sea turtles and seabirds. Data on bycatch in the EPO longline fisheries are lacking. There is currently no IATTC-coordinated longline observer program, but requirements were implemented in January 2013 mandating 5% longline coverage for vessels longer than 20 m and recording of seabird, sea turtle and shark interactions by national observer programs (Clarke et al. 2014). Bycatch species were included based on two primary criteria: constituting at least 1% - 5% of the total catch and/or due to their vulnerable status and potential interactions (i.e. overfished, endangered) per the Seafood Watch criteria and a recent ecological risk assessment provided by the IATTC (IATTC 2017b)(IATTC 2017c). Data sources included IATTC and FAO bycatch reports and presentations as well as IATTC catch statistics and independent analysis of potential bycatch issues. The additional species included in this report, the justification for their inclusion and the source of information are included in the table below.

Sea turtles and seabirds generally limited the C2 scores for the EPO longline fishery due to their endangered and/or threatened status and potential to interact with longline gear.

Species	Justification	Source
silky shark	Common shark bycatch; Status	IATTC 2017b; IATTC 2017c; IATTC 2018c
blue shark	Common shark bycatch	IATTC 2017c; IATTC 2017b
dolphinfish	Common large fish bycatch	IATTC 2017b; IATTC 2017c
indopacific sailfish	Common large fish bycatch	IATTC 2017b; IATTC 2017c
olive ridley	Status	IATTC 2018c
green turtle	Status	IATTC 2018c
hawksbill	Status	ATTC 2018c
leatherback	Status	ATTC 2018c
loggerhead	Status	ATTC 2018c
black-footed albatross	36% overlap with convention area; Status	Anderson 2009
Laysan albatross	5% overlap with convention area; Status	IATTC 2018c
Blue marlin	Common billfish bycatch; Status	IATTC 2017c; IATTC 2017b; IATTC 2018c
Striped marlin	Common billfish bycatch; Status	IATTC 2017c; IATTC 2017b; IATTC 2018c
Shortfin mako shark	Common shark bycatch; Status	IATTC 2017c; IATTC 2017b; IATTC 2018c
False killer whale	Reported interactions; Status	IATTC 2017c; IATTC 2017b; IATTC 2019j

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

Black-footed albatross

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern

According to the International Union for Conservation of Nature (IUCN), black-footed albatross are classified as Near Threatened with a stable or increasing population trend (BirdLife International 2017). The previous assessment's, classified this species as Endangered and Vulnerable but recent data suggest rapid population declines are no longer occurring {Birdlife International 2017}. Although their populations may have stabilized, they remain at depleted levels relative to historic populations, and we have awarded a high concern score based on the depleted population abundance and IUCN Near Threatened status.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern

Black-footed albatross have been identified as a species of concern for longline fisheries operating in the Eastern Pacific Ocean (EPO) (IATTC 2006). It is estimated that 36% of their distribution during the breeding season occurs within the convention area of the Inter-American Tropical Tuna Commission (Anderson 2009). Low observer coverage makes it difficult to estimate seabird mortality in longline fisheries; however albatross species are one of the most susceptible to incidental longline capture (Anderson 2009b). It has been estimated that more than 4,000 birds (all species combined) are killed within IATTC waters per year (Anderson 2009b). While the IATTC does require two bycatch mitigation measures be in place to reduce seabird takes, the efficacy of these measures is unknown, and black-footed albatross receive a "high concern" score due to a lack of fishing data and species overlap with the fishery.

Justification:

The IATTC has a list of best practice recommendations as described by the 2013 Seabird Bycatch Working Group. These recommendations include branchline weighting, setting at night, bird scaring devices, etc. (IATTC 2014). Under resolution C-11-02, vessels greater than 20 m in length are required to use at least two of the recommended seabird bycatch mitigation techniques. The efficacy of this measure is unknown due to limited observer coverage (IATTC 2018g).

Blue marlin

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Low Concern
Blue marlin are classified as IUCN Vulnerable with a decreasing population trend (Collette et al. 2011). The most recent stock assessment for blue marlin (2016) is Pacific-wide and indicated the time series of spawning stock biomass and recruitment estimates show a long-term decline in spawning stock biomass and a fluctuating pattern without trend for recruitment. Population biomass (age-1 and older) averaged roughly 130,965 t in 1971-1975, the first five years of the assessment time frame, and has declined by approximately 40% to 78,082 t in 2014. Female spawning biomass was estimated to be 24,809 t in 2014, or about 25% above SSB_{MSY} (ISC 2016). Blue marlin are IUCN Vulnerable with a decreasing trend, but abundance and stock status are still above regional target reference points, and they are not considered overfished. In light ongoing data uncertainties, blue marlin receive a "low concern" score for abundance.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Low Concern
Blue marlin are frequently caught and retained in the EPO longline fishery (IATTC 2017b), although data are limited. Results from the base case assessment model indicate that the Pacific blue marlin stock is currently not overfished and is not experiencing overfishing relative to either MSY-based or $F_{20\%}$-based biological reference points. Fishing mortality on the stock (average F, ages 2 and older) averaged roughly F = 0.28 during 2012-2014, or about 12% below F_{MSY}. The estimated spawning potential ratio of the stock (SPR, the predicted spawning output at the current F as a fraction of unfished spawning output) is currently $SPR_{2012\text{-}2014}$ = 21% (ISC 2016). In summary, while data are limited due to low observer coverage, the best available information suggests that blue marlin fishing mortality is within reasonable target reference points, and blue marlin receive a "low concern" score for fishing mortality.

East Pacific green sea turtle

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

High Concern
The IUCN has classified green sea turtles worldwide as Endangered with a decreasing population trend (Seminoff 2004). Wallace et al. (2011, 2013) identified the Northwest Pacific Regional Management Unit (RMU) of green sea turtles as at high risk of population decline, but with low threats (i.e., combination of bycatch, take, coastal development, pollution/pathogens and climate change) (Wallace et al. 2011) (Wallace et al. 2013). The southwest Pacific RMU had low risk, but

high threats, while the Coral Triangle had high risk and high threats and a critical need for data. Finally, the West Central Pacific RMU had low risk and low threats. (Wallace et al. 2011). We have awarded a "high concern" score because more than one RMU is at high risk of population decline and some have high threat levels.

Justification:
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). The United States has listed the central north Pacific distinct population segment (DPS) as Endangered under the Endangered Species Act (ESA) and the central Pacific DPS is listed as Threatened under the ESA.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines

High Concern
Data are extremely limited on sea turtle bycatch in the EPO longline fleets. Hawksbill and green sea turtles had the second and third highest estimated mean interaction rates for the EPO longline fleet respectively (olive ridley turtles have the highest)(Clarke et al. 2014)(Wallace et al. 2013). Fishing mortality is unknown for Pacific Ocean longline fisheries, and the Unknown Bycatch Matrix scores sea turtles as highly susceptible to bycatch in EPO longline fisheries. Hawksbill and green sea turtles therefore receive a "high concern" score for fishing mortality.

Justification:
Hawksbill and green sea turtles are reported as incidentally captured in longline fisheries in the EPO but the impacts are considered unknown (Wallace et al. 2013)(IATTC 2018c).The incidental capture of hawksbill turtles has been identified as adversely affecting their recovery worldwide, although initial declines in the population of hawksbill turtles is mainly a factor of historical targeting of this species (Mortimer and Donnelly 2008). The incidental capture in fisheries is considered a major threat to green sea turtles worldwide (Seminoff 2004).

Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

Low Concern
Eastern Pacific green sea turtles, hawksbill and leatherback turtles interact with purse seine fishing gear, however, turtle mortalities have declined significantly since the mid-2000s due to safe handling guidelines and release procedures (IATTC 2018c). The encounter rate in purse seine fisheries ranges from 0% to 1.6%, being highest in animal associated sets, followed by log sets (0.8%) (Hall & Ramon 2013). One green sea turtle mortality occurred in the EPO object associated purse seine fishery in 2013; one loggerhead turtle mortality occurred the EPO object associated purse seine fishery in 2014; and one hawksbill mortality occurred in an EPO dolphin associated set in 2014 (IATTC 2018c). It's important to note these fisheries are 100% observed, so these are not

considered minimum estimates.We have awarded a "low concern" due to the low interaction rates between object associated sets and green sea turtles/ loggerhead turtles and dolphin associated sets and hawksbill turtles, which suggests that purse seines may not be a substantial contributor to green sea turtle, loggerhead turtle, and/or hawksbill turtle fishing mortality in tuna fisheries in the EPO.

False killer whale

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
False killer whales were listed as Data Deficient on the IUCN Red List in 2008, and the species remains data-poor for most of its range. More recent information resulted in the updated rating of IUCN Near Threatened in 2018 {Baird 2019}. There are a number of different stocks globally, and abundance trends are unclear for most stocks. However, the IUCN notes that there has been an estimated population decline of >50% in two generations in the one population that has been quantitatively assessed, with the primary cause thought to be fishery interactions, and the Hawaiian Islands Insular Distinct Population Segment is ESA Endangered. In light of the endangered status of some portions of the false killer whale population, the unknown stock status of pelagic false killer whales, and their IUCN Near Threatened Status, pelagic false killer whales receive a "high concern" score for abundance per Seafood Watch criteria.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
Data on marine mammal takes and bycatch in EPO longline fisheries are limited. The United States is the only country that has 100% coverage on shallow sets and roughly 20% observer coverage on deep sets in the IATTC convention area (IATTC 2019f). While fishing mortality is therefore largely unknown and unreported, the 2018 United States Annual Observer Program Report did confirm three "catches" of false killer whales in the US deep set fishery in 2018 (IATTC 2019i). Cumulative and EPO longline fishing mortality of false killer whales is largely unknown, and the Seafood Watch Unknown Bycatch Matrix scores vulnerable marine mammals as susceptible to bycatch in EPO pelagic longline fisheries. False killer whales receive a "high concern" score for fishing mortality in EPO longline fisheries due to the significant probability of interactions with this fleet.

Justification:
The overlap of false killer whale diet with species targeted by large-scale fisheries, in particular high-value species such as tunas and billfishes, results in a number of types of interactions that can reduce local populations, although the sparseness of observer coverage in most hook-and-line and other fisheries limits data availability (Baird 2018). One study did estimate the incidental catch rate (including animals hooked but released alive) from 1992-2005 from observers in the Spanish

longline fleet to be 1.464, 1.685, and 0.797 individuals per million hooks for the Atlantic, Indian, and Pacific Oceans, respectively (Ramos-Cartelle & Mejuto 2008). While overall mortality is unknown, available information suggests that the EPO longline fishery is likely to interact with false killer whales, however, the impacts of fishing on the population are unknown due to data limitations.

Hawksbill turtle

Factor 2.1 - Abundance

Eastern Central Pacific | Dolphin set purse seine
Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
The IUCN has classified hawksbill turtles as Critically Endangered with a decreasing population trend (Mortimer and Donnelly 2008). The North Central, West Central and West Pacific hawksbill RMUs are at a high risk of population decline with high threats (Wallace et al. 2011)(Wallace et al. 2013). 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. It has been estimated that populations in the Pacific Ocean have declined by over 75% over three generations (Mortimer and Donnelly 2008). In the Western Pacific, 7 out of 10 nesting locations have depleted or declining populations (Mortimer and Donnelly 2008). Hawksbill sea turtles are listed as Endangered under the US ESA throughout their range (NOAA 2017). We have awarded a "high concern" score based on the IUCN and ESA listings and because more than one RMU is at high risk with high threats

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Dolphin set purse seine

Low Concern
Eastern Pacific green sea turtles, hawksbill and leatherback turtles interact with purse seine fishing gear, however, turtle mortalities have declined significantly since the mid-2000s due to safe handling guidelines and release procedures (IATTC 2018c). The encounter rate in purse seine fisheries ranges from 0% to 1.6%, being highest in animal associated sets, followed by log sets (0.8%) (Hall & Ramon 2013). One green sea turtle mortality occurred in the EPO object associated purse seine fishery in 2013; one loggerhead turtle mortality occurred the EPO object associated purse seine fishery in 2014; and one hawksbill mortality occurred in an EPO dolphin associated set in 2014 (IATTC 2018c). It's important to note these fisheries are 100% observed, so these are not considered minimum estimates.We have awarded a "low concern" due to the low interaction rates between object associated sets and green sea turtles/ loggerhead turtles and dolphin associated sets and hawksbill turtles, which suggests that purse seines may not be a substantial contributor to green sea turtle, loggerhead turtle, and/or hawksbill turtle fishing mortality in tuna fisheries in the EPO.

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern

Data are extremely limited on sea turtle bycatch in the EPO longline fleets. Hawksbill and green sea turtles had the second and third highest estimated mean interaction rates for the EPO longline fleet respectively (olive ridley turtles have the highest)(Clarke et al. 2014)(Wallace et al. 2013). Fishing mortality is unknown for Pacific Ocean longline fisheries, and the Unknown Bycatch Matrix scores sea turtles as highly susceptible to bycatch in EPO longline fisheries. Hawksbill and green sea turtles therefore receive a "high concern" score for fishing mortality.

Justification:

Hawksbill and green sea turtles are reported as incidentally captured in longline fisheries in the EPO but the impacts are considered unknown (Wallace et al. 2013)(IATTC 2018c).The incidental capture of hawksbill turtles has been identified as adversely affecting their recovery worldwide, although initial declines in the population of hawksbill turtles is mainly a factor of historical targeting of this species (Mortimer and Donnelly 2008). The incidental capture in fisheries is considered a major threat to green sea turtles worldwide (Seminoff 2004).

Laysan albatross

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern

Laysan albatross are listed as Near Threatened with a stable population trend. Globally, there are estimated to be over 1.6 million mature birds (Birdlife International 2019). This species declined significantly in the late 1990s and early 2000s, and has stabilized since then. However, given the difficulty of predicting long-term trends for such a long-lived species in light of changing oceanic conditions, the species is projected to undergo a moderately rapid population decline over three generations (84 years)(Birdlife International 2019). Laysan albatross receive a "high concern" score for abundance due to their IUCN status.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern

Laysan albatross have a 5% distributional overlap with the IATTC area in the Eastern Pacific Ocean EPO {Anderson 2009a} but have been reported as one of the most commonly caught species in in some longline fisheries operating in these waters (IATTC 2006). Estimates of seabird mortality in longlines operating within the EPO are highly uncertain due to low observer coverage (Anderson 2009b). It has been estimated that at least 4,000 birds (all species combined) are killed within

IATTC waters per year (Anderson 2009b). The impact of fishing mortality on laysan albatross is unknown, and laysan albatross are susceptible to bycatch in longline fisheries per the Unknown Bycatch Matrix. Laysan albatross therefore receive a "high score" for fishing mortality in the EPO longline fleet.

Justification:
The IATTC has a list of best practice recommendations as described by the 2013 Seabird Bycatch Working Group. These recommendations include branchline weighting, setting at night, bird scaring devices, etc. (IATTC 2014). Under resolution C-11-02, vessels greater than 20 m in length are required to use at least two of the recommended seabird bycatch mitigation techniques. The efficacy of this measure is unknown due to limited observer coverage (IATTC 2018g).

Leatherback turtle

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
Leatherback sea turtles have been listed as Endangered under the ESA since 1970 {NMFS 2012} and IUCN Vulnerable with a decreasing population trend (Wallace et al. 2013). Leatherback turtles have been listed CITES since 1975 and are currently listed on Appendix 1 because they are threatened with extinction and international trade is prohibited. It's important to note that research suggests that leatherbacks in the EPO may be resource limited, and EPO leatherbacks in the eastern Pacific are on average the smallest in body size and exhibit the lowest reproductive output of any population in the world (Wallace et al. 2009)(Wallace et al. 2006). Over the past 25 years the population of leatherbacks in the Pacific Ocean has decreased by 97% (NOAA 2016). Leatherbacks receive a "high concern" score based on the ESA, IUCN and CITES listings and significant population declines.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
The population of leatherback turtles in the EPO continues to decline due to several reasons including the incidental capture in commercial fisheries and nesting habitat destruction (NOAA 2016). Fishing mortality is one of the major threats to leatherback turtles, especially for juveniles and adults that can be incidentally captured in fisheries along their migration routes (Zug & Parham 1996)(Martinez 2000)(Wallace et al. 2013). Leatherback turtles are susceptible to bycatch in EPO pelagic longline fisheries per the Seafood Watch Unkown Bycatch Matrix. Leatherbacks receive a "high concern" score for fishing mortality because data on interactions are limited in most EPO longline fisheries, and it is likely that fishing is a contributing factor to the substantial decline of leatherback turtles in this region.

Justification:
Some estimates suggest 20,000 leatherback turtles were caught in longlines throughout the entire Pacific Ocean during 2000, with 1,000 to 3,200 of these being killed as a result. These results also suggest that continued bycatch in longline fisheries will have major consequences for leatherback turtles in the Pacific Ocean and that the mortality threshold for this species in the Pacific may have been exceeded (Lewison et al. 2004).

Loggerhead turtle

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

High Concern
The IUCN classified loggerhead turtles in the North Pacific Regional Management Unit (RMU) as Least Concern with an increasing population trend (Casale & Tucker 2017), and loggerheads in the South Pacific RMU as Critically Endangered with a decreasing population trend. Wallace et al. (2010, 2011) identified the North Pacific RMU of loggerhead sea turtles as among the 11 most endangered sea turtle RMUs in the world and that loggerheads are at a high risk of population declines and have high threat levels in the North and South Pacific Ocean (Wallace et al. 2011). Loggerheads are listed on Appendix 1 of the Convention on International Trade in Endangered Species (CITES). In the North Pacific Ocean, loggerheads have been listed as Endangered on the United States Endangered Species Act list since 1978 {FR 2011}. We have therefore awarded a "high concern" score for loggerhead abundance.

Justification:
Data are limited on population trends in the Pacific, however, available long-term series of nest counts (used as an index of population abundance) suggest recent population-level decreases (47%) and regionally significant declines (especially in the South Pacific population)(Casale & Tucker 2017).

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Floating object purse seine (FAD)

Low Concern
Eastern Pacific green sea turtles, hawksbill and leatherback turtles interact with purse seine fishing gear, however, turtle mortalities have declined significantly since the mid-2000s due to safe handling guidelines and release procedures (IATTC 2018c). The encounter rate in purse seine fisheries ranges from 0% to 1.6%, being highest in animal associated sets, followed by log sets (0.8%) (Hall & Ramon 2013). One green sea turtle mortality occurred in the EPO object associated

purse seine fishery in 2013; one loggerhead turtle mortality occurred the EPO object associated purse seine fishery in 2014; and one hawksbill mortality occurred in an EPO dolphin associated set in 2014 (IATTC 2018c). It's important to note these fisheries are 100% observed, so these are not considered minimum estimates.We have awarded a "low concern" due to the low interaction rates between object associated sets and green sea turtles/ loggerhead turtles and dolphin associated sets and hawksbill turtles, which suggests that purse seines may not be a substantial contributor to green sea turtle, loggerhead turtle, and/or hawksbill turtle fishing mortality in tuna fisheries in the EPO.

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
The incidental capture of loggerhead turtles is considered a primary threat to their populations {Casale and Tucker 2017}(Clarke et al. 2014). Research in the Pacific Ocean suggested that 67,000 loggerhead sea turtles were incidentally captured in the Pacific Ocean during 2000 and of these, 2,600 to 6,000 were killed by this incidental capture and it is possible their mortality threshold has been exceeded in this region (Lewison et al. 2004). The populations in the eastern and southern Pacific continue to decline, and incidental capture in longline fisheries is a contributing factor to this decline (NMFS 2017). Loggerhead turtles therefore receive a "high concern" score for fishing mortality in EPO longline fisheries.

Manta ray (unspecified)

Factor 2.1 - Abundance

Eastern Central Pacific | Unassociated purse seine (non-FAD)

High Concern
Manta rays (species) are data deficient and tend to exhibit K-selected life history traits including slow growth and low fecundity (IATTC 2019e). Manta rays in general are of concern because stock structure data are unknown and local impacts of fishing may be significant (IATTC 2019d). Giant manta rays are listed as IUCN "Vulnerable" with a decreasing population trend; spinetail, and smoothtail mantas and munk's devilray are listed as IUCN "Near Threatened (Clark et al. 2006) (White et al. 2006){IUCN 2019}." Manta rays (species) receive a "high concern" score based on "Vulnerable" and "Near Threatened" IUCN classifications and significant data limitations.

Justification:
Population sizes and status of giant manta rays for individual areas is typically unknown, but it is thought that sub-populations are small in size. Although widely distributed throughout the oceans, the populations are considered fragmented and highly dispersed. Subsequently, regional depletions are more likely for manta rays, and it is highly likely that population declines have occurred in areas that are fished. It is suspected that the overall global population of giant manta rays has declined by 30% over the past 75 years (Marshall et al. 2011).

A recent draft management strategy evaluation explored spinetail devil ray vulnerability status

using a new spatially-explicit ecological risk assessment (ERA) approach called the Ecological Assessment for the Sustainable Impacts of Fisheries (EASI-Fish)(IATTC 2019e). The "status quo" and other explored management scenarios revealed that the SSB_{2016} exceeded precautionary biological reference points ($SSB_{40\%}$), rendering stock status a conservation concern (IATTC 2019e). It's important to note this report is a draft and preliminary.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Unassociated purse seine (non-FAD)

High Concern

Although information on fishing mortality rates are not known for the EPO unassociated purse seine fishery, manta rays are commonly reported as bycatch. Because their spatial stock structure is not well known, localized fishing mortality impacts may be significant (IATTC 2019d) for ray species. Between 1993 and 2018, an estimated 2,423 rays, on average, were captured in the EPO across all purse seine gear types (IATTC 2019d). Rays receive a "high concern" score because population depletions in some of these species have been linked to fishing mortality despite data limitations.

Justification:

Giant manta rays are caught by a variety of fishing gears both through targeted and incidental capture (Marshall et al. 2011). The average number of giant manta rays captured between 1993 and 2018 in purse seine fisheries (combined) was 126 individuals (IATTC 2019d). It is believed that fishing pressure on this species is likely to lead to population declines (Marshall et al. 2011).

Spinetail and smoothtail manta rays are susceptible to capture in net fisheries, and it is not thought that their populations can handle significant fishing pressure (Clark et al. 2006)(White et al. 2006). The average number of spinetail and smoothtail manta rays caught in purse seine fisheries operating in the EPO between 1993 and 2016 was 187 and 333, respectively (IATTC 2019d).

Olive Ridley turtle

Factor 2.1 - Abundance

Eastern Central Pacific | Dolphin set purse seine
Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

High Concern

The International Union for Conservation of Nature (IUCN) considers Olive Ridley sea turtles to be Vulnerable globally 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}. Overall, in the Western and Central Pacific Ocean there has been a decrease in annual nesting females of 92%, from 1,412 to 108 {Abreu-Grobis and Plotkin 2008}. More

recent information by Wallace et al. (2011), however, shows that the West Pacific olive ridley sea turtle RMU is at low risk of population decline but has a high threats (Wallace et al. 2011). The breeding population off the coast of Mexico is considered Endangered under the US ESA, and all other populations in the region as considered Threatened under the ESA. Despite historic declines, they are highly abundant and largely stable (Wallace pers. comm). We have awarded a high concern score, however, because abundance is unknown, and sea turtles are highly vulnerable to the effects of fishing mortality.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Dolphin set purse seine
Eastern Central Pacific | Floating object purse seine (FAD)

Low Concern
While data are limited on overall interaction rates for olive ridley sea turtles, olive ridleys have the highest interaction rates of any turtle species with purse seine fisheries in the EPO. The encounter rate in purse seine fisheries ranges from 0% to 1.6%, being highest in dolphin associated sets, followed by log sets (0.8%) {Hall and Roman 2013}. Olive ridley mortalities have decreased since the early 2000s in purse seine fisheries due to improved release procedures. On average, approximately 1-2 olive ridley turtles have been taken in FAD and dolphin associated sets from 2013-2017 (IATTC 2018c). We have awarded a score of "low concern" due to the low interaction rates between FAD and dolphin associated sets and olive ridley turtles, which suggests that purse seines may not be a substantial contributor to olive ridley sea turtle fishing mortality in tuna fisheries in the EPO.

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Moderate Concern
The incidental capture of olive ridley sea turtles occurs worldwide {Abreu-Grobois & Plotkin 2008}. Olive ridley turtles were estimated to have the highest longline fishery interaction rates of all impacted turtles in the EPO (Clarke et al. 2014)(Wallace et al. 2013). For example, during 2000 the Japanese reported the incidental capture of 6,000 sea turtles, the majority of which were olive ridleys (exact number not provided) (IATTC 2013f). Nonetheless, it is likely that other fisheries, such as trawls and gillnets, also have significant impacts on olive ridley turtles (Lewison & Crowder 2007)(Wallace et al. 2013){Abreu-Grobois & Plotkin 2008}. Overall estimates of olive ridley fishing mortality rates are unknown. We have awarded a score of "moderate concern' because the olive ridley population is not at high risk of decline, but bycatch and other threats to the EPO RMUs are high.

Pacific bluefin tuna

Factor 2.1 - Abundance

Eastern Central Pacific | Floating object purse seine (FAD)

High Concern

An updated assessment for Pacific bluefin tuna was conducted in 2018, and the ratio of the Pacific bluefin tuna SSB in 2015-2016 to that of unfished levels was 3.3%. Annual recruitment of Pacific bluefin tuna is variable and unpredictable, which contributes to uncertainty in calculating abundance (ISC 2018). There are no defined reference points for Pacific bluefin tuna; however, applying a reference point of $SSB_{20\%}$, the bluefin population would be considered overfished currently and has been overfished for the majority of the assessed time period (1950-2015) (ISC 2018). Pacific bluefin tuna, therefore, receive a "high concern" score for abundance.

Justification:

Historical recruitment estimates have fluctuated since 1952 without an apparent trend. The low recruitment levels estimated in 2010-2014 were a concern in the 2016 assessment. And the 2018 assessment estimate of 2015 recruitment is low, and similar to estimates from previous years, while the 2016 recruitment estimate is higher than the historical average. Initial data indicates that the 2017 recruitment is also high. There is no evidence of a stock-recruitment relationship for this stock (IATTC 2018c)(ISC 2018).

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Floating object purse seine (FAD)

High Concern

Pacific bluefin tuna are taken in purse seine and longline fisheries in the EPO. There are currently no defined fishing mortality reference points for Pacific bluefin tuna. However, the 2018 assessment results indicate overfishing is occurring relative to 'most' of the potential reference points evaluated (ISC 2018). For instance, current fishing mortality rates (2012-2014)(2015-2016) are higher than all potential biological reference points, except F_{MED} and F_{LOSS}, and bluefin tuna therefore receive a "high concern" score because overfishing has been occurring for most of the assessed time period.

Justification:

Most of the commercial catches of bluefin in the EPO are taken by purse seiners, primarily by object associated sets. Nearly all of the purse-seine catches have been made west of Baja California and California, within about 100 nautical miles of the coast. Roughly 90% of the bluefin catch is estimated to be about 60 and 100 cm in length, representing mostly fish 1 to 3 years of age (IATTC 2018d).

	F_{max}	F0.1	Fmed	Floss	(1-SPR)/(1-SPRxx%)				Estimated SSB for terminal year of each reference period	Depletion ratio for terminal year of each reference period
					SPR10%	SPR20%	SPR30%	SPR40%		
2002-2004	1.77	2.47	1.04	0.78	1.07	1.21	1.38	1.61	40,707	6.3%
2012-2014	1.47	2.04	0.86	0.65	1.05	1.19	1.36	1.58	19,031	3.0%
2015-2016	1.32	1.85	0.78	0.58	1.02	1.15	1.32	1.54	21,311	3.3%

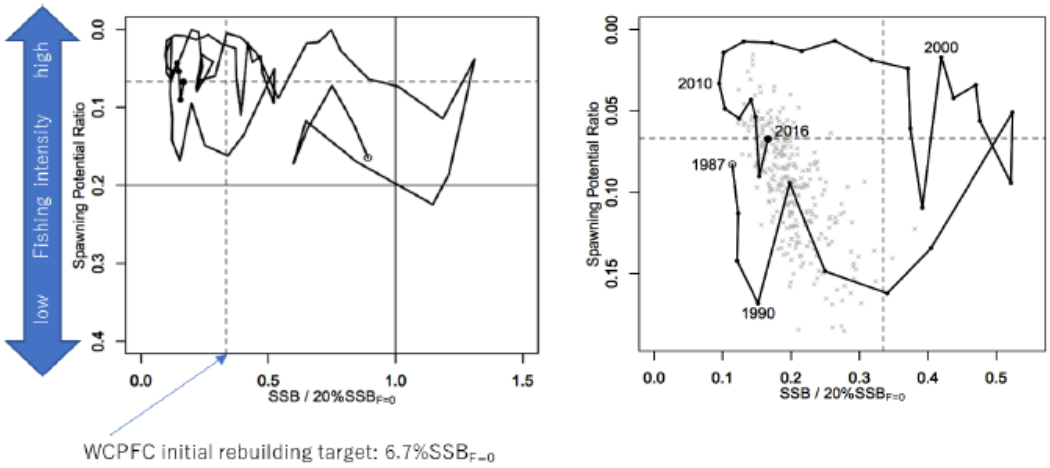

Figure 12: Ratios of the estimated fishing intensities mortalities (Fs and 1-SPRs for 2002-04, 2012-14, 2015- 16) relative to potential fishing intensity-based reference points, and terminal year SSB (t) for each reference period, and depletion ratios for the terminal year of the reference period for Pacific bluefin tuna (Thunnus orientalis) (ISC 2018).

Pantropical spotted dolphin

Factor 2.1 - Abundance

Eastern Central Pacific | Dolphin set purse seine

Moderate Concern

The abundance of pantropical spotted dolphins in 2010 was estimated to be 911,177 and 911,830 individuals for the northeastern and western/southern populations respectively. Abundances have been fairly stable since the late 1970's with slightly increasing trends for the eastern spinner and northeastern pantropical spotted dolphins over the past decade, however the population rate of increase remains low (Scott et al. 2016). Abundances were the highest during the 1960's and have not returned to historic levels (IATTC 2009a)(IATTC 2011e). Current data on population abundance are limited because surveys conducted by the National Marine Fisheries Service ended in 2006, and the population status of pantropical spotted dolphins is considered ambiguous (Scott et al. 2016). The IUCN lists the pantropical spotted dolphin as a species of Least Concern (Kiszka and Braulik 2018), and they receive a "moderate concern" score.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Dolphin set purse seine

Moderate Concern

Total dolphin mortality in purse seine fisheries operating in the EPO has decreased significantly since peak levels occurred in the 1960's with dolphin-encircling sets (IATTC 2011e). Reductions in dolphin mortality are associated with the 1992 Agreement on the Conservation of Dolphins and subsequent 1999 Agreement on the International Dolphin Conservation Program. The goal of both Agreements was to reduce dolphin mortalities in purse seine fisheries to levels approaching zero (IATTC 2013h). Mortality levels for all dolphins reduced from 132,000 in 1986 to 688 documented mortality events in 2017 (IATTC 2018c). Spotted dolphins in particular associate with yellowfin tuna, and bycatch primarily occurs in dolphin sets.

Population-level research suggests there may significant stress effects and the potential for reduced reproductive output as a result of incidental capture and interactions with purse seine fisheries. These impacts could be negatively impacting the ability of this species to recover (Cramer et al. 2008)(Keller et al. 2013)(Wade et al. 2007)(Edwards 2007), and EPO purse seine fisheries therefore receive a "moderate concern" score for pantropical spotted and spinner dolphin fishing mortality.

Justification:

Estimated incidental takes of northeastern spotted dolphins in 2017 was 92 individuals or 14% of the most recent Stock Mortality Limit (SML; 2010, 648). For western spotted dolphins, the 2017 estimated incidental take was 178 individuals or 16% of the SML (1145). Estimated fishing-associated mortalities for eastern and whitebelly spinner dolphins in 2017 was 266 and 98 individuals, respectively. This equates to roughly 51% of the eastern spinner dolphin 2010 SML (518) and 11% of the whitebelly 2010 SML (871)(IATTC 2009a)(IATTC 2018c). It's important to note that SMLs have not been updated because there have been no standardized surveys since 2006.

	Incidental mortality	
Species and stock	Numbers	t
Offshore spotted dolphin		
Northeastern	92	6.0
Western-southern	178	11.6
Spinner dolphin		
Eastern	266	11.8
Whitebelly	98	5.9
Common dolphin		
Northern	26	1.8
Central	9	0.6
Southern	16	1.1
Other mammals*	3	0.2
Total	**688**	**39.1**

*"Other mammals" includes the following species and stocks, whose observed mortalities were as follows: unidentified dolphins 2 (0.1 t) and striped dolphin (*Stenella coeruleoalba*) 1 (0.06 t).

Figure 13: Mortality of dolphins and other marine mammals caused by the fishery in the EPO during 2017 (preliminary data). (IATTC 2018c)

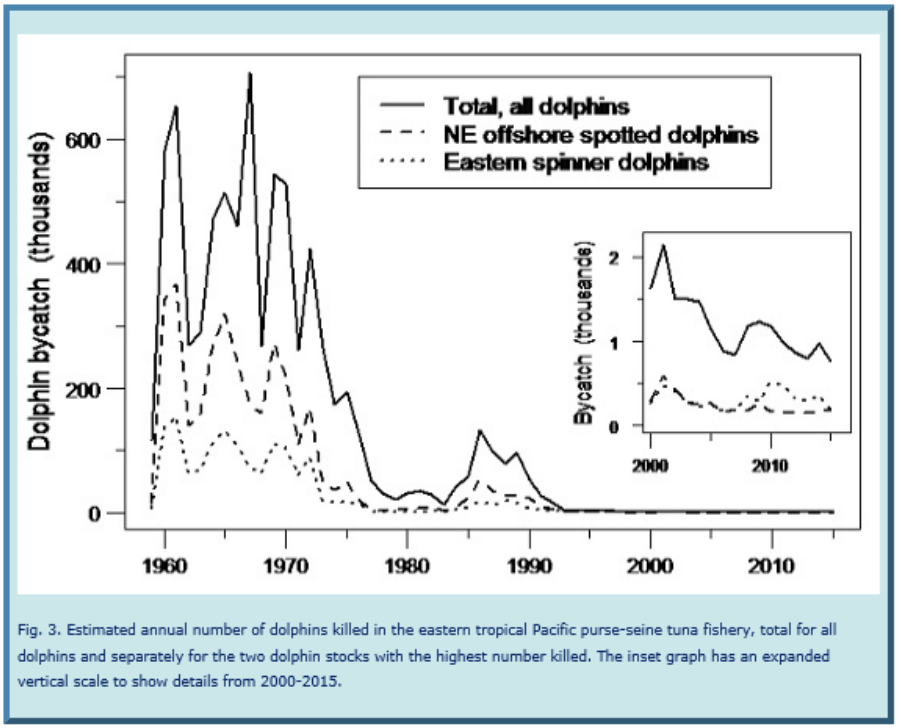

Figure 14: Estimated annual number of dolphins killed in the eastern tropical Pacific purse-seine tuna fishery, total for all dolphins and separately for the two dolphin stocks with the highest number killed. The inset graph has an expanded vertical scale to show details from 2000-2015 (NOAA 2016).

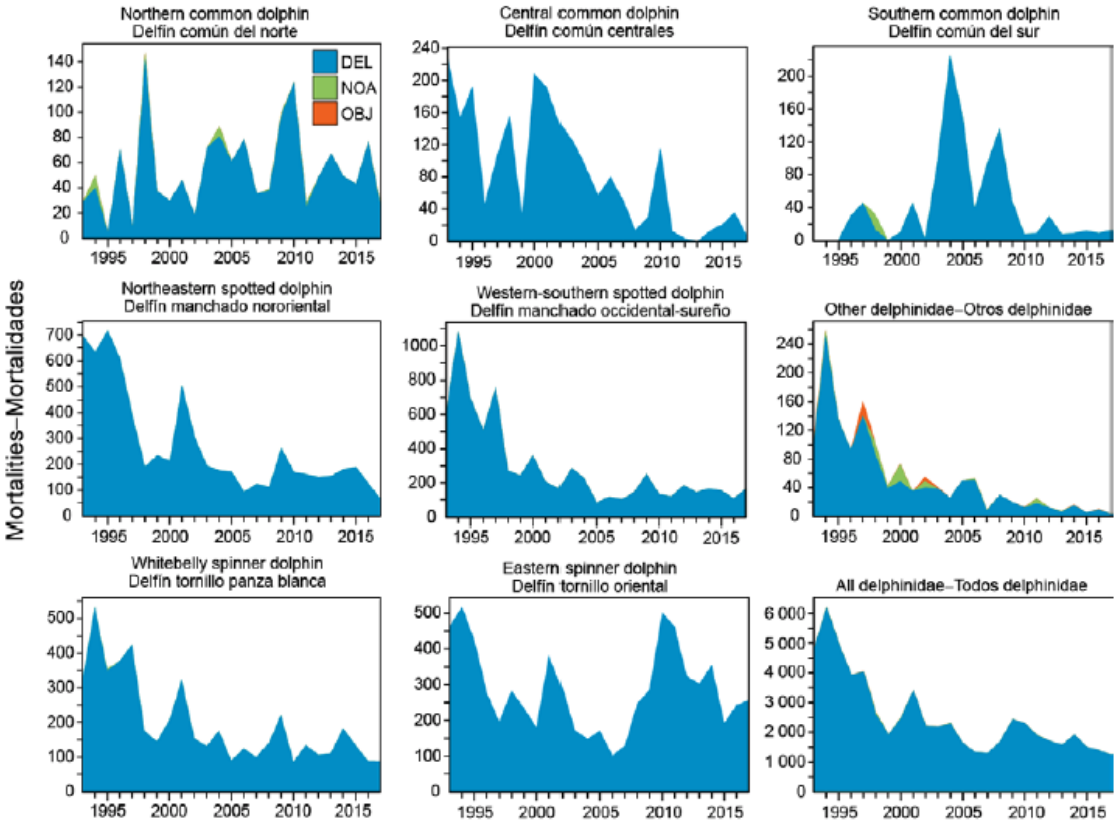

Figure 15: Incidental dolphin mortalities, in numbers of animals, reported by observers on large purse-seine vessels, 1993-2017, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)). Data for 2017 are preliminary (IATTC 2018c).

Rainbow runner

Factor 2.1 - Abundance

Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Moderate Concern

No formal stock assessments for rainbow runner have been conducted in the EPO. Rainbow runner exhibit a medium vulnerability to fishing (see detailed justification section PSA=2.96), and rainbow runners receives a "moderate concern" score due to unknown stock status and medium vulnerability.

Justification:

Table 2. EPO Purse Seine Rainbow Runner PSA

Rainbow runner, EPO Purse Seine

Productivity Attributes	Value	Score (1 = low risk; 2 = medium risk; 5 = high risk)	Reference	Susceptibility Attribute	Information	Score (1 = low risk; 2 = medium risk; 5 = high risk)	Reference
Average age at maturity (years)	NA		fishbase.org	**Areal overlap**		3	IATTC 2018
Average maximum age (years)	6	1	fishbase.org	**Vertical overlap**		3	IATTC 2018
Fecundity (eggs/yr)	NA		fishbase.org	**Selectivity of fishery**		2	IATTC 2018
Average maximum size (cm) (not to be used when scoring invertebrate species)	180	2	fishbase.org	**Post-capture mortality**		3	IATTC 2018
Average size at maturity (cm) (not to be used when scoring invertebrate species)	64.6	2	fishbase.org	**Susceptibility Subscore**		**2.325**	
Reproductive strategy	Broadcast spawner	1	fishbase.org				
Trophic level	4.3	3	fishbase.org	**Productivity-Susceptibility Score**	**2.96**		
Density dependence (invertebrates only)	NA		fishbase.org	**Vulnerability Rating (high, medium or low)**	**Medium**		
Quality of Habitat	Moderately altered	2	IATTC 2018				
Productivity Subscore		**1.83**					

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Moderate Concern

Fishing mortality rates for rainbow runner are not available in the EPO but they are frequently caught in the floating object purse seine fishery and in the unassociated fishery. The average catch of rainbow runner 1992-2017 is 50 t, with 50% coming from the each of the two purse seine fisheries, and bycatch of rainbow runner shows a general declining trend during since the early 2000s (IATTC 2019d). The capture probability (percent of sets with capture) of rainbow runner remained fairly stable 1994-2008, between 20% and 30% for the floating object purse seine fishery (Hall & Ramon 2013), and rainbow runner receive a "moderate concern" score due to data limitations and because the impact of this fishery on rainbow runner is unknown.

Sailfish

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Moderate Concern

Sailfish are most abundant in waters relatively near the continents and the Indo-Pacific land masses bordering the Pacific, and infrequent in the high seas separating them. The populations in the EPO and in the western Pacific are genetically distinct (IATTC 2013e)(IATTC 2018c). An assessment of Indo-Pacific sailfish populations in the EPO was conducted in 2010 and updated in 2013. However, the model presented unreliable results and could not be used to assess the status of the population with regard to management reference points against SSB and MSY. The abundance data used in the model did show a downward trend in abundance from 1994 to 2009, with a more moderate stable trend since that time (IATTC 2018c)(IATTC 2013e). The IUCN lists sailfish as a species of Least Concern (Collette et al. 2011b), and sailfish receive a "moderate concern" score because stock status is unknown but it is listed as IUCN-Least Concern.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Moderate Concern

The principal fisheries that capture sailfish in the EPO include the large-scale tuna longline fishery primarily consisting of China, Chinese Taipei, Japan, and Korea; the smaller-vessel longline fisheries targeting tuna and other species, particularly those operating off Central America; and the artisanal and recreational fisheries of Central and South America. Sailfish are also taken occasionally in the purse-seine fisheries targeting tropical tunas (IATTC 2018c). The 2013 Indo-Pacific sailfish assessment was unable to quantify fishing mortality rates, but results did suggests it is likely that catches are severely under reported for this species (IATTC 2018c). Sailfish receive a "moderate concern" score for fishing mortality because F is unknown.

Shortfin mako shark

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines

Moderate Concern

A single stock of shortfin mako sharks is assumed in the north Pacific Ocean based on evidence from tagging studies and lower catch rates of shortfin makos near the equator relative to temperate areas. Data are more limited for the southern Pacific shortfin mako stock, and there is a high degree of uncertainty regarding north and south stock delineations (microsatellite DNA analyses reveal no

differentiation between the north and south Pacific Ocean) (ISC 2018b). Thus, the north and south shortfin mako stocks will be reviewed as one entity for the purposes of this report.

The most recent north Pacific Ocean stock assessment (2018) indicated that the most recent spawning abundance (SA_{2016}) was 860,200 sharks (CV=46%) and was 36% (CV=30%) higher than the estimated SA at MSY (SA_{MSY}). Estimated SA has slightly increasing since 1999 but generally exhibits a declining long term trend since 1975 (ISC 2018b). The maximum likelihood estimate suggests SA has been above MSY throughout the entire assessment period, and shortfin make are not considered overfished (ISC 2018b){NMFS 2019a}. Because of declines in the North Pacific (and more significant declines in the Atlantic), IUCN listed shortfin mako as endangered with a decreasing trend (Rigby et al. 2019). Shortfin mako therefore receive a "moderate concern" in consideration of the endangered IUCN listing, data limitations for the southern stock, and a recent stock assessment that suggests the north Pacific stock is within target reference points and is not overfished.

Justification:
Larger subadults and adults are observed in greater proportions in the central north Pacific Ocean.Shortfin mako sharks are distributed throughout the pelagic, tropical to temperate north Pacific Ocean. Pupping and/or nursery areas areas are thought to be distributed along the continental margins of the north Pacific Ocean, off the coast of U.S. and Mexico in the EPO and off the coast of Japan. There is ongoing uncertainty regarding smaller regional groupings (ISC 2018b).

The trend analysis of the modeled spawning abundance for 1975–2016 revealed annual rates of decline of 0.6%, consistent with a median decline of 36.5% over three generation lengths (72 years), with the highest probability of 30–49% reduction over three generation lengths (Rigby et al. 2019)(ISC 2018b).

Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
No population assessment of shortfin mako sharks in the southern Pacific Ocean has been conducted. The International Union for the Conservation of Nature has assessed this species globally as "Endangered" (Rigby et al. 2019). According to the IUCN, the population in the south Pacific appears to be increasing. We have, however, awarded a score of "high" concern based on the IUCN listing and lack of a stock assessment to override the listing.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines

Low Concern
The recent annual fishing intensity ($1\text{-}SPR_{2013\text{-}2015}$) was estimated to be 0.16 (CV=38%) and was 62% (CV=38%) of fishing intensity at MSY ($1\text{-}SPR_{MSY}$; 0.26), and these results suggest the stock is not likely (>50%) to be experiencing overfishing (ISC 2018b). While there is concern regarding

fishing mortality species-wide, longline fisheries in the EPO are presumed to be within target reference points for fishing mortality, and they receive a "low concern".

Justification:
Currently, the primary source of known shortfin mako shark fishing intensity is oceanic longline fisheries targeting swordfish and tuna, including mostly shallow-set longline fisheries in temperate waters, and deep-set longline fisheries in more tropical areas. Asian shark markets, which have been developing for over a decade, provide economic value to shortfin mako shark bycatch in these fisheries (ISC 2018b). Catch data pre-1993 are highly uncertain. The total estimated catch of North Pacific shortfin mako sharks reached a peak of 7,068 mt in 1981 and then declined in the early 1990s, with catches fluctuating between 1,948 mt and 2,395 mt since the early 1990s.

Eastern Central Pacific, Southeast Pacific | Drifting longlines

High Concern
No assessment of shortfin mako sharks has been conducted in the South Pacific. However, some information on catch and discard rates is available. For example, in 2017, a minimum of 1,606 t of shortfin mako sharks were caught in the EPO longline fleet (unspecified if in the northern Pacific or southern Pacific) (IATTC 2019k). Catch in EPO longlines peaked at about 2,500 t in 2014 (IATTC 2019k). We have awarded a score of "high" concern because information on fishing mortality rates in the South Pacific are not available, the population is depleted and susceptible to longline gear, and no management is place to protect the species.

Silky shark

Factor 2.1 - Abundance

Eastern Central Pacific | Dolphin set purse seine
Eastern Central Pacific | Unassociated purse seine (non-FAD)

High Concern
Silky sharks are assessed as "Vulnerable" with a decreasing population trend by the IUCN (Rigby et al. 2017), and they therefore receive a "high concern" score based on their IUCN rating and unknown population status.

Justification:
Due to data limitations and uncertainty, the IATTC has been unable to conduct a full silky shark assessment specific to the EPO, however a more recent assessment explored a Pacific-wide silky shark stock assessment. Results suggest that the biomass of silky sharks has declined significantly in the last 20 years, although there is much uncertainty and these values are not adequate for regulatory action (IATTC 2018e).

In 2014, the IATTC proposed a suite of possible stock status indicators, including standardized bycatch-per-set (BPS) indices from the purse-seine fishery, that could be considered for managing the silky shark regionally. As a proxy for abundance, the BPS of silky sharks caught in purse seine

sets made on floating objects decreased dramatically in the EPO in late 1990's and has been slightly increasing to stable in recent years (not approaching historic levels)(Figure A) (IATTC 2019e).

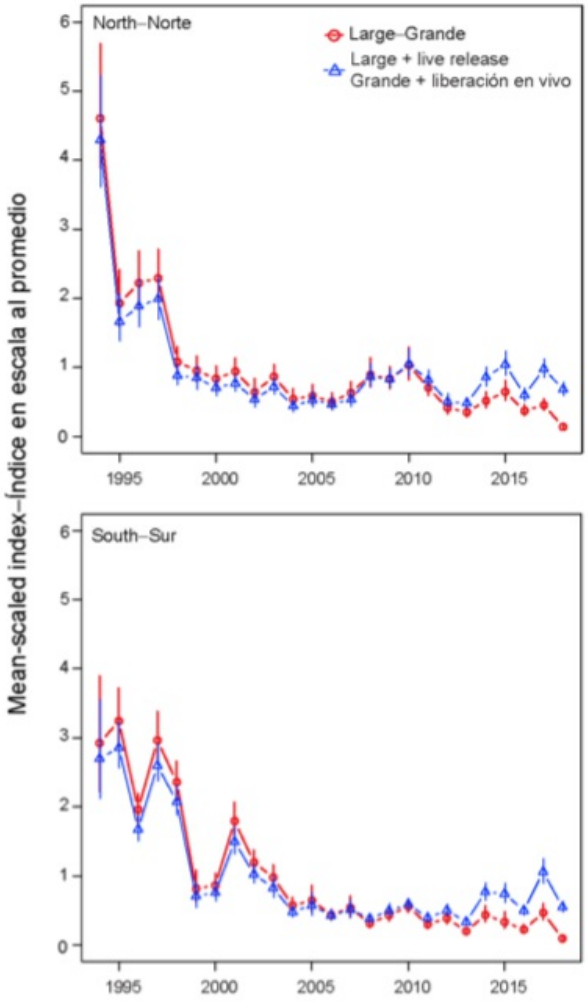

Figure 9: Mean-scaled standardized silky shark bycatch-per-set (BPS; in numbers of sharks per set) in sets on floating objects for large sharks, with and without live release, in the north (top) and south (bottom) EPO. Vertical bars indicate pointwise approximate 95% confidence intervals (IATTC 2019e).

Purse seine indices of abundance were updated in 2019, which indicated a decrease in silky sharks (index) in 2018 compared to 2017 in both areas (IATTC 2019e). Recent research suggests a correlation between north EPO silky shark indices and oceanographic condition variability (e.g. El Nino), especially for small and medium sharks (IATTC 2019e)(Lennert-Cody et al. 2019).

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Dolphin set purse seine

Eastern Central Pacific | Unassociated purse seine (non-FAD)

High Concern

Silky sharks are caught as bycatch in purse seine and longline fisheries operating in the Eastern Pacific Ocean but are also targeted, in small amounts, in some longline fisheries (IATTC 2013g). Fishing pressure from longline and purse seine fisheries targeting tunas and swordfish is high, and it is the main shark species caught in fisheries using FADs as well as longline fisheries in the eastern Pacific. Research suggests that silky shark diet composition parallels FAD-associated prey items, and silky sharks may be modifying their behavior to target FAD sets. This could in turn increase silky shark fishing mortality in FAD-associated sets, where it is already likely very high (IATTC 2019e) (IATTC 2018e)(Rigby et al. 2017).

The most recent attempt at a stock assessment for this species indicated that the current fishing mortality rates are unknown but that they have likely increased significantly in the last 20 years (IATTC 2018e). The IUCN assessment indicates that incidental capture in purse seine fisheries is a major threat to this species (Rigby et al. 2017), and therefore, cumulative fishing mortality of silky sharks is "high concern".

Spinner dolphin

Factor 2.1 - Abundance

Eastern Central Pacific | Dolphin set purse seine

High Concern

The abundance of spinner dolphins 2010 was estimated to be 790,613 and 711,883 individuals for the eastern and whitebelly populations respectively (IATTC 2012a). Abundances were the highest during the 1960's and have not recovered to historic levels (IATTC 2009a). More recent information on population abundance is limited because biomass surveys conducted by the NMFS ended in 2006 {Scott et la. 2016}. The IUCN lists spinner dolphins as "Data Deficient" (Bearzi et al. 2012), and the eastern stock of spinner dolphins are MMPA "depleted" (NMFS 2019). Spinner dolphins therefore receive a "high concern" score for abundance due to unknown/depleted stock status and data deficiency.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Dolphin set purse seine

Moderate Concern

Total dolphin mortality in purse seine fisheries operating in the EPO has decreased significantly since peak levels occurred in the 1960's with dolphin-encircling sets (IATTC 2011e). Reductions in dolphin mortality are associated with the 1992 Agreement on the Conservation of Dolphins and subsequent 1999 Agreement on the International Dolphin Conservation Program. The goal of both Agreements was to reduce dolphin mortalities in purse seine fisheries to levels approaching zero (IATTC 2013h). Mortality levels for all dolphins reduced from 132,000 in 1986 to 688 documented mortality events in 2017 (IATTC 2018c). Spotted dolphins in particular associate with yellowfin

tuna, and bycatch primarily occurs in dolphin sets.

Population-level research suggests there may significant stress effects and the potential for reduced reproductive output as a result of incidental capture and interactions with purse seine fisheries. These impacts could be negatively impacting the ability of this species to recover (Cramer et al. 2008)(Keller et al. 2013)(Wade et al. 2007)(Edwards 2007), and EPO purse seine fisheries therefore receive a "moderate concern" score for pantropical spotted and spinner dolphin fishing mortality.

Justification:
Estimated incidental takes of northeastern spotted dolphins in 2017 was 92 individuals or 14% of the most recent Stock Mortality Limit (SML; 2010, 648). For western spotted dolphins, the 2017 estimated incidental take was 178 individuals or 16% of the SML (1145). Estimated fishing-associated mortalities for eastern and whitebelly spinner dolphins in 2017 was 266 and 98 individuals, respectively. This equates to roughly 51% of the eastern spinner dolphin 2010 SML (518) and 11% of the whitebelly 2010 SML (871)(IATTC 2009a)(IATTC 2018c). It's important to note that SMLs have not been updated because there have been no standardized surveys since 2006.

	Incidental mortality	
Species and stock	Numbers	t
Offshore spotted dolphin		
Northeastern	92	6.0
Western-southern	178	11.6
Spinner dolphin		
Eastern	266	11.8
Whitebelly	98	5.9
Common dolphin		
Northern	26	1.8
Central	9	0.6
Southern	16	1.1
Other mammals*	3	0.2
Total	**688**	**39.1**

*"Other mammals" includes the following species and stocks, whose observed mortalities were as follows: unidentified dolphins 2 (0.1 t) and striped dolphin (*Stenella coeruleoalba*) 1 (0.06 t).

Figure 13: Mortality of dolphins and other marine mammals caused by the fishery in the EPO during 2017 (preliminary data). (IATTC 2018c)

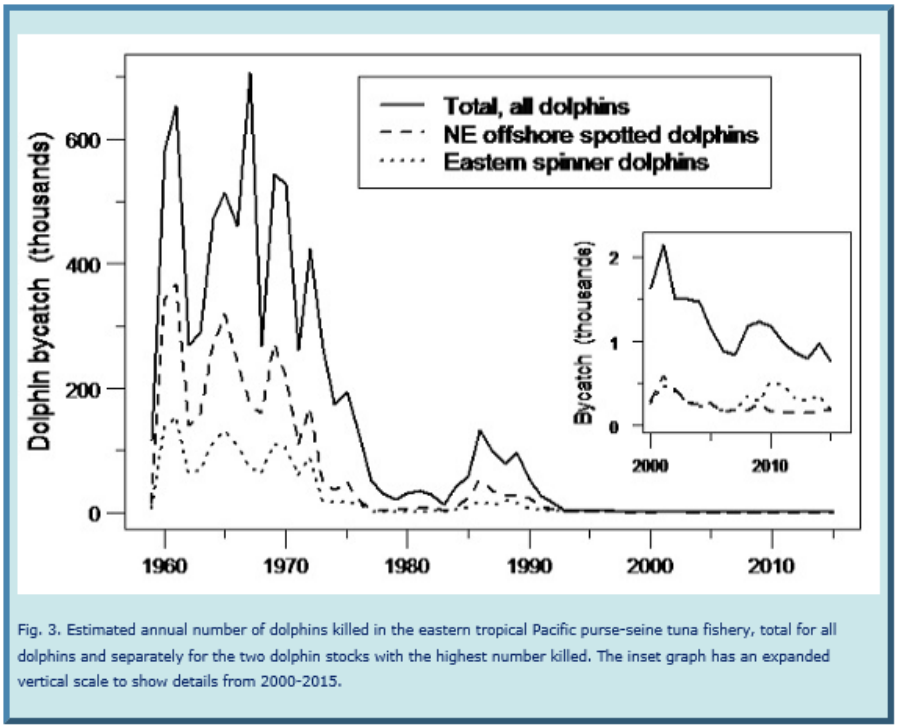

Figure 14: Estimated annual number of dolphins killed in the eastern tropical Pacific purse-seine tuna fishery, total for all dolphins and separately for the two dolphin stocks with the highest number killed. The inset graph has an expanded vertical scale to show details from 2000-2015 (NOAA 2016).

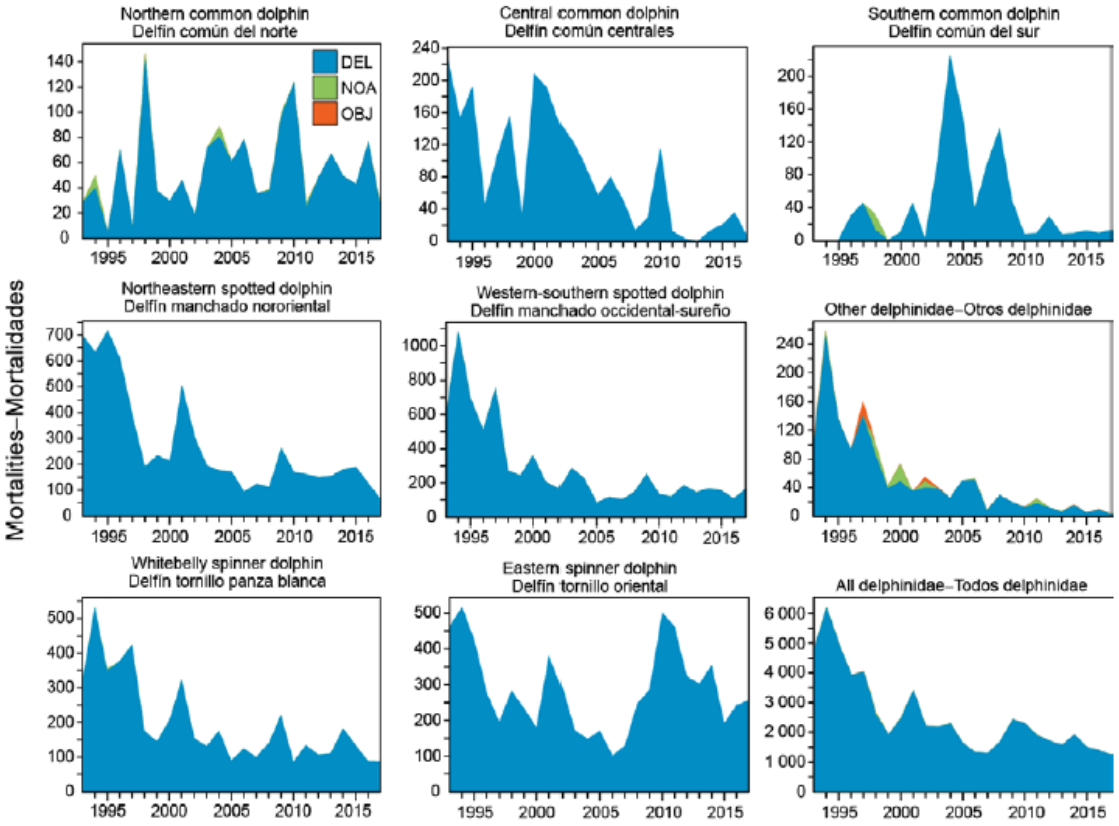

Figure 15: Incidental dolphin mortalities, in numbers of animals, reported by observers on large purse-seine vessels, 1993-2017, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)). Data for 2017 are preliminary (IATTC 2018c).

Wahoo

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Moderate Concern

Wahoo are listed as a species of "Least Concern" by the IUCN (Collette et al. 2011c). They are widespread in the EPO, and there are no targeted fisheries for them, but they are caught as bycatch and are increasingly retained (Hall & Ramon 2013). No population assessments have been conducted in this region. Data limitations coupled with an IUCN "Least Concern" rating yield a "moderate concern" score for wahoo in the EPO.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Moderate Concern

Although no targeted fisheries occur for wahoo in the EPO, they are caught as bycatch in several fisheries including purse seine and longline fisheries and are increasingly retained. Catches of wahoo the region have been increasing over the past 20 years, with a particularly sharp uptick around 2006. Higher catches of wahoo are likely related to changes in longline data reporting and an increasing number of floating object purse seine sets (Collette et al. 2011c)(IATTC 2018c). Roughly 368 t and 243 t of wahoo were caught in 2017 in purse seine and longline fisheries, respectively (IATTC 2018c). Fishing mortality is unknown for this species, and wahoo therefore receive a "moderate concern" score for fishing mortality in longline and purse seine fisheries.

Whitetip shark

Factor 2.1 - Abundance

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

High Concern

Whitetip sharks are classified globally as "Vulnerable" by the IUCN (Baum, J. 2015), and "Threatened" under the ESA (NMFS 2019), and therefore score "high concern" for abundance.

Justification:

Oceanic whitetip sharks are large sharks found in tropical and subtropical oceans throughout the world, primarily residing in surface waters. Oceanic whitetip sharks are long-lived, late maturing, and have low to moderate productivity (NMFS 2019). Data are limited on oceanic whitetip shark stock structure and abundance, however, NMFS (2019) states it is believed that the oceanic whitetip shark has declined by approximately 80-95% across the Pacific Ocean since the mid-1990s.

Factor 2.2 - Fishing Mortality

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)

High Concern

Oceanic whitetip sharks are taken, primarily as bycatch, in a number of EPO fisheries including longline and purse seine. Fishing mortality rates for oceanic whitetip sharks are not known in the EPO. Dramatic declines in fishing mortality and whitetip catch per set in the EPO for both longline and purse seine fisheries suggest overexploitation for this vulnerable species may have occurred in the 1990s and 2000s (IATTC 2017b). Despite conservation concerns and the 2016 listing as ESA "Threatened," whitetip sharks are still caught as bycatch, primarily in longline fisheries followed by purse seine fisherie (especially sets associated with floating object), and whitetip sharks receive a "high concern" for fishing mortality due to dramatic declines in biomass and CPUE indicators and a high probability that fishing mortality was and may still be above a sustainable level for this species.

Justification:
Oceanic whitetip sharks are primarily caught in longline fisheries, and the reported catch of oceanic whitetips in the longline fishery in 2017 was 65 t (high degree of uncertainty due to limited reporting)(IATTC 2018c). Additionally, a preliminary metadata analyses estimated that 11,935 whitetip sharks (in numbers) were caught by the EPO longline fisheries from 2007-2015 (IATTC 2017b).

Captures of oceanic whitetip sharks were estimated at 3400 sharks/year from 1994 to 2009. Floating objects sets accounted for over 90% of the removals during this period (Hall & Ramon 2013), however capture of whitetip sharks for all gear types declined dramatically in the early 2000s. For instance, the annual average capture of whitetip sharks 1993-2017 in floating objects sets was 58 t, however the average capture of whitetip sharks 2006-2017 was approximately 2.8 t. In another example, whitetip shark capture equated to roughly 0.5 /1,000 t of tuna in 2012, but this value has dropped to close to 0 in recent years (IATTC 2014h)(IATTC 2019d).

NMFS considers incidental bycatch in commercial fisheries to be the primary threat to the oceanic whitetip shark. Because of their preferred distribution in warm, tropical waters, and their tendency to remain at the surface, oceanic whitetip sharks have high encounter and mortality rates in fisheries throughout their range (NMFS 2019)

Yellowtail amberjack

Factor 2.1 - Abundance

Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Moderate Concern
No stock wide assessment of yellowtail has been conducted in the EPO. In 2001, California investigated the coastal population through landings and catch per unit effort data. At that point in time the population was deemed healthy (CDFG 2001b). This species has not been assessed by the IUCN. Abundance information for yellowtail throughout the EPO is not available, and they are not considered highly vulnerable (see detailed justification Table 2, PSA=2.91), and yellowtail receive a "moderate concern" score.

Justification:

Yellowtail, Eastern Pacific Ocean FAD & Non-FAD purse seine							
Productivity Attributes	**Value**	**Score (1 = low risk; 2 = medium risk; 5 = high risk)**	**Reference**	**Susceptibility Attribute**	**Information**	**Score (1 = low risk; 2 = medium risk; 5 = high risk)**	**Reference**

Average age at maturity (years)	3	1	(CDFG 2001a)	**Areal overlap**		3	(IATTC 2018c)
Average maximum age (years)	12	2	(Altman and Dittmer 1962)	**Vertical overlap**		3	(IATTC 2018c)
Fecundity (eggs/yr)	450,000	1	(Baxter 1960)	**Selectivity of fishery**		2	(IATTC 2018c)
Average maximum size (cm) (not to be used when scoring invertebrate species)	150	2	(Love 1996)	**Post-capture mortality**		3	(IATTC 2018c)
Average size at maturity (cm) (not to be used when scoring invertebrate species)	71	2	{CDFG 2001}	**Susceptibility Subscore**		2.325	
Reproductive strategy	Broadcast spawner	1	{Froese and Pauly 2018}				
Trophic level	4.1	3	{Froese and Pauly 2018}	**Productivity-Susceptibility Score**	**2.91**		
Density dependence (invertebrates only)	NA			**Vulnerability Rating (high, medium or low)**	**Medium**		
Quality of Habitat	Moderately altered	2					
Productivity Subscore		**1.75**					

Factor 2.2 - Fishing Mortality

Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Moderate Concern

Yellowtail are taken primarily in school (unassociated) and floating object associated sets, with 24 t and 37 t, respectively taken in the 2017 purse seine fisheries (IATTC 2018c). A review conducted in Mexican waters found the population of California yellowtail to be fully exploited (SAGARPA 2010). However, fishing mortality rates for the entire population are unknown. Yellowtail are reported to have a frequency of occurrence rate in floating object purse seine fisheries of 10-18% (1994-2009) (Hall & Ramon 2013). Yellowtail receive a "moderate concern" score because fishing mortality rates are unknown.

Factor 2.3 - Discard Rate/Landings

Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)
Eastern Central Pacific | Dolphin set purse seine

< 100%

Purse seine fisheries have an average discard rate of just under 5% (0.4-10%)(Kelleher 2005),

however discard rates vary by gear type and have decreased moderately in more recent years. Floating object associated sets have the highest discard rate (~6.4%), followed by school sets (~2%) and dolphin sets (0.3%) 1993-2017 (IATTC 2019f). Tuna purse seine fisheries therefore receive a score of <100% for the discard rate versus landings.

Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines
Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines
North Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines
South Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

< 100%

The average overall discard rate in tuna longline fisheries worldwide is 22% but discard rates reported by the Food and Agriculture Organization (FAO) in the central EPO are much less, 7.7% (Kelleher 2005). Data on bait use are also limited. Extant information indicates that bait species varies by region and target species, but longline fisheries in the EPO are known to use squid, sardines, milkfish, etc (Clarke et al. 2014). Summarily, information on discard rates and bait use from IATTC longline fisheries is not well-reported, but in combination the discards and bait use ratio to landings is likely well under 100%.

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
Eastern Central Pacific | Dolphin set purse seine	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Eastern Central Pacific | Floating object purse seine (FAD)	Ineffective	Ineffective	Moderately Effective	Moderately Effective	Highly effective	**Red (1.000)**
Eastern Central Pacific | Unassociated purse seine (non-FAD)	Moderately Effective	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	**Yellow (3.000)**
Eastern Central Pacific, Northeast Pacific | Drifting longlines	Moderately Effective	Ineffective	Moderately Effective	Moderately Effective	Highly effective	**Red (1.000)**

Eastern Central Pacific, Southeast Pacific | Drifting longlines	Moderately Effective	Ineffective	Moderately Effective	Moderately Effective	Highly effective	**Red (1.000)**

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

Eastern Central Pacific | Floating object purse seine (FAD)

Ineffective

The number of object associated or FAD sets has increased significantly since 2005. The total number of FADs deployed in the EPO per year experienced a dramatic increase in 2017 to well over 20,000, a new record level (IATTC 2019d)(IATTC 2018c). Increases in overall fishing capacity and particularly in FAD fishing effort has resulted in increased catches of juvenile yellowfin and bigeye tuna in the EPO, two species with variable trends and/or significant uncertainty in stock assessment models (IATTC 2019g)(IATTC 2019)(IATTC 2019a)(IATTC 2019b)(IATTC 2018f)(IATTC 2018c). It is generally accepted that insufficient regulation of the increasing number of FAD sets in the EPO may be responsible for reduced yield per recruits for bigeye and yellowfin tuna and increased stock assessment uncertainty for all species of tropical tuna (Fonteneau et al. 2015)(Griffiths et al. 2017).

An increasing number of FAD/object associated purse seine sets coupled with high catches of bigeye and yellowfin juvenile tuna in FAD sets has likely contributed to some population-level depletions. The IATTC has decided not to decrease the number of FAD sets in the upcoming year (IATTC 2020e). There is a high degree of uncertainty regarding yellowfin and bigeye stock status and fishing mortality, and management has been unable to mitigate negative fishery effects; therefore, the FAD purse seine fishery for tuna in the EPO receives an "ineffective" score for management strategy and implementation.

Justification:

The IATTC has been tasked with developing target and limit reference points for tuna (ISSF 2017). Currently interim limit and target reference points have been defined for bigeye, skipjack and yellowfin (IATTC 2019a)(IATTC 2019b)(IATTC 2019c). Management measures specific to the purse seine fisheries include a mandatory closure for 72 days during one of two predetermined closure periods (IATTC 2017). There is an additional time/area closure off the coast of Central and South America for purse seine vessels (IATTC 2013i). Purse seine vessels must retain and land all bigeye, skipjack and yellowfin tuna caught (IATTC 2013i) and are prohibited from setting on data buoys in the EPO (IATTC 2010).

IATTC's management of FAD fisheries has improved in recent years. In 2016, new measures were adopted that limit the number of FADs active at a time (limits based on vessel size) and daily information on all active FADs must be provided to the Secretariat within 60-90 days. In addition, purse seine vessels cannot deploy FADs during the 15 days prior to the start of the selected closure period and large vessels must recover a specific number of FADs prior to the start of the closure (IATTC 2017). However, current FAD regulations have not been effective at limiting fishing mortality and additional conservation measures are needed, as indicated within the scientific advice (IATTC 2020e). FADs have the potential to aggregate the biomass of species across trophic levels across wide distances, and therefore may extract a greater proportion of the biomass with higher efficiency than other types of purse seine sets (Griffiths et al. 2017). This has not been accounted for under the current management strategy.

Eastern Central Pacific | Unassociated purse seine (non-FAD)
Eastern Central Pacific | Dolphin set purse seine

Moderately Effective

Dolphin and unassociated (school sets) receive a "moderate concern" score because of management measures in place for the purse seine fleet, methods to deal with compliance are in place to some degree, and work is being done to develop reference points and harvest control rules (IATTC 2017) (IATTC 2020e). We have not awarded a highly effective score because there remains a significant degree of uncertainty with regards to yellowfin and bigeye tuna reference points and management, and additional conservation measures are needed to limit overall fishing mortality for yellowfin, skipjack, and bigeye tunas in accordance with scientific advice.

Justification:

The IATTC is responsible for developing target and limit reference points for tuna. Currently interim limit and/or target reference points have been defined for all targeted bigeye, skipjack and yellowfin tuna. However in 2019, yellowfin models failed to reconcile the data, and a number of uncertainties remain with regards to recruitment, stock assessment and general management of all three tuna species (IATTC 2018c)(IATTC 2019)(IATTC 2019b)(IATTC 2019c). The IATTC also acknowledges the need to adopt comprehensive measures to address the increasing fishing mortality for tropical tunas, particularly measures for associated sets. (IATTC 2020e).

Management measures specific to the purse seine fisheries include a mandatory closure for 72 days during one of two predefined time periods. However, if a fisheries observer is onboard from the On-Board Observer Program of the Agreement on the International Dolphin Conservation Program (AIDCP), the vessels (182-272 metric tons carrying capacity) can make one 30 day trip during the specified closures dates. There is an additional time/area closure off the coast of Central and South America for purse seine vessels (IATTC 2017). Purse seine vessels must retain and land all bigeye, skipjack and yellowfin tuna caught (IATTC 2013i) and are prohibited from setting on data buoys in the EPO (IATTC 2010).

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Moderately Effective

The IATTC is responsible for developing target and limit reference points for tuna and swordfish. Currently interim limit and/or target reference points have been defined for all targeted swordfish, and bigeye, albacore and yellowfin tuna. However in 2019, yellowfin models failed to reconcile the data, and no rebuilding plan is in place. A number of uncertainties remain with regards to recruitment, stock assessment and management of all three tuna species (IATTC 2018c)(IATTC 2019)(IATTC 2019a)(IATTC 2019b). We have awarded a moderate concern score to account for IATTC's initiatives to develop reference points and for the adoption of harvest control rules for some species, however, many retained species (e.g. billfish and sharks) do not have target reference points, and due to limited observer coverage in the fleet it is not possible to determine if management measures are effective. The EPO longline fishery therefore receives a "moderately effective" score for management strategy and implementation.

Justification:
Management measures specific to pelagic longline fisheries operating in the EPO include catch limits for bigeye for for China (2,507 t), Japan (32,372 t), Korea (11,947 t) and Chinese Taipei (7,555 t) (IATTC 2017). The remaining member countries of IATTC must keep catches of bigeye below 500 tons or at catch levels from 2001 (IATTC 2017).

Albacore tuna management measures were adopted in 2005 and were aimed at not allowing albacore catch levels to increase beyond 2005 levels in order to maintain the long-term sustainability of albacore North Pacific population via a collaboration between the WCPFC and IATTC (IATTC 2005a). In an effort to determine previous catches and potential catch limits for albacore tuna, countries are to report catches of North Pacific albacore tuna from 2007-2012 and the corresponding fishing effort to the IATTC (IATTC 2013k). Work has begun to identify target and limit reference points as well as harvest control rules for albacore tuna (IATTC 2013k).

Factor 3.2 - Bycatch Strategy

Eastern Central Pacific | Dolphin set purse seine

Moderately Effective
The Agreement of the International Dolphin Conservation Program (AIDCP) is generally considered a successful bycatch reduction measure for dolphins, and bycatch of all dolphin species have declined precipitously since high 1970s levels. However, conservation concerns remain for impacted spotted and spinner dolphin species (IATTC 2018c). Bycatch rates in dolphin sets are generally lower than school and FAD sets, however, dolphin sets do occasionally take vulnerable shark and ray species (IATTC 2019d)(IATTC 2019f). There is a 5% fin to body weight rule in place to minimize shark finning (IATTC 2005). Overall while efforts to reduce bycatch of dolphins have been effective, best management practices for other bycatch species are more limited, and the dolphin set purse seine fishery receives a "moderate" score for bycatch strategy.

Justification:
Under the Agreement of the International Dolphin Conservation Program (AIDCP), IATTC member countries use fisheries observers and are responsible for tracking tuna caught in dolphin sets and ensuring limited serious injury or mortality to dolphins during their capture (IATTC 2003). The aim of the AIDCP program is to reduce the incidental mortality of dolphins to levels approaching zero along while maintaining long term stability of tunas (IATTC 1999). Associated agreements regulated the equipment the vessels should carry; established a system based on an overall dolphin mortality limit, complemented with individual vessel dolphin mortality limits; raised observer coverage to 100 percent; instituted a captain training system; promoted research on gear and techniques to reduce dolphin bycatch; promoted research on alternative ways of caching tunas; and established a tuna-tracking system (Hall & Ramon 2013).

Eastern Central Pacific | Floating object purse seine (FAD)

Ineffective
Despite management measures in place and some best practice recommendations that exist, there

are no catch limits in place for the majority of bycatch species in the FAD fishery. Mitigation measures for most bycatch taxa (especially vulnerable sharks and rays) are minimal and insufficient to date to protect frequently captured and/or endangered species, and the FAD tuna purse seine fishery receives an "ineffective" score for bycatch strategy.

Justification:
(IATTC 2019d)(IATTC 2019d)Management measures in place for the associated purse seine fisheries include the suggestion that the deployment of purse seines on FADs is to be done according to a specific method to avoid entangling sharks, sea turtles or other bycatch species with any interactions being reported {IATTC 2012}(IATTC 2013l). This measure must be put into place by January 1, 2019 (IATTC 2017). In addition, IATTC has implemented a 5% shark fin rule, meaning shark fins can weigh no more than 5% of the total sharks on board (IATTC 2005), and oceanic whitetip sharks and silky sharks are prohibited from being captured in the EPO (IATTC 2011c)(IATTC 2016e).

Any incidentally captured sea turtles must be released (IATTC 2007). It has been suggested that sea turtle and shark bycatch could be further reduced by restricting setting on FADs or through the implementation of bycatch avoidance/mitigation devices {Gilman et al. 2011}, which have not been implemented by the IATTC. Abandoned FADs can also lead to ghost fishing (Beverly et al. 2012).

Eastern Central Pacific | Unassociated purse seine (non-FAD)

Moderately Effective
A number of management measures exist to protect vulnerable species, however the efficacy of these measures is uncertain. Therefore, the unassociated tuna purse seine fishery receives an "moderately effective" score for bycatch strategy.

Justification:
Management measures in place for the unassociated purse seine fisheries (other than dolphin sets), include the prohibition of catching oceanic whitetip and silky sharks (IATTC 2011c)(IATTC 2016e), and any incidentally captured sea turtles must be released (IATTC 2007). In addition, setting a purse seine around a school of tuna associated with a whale shark and/or encircling a sea turtle is prohibited (IATTC 2018g) (IATTC 2007) .

The IATTC implemented a 5% shark fin rule, meaning shark fins can weight no more than 5% of the total sharks on board (IATTC 2005) and oceanic whitetip sharks are prohibited from being captured in the EPO (IATTC 2011c). IATTC members are prohibited from retaining, shipping, landing, storing or selling mobulid (manta) rays (IATTC 2015). Any incidentally captured mobulid rays must be released alive when possible, and captures must be recorded (IATTC 2015). However, there are no catch limits in place for bycatch species and many of these measures do not meet suggested best practices {Gilman et al. 2011}.

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Ineffective

A number of management measures aimed at protecting bycatch species caught in longline fisheries operating in the EPO have been adopted by the IATTC including seabird and turtle protections. Nonetheless, the EPO longline fishery is largely unobserved with limited bycatch tracking capability inherent in its current structure (IATTC 2019j)(IATTC 2017c)(IATTC 2019f). A number of vulnerable bycatch species are taken this fishery, and as in the case of silky sharks, management measures to protect vulnerable bycatch are not in place. The EPO tuna and swordfish longline fisheries therefore receive an "ineffective" score for bycatch strategy.

Justification:

Member countries have implemented International Plans of Action for seabirds and longline vessels larger than 20 m in length, fishing in specific areas of the Convention area, and must use at least two mitigation methods and are required to provide information to IATTC on any incidental interactions (IATTC 2011b). Sea turtle management measures include the institution of a 3 year program to reduce the impact of tuna fishing on turtles, require the reporting of interactions to IATTC and the requirement that longline vessels carry proper sea turtle release gear (IAC 2012). In addition, IATTC has implemented a 5% shark fin rule, meaning shark fins can weight no more than 5% of the total sharks on board (IATTC 2005) and oceanic whitetip and silky sharks are prohibited from being captured in the EPO (IATTC 2011c). In addition, longline vessels without a license to target sharks, must limit the bycatch of silky sharks to 20% of the total catch (IATTC 2016e).

However, there are no catch limits in place for bycatch species and many of these measures do not meet suggested best practices (Gilman et al. 2013). In addition, despite calls by the Scientific Committee to institute immediate precautionary measures to protect silky sharks, similar to measures implemented by the Western and Central Pacific Fisheries Commission (i.e. prohibiting retention), these measures have not been adopted (IATTC 2013g).

Factor 3.3 - Scientific Research And Monitoring

Eastern Central Pacific | Floating object purse seine (FAD)

Moderately Effective

Yellowfin, bigeye and skipjack tuna are assessed on a regular basis (IATTC 2013b)(IATTC 2013f). A variety of information including catch and effort data, size (for some species) and biological information are included in these assessments. The Inter-American Tropical Tuna Commission (IATTC) conducts assessments for these three tuna species. In addition, the IATTC is starting a process to advance a Management Strategy Evaluation (MSE) for tropical tunas in working toward a more comprehensive Harvest Strategy (Valero and Aires-da-Silva 2019).

An assessment of silky sharks is currently underway but assessments have not been conducted for the other species included in this report, so we have awarded a moderately effective score.

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Unassociated purse seine (non-FAD)

Eastern Central Pacific | Dolphin set purse seine

Moderately Effective

Yellowfin, bigeye and skipjack tuna are assessed on a regular basis (IATTC 2018a). A variety of information including catch and effort data, size (for some species) and biological information are included in tuna assessments, although high levels of uncertainty are problematic for all EPO tuna purse seine fishery species. In addition, the IATTC is starting a process to advance a Management Strategy Evaluation (MSE) for tropical tunas in working toward a more comprehensive Harvest Strategy (Valero and Aires-da-Silva 2019). The IATTC also strives to assess the sustainability of primary bycatch species when there are sufficient data, including a recent review of silky sharks and a developing ecological risk assessment for mobulid rays (IATTC 2018b)(IATTC 2019e)(IATTC 2018e). While data collection and stock assessment schedules are consistent for tuna species, tuna stock status and fishing mortality are notoriously difficult to assess, and data/assessments exist for only a few of the primary EPO purse seine fishery bycatch species. The IATTC therefore receives a "moderately effective" score for scientific research and monitoring.

Factor 3.4 - Enforcement Of Management Regulations

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)
Eastern Central Pacific | Dolphin set purse seine

Moderately Effective

The IATTC-managed EPO purse seine fisheries receives a "moderately effective" score for enforcement of management regulations. Monitoring committees and/or observers are generally in place to ensure IATTC goals are successfully met, although the effectiveness of enforcement/monitoring may be uncertain in some cases due to limited application of sanctions (Koehler 2013).

Justification:

Information on catches of tuna and tuna like species in the EPO is provided to IATTC through vessel logbooks, observer programs, unloading records, export/import records and from sampling programs (IATTC 2013f). There are several purse seine specific enforcement measures in place. For example, countries must report the names of purse seine vessels and relevant closure dates to IATTC. Countries are also responsible for taking legal and administrative actions necessary to implement closures and inform the IATTC Director that such steps have been taken (IATTC 2013i).

The compliance committee has noted that the amount of non-compliance has been reduced in recent years (IATTC 2014g). Vessels larger than 24 m in length must have a VMS in place (IATTC 2004).

In terms of compliance with management measures, the IATTC has a Permanent Working Group on

Compliance with Conservation and Management Measures and has a standard questionnaire on compliance that is to be submitted by individual countries prior to Commission meetings. IATTC reviews the implementation of management measures and other obligations requested within resolutions. There is some transparency in this process as the IATTC Review Committee is open to observers, and documents are made available to member countries and observers. The Review Committee provides instances of non-compliance to the Commission, however, the IATTC has not yet developed a scheme of sanctions and incentives, and a process for their application, to improve compliance by all members (Koehler 2013).

Factor 3.5 - Stakeholder Inclusion

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)
Eastern Central Pacific | Dolphin set purse seine

Highly effective

The IATTC allows for outside accredited observers, which can be made up of scientists, NGO's or other interested parties to attend and present at meetings. In addition, individual country delegations have representatives from various stakeholders including NGO's, government, producers, suppliers and exporters (Koehler 2013). Additionally, the IATTC will conduct a series of Management Strategy Evaluations going forward and is actively seeking input from interested stakeholders to inform the process (IATTC 2018d). The IATTC therefore receives a "highly effective" score for stakeholder inclusion.

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
Eastern Central Pacific | Dolphin set purse seine	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Eastern Central Pacific | Floating object purse seine (FAD)	Score: 5	Score: 0	High Concern	**Yellow (3.162)**
Eastern Central Pacific | Unassociated purse seine (non-FAD)	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Northeastern Pacific Stock | Eastern Central Pacific, Northeast Pacific | Drifting longlines	Score: 5	Score: 0	Moderate Concern	**Green (3.873)**
Southeastern Pacific Stock | Eastern Central Pacific, Southeast Pacific | Drifting longlines	Score: 5	Score: 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

Eastern Central Pacific | Floating object purse seine (FAD)

Score: 5

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

Eastern Central Pacific | Unassociated purse seine (non-FAD)
Eastern Central Pacific | Dolphin set purse seine

Score: 5

Unassociated purse seine sets and dolphin sets do not come in contact with bottom habitats (Hall & Ramon 2013).

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Score: 5

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

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Eastern Central Pacific | Floating object purse seine (FAD)
Eastern Central Pacific | Unassociated purse seine (non-FAD)
Eastern Central Pacific | Dolphin set purse seine

Score: 0

Not Applicable

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines

Score: 0

N/A

Factor 4.3 - Ecosystem-based Fisheries Management

Eastern Central Pacific | Floating object purse seine (FAD)

High Concern

Purse seine fisheries in the EPO catch several ecologically important groups including other tunas and sharks. Sharks are considered apex 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 to prey abundance, which can lead to a cascade of other effects (Duffy 2003)(Myers et al. 2007)(Ferretti et al. 2010)(Schindler et al. 2002) and behavioral changes (Heithaus et al. 2007).

In 2018, the IATTC reviewed silky shark stock status indicators and banned the capture of oceanic whitetip sharks (IATTC 2019e)(IATTC 2018e). The IATTC has objectives which address ecosystem considerations in management, and work has been done within IATTC to create ecosystem based models and other types of analyses. Additionally, the IATTC considers management measures aimed at protecting dolphins, sea turtles and seabirds to address ecosystem considerations (IATTC 2012c)(IATTC 2018d). However, IATTC has not effectively managed the FAD fishery, and the fishery on FADs may be having significant negative impacts on EPO ecology and vulnerable species, and therefore, the FAD fishery receives a "high concern" score for EBFM.

Justification:

Behavioral changes in tunas could be associated with the introduction of FADs into the Pacific region. These include increases in the biomass of tunas under FADs, reduced free-school abundance, changes in school movement patterns and structure and differences between the age and size of free and FAD associated schools (Fonteneau et al. 2000)(Josse et al. 2000)(Menard et al. 2000b)(Menard et al. 2000a). FADs are also known to attract silky sharks (Rigby et al. 2017). The negative long-term impacts of FAD fishing is difficult to evaluate due to insufficient qualitative data (Fonteneau et al. 2000), and additional research should be undertaken to determine the potential effects of FADs on the ecosystem, including improved monitoring of the number of FADs being used and bycatch composition.

Eastern Central Pacific, Northeast Pacific | Drifting longlines
Eastern Central Pacific, Southeast Pacific | Drifting longlines
Eastern Central Pacific | Unassociated purse seine (non-FAD)
Eastern Central Pacific | Dolphin set purse seine

Moderate Concern

In addition to juvenile and adult tuna and swordfish, IATTC-managed unassociated and dolphin-set purse seine and longline fisheries in the EPO catch a number of upper trophic level species such as billfish, sharks, dolphins, etc. Many of the bycatch species (rays, dolphins, and sharks) are vulnerable and in some cases exhibit declining trends and/or failure to recover (IATTC 2019a) (IATTC 2019b)(IATTC 2019c)(IATTC 2019d)(IATTC 2018c). The IATTC is currently working to document and evaluate stock trends for most bycatch species, including sharks and rays. However, it is possible that the IATTC-managed tuna purse seine and longline fisheries in the EPO are causing detrimental impacts to the ecosystem, and stronger policies may be needed to fully protect the ecological role of harvested and non-target species. Therefore, IATTC-managed tuna purse seine and longline fisheries in the EPO receive a "moderate concern" score for ecosystem based fisheries management.

Justification:
One of the functions of the IATTC under the 2003 Antigua Convention is to "adopt, as necessary, conservation and management measures and recommendations for species be-longing to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered by this Convention, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened (IATTC 2018c)."

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

Bycatch of rays is another significant ecosystem conservation concern. And post release mortality rates of manta rays are unknown but could be significant (Hall & Ramon 2013){Hall and Roman 2013}. A recent draft management strategy evaluation explored spinetail devil ray vulnerability status using a new spatially-explicit ecological risk assessment (ERA) approach called the Ecological Assessment for the Sustainable Impacts of Fisheries (EASI-Fish). This project is ongoing (IATTC 2019e). Additionally, the IATTC supports create ecosystem based models and/or other ecological risk assessments, such as the 2017 preliminary risk assessment for species impacted by the longline fishery (IATTC 2017c).

IATTC recently conducted assessment of silky sharks in the EPO, which are the most common shark bycatch species and banned the capture of oceanic whitetip sharks (IATTC 2018e). The IATTC currently conducts stock assessments or tracks stock status indicators for five shark species in the EPO (IATTC 2018c). In addition, IATTC objectives address incorporating ecosystem considerations into management, and work has been done within IATTC to create ecosystem based models and other types of analysis. IATTC considers management measures aimed at protecting dolphins, sea turtles and sea birds as addressing ecosystem considerations (IATTC 2012c).

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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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Appendix A: Interim Update May 2021

The table below summarizes the changes made to this report as a result of the interim update for mahi mahi in the Northeast Pacific Ocean only.

Criterion	What changed?	Explanation of change	Caused a Ratings Change?
1. Impacts on the Species under assessment	C1.2 changed from low concern to moderate concern	• Exploratory stock assessment only applies to south of the Equator ($F < 0.5F_{MSY}$) • Too much uncertainty north of the Equator to apply the results of the stock assessment to this area. Therefore, moderate concern, not low concern.	No
2. Impacts on other species	No change	No change – bycatch of ETP spp. for longlines	No
3. Management Effectiveness	No change	No change	No
4. Habitat and Ecosystem	No change	No change	No