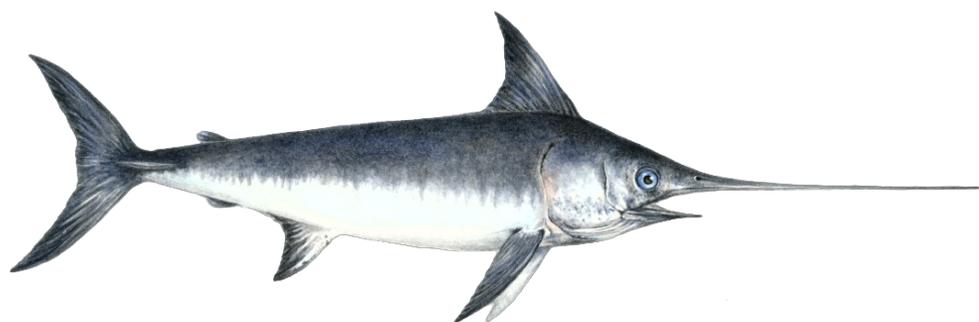




Monterey Bay Aquarium Seafood Watch®

Swordfish and Shortfin mako shark

Xiphias gladius, Isurus oxyrinchus



East Pacific, Peru, Chile

Harpoons, Handlines, and Drift gillnets (driftnets)

Seafood Watch Consulting Researcher

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Seafood Watch Standard used in this assessment: Fisheries Standard v2

Disclaimer

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

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About Seafood Watch

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

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Watch Assessment. Each assessment synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." This ethic is operationalized in the Seafood Watch standards, available on our website here. In producing the assessments, Seafood Watch seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying assessments will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Watch assessments in any way they find useful.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished¹ or farmed that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

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

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

These guiding principles are operationalized in the four criteria in this standard. Each criterion includes:

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

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

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

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

Avoid/Red: Take a pass on these for now; they're overfished, lack strong management or are caught or farmed in ways that harm other marine life or the environment.

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

Summary

Swordfish (*Xiphias gladius*) is targeted in several fisheries within the Eastern Pacific Ocean (EPO), including the harpoon, handline and Southeastern Pacific gillnet fisheries. Shortfin mako shark (*Isurus oxyrinchus*) is also targeted in the gillnet fishery. This assessment covers fisheries that catch swordfish from the Northeast Pacific Ocean stock and the Southeast Pacific Ocean stock. Fisheries that catch fish from the Western Central Pacific swordfish stock - including the California harpoon fishery - are not covered here. The swordfish stock in the Northeastern Pacific Ocean is healthy, but fishing mortality rates are not sustainable. In the Southeastern Pacific, where the gillnet fisheries included in this report occur, the swordfish stock is healthy and sustainably fished.

The harpoon and handline fisheries have little to no bycatch associated with them. But the gillnet fisheries capture sea turtles, sharks, and marine mammals. Sea turtles encountered by the surface gillnet fishery are some of the most endangered populations in the world, particularly leatherback and loggerhead turtles, and there are no effective management measures in these fisheries to protect them. In addition, observer coverage rates are quite low, making it unclear what impact these fisheries are really having on sea turtle, shark, and marine mammal populations in the South Pacific.

In the Eastern Pacific Ocean, swordfish is managed by the Inter-American Tropical Tuna Commission (IATTC), a Regional Fisheries Management Organization (RFMO); in Chile by the National Fisheries Service (SERNAPESCA); and in Peru by the Ministry of Fisheries. There are no management measures currently in place, but stock assessments are conducted periodically, with the most recent assessment being conducted in 2014.

The use of harpoons, handlines, and surface gillnets to capture swordfish does not result in any negative impacts to the bottom habitat. IATTC does not take into account the ecosystem when creating management plans. Chile and Peru do not take into account ecosystem impacts in this fishery.

Final Seafood Recommendations

SPECIES FISHERY	CRITERION 1 TARGET SPECIES	CRITERION 2 OTHER SPECIES	CRITERION 3 MANAGEMENT	CRITERION 4 HABITAT	OVERALL RECOMMENDATION
Shortfin mako shark Southeast Pacific Drift gillnets Chile	1.414	0.000	0.000	3.162	Avoid (0.000)
Swordfish East Pacific Handlines	2.236	5.000	2.000	3.873	Good Alternative (3.050)
Swordfish Eastern Central Pacific, Southeast Pacific Harpoons	2.236	5.000	2.000	3.873	Good Alternative (3.050)
Swordfish Southeast Pacific Drift gillnets Chile	5.000	0.000	0.000	3.162	Avoid (0.000)
Swordfish Southeast Pacific Drift gillnets Peru	5.000	0.000	0.000	3.162	Avoid (0.000)

Summary

Swordfish (*Xiphias gladius*) is a highly migratory species found throughout the world's oceans. This report covers swordfish caught by harpoon and handline in the Eastern Pacific Ocean (EPO) and by gillnet in Peru and Chile.

The **Good Alternative** is for swordfish caught by both harpoon and handline in the EPO. There are some concerns of current fishing mortality rates of swordfish in the EPO, which is why it is not Best Choice. There is no bycatch associated with this fishery, which leads to its **Good Alternative** ranking.

The **Avoid** is for swordfish caught in Peru and Chile gillnet fisheries. This ranking is driven by high bycatch rates and poor management.

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

Swordfish (*Xiphias gladius*) is targeted in several fisheries within the Eastern Pacific Ocean (EPO), including the harpoon, handline and Southeastern Pacific gillnet fisheries. Shortfin mako shark (*Isurus oxyrinchus*) is also targeted in the gillnet fishery. This assessment covers fisheries that catch swordfish from the Northeast Pacific Ocean stock and the Southeast Pacific Ocean stock. Fisheries that catch fish from the Western Central Pacific swordfish stock - including the California harpoon fishery - are not covered here.

Species Overview

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

Globally, longlines are the most common fishing gear used to capture swordfish, including in the Eastern Pacific Ocean. Gears such as harpoons and handlines are also used by fishers within the EPO to target and capture swordfish, and gillnets are used in the South Pacific region (IATTC 2011a).

Swordfish is managed by the Inter-American Tropical Tuna Commission (IATTC), a Regional Fisheries Management Organization (RFMO), in the Eastern Pacific Ocean; by the National Fisheries Service in Chile; and by the Ministry of Fisheries in Peru.

Production Statistics

Longline catches of swordfish in the northern region of the Eastern Pacific Ocean (EPO) have varied over time, with peaks occurring during the late 1960s and early 2000s ($\approx 6,000$ t). In 2012, catches were around 3,000 t and lower than in previous years (approximately 2008–2011) {IATTC 2014}. In the southern region of the EPO, catches have been increasing dramatically since the late 1980s. In 2013, catches were 27,303 t {IATTC 2015}. Catches by harpoon and handline fisheries are much less than longline catches.

Importance to the US/North American market.

Swordfish was primarily imported from Ecuador (51%) during 2013 {NMFS 2014}.

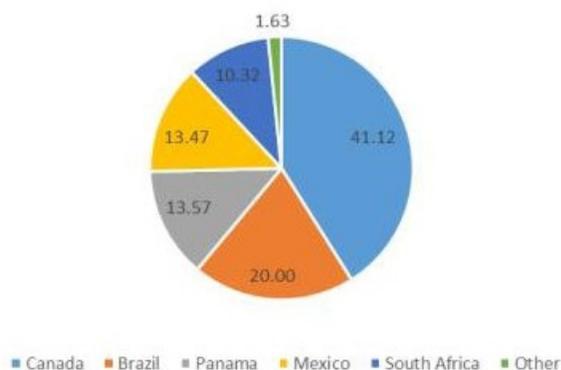


Figure 1: Swordfish imports, IATTC Convention Area, 2013 (country of origin) {NMFS 2014}.

Common and market names.

Swordfish is also known broadbilled swordfish, broadbill, espada, and emperador.

Primary product forms

Swordfish is sold in fresh and frozen forms.

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

SHORTFIN MAKO SHARK				
REGION / METHOD	INHERENT VULNERABILITY	ABUNDANCE	FISHING MORTALITY	SCORE
Southeast Pacific Drift gillnets Chile	1.000: High	2.000: High Concern	1.000: High Concern	Red (1.414)

SWORDFISH				
REGION / METHOD	INHERENT VULNERABILITY	ABUNDANCE	FISHING MORTALITY	SCORE
East Pacific Handlines	2.000: Medium	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Eastern Central Pacific, Southeast Pacific Harpoons	2.000: Medium	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)
Southeast Pacific Drift gillnets Chile	2.000: Medium	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)
Southeast Pacific Drift gillnets Peru	2.000: Medium	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)

Swordfish populations in the Southeastern Pacific Ocean are healthy, and fishing mortality rates appear to be sustainable. In the Northeastern Pacific Ocean, swordfish biomass is healthy but fishing mortality rates are too high.

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.*

Shortfin mako shark

Factor 1.1 - Inherent Vulnerability

Southeast Pacific | Drift gillnets | Chile

High

FishBase assigned a very high vulnerability of 86 out of 100 {Froese and Pauly 2013}. Shortfin mako shark reaches sexual maturity between 180 and 200 cm in size. It can attain a maximum size of 325–375 cm and live up to 40 years. It is a top predator and gives birth to live young (ISC 2015). These life history characteristics also suggest a high inherent vulnerability to fishing based on the Seafood Watch productivity and susceptibility table (PSA = 1).

Justification:

Life history trait	Parameter	Score
Average maximum size	> 300 cm	1
Average maximum age	> 25 years	1
Average size at maturity	> 300 cm	1
Reproductive strategy	Live bearer	1
Trophic level	> 3.25	1

Factor 1.2 - Abundance

Southeast Pacific | Drift gillnets | Chile

High Concern

The International Union for the Conservation of Nature (IUCN) has assessed this species globally as "Vulnerable" {Cailliet et al. 2009}. No stock assessment for shortfin mako shark in the South Pacific has been conducted. We have awarded a "high" concern score because the status is unknown and shortfin mako shark has a high inherent vulnerability score.

Factor 1.3 - Fishing Mortality

Southeast Pacific | Drift gillnets | Chile

High Concern

No assessment of shortfin mako shark has been conducted in the South Pacific region. But some information on catch and discard rates is available. We have awarded a "high" concern score because information on fishing mortality rates in the South Pacific is not available, the population is depleted and susceptible to longline gear, and no management is place to protect the species.

Swordfish

Factor 1.1 - Inherent Vulnerability

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Medium

FishBase assigned a high to very high vulnerability of 72 out of 100 {Froese and Pauly 2013}. But the life history characteristics of swordfish indicate a lower vulnerability to fishing. For example, swordfish reaches sexual maturity around 180 cm in size and around 5 years of age. Swordfish reaches a maximum length of 455 cm and lives more than 10 years. Swordfish is a broadcast spawner and a top predator {Froese and Pauly 2013}. These traits are more indicative of a medium vulnerability to fishing, so we have adjusted the score accordingly.

Factor 1.2 - Abundance

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Very Low Concern

There are likely two populations of swordfish in the Eastern Pacific Ocean (EPO): one in the Northeastern EPO (NEPO) and one in the Southeastern Pacific Ocean (SEPO). The most recent assessment conducted on the NEPO population indicated that the biomass has been increasing since 1995 and has generally remained above the levels needed to produce the maximum sustainable yield (B_{MSY}). The biomass in 2012 was 58,590 t, and the biomass needed to produce the maximum sustainable yield is 31,170 t (ISC 2014). Information is needed on fishing trends in the gillnet fishery in recent years. Swordfish in this region is not overfished and we have awarded a "very low" concern score.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Very Low Concern

There are likely two populations of swordfish in the Eastern Pacific Ocean (EPO): one in the Northeastern EPO (NEPO) and one in the Southeastern Pacific Ocean (SEPO). The Inter-American Tropical Tuna Commission conducted an assessment of the SEPO population. The spawning stock biomass is around 45% higher than that needed to produce the maximum sustainable yield ($SSB_{CURRENT}/SSB_{MSY} = 1.45$), which indicates that the population is not overfished (IATTC 2013f). We have therefore awarded a "very low" concern score.

Factor 1.3 - Fishing Mortality

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

High Concern

Fishing mortality rates of swordfish in the Eastern Pacific Ocean (northern region) have been increasing over time. During 1998, 2002, 2003, and 2012, fishing mortality rates were higher than those needed to produce the maximum sustainable yield (H_{MSY}). There is a 55% chance that overfishing is occurring (ISC 2014). We have therefore awarded a "high" concern score.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Very Low Concern

In the Southeastern region of the Eastern Pacific Ocean, overfishing is not occurring and there is no indication that fishing has significantly affected the population, with recent catches being right around maximum sustainable yield levels (25,000 t) (IATTC 2013f). We have therefore awarded a "very low" concern score.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

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

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

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.

SHORTFIN MAKO SHARK			
REGION / METHOD	SUB SCORE	DISCARDS+BAIT / LANDINGS	SCORE
Southeast Pacific Drift gillnets Chile	0.000	0.900: 40-60%	Black (0.000)

SWORDFISH			
REGION / METHOD	SUB SCORE	DISCARDS+BAIT / LANDINGS	SCORE
East Pacific Handlines	5.000	1.000: < 20%	Green (5.000)
Eastern Central Pacific, Southeast Pacific Harpoons	5.000	1.000: < 20%	Green (5.000)
Southeast Pacific Drift gillnets Chile	0.000	0.900: 40-60%	Black (0.000)
Southeast Pacific Drift gillnets Peru	0.000	0.900: 40-60%	Black (0.000)

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.

EAST PACIFIC HANDLINES				
SUB SCORE: 5.000		DISCARD RATE: 1.000		SCORE: 5.000
SPECIES	INHERENT VULNERABILITY	ABUNDANCE	FISHING MORTALITY	SCORE
Swordfish	2.000: Medium	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)

EASTERN CENTRAL PACIFIC, SOUTHEAST PACIFIC HARPOONS				
SUB SCORE: 5.000		DISCARD RATE: 1.000		SCORE: 5.000
SPECIES	INHERENT VULNERABILITY	ABUNDANCE	FISHING MORTALITY	SCORE
Swordfish	2.000: Medium	5.000: Very Low Concern	1.000: High Concern	Yellow (2.236)

SOUTHEAST PACIFIC DRIFT GILLNETS CHILE				
SUB SCORE: 0.000		DISCARD RATE: 0.900		
SPECIES	INHERENT VULNERABILITY	ABUNDANCE	FISHING MORTALITY	SCORE
Sea turtle (unspecified)	1.000: High	1.000: Very High Concern	0.000: Critical	Black (0.000)
Shortfin mako shark	1.000: High	2.000: High Concern	1.000: High Concern	Red (1.414)
Mammals	1.000: High	3.000: Moderate Concern	2.330: Moderate Concern	Yellow (2.644)
Swordfish	2.000: Medium	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)

SOUTHEAST PACIFIC DRIFT GILLNETS PERU				
SUB SCORE: 0.000		DISCARD RATE: 0.900		
SPECIES	INHERENT VULNERABILITY	ABUNDANCE	FISHING MORTALITY	SCORE
Sea turtle (unspecified)	1.000: High	1.000: Very High Concern	0.000: Critical	Black (0.000)
Swordfish	2.000: Medium	5.000: Very Low Concern	5.000: Very Low Concern	Green (5.000)

Harpoon and handline fisheries are highly selective for their target species and have very low bycatch. We have therefore not included any additional main species in this report.

Information on bycatch in both the Chilean and Peruvian fisheries is limited {Martinez et al. 2014}. According to a 2014 report on bycatch in the Chilean fishery, during 2013 three mammals — two common dolphin (*Delphinus capensis*) and one sea lion (*Otaria flavescens*) — were observed caught in the drift gillnet fishery. Based on 3.9% observer coverage, the estimated average marine mammal bycatch is 0.011 (+/-0.05) dolphins/fishing day and 0.0055 (+/-0.03) sea lions/fishing day {Martinez et al. 2014}. Shortfin mako shark has been reported as the second-most important capture species after swordfish during the 2007–2008 fishing years {Vega 2012}, so it has been included in this report. Chile reported observed interactions in the drift gillnet fishery with sea turtles (particularly leatherback and loggerhead, which are species of concern) to the Inter-American Convention for Protection and Conservation of Sea Turtles. Observed interactions occurred with 18 loggerhead sea turtles (*Caretta caretta*), 9 leatherback turtles (*Dermochelys coriacea*), 7 olive ridley turtles (*Lepidochelys olivacea*), and 6 green sea turtles (*Chelonia mydas*) between 2007 and 2013. Observer coverage rates were around 2% during this period (Chile 2014), so actual interactions could be much higher in number. We have included a general "turtle sp." as bycatch in this report.

Peru does not currently provide information on gillnet captures of these species to agencies such as the Inter-American Convention for the Protection and Conservation of Sea Turtles (Peru 2013). Based on historical information, we have included "sea turtles" in this report. Information is not available on other bycatch species in this fishery; however, because turtle bycatch in this fishery is a "critical concern," it is the limiting factor for the Criterion 2 score. There is no need to include any other taxa.

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

Mammals

Factor 2.1 - Inherent Vulnerability

Southeast Pacific | Drift gillnets | Chile

High

Marine mammals have a high inherent vulnerability to fishing because of their life history characteristics. These include a late age at maturity, a long life span, and few young.

Factor 2.2 - Abundance

Southeast Pacific | Drift gillnets | Chile

Moderate Concern

The status of long-beaked common dolphin in Chile is unknown. The International Union for the Conservation of Nature (IUCN) has listed this species as "Least Concern." The long-beaked common dolphin is a generally abundant species. Previous estimates in the Eastern Pacific Ocean have indicated a population size of 352,000 {Hammon et al. 2008}. South American sea lion also has generally large population sizes throughout its range; however, in Chilean waters, the population was reported to be declining, which is an effect of hunting during the late 1990s and early 2000s {Compagna 2008}. It is unclear what the current population status is since hunting has been prohibited. We have awarded a "moderate" concern score because there is concern over the status of sea lions. In addition, it is possible that other marine mammal species are also incidentally captured by this fishery but are not observed caught because of low observer coverage.

Factor 2.3 - Fishing Mortality

Southeast Pacific | Drift gillnets | Chile

Moderate Concern

According to a 2014 report on bycatch in the Chilean fishery, during 2013 three mammals — two long-beaked common dolphin (*Delphinus capensis*) and one sea lion (*Otaria flavescens*) — were observed caught in the drift gillnet fishery. Based on 3.9% observer coverage, the estimated average marine mammal bycatch is 0.011 (+/-0.05) dolphins/fishing day and 0.0055 (+/-0.03) sea lions/fishing day {Martinez et al. 2014}. We have awarded a "moderate" concern score because observer coverage is very low and the fishery may be negatively affecting sea lion populations in Chile.

Sea turtle (unspecified)

Factor 2.1 - Inherent Vulnerability

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

High

Sea turtles have a high inherent vulnerability to fishing because of their life history characteristics. These include a late age at maturity, a long life span, and few young.

Factor 2.2 - Abundance

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Very High Concern

Green sea, leatherback, loggerhead, and olive ridley turtles

The International Union for Conservation of Nature (IUCN) has classified green sea turtle as "Endangered" with a decreasing population trend. Green sea turtle has been listed on the Convention on International Trade in Endangered Species (CITES) since 1975 and is currently listed on Appendix I, which means that it is threatened with extinction and that international trade is prohibited (Seminoff 2004). But there is conflicting information on its status {Delgado-Trejo and Alvarado-Diaz 2012}.

Leatherback sea turtle has been listed as "Endangered" under the U.S. Endangered Species Act (ESA) since 1970 (NMFS 2012). The International Union for the Conservation of Nature (IUCN) classified leatherback turtle as "Critically Endangered" with a decreasing population trend in 2000 (Martinez 2000). Leatherback turtle has been listed on the Convention on International Trade in Endangered Species (CITES) since 1975 and is currently listed on Appendix I, which means that it is threatened with extinction and that international trade is prohibited. Over the past 25 years, the population of leatherbacks in the Pacific Ocean has decreased significantly (Spotila et al. 1996). Recent estimates from the Pacific Ocean suggest a population size of 294,068 turtles and, out of these, 6,199 are adults (Jones et al. 2012).

The International Union for the Conservation of Nature (IUCN) classified loggerhead turtle as "Endangered" in 1996, although it has been suggested that this assessment needs to be updated (MTSG 2006). Loggerhead is listed on Appendix I of CITES. In the North Pacific Ocean, loggerhead has been listed as "Endangered" under the U.S. Endangered Species Act since 1978 (NMFS 2012).

The International Union for the Conservation of Nature (IUCN) considers the population of olive ridley sea turtle to be "Vulnerable" {Abreu-Grobois and Plotkin 2008}.

We have awarded a "very high" concern score because of the IUCN classifications.

Factor 2.3 - Fishing Mortality

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Critical

Chile reports observed interactions with sea turtles and the drift gillnet fishery to the Inter-American Convention for Protection and Conservation of Sea Turtles. Observed interactions occurred with 18 loggerhead sea turtles (*Caretta caretta*), 9 leatherback turtles (*Dermochelys coriacea*), 7 olive ridley turtles (*Lepidochelys olivacea*), and 6 green sea turtles (*Chelonia mydas*) between 2007 and 2013. Observer coverage rates were around 2% during this period (Chile 2014), therefore interactions are much higher. Historically, Chile was reported to kill up to 2,000 sea turtles per year (combined with Peru) (Eckert and Eckert 1997). More recent information on capture rates of sea turtles in Chile's gillnet fisheries is not available.

Little information is available on the incidental capture of sea turtles by the Peruvian gillnet fishery. Peru does not currently provide information on gillnet captures of these species to agencies such as the Inter-American Convention for the Protection and Conservation of Sea Turtles (Peru 2013). Historically, the Peruvian gillnet fishery was reported to kill 2,000 leatherback sea turtles per year (combined with Chile) (Eckert and Eckert 1997). Other species including green, loggerhead, and olive ridley sea turtles can be found in waters fished by the Peruvian gillnet fishery.

Fishing mortality is thought to be a major threat to leatherback turtles, especially for juveniles and adults that can be incidentally captured in fisheries along the migration routes (Martinez 2000) {Zug and Parham 1996}. The incidental capture of loggerhead and green sea turtles in commercial fisheries is considered a primary threat to their populations {MTSG 2006}{Seminoff 2004}. In addition, there is some thought that fisheries such as gillnet fisheries appear to have a larger negative impact compared to longlines on olive ridley turtles in many areas {Abreu-Grobois and Plotkin 2008}. The fishery's impact on leatherback and loggerhead turtles is of particular concern given the poor status of these species in the Pacific. We have awarded a "critical" concern score because this fishery is affecting Endangered species, there is an overall lack of information on these observed interactions and their impact, and there are no effective management measures in place.

Factor 2.3 - Modifying Factor: Discards and Bait Use

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

< 20%

Harpoon and handline fisheries typically have a negligible discard rate, even as low as zero in some areas (Kelleher 2005). We have therefore awarded the full score of 1.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

40-60%

Discard information for the Chilean and Peruvian gillnet fisheries is unknown. Globally, discard rates for gillnet fisheries range from 0% to 66% (Kelleher 2005). We have therefore awarded a medium score of 40%–60%, to be conservative.

Criterion 3: Management Effectiveness

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

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

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**

Criterion 3 Summary

FISHERY	HARVEST STRATEGY	BYCATCH MANAGEMENT STRATEGY	SCORE
East Pacific Handlines	2.000	0.000	Red (2.000)
Eastern Central Pacific, Southeast Pacific Harpoons	2.000	0.000	Red (2.000)
Southeast Pacific Drift gillnets Chile	3.000	0.000	Black (0.000)
Southeast Pacific Drift gillnets Peru	3.000	0.000	Black (0.000)

Factor 3.1 Summary

FISHERY	STRATEGY	RECOVERY	RESEARCH	ADVICE	ENFORCE	TRACK	INCLUSION
East Pacific Handlines	Moderately Effective	N/A	Moderately Effective	Ineffective	Moderately Effective	Moderately Effective	Highly effective
Eastern Central Pacific, Southeast Pacific Harpoons	Moderately Effective	N/A	Moderately Effective	Ineffective	Moderately Effective	Moderately Effective	Highly effective
Southeast Pacific Drift gillnets Chile	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Moderately Effective
Southeast Pacific Drift gillnets Peru	Moderately Effective	N/A	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Moderately Effective

Factor 3.2 Summary

FISHERY	ALL SPECIES RETAINED?	CRITICAL?	STRATEGY	RESEARCH	ADVICE	ENFORCE
East Pacific Handlines	Yes					
Eastern Central Pacific, Southeast Pacific Harpoons	Yes	No				
Southeast Pacific Drift gillnets Chile	No	Yes				
Southeast Pacific Drift gillnets Peru	No	Yes	Ineffective	Ineffective		

The United Nations Straddling and Highly Migratory Fish Stocks Agreement (1995) indicated that the management of straddling and highly migratory fish stocks should be carried out through Regional Fisheries Management Organizations (RFMOs). RFMOs are the only legally mandated fishery management bodies on the high seas and within EEZ waters. There are currently 18 RFMOs (www.fao.org) that cover nearly all the world's high seas. Member countries must abide by the management measures set forth by individual RFMOs in order to fish in those waters {Cullis-Suzuki and Pauly 2010}. Some RFMOs manage all marine living resources within their authority (e.g., General Fisheries Commission for the Mediterranean [GFCM]), while others manage a group of species such as tunas (e.g., International Commission for the Conservation of Atlantic Tunas [ICCAT]). This report focuses on harpoon and handline fisheries for swordfish in waters within the Eastern Pacific Ocean, which are managed by the Inter-American Tropical Tuna Commission (see below for member countries). In addition, this report covers gillnet fisheries of Chile and Peru, which are managed by their respective fishery management bodies: SERNAPESCA and the Ministry of Fisheries.

IATTC members: 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, and Venezuela.

Bycatch of sea turtles and marine mammals has been observed in the gillnet fishery and historically reported as being very high {Martinez et al. 2014} (Chile 2014) (Peru 2013) (Eckert and Eckert 1997). But information on current interactions is quite limited and/or based on a very low percent observer coverage rate. There are no management measures in place to protect these species or reduce interactions in the gillnet fishery {Martinez et al. 2014} (Peru 2013). All bycatch management measures currently pertain to the longline fishery only. In addition, the low observer coverage rates mean that many interactions are likely not observed and/or not accounted for. We have therefore awarded a "critical" concern because there are no bycatch management measures in place even though known endangered and threatened species are captured in this fishery.

There is little to no bycatch in the harpoon or handline fishery.

Bycatch of sea turtles and marine mammals has been observed in the gillnet fishery and historically reported as being very high {Martinez et al. 2014} (Chile 2014) (Peru 2013) (Eckert and Eckert 1997). But information on current interactions is quite limited and/or based on a very low percent observer coverage rate. There are no management measures in place to protect these species or reduce interactions in the gillnet fishery {Martinez et al. 2014} (Peru 2013). Therefore, even though recent data are lacking, it is assumed that bycatch rates remain high (although declines in interactions due to sea turtle population declines are possible, but this would not reduce the level of concern with the bycatch). All bycatch management measures currently pertain to the longline fishery only. In addition, the low observer coverage rates mean that many interactions are likely not observed and/or not accounted for. We have therefore awarded a "critical" concern because there are no bycatch management measures in place, even though known threatened and endangered species are captured in this fishery.

The harpoon and handline fisheries have low to no bycatch.

Criterion 3 Assessment

SCORING GUIDELINES

Subfactor 3.1.1 – Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? To achieve a highly effective rating, there must be appropriate management

goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/ endangered species.

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

Subfactor 3.1.4 – Management Record of Following Scientific Advice

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

Subfactor 3.1.5 – Enforcement of Management Regulations

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

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

Subfactor 3.1.7 – Stakeholder Inclusion

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

Subfactor 3.2.2 – Management Strategy and Implementation

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

Subfactor 3.2.3 – Scientific Research and Monitoring

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

Subfactor 3.2.4 – Management Record of Following Scientific Advice

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

Subfactor 3.2.5 – Enforcement of Management Regulations

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

Factor 3.1.1 - Critical?

Southeast Pacific | Drift gillnets | Chile
East Pacific | Handlines
Eastern Central Pacific, Southeast Pacific | Harpoons
Southeast Pacific | Drift gillnets | Peru

No

Factor 3.1.2 - Mgmt Strategy / Implement

Southeast Pacific | Drift gillnets | Chile
East Pacific | Handlines
Eastern Central Pacific, Southeast Pacific | Harpoons
Southeast Pacific | Drift gillnets | Peru

Moderately Effective

The National Fisheries Service of Chile (SERNAPESCA) is in charge of national fisheries policy. Chile and Spain have a multilateral organization to manage swordfish. The jurisdiction of the organization is high seas waters outside of Chile, Peru, Colombia, and Ecuador {Comision Permanente del Pacifico Sur 2004}. Chile is not a member of the Inter-American Tropical Tuna Commission and is therefore not bound to their management measures. Management measures in Chile pertain to the longline and not gillnet fleets {Martinez et al. 2014}.

The Ministry of Fisheries is in charge of fisheries management in Peru. Peru is a member of the Inter-American Tropical Tuna Commission and must abide by adopted management measures; however, there are currently no measures related to swordfish. It does not appear that Peru has any additional management measures related to the swordfish gillnet fishery.

In the Eastern Pacific Ocean, swordfish is managed by the Inter-American Tropical Tuna Commission (IATTC). There are currently no management measures specific to swordfish in place.

Although no management measures are in place for swordfish in these fisheries, their populations are healthy so we have awarded a "moderately effective" score.

Factor 3.1.3 - Recovery of Stock Concerns

Southeast Pacific | Drift gillnets | Chile

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Southeast Pacific | Drift gillnets | Peru

N/A

There is no recovery plan in place for swordfish in the Eastern Pacific Ocean, but swordfish is neither overfished nor undergoing overfishing (ISC 2014).

Factor 3.1.4 - Scientific Research / Monitoring

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Moderately Effective

Swordfish is assessed on a periodic basis, and a variety of catch and effort data and biological information is included in these assessments, although effort data are lacking for gillnet fisheries (ISC 2014). The International Scientific Committee (ISC) for tuna and tuna-like species in the North Pacific Ocean conducts assessments of swordfish in the North Pacific. We have awarded a "moderately effective" score because swordfish is assessed on a periodic basis.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Moderately Effective

Swordfish is assessed on a periodic basis, and a variety of catch and effort data and biological information is included in these assessments, although effort data are lacking for gillnet fisheries (ISC 2014). The International Scientific Committee (ISC) for tuna and tuna-like species in the North Pacific Ocean conducts assessments of swordfish in the North Pacific. Chile and Peru have not conducted large amounts of research and/or monitoring of swordfish. We have therefore awarded a "moderately effective" score.

Factor 3.1.5 - Scientific Advice

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Ineffective

The last stock assessment in the North Pacific indicated that fishing mortality rates are too high. If catches remain at 9,700 t, overfishing will likely occur in 2016 but there will be a very small chance that the stock will be overfished (ISC 2014). IATTC has not adopted any management measures to address the concerns from the last assessment. We have therefore awarded an "ineffective" score.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Moderately Effective

No scientific advice was provided for swordfish in 2015, based on the most recent assessment. But swordfish populations are currently healthy in the Southeastern Pacific, so we have awarded a "moderately effective" score.

Factor 3.1.6 - Enforce

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Moderately Effective

Information on catches of tuna and tuna-like species in the Eastern Pacific Ocean is provided to IATTC through vessel logbooks, observer programs, unloading records, export/import records, and from sampling programs (IATTC 2013f). Vessels larger than 24 m in length must have a vessel monitoring system (VMS) in place (IATTC 2004). We have awarded a "moderately effective" score because data are not always reported in a timely fashion and there are issues with data quality.

Southeast Pacific | Drift gillnets | Chile

Moderately Effective

Enforcement of fisheries regulations in Chile is conducted by the National Fisheries Service, Navy and Police (MEERC 2004). Chile has a National Plan of Action to Prevent, Deter and Eliminate IUU Activities (MEERC 2004). We have awarded a "moderately effective" score to account for these measures.

Southeast Pacific | Drift gillnets | Peru

Moderately Effective

The Port Authority and Coast Guard are in charge of fisheries enforcement in Peru (Peru 2013). We have awarded a "moderately effective" score because some enforcement measures are in place.

Factor 3.1.7 - Track Record

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Moderately Effective

There are no management measures in place for swordfish. Fishing mortality rates are currently too high and no measures are in place to address this (ISC 2014). But, the biomass has been maintained at target levels. We have therefore awarded a "moderately effective" score.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Highly effective

There are no catch limits for swordfish in Chile or Peru; however, its populations are currently healthy. We have therefore awarded a "highly effective" score.

Factor 3.1.8 - Stakeholder Inclusion

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Highly effective

The IATTC allows for outside accredited observers, which can be made up of scientists, NGOs, or other interested parties, to attend and participate in a variety of IATTC meetings. Observers are also allowed to attend stock assessment meetings. We have therefore awarded a "highly effective" score.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Moderately Effective

It is unclear how much inclusion of stakeholders Chile and Peru have in their fisheries management processes. We have therefore awarded a "moderately effective" score.

Factor 3.2.1 - All Species Retained?

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Yes

There are no bycatch species in this fishery, so we have scored this "yes" for all species retained.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

No

Factor 3.2.2 - Critical?

Eastern Central Pacific, Southeast Pacific | Harpoons

No

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

Yes

Bycatch of sea turtles and marine mammals has been observed in this fishery and historically reported as being very high (Martinez, et al. 2014) (Chile 2014) (Peru 2013) (Eckert and Eckert 1997). But information on current interactions is quite limited and/or based on a very low percent observer coverage rate. There are no management measures in place to protect these species or reduce interactions in the gillnet fishery {Martinez et al. 2014} (Peru 2013). Thus, there is no apparent reason for historically high bycatch rates to have declined drastically over time. All bycatch management measures currently pertain to the longline fishery only. In addition, the low observer coverage rates mean that many interactions are likely not observed and/or not accounted for. We have therefore awarded a "critical" concern score because there are no bycatch management measures in place even though known threatened species are captured in this fishery.

Factor 3.2.3 - Mgmt Strategy / Implement

Southeast Pacific | Drift gillnets | Peru

Ineffective

Peru has programs for nesting turtles to monitor illegal takes and protects populations that use islands, islets and guano points for protection or migration routes. It is illegal to capture sea turtles. Peru has not created conservation or long term plans to reverse the population decline of leatherback sea turtles. Peru has not taken any actions to enforce legislation protecting hawksbill sea turtles, required through the Inter-American Convention for the Protection and Conservation of Sea Turtles. There are no requirements for the use of bycatch mitigation gears, although the fishermen are to release incidentally captured sea turtles. Peru has begun to evaluate incidental captures of some turtle species.

Factor 3.2.3 - Scientific Research / Monitoring

Southeast Pacific | Drift gillnets | Peru

Ineffective

Peru has had an observer program in place since 1997, although the percentage of coverage is unknown (Peru 2013).

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
East Pacific Handlines	None	Not Applicable	Moderate Concern	Green (3.873)
Eastern Central Pacific, Southeast Pacific Harpoons	None	Not Applicable	Moderate Concern	Green (3.873)
Southeast Pacific Drift gillnets Chile	None	Not Applicable	High Concern	Yellow (3.162)
Southeast Pacific Drift gillnets Peru	None	Not Applicable	High Concern	Yellow (3.162)

Harpoon fishing gear does not come into contact with the bottom habitat, so no mitigation measures are necessary. The Inter-American Tropical Tuna Commission indicates that it has taken ecosystem impacts into account while creating management measures.

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

Southeast Pacific | Drift gillnets | Chile

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Southeast Pacific | Drift gillnets | Peru

None

Fishing gears such as harpoon, handline, and surface gillnets rarely impact bottom habitats, although drift gillnet may have impacts on habitat through lost gear. Ghost fishing and lost gear impacts are not incorporated into the scoring of Criterion 4, though impacts on bycatch species because of ghost fishing are incorporated into Criterion 2 (Seafood Watch 2013). There is no information available on rates of gear loss in the fishery and how it may impact bottom habitat. According to the Seafood Watch criteria, the impact of the gear type on the seafloor habitat is rated as no concern.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Southeast Pacific | Drift gillnets | Chile

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Southeast Pacific | Drift gillnets | Peru

Not Applicable

Factor 4.3 - Ecosystem-based Fisheries Management

East Pacific | Handlines

Eastern Central Pacific, Southeast Pacific | Harpoons

Moderate Concern

Swordfish is considered an exceptional species because it is a top predator. The IATTC has objectives that 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 seabirds as addressing ecosystem considerations (IATTC 2012c). Although such measures do not apply directly to this fishery, we have awarded a "moderate" concern score to account for IATTC considering the ecosystem when making management plans, and because serious ecological harm caused by the fishery is unlikely, based on the benign nature of the fishing method.

Southeast Pacific | Drift gillnets | Chile

Southeast Pacific | Drift gillnets | Peru

High Concern

Swordfish is considered a top-level predator. Chile and Peru do not include ecosystem impacts in their current management systems. We have therefore awarded a "high" concern score for these fisheries.

Acknowledgements

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

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