2.6 INTERNATIONAL

2.6.1 INTRODUCTION

The U.S Pacific Island EEZs managed by the Council are surrounded by large and diverse fisheries targeting pelagic species. The International Module contains reported catches of pelagic species in the entire Pacific Ocean by fleets of Pacific Island nations and distant water fishing nations and information for a SAFE report that includes the most recent assessment information in relation to status determination criteria. Fishery trends in the entire Pacific Ocean are illustrated for the purse seine, longline and pole-and-line fisheries. The tables of this section show the catches of pelagic MUS by U.S. longline (Hawaii and California-based) and U.S. territorial longline fisheries in the WCPFC Convention Area from 2015-2019, as reported to the WCPFC (NMFS 2020). The catches for 2019 are preliminary.

Table 42 through Table 44 provide the U.S. longline landings as submitted to the Western and Central Pacific Fisheries Commission (WCPFC) and Inter-American Tropical Tuna Commission (IATTC).

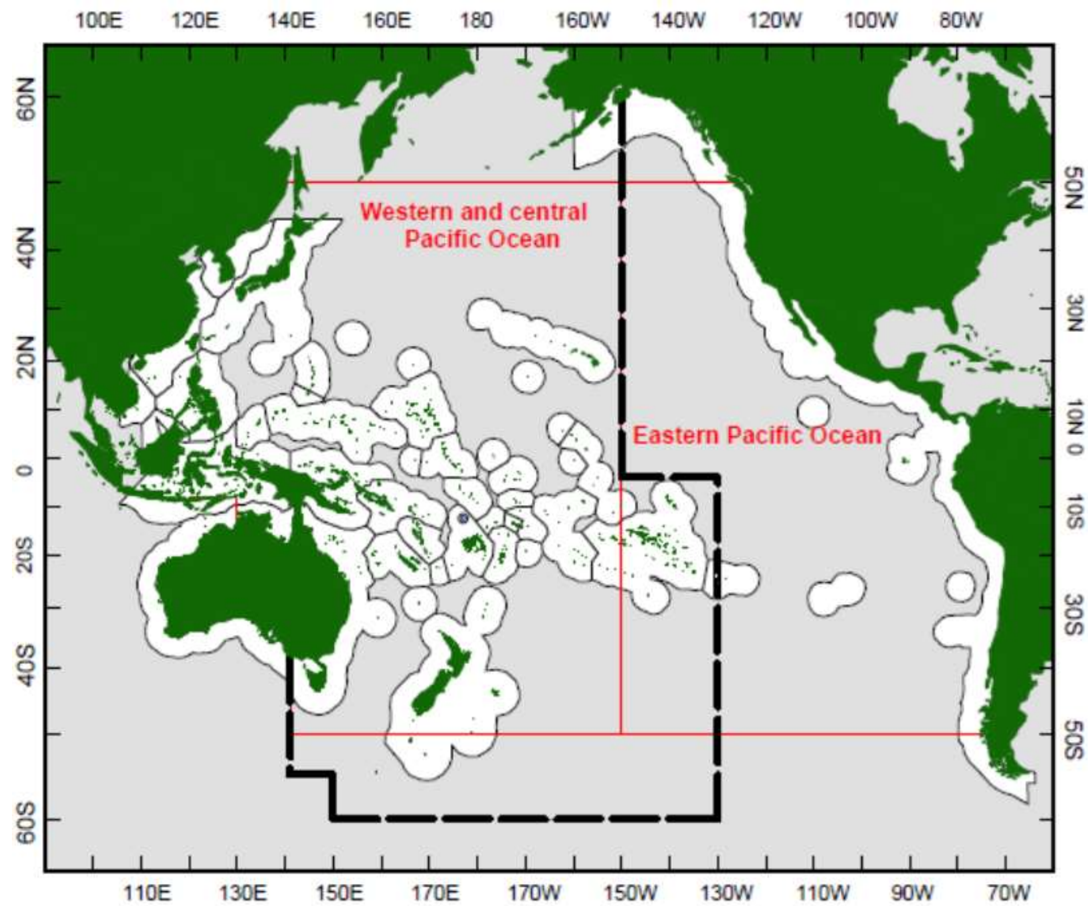


Figure 1. The Western and Central Pacific Ocean, Eastern Pacific Ocean and the WCPFC Convention Area (WCP–CA) [in dashed lines])

2.6.2 DATA SOURCES

The data sources for the international module of the SAFE Report are obtained from the various literature of the WCPFC, the IATTC, and the International Scientific Committee for Tuna and Tuna-like species (ISC). These can be found in the bibliography for this module. Additional sources of data include the US data submissions to the WCPFC and IATTC documented in this module.

2.6.3 PLAN TEAM RECOMMENDATIONS

There were no International module recommendations by the Pelagic Plan Team for the 2019 Annual SAFE Report to be forwarded to the Council, only Action Items to Pelagic Plan Team members on improvements to modules.

2.6.4 SUMMARY OF FISHERIES

This section presents the total catch of tuna species in the Pacific Ocean as reported to the Pacific Community (SPC) from all member countries. Table 36 and Figure 118 depict the combined catch of all fisheries, while the following subsections present fishery specific data for the three main fisheries: purse seine, longline, and pole-and-line.

Table 1. Estimated annual catch (mt) of tuna species in the Pacific Ocean

Year	Albacore	Bigeye	Skipjack	Yellowfin	Total
2009	167,041	255,763	2,016,260	787,614	3,226,678
2010	155,879	227,291	1,839,282	820,488	3,042,940
2011	146,125	243,533	1,813,238	736,941	2,939,837
2012	179,943	257,896	2,028,327	815,581	3,281,747
2013	171,186	231,901	2,110,533	781,847	3,295,467
2014	162,827	246,875	2,269,240	839,782	3,518,724
2015	155,233	240,840	2,123,546	833,921	3,353,540
2016	125,071	236,697	2,133,882	888,963	3,384,613
2017	153,284	225,679	1,952,678	915,940	3,247,581
2018	138,851	235,782	2,129,676	937,504	3,441,813
Average	155,544	240,226	2,041,666	835,858	3,273,294
STD deviation	16,078	11,003	141,957	62,593	174,840

Source: SPC 2019.

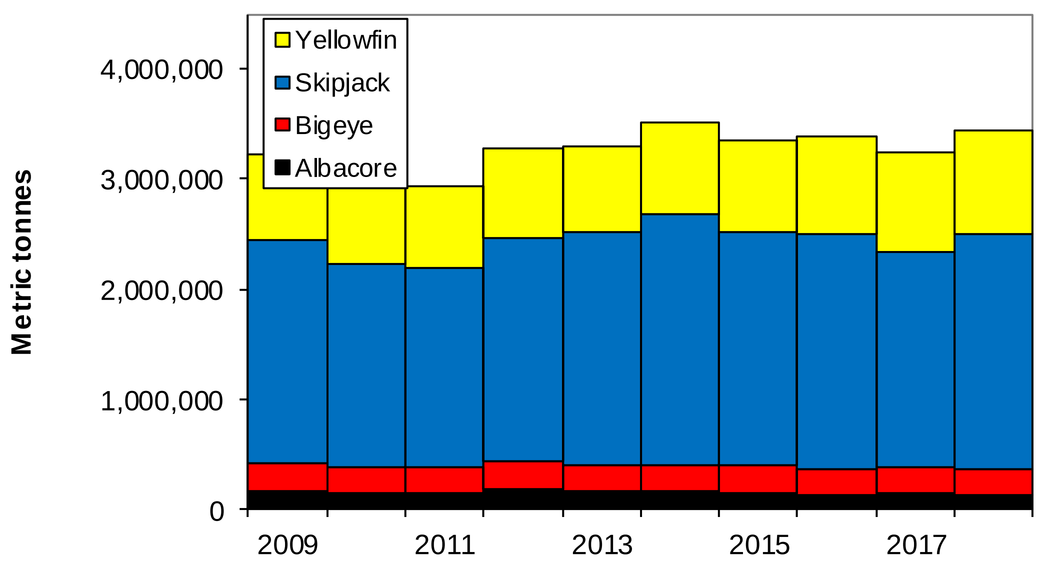


Figure 2. Estimated total annual catch of tuna species in the Pacific Ocean

Source: SPC 2019.

2.6.4.1 PURSE SEINE FISHERY IN THE WCPFC

Source: WCPFC-SC15-2019 GN-WP-01

Vessels: The majority of the historic WCP–CA purse seine catch has come from the four main Distant Water Fishing Nation (DWFN) fleets – Japan, Korea, Chinese-Taipei and USA, which combined numbered 163 vessels in 1992, but declined to a low of 111 vessels in 2006 (due to reductions in the US fleet), before some rebound in recent years (up to 129 vessels in 2017 and 122 vessels in 2018). The Pacific Islands fleets have gradually increased in numbers over the past two decades to a level of 130 vessels in 2017 and 126 vessels in 2018. The remainder of the purse seine fishery includes several fleets which entered the WCPFC tropical fishery during the 2000s (e.g. China, Ecuador, El Salvador, New Zealand and Spain).

The total number of purse seine vessels was relatively stable over the period 1990-2006 (in the range of 180–220 vessels), but thence until 2014, the number of vessels gradually increased, attaining a record level of 308 vessels in 2015, before steadily declining since (to 271 vessels in 2018).

Catch: The provisional 2018 purse-seine catch of 1,910,725 mt was the second highest on record, at nearly 150,000 mt less than the record in 2014 (2,059,008 mt). The 2018 purse-seine skipjack catch (1,469,520 mt; 77% of total catch) was the second highest on record, only 12,000 mt lower than the record in 2014 (1,481,038 mt). The 2018 purse-seine catch for yellowfin tuna (374,062 mt; 20%) was over 100,000 mt lower than the record catch in 2017 (480,176 mt) but still amongst the highest annual catches for this fishery. The provisional catch estimate for bigeye tuna for 2018 (64,119 mt) was the highest since 2014 and slightly higher than the past ten-year average.

Fleet distribution: Despite the FAD closure for certain periods in each year since 2010, drifting FAD sets remain an important fishing strategy, particularly to the east of 160°E. The relatively high proportion of unassociated sets in the eastern areas (e.g. Gilbert Islands) was a feature of the fishery in 2015–2016 (i.e. corresponding to El Nino conditions). The move to ENSO-neutral conditions, then weak La Nina during 2017 into early 2018 resulted in more effort in the area west of 160°E compared to recent years, and a higher use of drifting FADs in the area east of 160°E. By late 2018, weak El Nino conditions presided over the fishery and relatively high catches were taken in the eastern tropical areas, in and adjacent to the waters of Tokelau and the Phoenix Group.

Higher proportions of yellowfin in the overall catch (by weight) usually occur during El Niño years as fleets have access to “pure” schools of large yellowfin that are more available in the eastern tropical areas of the WCP–CA. However, it appears that most of the yellowfin catch east of 160°E was from drifting FAD (associated) sets during 2018.

Table 2. Total reported purse seine catch (mt) of skipjack, yellowfin and bigeye tuna in the Pacific Ocean

Year	Skipjack	Yellowfin	Bigeye	Total
2009	1,639,037	552,769	135,987	2,327,793
2010	1,449,457	595,204	114,093	2,158,754
2011	1,450,362	510,403	128,644	2,089,409
2012	1,666,433	573,793	129,910	2,370,136
2013	1,759,598	560,320	121,688	2,441,606
2014	1,901,260	585,755	125,964	2,612,979
2015	1,729,902	546,537	112,790	2,389,229
2016	1,720,726	627,125	117,860	2,465,711
2017	1,608,110	691,108	125,240	2,424,458
2018	1,746,918	606,878	129,141	2,482,937
Average	1,667,180	584,989	124,132	2,376,301
STD Deviation	139,519	49,927	7,444	154,257

Source: SPC 2019 and IATTC 2019.

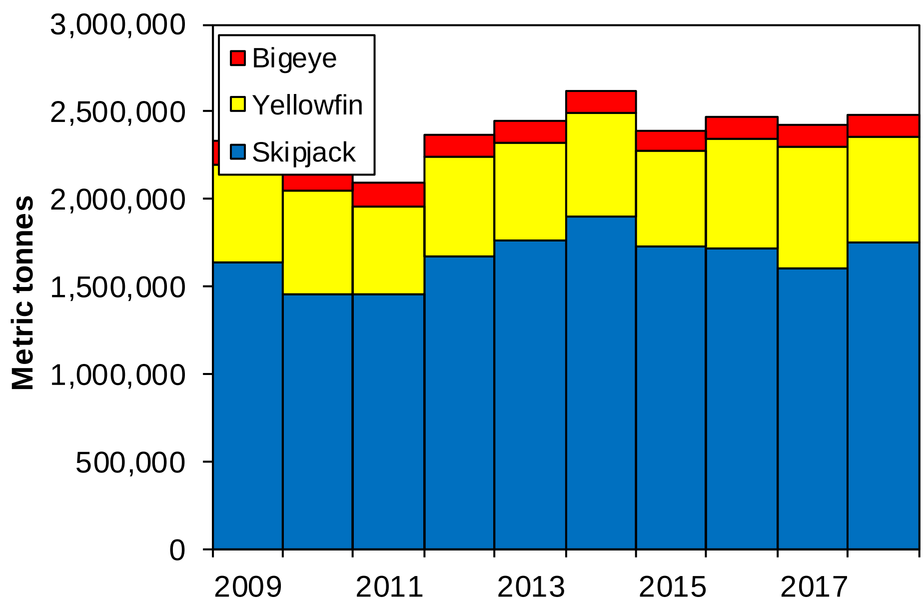


Figure 3. Total purse seine catch of skipjack, yellowfin and bigeye tuna in the Pacific Ocean, 1996–2018

Source: SPC 2019 and IATTC 2019.

2.6.4.2 LONGLINE FISHERIES IN THE WCPFC

Source: WCPFC-SC15-2019 GN-WP-01

Vessels: The total number of vessels involved in the fishery has generally fluctuated between 3,000 and 6,000 for the last 30 years. In recent years, total vessel numbers have dropped below 3,000 vessels for the first time since the 1960s with a provisional estimate of 2,781 vessels in 2018, a 17% drop on the vessels in 2015, mainly due to a decline in the category of non-Pacific Islands domestic fleets.

The fishery involves two main types of operation –

- Large (typically >250 gross registered tonnes [GRT]) distant-water freezer vessels which undertake long voyages (months) and operate over large areas of the region. These vessels may target either tropical (yellowfin, bigeye tuna) or subtropical (albacore) species. Voluntary reduction in vessel numbers by at least one fleet has occurred in recent years;
- Smaller (typically <100 GRT) offshore vessels which are usually domestically based, undertaking trips less than one month, with ice or chill capacity, and serving fresh or air-freight sashimi markets, or albacore canneries. There are several foreign offshore fleets based in Pacific island countries.

The following broad categories of longline fishery, based on type of operation, area fished and target species, are currently active in the WCP–CA:

South Pacific offshore albacore fishery comprises Pacific-Islands domestic "offshore" vessels, such as those from American Samoa, Cook Islands, Fiji, French Polynesia, Kiribati, New Caledonia, PNG, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu; these fleets mainly operate in subtropical waters, with albacore the main species taken. Two new entrants, Tuvalu and Wallis & Futuna, joined this category during 2011, although the latter fleet has not fished recently. Vessel numbers have stabilised in recent years but they may also vary depending on charter arrangements.

Tropical offshore bigeye/yellowfin-target fishery includes "offshore" sashimi longliners from Chinese-Taipei, based in Micronesia, Guam, Philippines and Chinese-Taipei, mainland Chinese vessels based in Micronesia, and domestic fleets based in Indonesia, Micronesian countries, Philippines, PNG, the Solomon Islands and Vietnam.

Tropical distant-water bigeye/yellowfin-target fishery comprises "distant-water" vessels from Japan, Korea, Chinese-Taipei, mainland China and Vanuatu. These vessels primarily operate in the eastern tropical waters of the WCP–CA (and into the EPO), targeting bigeye and yellowfin tuna for the frozen sashimi market.

South Pacific distant-water albacore fishery comprises "distant-water" vessels from Chinese-Taipei, mainland China and Vanuatu operating in the south Pacific, generally below 20°S, targeting albacore tuna destined for canneries.

Domestic fisheries in the sub-tropical and temperate WCP–CA comprise vessels targeting different species within the same fleet depending on market, season and/or area. These fleets include the domestic fisheries of Australia, Japan, New Zealand and Hawaii. For example, the Hawaiian longline fleet has a component that targets swordfish and another that targets bigeye tuna.

South Pacific distant-water swordfish fishery is a relatively new fishery and comprises "distant-water" vessels from Spain and Portugal (one vessel started fishing in 2011).

North Pacific distant-water albacore and swordfish fisheries mainly comprise “distant-water” vessels from Japan (swordfish and albacore), Chinese-Taipei (albacore only) and Vanuatu (albacore only).

Catch: The provisional WCP–CA longline catch (254,850 mt) for 2018 was at the average level for the past five years. The WCP–CA albacore longline catch (84,930 mt – 34%) for 2018 was amongst the lowest for ten years, and around 16,000 mt lower than the record of 101,820 mt attained in 2010. The provisional bigeye catch (71,305 mt – 28%) for 2018 was higher than the recent five-year average, but well down on the bigeye catch levels experienced in the 2000s (e.g .the 2004 longline bigeye catch was 99,705 mt). The yellowfin catch for 2018 (94,509 mt – 38%) was at the average level for the past five years and more than 30,000 mt less that the record for this fishery (1980: 125,113 mt).

A significant change in the WCP–CA longline fishery over the past 10 years has been the growth of the Pacific Islands domestic albacore fishery, which has risen from taking 33% of the total south Pacific albacore longline catch in 1998 to accounting for around 50-60% of the catch in recent years. The combined national fleets (including chartered vessels) mainly active in the Pacific Islands domestic albacore fishery have numbered more than 500 (mainly small “offshore”) vessels in recent years and catches are now at a similar level as the distant-water longline vessels active in the WCP–CA.

The distant-water fleet dynamics have continued to evolve in recent years, with catches down from record levels in the mid-2000s initially due to a reduction in vessel numbers, although vessel numbers for some fleets appear to be on the rise again in recent years, but with variations in areas fished and target species.

Fleet distribution: Effort by the large-vessel, distant-water fleets of Japan, Korea and Chinese-Taipei accounts for most of the effort, but there has been some reduction in vessel numbers in some fleets over the past decade. Effort is widespread as sectors of these fleets target bigeye and yellowfin for the frozen sashimi market in central and eastern tropical waters, and albacore for canning in the more temperate waters, mainly in international waters.

Activity by the foreign-offshore fleets from Japan, mainland China and Chinese-Taipei is restricted to tropical waters, targeting bigeye and yellowfin for the fresh sashimi market; these fleets have limited overlap with the distant-water fleets. The substantial "offshore" effort in the west of the region is primarily by the Indonesian, Chinese-Taipei and Vietnamese domestic fleets targeting yellowfin and bigeye (the latter now predominantly using the handline gear). The growth in domestic fleets targeting albacore tuna in the South Pacific over the past decade has been noted; the most prominent fleets in this category are the Cook Islands, Samoan, Fijian, French Polynesian, Solomon Islands (when chartering arrangements are active) and Vanuatu fleets.

Table 3. Total reported longline catch (mt) of PMUS in the Pacific Ocean

Year	Albacore	Yellowfin	Bigeye	Striped Marlin	Black Marlin	Blue Marlin	Swordfish	Total
2009	109,466	105,368	107,389	4,160	2,066	17,018	35,298	380,765
2010	113,338	103,052	99,576	4,984	2,264	18,824	35,747	377,785
2011	97,997	103,670	102,450	6,328	1,926	16,938	38,407	367,716
2012	120,897	97,914	111,316	6,461	2,007	18,262	43,138	399,995
2013	113,161	86,403	91,778	5,881	1,820	20,037	40,357	359,437
2014	109,032	104,715	106,651	5,625	2,201	20,982	39,376	388,582
2015	112,507	111,488	108,214	5,267	2,516	20,231	44,692	404,915
2016	90,878	94,001	93,569	4,320	1,291	18,346	41,607	344,012
2017	118,656	93,805	86,985	4,813	1,136	16,470	39,334	361,199
2018	104,350	106,871	91,059	4,606	1,178	15,585	40,316	363,965
Average	109,028	100,729	99,899	5,245	1,841	18,269	39,827	374,837
STD deviation	9,156	7,537	8,555	809	482	1,777	2,943	19,185

Source: SPC 2019 and IATTC 2019.

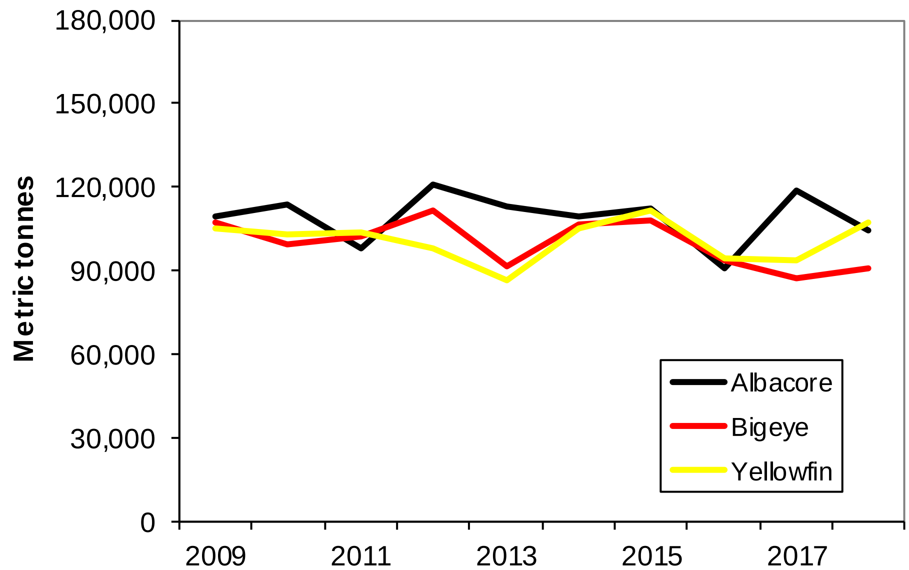


Figure 4. Reported longline tuna catches in the Pacific Ocean

Source: SPC 2019 and IATTC 2019.

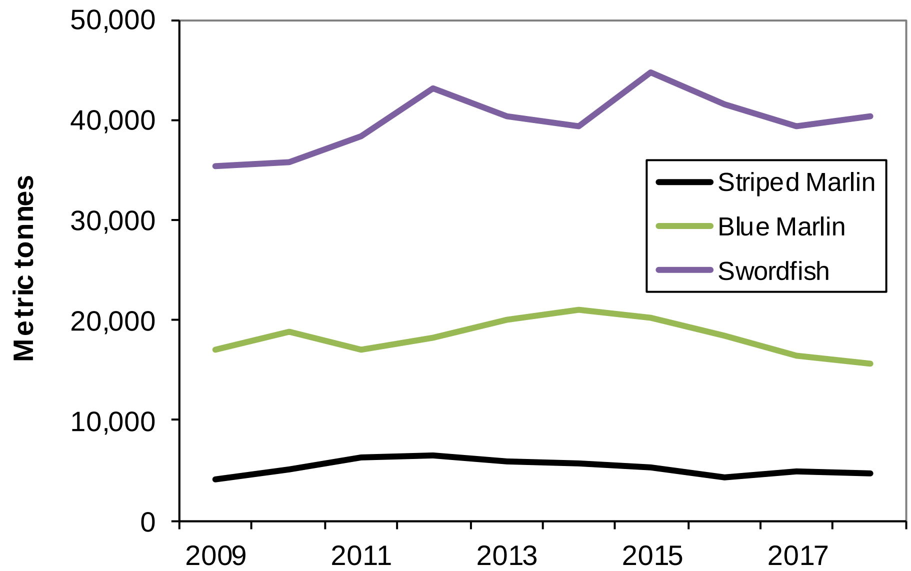


Figure 5. Reported longline billfish catches in the Pacific Ocean

Source: SPC 2019 and IATTC 2019.

2.6.4.3 POLE-AND-LINE FISHERY IN THE WCPFC

Source: WCPFC-SC15-2019 GN-WP-01

Vessels: Economic factors and technological advances in the purse seine fishery (primarily targeting the same species, skipjack) have resulted in a gradual decline in the number of vessels in the pole-and-line fishery (Figure 4.1.1) and in the annual pole-and-line catch during the past 15–20 years (Figure 4.1.2). The gradual reduction in numbers of vessels has occurred in all pole-and-line fleets over the past decade. Pacific Island domestic fleets have declined in recent years – fisheries formerly operating in Fiji, Palau and Papua New Guinea are no longer active, only one vessel is now operating (occasionally) in Kiribati, and fishing activity in the Solomon Islands fishery during the 2000s was reduced substantially from the level experienced during the 1990s. Several vessels continue to fish in Hawai'i, and the French Polynesian *bonitier* fleet remains active (36 vessels in 2018), but an increasing number of vessels have turned to longline fishing. Vessel and catches from Indonesian pole-and-line fleet have also declined over recent years. There is continued interest in pole-and-line fish associated with certification/eco-labelling.

Catch: The provisional 2018 pole-and-line catch (170,038 mt) was slightly higher than the 2017 catch which was the lowest annual catch since the mid-1960s, due to reduced catches in both the Japanese and the Indonesian fisheries. Skipjack tends to account for the majority of the catch (~70-83% in recent years, but typically more than 85% of the total catch in tropical areas) and albacore (8– 20% in recent years) is taken by the Japanese coastal and offshore fleets in the temperate waters of the north Pacific. Yellowfin tuna (5–16%) and a small component of bigeye tuna (1–4%) make up the remainder of the catch. There are only five pole-and-line fleets active in the WCPO (French Polynesia, Japan, Indonesian, Kiribati and

Solomon Islands). Japanese distant-water and offshore fleets (70,533 mt in 2018), and the Indonesian fleets (79,759 mt in 2017; the 2018 catch estimate was being reviewed at the time of writing this paper), account for nearly all of the WCP–CA pole-and-line catch (99% in 2018). The catches by the Japanese distant-water and offshore fleets in recent years have been the lowest for several decades and this is no doubt related to the continued reduction in vessel numbers (although the vessel numbers have been stable at around 75-80 over the past 5 years). The Solomon Islands fleet recovered from low catch levels experienced in the early 2000s (only 2,773 mt in 2000 due to civil unrest) to reach a level of 10,448 mt in 2003. This fleet ceased operating in 2009, but resumed fishing in 2011 with catches generally around 1,000 mt (1,080 mt in 2018 from 4 vessels).

Fleet distribution: The WCP–CA pole-and-line fishery has several components:

- the year-round tropical skipjack fishery, mainly involving the domestic fleets of Indonesia, Solomon Islands and French Polynesia, and the distant water fleet of Japan
- seasonal sub-tropical skipjack fisheries in the domestic (home) waters of Japan, Australia, Hawai`i and Fiji
- a seasonal albacore/skipjack fishery east of Japan (largely an extension of the Japan home-water fishery).

Table 4. Total reported pole-and-line catch (mt) of skipjack in the Pacific Ocean

Year	Catch
2009	200,843
2010	222,995
2011	206,566
2012	170,537
2013	169,023
2014	148,619
2015	151,157
2016	156,503
2017	122,855
2018	172,043
Average	172,114
STD deviation	30,322

Source: SPC 2019.

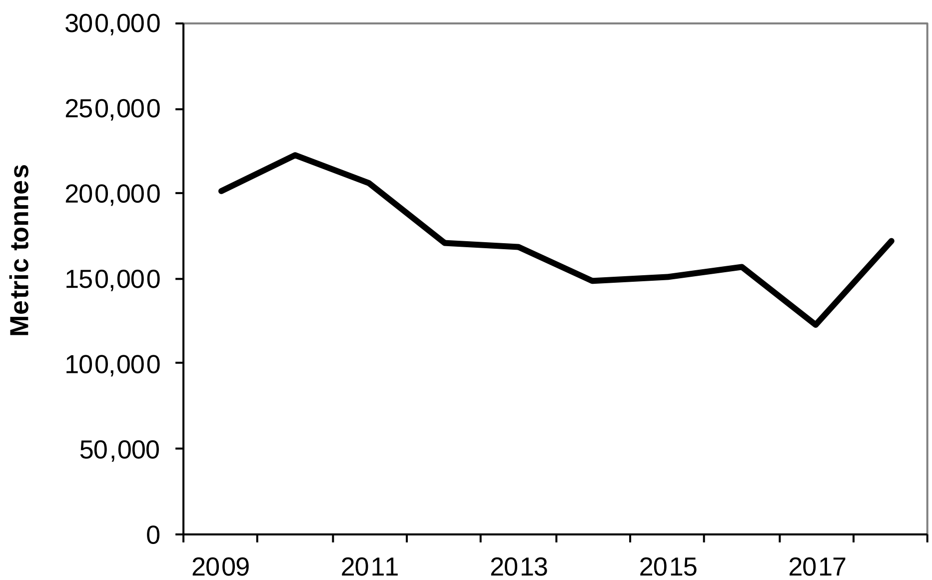


Figure 6. Reported pole-and-line catch (mt) in the Pacific Ocean
Source: SPC 2019.

2.6.5 STATUS OF THE STOCKS

National Standard 1 of the MSA requires that conservation and management measures prevent overfishing while achieving, on a continual basis, the optimum yield from each fishery for the U.S. fishing industry. NMFS advisory guidelines for National Standard 1 require the Council to evaluate and describe in their fishery management plans, the criteria for determining if a stock is subject to overfishing, and when a stock is overfished, or approaching a condition of becoming overfished. This section briefly summarizes the status determination criteria (SDC) for pelagic MUS described in the Pelagic FEP, the stock status relative to the SDC, and lists the stock assessments completed since the last SAFE report.

2.6.5.1 DESCRIPTION OF OVERFISHED STATUS DETERMINATION CRITERIA

For all pelagic MUS, the Council adopted a maximum sustainable yield (MSY) control rule shown in **Figure 123**. The Pelagic FEP uses minimum stock size threshold (MSST) as the SDC for an overfished determination, and a stock is considered overfished when its biomass (B) has declined below the MSST. The MSST is determined based on the natural mortality (M) of the stock and the biomass at MSY (B_{MSY}). Specifically, MSST = cB_{MSY}, where c is the greater of 0.5, or 1 minus the natural mortality rate (M). Expressed as a ratio, a stock is overfished when $B_{year}/B_{MSY} < 1\text{-M}$ or 0.50, whichever is greater. To illustrate these specifications of the MSST, for a stock with a natural mortality rate of 0.2, MSST would be set at $0.8B_{MSY}$, and the stock would be overfished if $B_{year}/B_{MSY} < 0.8$. For a stock with a natural mortality rate greater than 0.5, MSST cannot be set below $0.5B_{MSY}$, and the stock would be overfished if $B_{year}/B_{MSY} < 0.5$.

The Council has also adopted a warning reference point, B_{FLAG}, set equal to B_{MSY} to provide a trigger for consideration of management action before a stock's biomass reaches the MSST. A stock is approaching an overfished condition when there is more than a 50 percent chance that the biomass will decline below the MSST within two years.

It is important to note that NMFS National Standard 1 guidelines at 50 CFR 665.310(e)(1)(i)(C) defines B_{MSY} as the long-term average size of the stock measured in terms of spawning biomass (SB) or other appropriate measure of the stock's reproductive potential that would be achieved by fishing at B_{MSY}. Thus, whenever available, NMFS will use estimates of SB in determining the status of a stock. When estimates of SB are not available, NMFS may use estimates of total biomass (B), or other reasonable proxies for determining stock status.

2.6.5.2 OVERFISHING SDC

The Pelagic FEP uses maximum fishing mortality threshold (MFMT) as the SDC for overfishing. Specifically, overfishing occurs when fishing mortality (F) is greater than the fishing mortality rate that results in MSY (F_{MSY}). Expressed as a ratio, the MFMT is exceeded and a stock is subject to overfishing when $F/F_{MSY} > 1.0$. However, for a stock where biomass has declined below MSST, the default MSY control rule requires the MFMT to be reduced linearly below F_{MSY} to allow for rebuilding of the stock.

It is also important to note that all finfish managed under the Pelagic FEP are also managed under the international agreements governing the WCPFC and/or the IATTC to which the U.S. is a party. Additionally, both the WCPFC and IATTC have adopted criteria for overfishing and overfished for certain species that differ from those described above. Pursuant to Section 304(e)(1), for those fisheries managed under a fishery management plan or international agreement, NMFS shall determine the status of a stock using the criteria specified in the plan, or the agreement. For the purpose of stock status determinations, NMFS will determine stock status of Pelagic MUS using the SDC described in the Pelagic FEP.

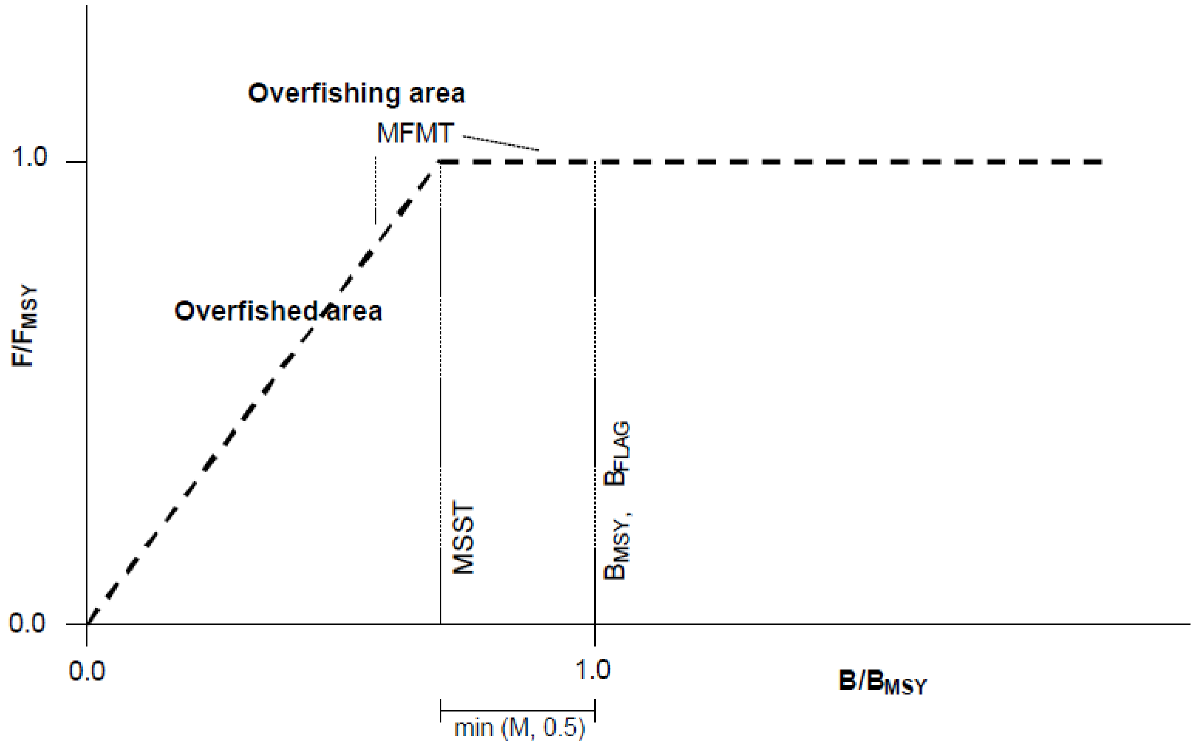


Figure 7. MSY control rule and reference points for pelagic MUS

2.6.6 INFORMATION ON OFL, ABC, AND ACL

Because pelagic squid have an annual life cycle, and all pelagic finfish are subject to management under the international agreements governing the WCPFC and/or the IATTC, all pelagic MUS are excepted from annual catch limit (ACL) and accountability measure requirements of section 303(a)(15) of the MSA, and related reference points. However, this statutory exception does not preclude the Council from specifying ACLs and related reference points for pelagic MUS using the ACL process described in the Pelagic FEP, if the Council deems such specifications are necessary to meet the objectives of the plan.

2.6.7 STOCK ASSESSMENTS COMPLETED SINCE THE LAST PELAGIC SAFE REPORT

Stock status is most reliably determined from stock assessments that integrate fishery and life history information across the range of the stock. For Pelagic MUS, most stock assessments are conducted by several international organizations. In the EPO, IATTC staff conduct stock assessments mainly for tropical tunas (bigeye and yellowfin) and some billfish (striped marlin, swordfish). These assessments are presented to the Scientific Advisory Committee of the IATTC and then to the full IATTC plenary. Assessments for IATTC managed stocks may be accessed on the IATTC meeting webpage.

In the WCPO, the Secretariat of the Pacific Community's Oceanic Fisheries Program (OFP-SPC) conducts stock assessments as the science provider to the WCPFC. Like the IATTC, the OFP-SPC generally focuses on the tropical tunas, but also conduct stock assessments for South Pacific albacore and southwest Pacific swordfish and striped marlin. In the North Pacific Ocean, the ISC for Tuna and Tuna-like Species in the North Pacific Ocean conducts stock assessments specifically for the WCPFC Northern Committee. These assessments are presented to the Scientific Committee of the WCPFC and then to the full WCPFC plenary. Assessments for WCPFC managed stocks may be accessed on the WCPFC meeting webpage.

Table 40 summarizes the stock assessments for pelagic MUS completed or scheduled for completion between 2012 and 2018.

Table 5. Schedule of completed stock assessments for WPRFMC PMUS

Management Unit Species	Year Completed	Management Unit Species	Year Completed
Albacore (S. Pacific)	2018	Swordfish (N. Pacific)	2018
Albacore (N. Pacific)	2014	Wahoo	
Other tuna relatives (*Auxis* sp.)		Yellowfin Tuna (WCPO)	2017
(*allothunnus* sp., *Scomber* sp.)		Kawakawa	
Bigeye Tuna (WCPO)	2018	Bluefin Tuna (Pacific)	2018
Black Marlin		Common Thresher Shark	
Blue Marlin	2016	Pelagic Thresher Shark	
Mahimahi		Bigeye Thresher Shark	2017 - risk assessment
Oilfishes		Shortfin Mako Shark	2018
Opah		Longfin Mako Shark	
Pomfrets		Blue Shark (N. Pacific)	2017
Sailfish		Silky Shark	2018
Shortbill Spearfish		Oceanic Whitetip Shark	2019
Skipjack Tuna (WCPO)	2019	Salmon Shark	
Striped Marlin (N. Pacific)	2019	Squid	

The following pages include a description of the most recent stock assessments and assessment results completed in 2019 based on the WCPFC SC15 Summary Report. For more information on stock assessments and assessment results completed prior to 2019, please see the past Annual Pelagic SAFE Reports.

2.6.7.1 WESTERN AND CENTRAL PACIFIC OCEAN SKIPJACK TUNA

Stock assessment: Vincent et al. 2019.

a. Stock status and trends

SC15 noted that the total provisional catch in 2018 was 1,795,048 mt, a 10% increase from 2017 and a 1% decrease from 2013-2017. Purse seine catch in 2018 (1,469,520 mt) was a 15%

increase from 2017 and a 2% increase from the 2013-2017 average. Pole and line catch (138,534 mt) was a 4% increase from 2017 and a 9% decrease from the average 2013-2017 catch. Catch by other gear (182,888 mt) was a 16% decrease from 2017 and 19% decrease from the average catch in 2013-2017.

SC15 agreed to use the 8-region model to describe the stock status of skipjack tuna because SC15 considers that it better captures the biology of skipjack tuna than the existing 5 region structure. Stock status was determined over an uncertainty grid of 54 models with assumed weightings as illustrated in Table SKJ-01.

The median values of recent (2015–2018) spawning biomass depletion ($SB_{recent}/SB_{F=0}$) and relative recent (2014–2017) fishing mortality (F_{recent}/F_{MSY}) over the uncertainty grid of 54 models (Table SKJ-02) were used to define stock status. The values of the upper 90th and lower 10th percentile of the empirical distributions of relative spawning biomass and relative fishing mortality from the uncertainty grid were used to characterize the probable range of stock status.

The spatial structure used in the assessment model is shown in Figure SKJ-01. Time series of total annual catch (1000's mt) by fishing gear for all regions is shown in Figure SKJ-02 and by region separately is shown in Figure SKJ-03. The annual average recruitment, spawning potential, and total biomass by model region for the diagnostic model are shown in Figure SKJ-04. The overall spawning potential summed across region for the diagnostic model is shown in Figure SKJ-05. The estimated annual average juvenile and adult fishing mortality for the diagnostic model is shown in Figure SKJ-06. The estimated impact of fishing ($1 - SB_{latest}/SB_{F=0}$) by region and overall regions for the diagnostic model is shown in Figure SKJ-07. The median and 80th percent quantile trajectories of fishing depletion for models in the weighted structural uncertainty grid in Table SKJ-01 is shown in Figure SKJ-08, where it can be seen that the median has been below the target since 2009. The Majuro plot shows the recent fishing mortality and spawning potential relative to the unfished spawning potential for all models in the structural uncertainty grid for (i) spawning potential in the recent time period (2015–2018) in Figure SKJ-09, and (ii) spawning potential in the latest time period (2018) in Figure SKJ-10. The Kobe plot shows the recent fishing mortality and spawning potential relative to spawning potential at MSY for all models in the structural uncertainty grid for (i) spawning potential in the recent time period (2015–2018) in Figure SKJ-11, and (ii) spawning potential in the latest time period (2018) in Figure SKJ-12.

SC15 noted that the median level of spawning potential depletion from the uncertainty grid was $SB_{recent}/SB_{F=0} = 0.44$ with a probable range of 0.37 to 0.53 (80% probability interval). There were no individual models where $SB_{recent}/SB_{F=0} < 0.2$, which indicated that the probability that recent spawning biomass was below the LRP was zero.

SC15 noted that the grid median F_{recent}/F_{MSY} was 0.45, with a range of 0.34 to 0.60 (80% probability interval) and that no values of F_{recent}/F_{MSY} in the grid exceed 1. Therefore, SC15 noted that there was a zero probability that the recent fishing mortality exceeds F_{MSY}.

SC15 noted that the largest uncertainty in the structural uncertainty grid was due to the assumed tag mixing period. In addition, SC15 acknowledges that further study is warranted to investigate the uncertainty surrounding the appropriate mixing period for the tagging data.

SC15 acknowledges that the spatial extent of the Japanese pole-and-line fishery has decreased over the time period and that the future use of this standardized CPUE index within future stock assessments is uncertain.

Therefore, SC15 acknowledges that further study of alternative indices of abundance is warranted, such as investigation of standardizing the purse seine fishery and evaluation of the feasibility of conducting fishery independent surveys.

Table SKJ-01. Description of the updated structural sensitivity grid used to characterize uncertainty in the assessment.

Axis	**Value**	**Relative weight**
Steepness	0.65	0.8
	0.80	1.0
	0.95	0.8
Growth	Low	1.0
	Diagnostic	1.0
	High	1.0
Length composition scalar	50	0.8
	100	1.0
	200	1.0
Tag mix	1	1.0
	2	1.0

Table SKJ-02. Summary of reference points over the various models in the structural uncertainty grid. F_{mult} is the multiplier of recent (2014-2017) fishing mortality required to attain MSY, F_{recent} is the average fishing mortality of recent (2014-2017), SB_{recent} is the average spawning potential of recent years (2015-2018) and SB_{latest} is the spawning potential in 2018.

	Mean	Median	Minimum	10th %ile	90th %ile	Maximum
C_{latest}	1,755,328	1,755,693	1,749,846	1,753,471	1,757,057	1,757,083
$Y_{Frecent}$	1,877,914	1,864,040	1,679,600	1,737,702	2,043,556	2,135,200
f_{mult}	2.282	2.258	1.472	1.757	2.957	3.705
F_{MSY}	0.223	0.222	0.180	0.189	0.264	0.270
MSY	2,296,566	2,294,024	1,953,600	1,995,987	2,767,083	2,825,600
F_{recent}/F_{MSY}	0.461	0.447	0.270	0.343	0.600	0.679
$SB_{F=0}$	6,220,675	6,299,363	5,247,095	5,580,942	6,913,431	7,349,557
SB_{MSY}	1,100,947	1,064,400	631,900	723,742	1,544,060	1,688,000
$SB_{MSY}/SB_{F=0}$	0.175	0.176	0.117	0.131	0.225	0.23
$SB_{latest}/SB_{F=0}$	0.414	0.415	0.325	0.36	0.487	0.525
SB_{latest}/SB_{MSY}	2.468	2.382	1.551	1.779	3.356	3.925

SB $_{recent}$/SB$_{F=0}$	0.440	0.440	0.336	0.372	0.530	0.551
SB $_{recent}$/SB$_{MSY}$	2.623	2.579	1.601	1.892	3.613	4.139

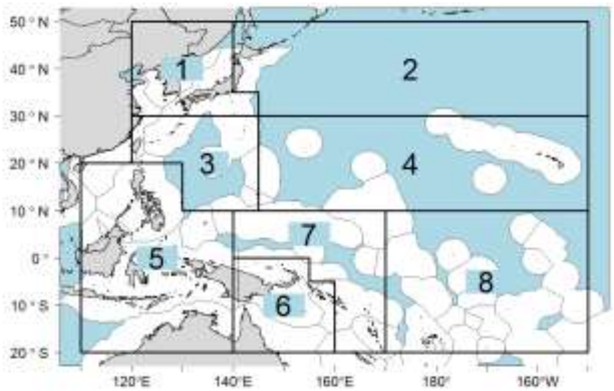


Figure SKJ-01. Eight region spatial structure used in the 2019 stock assessment model.

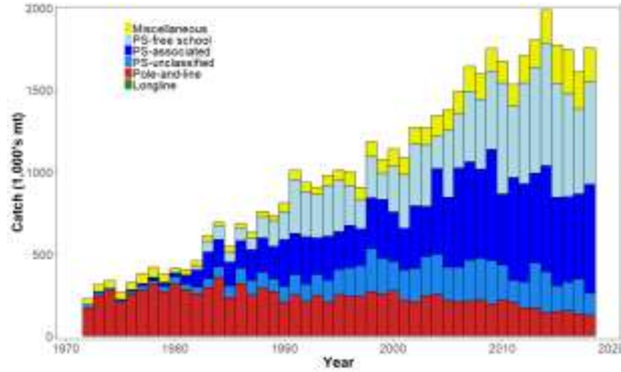


Figure SKJ-02. Time series of total annual catch (1000's mt) by fishing gear over the full assessment period.

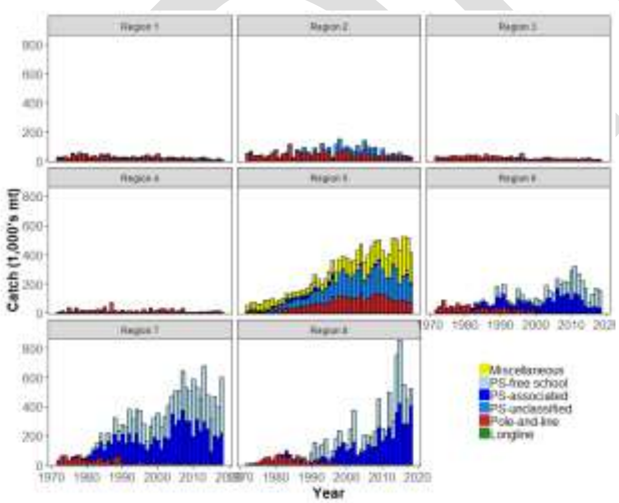


Figure SKJ-03. Time series of total annual catch (1000's mt) by fishing gear and assessment region over

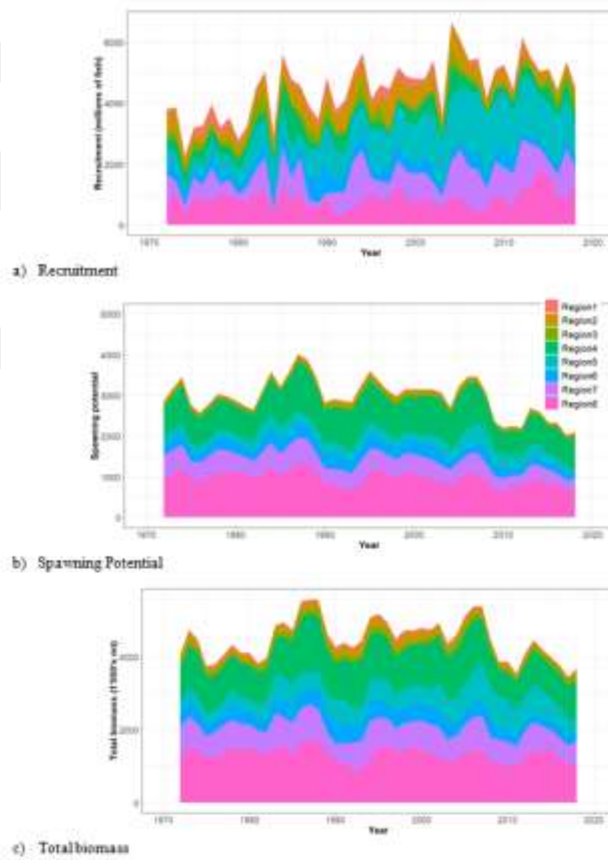


Figure SKJ-04. Estimated annual average recruitment, spawning potential and total biomass by model region the full assessment period.

for the diagnostic model, showing the relative sizes among regions.

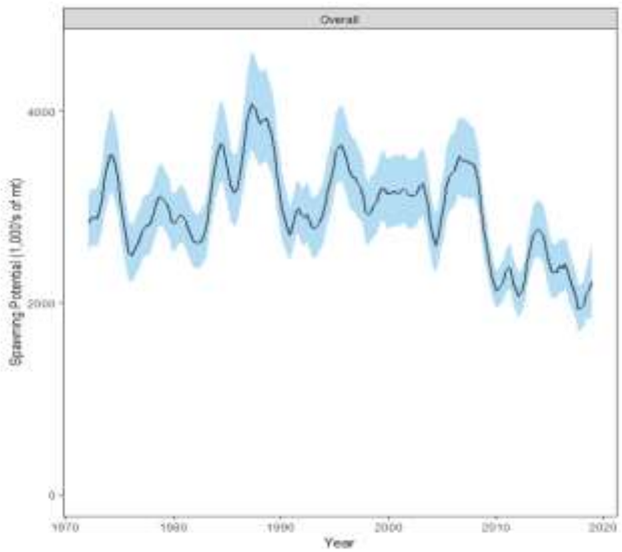


Figure SKJ-05. Estimated temporal overall spawning potential summed across regions from the diagnostic model, where the shaded region is ± 2 standard deviations (i.e., 95% CI).

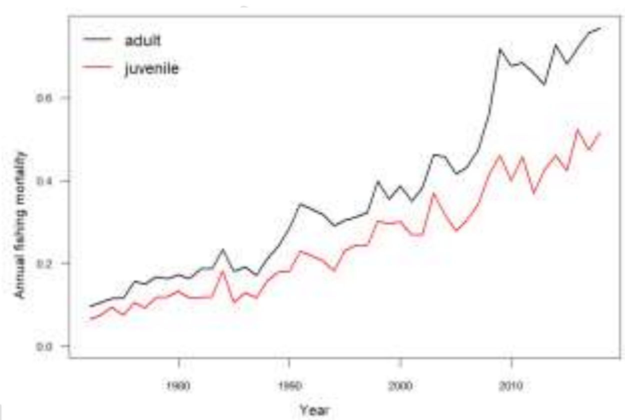


Figure SKJ-06. Estimated annual average juvenile and adult fishing mortality for the diagnostic model.

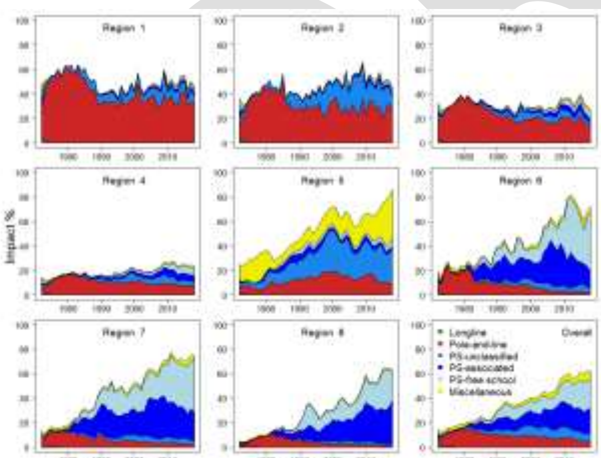


Figure SKJ-07. Estimates of reduction in spawning potential due to fishing (fishery impact = 1-SB_{latest}/$SB_{F=0}$) by region for the diagnostic model.

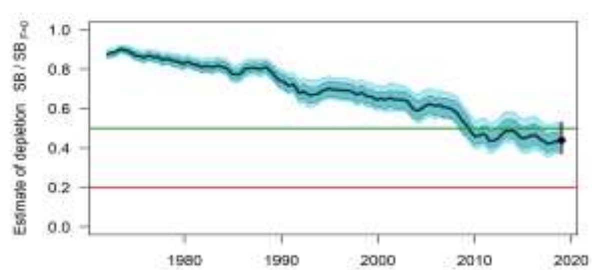


Figure SKJ-08. Plot showing the trajectories of spawning potential depletion for the model runs included in the structural uncertainty grid weighted by the values given in Table SKJ-01. Red horizontal line indicates the agreed limit reference point, the green horizontal line indicates the interim target reference point.

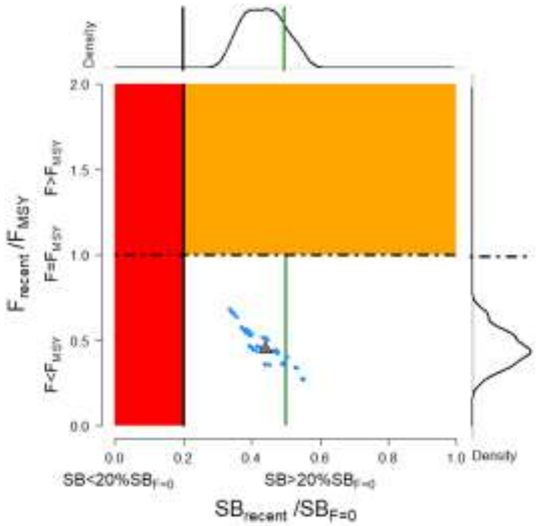


Figure SKJ-09. Majuro plot for the recent spawning potential (2015 – 2018) summarizing the results for each of the models in the structural uncertainty grid with weighting. The plots represent estimates of stock status in terms of spawning potential depletion and fishing mortality, and marginal distributions of each are presented. Vertical green line denotes the interim TRP. Brown triangle indicates the median of the estimates. The size of the circle relates to the weight of that particular model run.

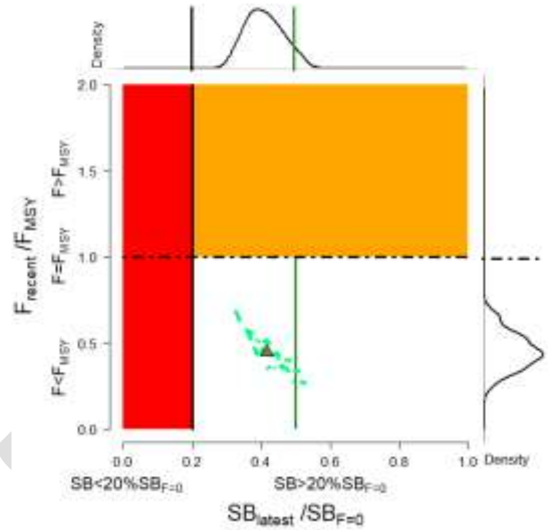


Figure SKJ-10. Majuro plot for the latest spawning potential (2018) summarizing the results for each of the models in the structural uncertainty grid with weighting. The plots represent estimates of stock status in terms of spawning potential depletion and fishing mortality, and marginal distributions of each are presented. Vertical green line denotes the interim TRP. Brown triangle indicates the median of the estimates. The size of the circle relates to the weight of that particular model run.

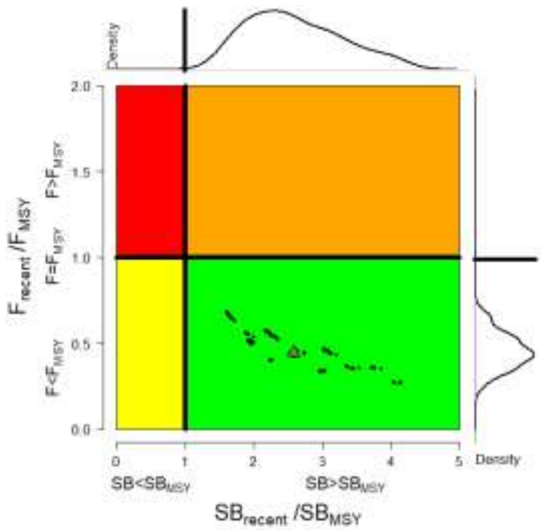


Figure SKJ-11. Kobe plot for the recent spawning potential (2015 – 2018) summarizing the results for each of the models in the structural uncertainty grid. The plots represent estimates of stock status in terms of spawning potential depletion and fishing mortality and marginal distributions of each are presented. Brown triangle indicates the median of the estimates. The size of the circle relates to the weight of that particular model run.

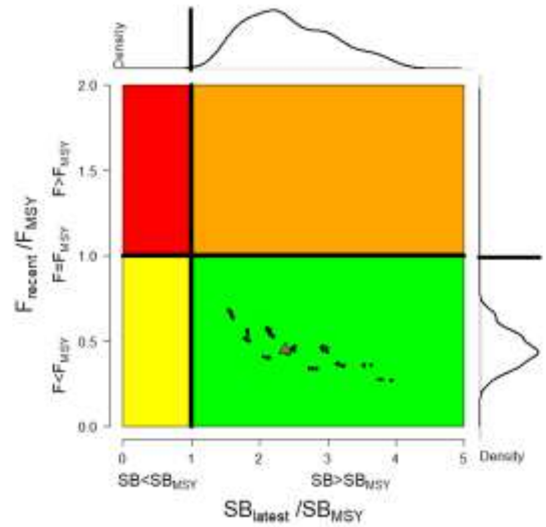


Figure SKJ-12. Kobe plot for the latest spawning potential (2018) summarizing the results for each of the models in the structural uncertainty grid. The plots represent estimates of stock status in terms of spawning potential depletion and fishing mortality and marginal distributions of each are presented. Brown triangle indicates the median of the estimates. The size of the circle relates to the weight of that particular model run.

b. Management advice and implications

SC15 noted that the skipjack assessment continues to show that the stock is currently moderately exploited and the level of fishing mortality is sustainable.

The 2019 stock assessment includes additional data and a range of model improvements such as a change to the maturity schedule used in this assessment, with length-at-maturity now larger than in the previous assessment, which has resulted in a reduction in the estimate of potential spawning biomass, relative to the 2016 assessment.

SC15 noted that the stock was assessed to be above the adopted Limit Reference Point and fished at rates below F_{MSY} with 100% probability. Therefore, the skipjack stock is not overfished, nor subject to overfishing. At the same time, it was also noted that fishing mortality is continuously increasing for both adult and juvenile while the spawning biomass reached the historical lowest level.

The skipjack interim Target Reference Point (TRP) is 50% of spawning biomass in the absence of fishing. The trajectory of the median spawning biomass depletion indicates a long-term trend, and has been under the interim TRP since 2009 (i.e., for 10 years). Since the median spawning biomass has been consistently below the interim TRP, SC15 recommends that the Commission take appropriate management action to ensure that the biomass depletion level fluctuates around the TRP (e.g., through the adoption of a harvest control rule).

c. Research Recommendations

In order to maintain the quality of stock assessments for this important stock SC15 recommends:

a) continuing work to develop an index of abundance based on purse seine data and from FAD acoustic sensors;
b) evaluating the possibility of conducting fishery independent surveys to provide relative abundance indices;
c) conducting regular large-scale tagging cruises and expanding the infrastructure for rapid return of recaptured tags in a manner that provides the best possible data for stock assessment purposes;
d) investigating skipjack growth by validation studies of otolith readings and/or estimation of growth within MFCL from tag recapture data;
e) attempting to provide finalized catch estimates to SPC no later than June 1st.

2.6.7.2 WESTERN AND CENTRAL PACIFIC OCEAN OCEANIC WHITETIP SHARK

Stock assessment: Tremblay-Boyer et al. 2019.

a. Stock status and trends

The median values of relative recent (2013-2015) spawning biomass ($SB_{recent}/SB_{F=0}$, SB_{recent}/SB_{MSY}) and relative recent fishing mortality (F_{recent}/F_{MSY}) over the structural uncertainty grid were used to measure the central tendency of stock status. The span of the recent time period was determined to only include years following the adoption of CMM-2011-04. The values of the upper 90th and lower 10th percentiles of the empirical distributions of relative spawning biomass and relative fishing mortality from the uncertainty grid were used to characterize the probable range of stock status.

Descriptions of the updated structural sensitivity grid used to characterize uncertainty in the assessment are provided in Table OCS-01. Historical catch data used for the diagnostic case is presented in Figure OCS-01. Estimated annual average total biomass, recruitment and spawning biomass are shown in Figure OCS-02, and fishing mortality in Figure OCS-03. The time series of depletion in spawning biomass over all runs in the structural uncertainty grid is shown in Figure OCS-04. Kobe and Majuro plots summarizing the results for each of the models in the structural uncertainty grid retained for management advice are represented in Figures OCS-05 and OCS-06. Table OCS-02 provides a summary of reference points used to determine stock status over the 648 models in the structural uncertainty grid using the grid weights agreed upon by SC and outlined in Table OCS-01.

SC15 noted that the median level of spawning biomass depletion from the uncertainty grid was $SB_{recent}/SB_0 =$ 0.04 with a probable range of 0.03 to 0.05 (80% probability interval). While no limit reference point has been adopted, the depletion in spawning biomass is very high. The median level of recent spawning biomass relative to that leading to MSY was $SB_{recent}/SB_{MSY} =$ 0.09 (range: 0.05–0.17).

SC15 noted that the recent relative fishing mortality was very high and the grid median F_{recent}/F_{MSY} was 3.94, with a range of 2.67 to 5.89 (80% probability interval), and that there were no model runs in the grid where F_{recent}/F_{MSY} was below 1.

The key conclusions are that overfishing is occurring and the stock is in an overfished state relative to MSY and depletion-based reference points (noting that depletion-based reference points have only been adopted for tunas) (Tables OCS-1 and OCS-2). This conclusion is robust to uncertainties in key model assumptions (Figure OCS-5).

SC noted that the inclusion of discard mortality (DM) scenarios in the historical catches was an improvement to the assessment and was necessary to account for the potential impacts of the no-retention measure (CMM-2011-04) for oceanic whitetip sharks.

SC noted that stock status improved relative to F-based reference points in the period since CMM 2011-04 became active, which covers the last 4 years of the assessment's time-span (2013–2016). Notably, F/F_{MSY} is predicted to have declined by more than half from 6.12 to 2.67 (n=432, unweighted grid median) (Figure OCS-2), for the last year of the assessment when the impact of CMM 2011-04 on survival is accounted for under 25% and 43.75% discard mortality scenarios (Figure OCS-6 and OCS-7). Relative fishing mortalities under two alternative reference points that have not been adopted by the WCPFC, specifically $F/F_{lim,AS}$ (the fishing mortality resulting in 0.5 of SB_{MSY}) and $F/F_{crash,AS}$ (the fishing mortality resulting in population extinction when sustained over the long-term, follow similar trends. Under the survival scenarios above, median SB/SB_{MSY} is predicted to have increased slightly from 2013 to 2016 (8.6% to 9.2%).

SC15 noted that there was some inconsistency between observed and estimated CPUEs for 2013-2016 in the diagnostic case, which is probably caused by the assumptions about the stock recruitment relationship in this stock assessment. Whether or not this inconsistency is present in all models across the included uncertainty grid remains unknown.

b. Management advice and implications

Despite the data limitations going into the assessment and the wide range of uncertainties considered, all of the feasible grid model runs indicate that the WCPO oceanic whitetip shark stock continues to be overfished and overfishing is occurring relative to commonly used depletion and MSY-based reference points.

SC15 noted that while the assessment estimates that overfishing is still occurring (F_{recent}/F_{MSY} was 3.94) the stock assessment also estimates a slight recovery in stock biomass in recent years (2013-2016). It remains unclear whether the stock status will continue to improve or perhaps decline in the future. To help clarify this issue SC15 recommends that stock projections based on the assessment are undertaken and presented to SC16.

SC15 noted that there now appear to be few if any major fisheries targeting oceanic whitetip. The greatest impact on the stock is attributed to bycatch from the longline fisheries, with lesser impact from purse seining.

Noting that there are existing CMMs directed at oceanic whitetip, SC15 recommended that further efforts to mitigate catch and improve handling and release practices are required to further reduce fishing mortality and improve stock status.

SC15 noted that the assessment would be improved with better data collection for longline fisheries, such as improved observer coverage, as these fisheries are the major component of fishing mortality and would provide additional information on interaction rates, mitigation options and the fate and condition at release.

SC15 recommends that, as a minimum, CCM's meet the observer coverage specified in CMM 2018-05.

SC15 noted the need for improved estimates of age, growth and fecundity, as well as new length-length conversion factors that would allow for an improved assessment and the inclusion of a greater number of observed lengths.

SC15 noted that following the implementation of CMM 2011-04 and CMM 2014-05, the amount of scientific information available per year on oceanic whitetip sharks and other sharks species covered by a retention ban and the ban on shark lines or wire traces (e.g., bycatch estimates, length measurement, species and sex identification, and biological samples) has declined. SC15 also noted that the decline in information available for the oceanic whitetip shark assessment resulted in higher uncertainty in stock status, especially in more recent years since the introduction of these CMMs. This will also affect the capacity of SC to undertake future assessments if this decline in available information persists. SC15 recommends that WCPFC16 gives more consideration to the data needs for estimating reliable CPUE and other inputs into assessments when management measures are put in place, as these measures may have unintended consequences on continued availability and reliability of data. SC15 also recommended that WCPFC16 also take these considerations into account when reviewing the relevant sharks CMMs.
Noting that no limit reference points have been adopted for oceanic whitetip sharks, as well as other WCPO shark species, SC15 recommends that WCPFC16 consider identifying appropriate limit reference points for WCPO sharks.

Table OCS-01. Description of the axes for the structural uncertainty grid, and assigned weight by level in the final resampling of stock status metrics. Settings used under the diagnostic case are highlighted with a star.

Axis	Description	Weight
Growth and fecundity	Joung (⋆), Seki	0.5, 0.5
Catch	MedianDM100	0.1
	MedianDM44	0.25
	MedianDM25 (⋆)	0.15
	HighDM100	0.1
	HighDM44	0.25
	HighDM25	0.15
Initial F	0.1, 0.15 (⋆), 0.2	0.25, 0.5, 0.25
Steepness	0.34, 0.41 (⋆), 0.49	0.25, 0.5, 0.25
Natural mortality	0.1, 0.18 (⋆), 0.26	0.35, 0.5, 0.15
Recruitment σ_R	0.1 (⋆), 0.2	0.5, 0.5

Table OCS-02. Summary of reference points using SC15 adopted weights by axes over the 648 models in the structural uncertainty grid.

	Mean	Median	Min	10%	90%	Max
C_{latest}	2464	2159	681	1002	4559	9233
C_{recent}	3007	2689	893	1311	5264	10348
MSY	7055	6052	1774	3036	11878	19122
SB_0	10387	8385	1510	3603	20148	34572
SB_{MSY}	4357	3433	523	1420	8524	15593
SB_{latest}	393	314	43	110	793	1217
SB_{recent}	404	324	36	106	795	1616
SB_{latest}/SB_0	0.04	0.04	0.02	0.03	0.05	0.07
SB_{recent}/SB_0	0.04	0.04	0.02	0.03	0.05	0.08
SB_{latest}/SB_{MSY}	0.09	0.09	0.05	0.06	0.13	0.16
SB_{recent}/SB_{MSY}	0.09	0.09	0.05	0.07	0.12	0.17
F_{MSY}	0.056	0.054	0.026	0.037	0.088	0.116
$F_{lim,AS}$	0.089	0.083	0.041	0.058	0.137	0.183
$F_{crash,AS}$	0.138	0.123	0.060	0.084	0.208	0.290
F_{latest}	0.194	0.171	0.096	0.116	0.335	0.473
F_{recent}	0.216	0.205	0.136	0.165	0.288	0.395
F_{latest}/F_{MSY}	3.78	3.30	1.09	1.96	6.55	12.07
F_{recent}/F_{MSY}	4.17	3.94	1.81	2.67	5.89	9.88
$F_{latest}/F_{lim,AS}$	2.40	2.10	0.69	1.23	4.10	7.73
$F_{recent}/F_{lim,AS}$	2.64	2.51	1.15	1.68	3.73	6.33
$F_{latest}/F_{crash,AS}$	1.57	1.38	0.44	0.76	2.70	5.26
$F_{recent}/F_{crash,AS}$	1.73	1.64	0.72	1.05	2.48	4.31

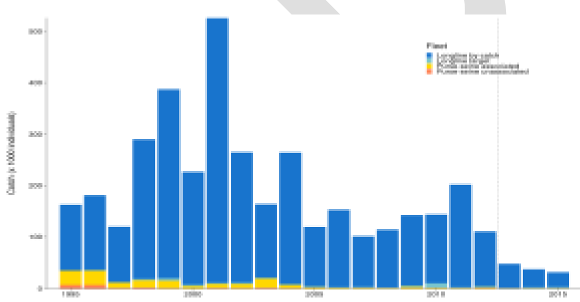


Figure OCS-01. Total reconstructed catches by fleet over time used for the diagnostic case.

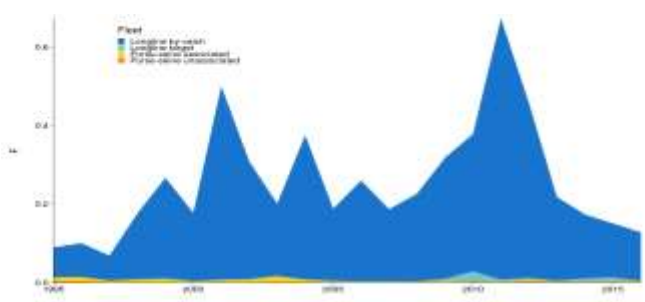


Figure OCS-02. Cumulative fishing mortality by fleet estimated for the diagnostic case over the time-span of the assessment (1995-2016).

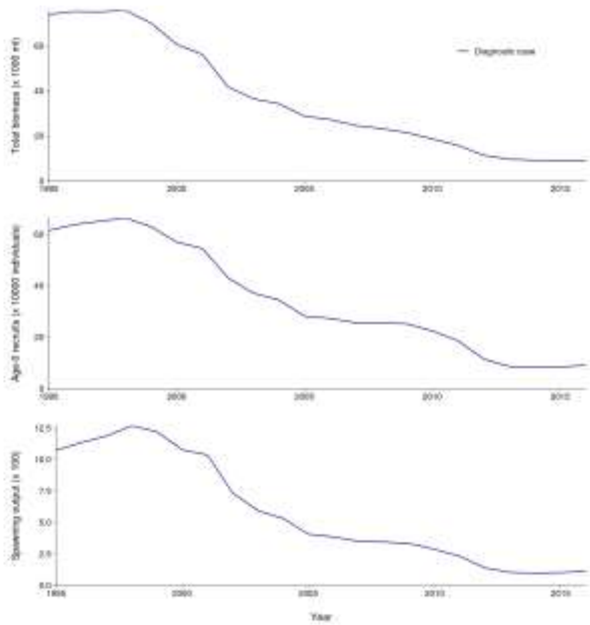


Figure OCS-03. Total biomass, recruitment and spawning biomass for the diagnostic case over the time-span of the assessment (1995-2016).

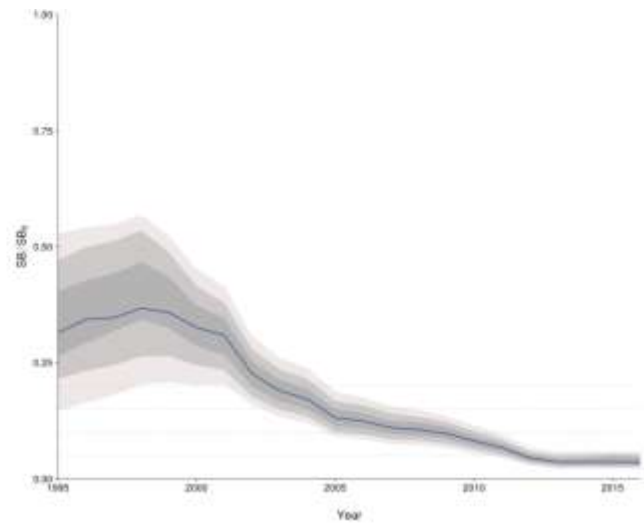


Figure OCS-04: Median estimates of depletion in spawning biomass over all (weighted) grid runs, with 2.5th -97.5th, 10th-90th and 25th -75th quantile intervals. Horizontal grey lines are placed at intervals of 5% in the lower part of the graph to aid visualization.

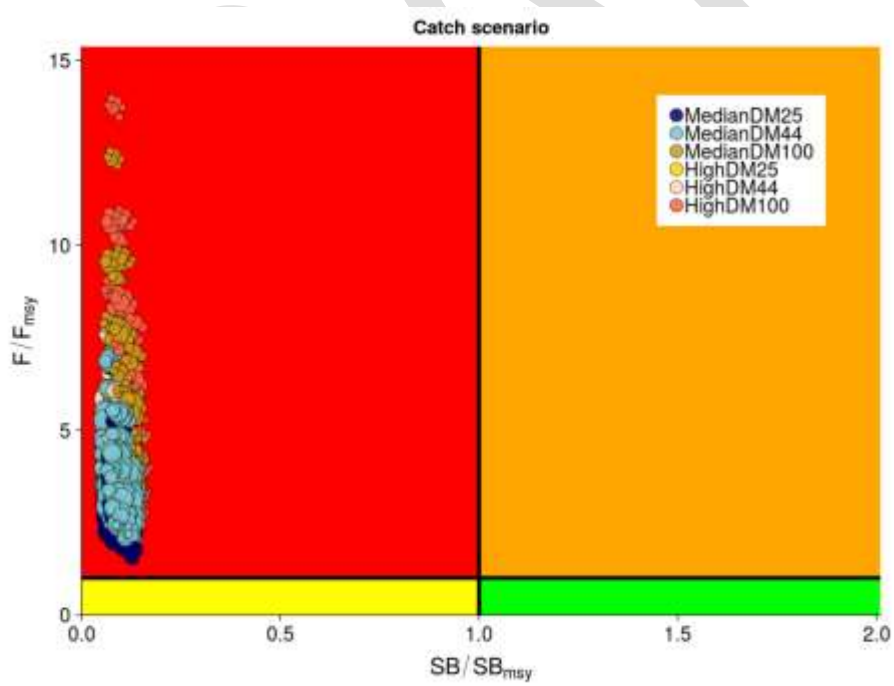
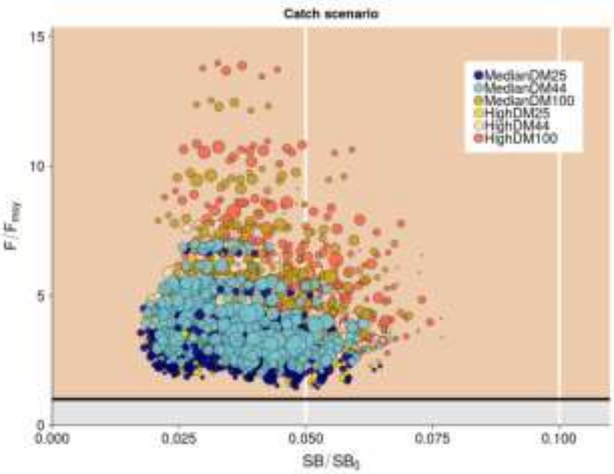


Figure OCS-05: Kobe plot summarizing recent status (2013-2015) for each of the (weighted) models in the structural uncertainty grid, based on SB/SB_{MSY} and F/F_{MSY}. The stock is considered to be overfished when $SB/SB_{MSY} > 1$ and undergoing overfishing when $F/F_{MSY} > 1$. The points are coloured according to the catch scenario that was used as input to the individual grid run. The size of the circle relates to the weight of that particular model run.



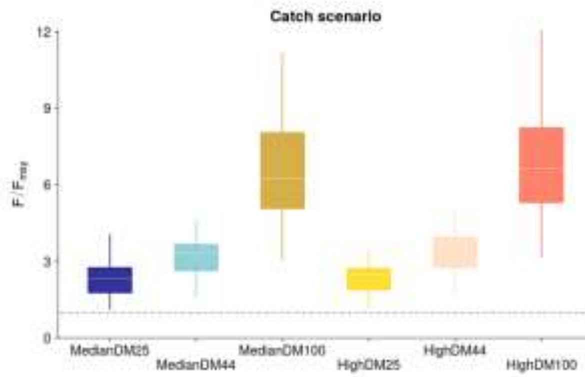


Figure OCS-06: Panel plot summarizing recent stock status (2013-2015) for each of the weighted models in the structural uncertainty grid for SB/SB_0 and F/F_{MSY}, noting no limit or target reference points have been adopted for oceanic whitetip shark. The stock is considered to be undergoing overfishing when $F/F_{MSY} > 1$ (beige zone). The SB/SB_0 axis was scaled to span the range of depletion values. Guidelines were added in white at $0.5SB/SB_0$ and $0.1SB/SB_0$. The points are coloured according to the catch scenario that was used as input to the individual grid run. The size of the circle relates to the weight of that particular model run.

Figure OCS-07: Median (white bar) and inter-quartile bounds (box) for F/F_{MSY} in the final year of the assessment (2016) under the 6 catch scenarios used in the structural uncertainty axis. The catch scenarios included baseline and high levels of catches with 3 scenarios of discard mortality (25%, 43.75% and 100%). The whiskers extend to 1.5 times the interquartile range.

2.6.7.3 WESTERN AND CENTRAL NORTH PACIFIC OCEAN STRIPED MARLIN

Stock assessment: ISC 2019.

a. Stock status and trends

SC15 noted that ISC provided the following conclusions on the stock status of Western and Central North Pacific striped marlin:

> Estimates of population biomass of the Western and Central North Pacific Ocean (WCNPO) striped marlin fluctuated without trend between 1975 and 1993. The population deceased substantially in 1994 and fluctuated without trend until the present year. Population biomass (age-1 and older) averaged roughly 17,969 mt, or 54% below unfished biomass during the 1975-1993 period and declined to 4,508 mt, or 89% below unfished biomass by 2008. The minimum spawning stock biomass was estimated to be 618 t in 2011 (76% below SSB_{MSY}, the spawning stock biomass to produce MSY, Figure NMLS-1a). In 2017, SSB = 981 t and SSB/SSB_{MSY} = 0.38. Fishing mortality on the stock

(average F on ages 3-12) has been around F_{MSY} since 2014 (Figure NMLS-1b). It averaged roughly 0.64 yr^{-1} during 2015-2017, or 7% above F_{MSY} and in 2017, F=0.80 yr^{-1} with a relative fishing mortality of F/F_{MSY} = 1.33 (Table NMLS-02). Fishing mortality has been above F_{MSY} in every year except 1984, 1992, and 2016. The predicted value of the spawning potential ratio (SPR, the predicted spawning output at current F as a fraction of unfished spawning output) is estimated to be $SPR_{2015\text{-}2017}$ = 17% and is approximately equal to the SPR required to produce MSY. Recruitment averaged about 263,000 age-0 recruits between 1994 and 2017, which was 34% below the 1975-2017 average. No target or limit reference points have been established for the WCNPO striped marlin stock under the auspices of the WCPFC. Despite the relatively large L_{50}/L_{inf} ratio for WCNPO striped marlin, the stock is expected to be highly productive due to its rapid growth and high resilience to reductions in spawning potential. Recent recruitments have been lower than expected and have been below the long-term trend since 2005. Although fishing mortality has decreased since 2000, due to the prolonged low recruitment and landings of immature fish, the biomass of the stock has remained below MSY. When the status of WCNPO striped marlin is evaluated relative to MSY-based reference points, the 2017 spawning stock biomass of 981 mt is 62% below SSB_{MSY}(2,604 t) and the 2015-2017 fishing mortality exceeds F_{MSY} by 7%. Therefore, relative to MSY-based reference points, overfishing is occurring and the WCNPO striped marlin stock is overfished (Figure NMLS-02).

Biological reference points were computed for the base case model with Stock Synthesis (Table NMLS-01 and Table NMLS-02). The point estimate of maximum sustainable yield (MSY) was 4,946 t. The point estimate of the spawning biomass to produce MSY (adult female biomass, SSB_{MSY}) was 2,604 t. The point estimate of F_{MSY}, the fishing mortality rate to produce MSY (average fishing mortality on ages 3 – 12) was 0.60 and the corresponding equilibrium value of spawning potential ratio at MSY was SPR_{MSY} = 18%.

Stock projections for WCNPO striped marlin were conducted using the age-structured projection model software AGEPRO. Stochastic projections were conducted using results from the base case model to evaluate the probable impacts of alternative fishing intensities or constant catch quotas on future spawning stock biomass and yield for striped marlin in the WCNPO. For fishing mortality projections, a standard set of F-based projections were conducted. For catch quota projections, the set of rebuilding projection analyses requested by NC14 were conducted. Two future recruitment scenarios were evaluated (Figure 3 and Figure 4): (1) a short-term recruitment scenario based on resampling the empirical cumulative distribution function of recruitment observed during 2012-2016 and (2) a long-term recruitment scenario based on resampling the empirical cumulative distribution function of recruitment observed during 1975- 2016. The short-term recruitment scenario had an average recruitment of 134,020 age-0 fish and the long-term recruitment mean was 306,989 age-0 fish. The stochastic projections employed model estimates of the multi-fleet, multi-season, size- and age-selectivity, and structural complexity in the assessment model to produce consistent results. Fishing mortality-based projections started in 2018 and continued through 2037 under five levels of fishing mortality and the two recruitment scenarios. The five fishing mortality stock projection scenarios were: 1) F status quo (average F during 2015-2017), 2) F_{MSY}, 3) F at $0.2 \cdot SSB_0$, 4) F_{High} at the highest 3-year average during 1975-2017, and 5) F_{Low} at $F_{30\%}$. For the F-based scenarios, fishing mortality in 2018-2019 was set to be F status quo (0.64) and fishing mortality during 2020-2037 was set to the projected level of F. Catch-based projections also ran from 2018 to 2037 and included seven levels of constant catch for the long-term recruitment scenario and 10 levels of catch for the short-term recruitment scenario. For the catch-based scenarios, catch biomass in 2018-2019 was set to be the status quo catch during 2015-2017 (2,151 t) and annual catches during 2020-2037 were set to the projected catch quota. The ten constant catch stock projection scenarios were: 1) Quota based upon WCPFC CMM10-01, 2) 90% of the quota, 3) 80% of the quota, 4) 70% of the quota, 5) 60% of the quota, 6) 50% of the quota, 7) 40% of the quota, 8) 30% of the quota, 9) 20% of the quota, and 10) 10% of the quota. Results show the projected female spawning stock biomasses and the catch biomasses under each of the scenarios (Table NMLS-03, Figure NMLS-03 and Figure NMLS-04).

SC15 noted the following stock status from ISC:

Biomass (age 1 and older) for the WCNPO striped marlin stock decreased from 17,000 t in 1975 to 6,000 t in 2017. Estimated fishing mortality averaged F=0.97 yr^{-1} during the 1975-1994 period with a range of 0.60 to 1.59 yr^{-1}, peaked at F=1.71 $year^{-1}$ in 2001, and declined sharply to F=0.64 yr^{-1} in the most recent years (2015-2017). Fishing mortality has fluctuated around F_{MSY} since 2013. Compared to MSY-based reference points, the current spawning biomass (average for 2015- 2017) was 76% below SSB_{MSY} and the current fishing mortality (average for ages 3 – 12 in 2015-2017) was 7% above F_{MSY}.

Based on these findings, the following information on the status of the WCNPO striped marlin stock is provided:

1. There are no established reference points for WCNPO striped marlin;
2. Results from the base case assessment model show that under current conditions the WCNPO striped marlin stock is overfished and is subject to overfishing relative to MSY- based reference points (Table NMLS-01, Table NMLS-02, and Figure NMLS-01).

SC15 noted that the assessment results are sensitive to the growth assumption and the ISC billfish working group (hereafter, WG) chair noted that the WG will attempt to revise the growth curve at the next stock assessment.

SC15 also highlighted the sharp decline in the stock biomass in the mid-1990s and recommends that ISC further investigate the reasons for this decline.

b. Management advice and implications

SC15 noted that some CCMs expressed concerns that based on the new assessment the WCNPO striped marlin stock was overfished and overfishing was occurring relative to MSY-based reference points.

SC15 noted that while fishing mortality has declined since 2000 fishing mortality has generally remained above F_{MSY} since the introduction of CMM 2010-01 and the stock biomass continues to remain well below SB_{MSY} and the NC target, while noting that the assessment model overestimate biomass in the terminal years. This is despite the phased reduction of the total catch to 80% of the levels caught in 2000-2003 as prescribed in the CMM. SC15 recommends that WCPFC16 note that further reduction in catch will be required to rebuild the stock to MSY levels and the NC target.

SC15 also noted that this stock does not have agreed upon limit reference points and measures on catch limits and reductions in fishing mortality to allow rebuilding of this stock.

SC15 recommends that WCPFC16 consider identifying appropriate limit reference points for WCNPO striped marlin.

SC15 recommends the WCPFC consider appropriate actions to ensure rebuilding this stock to the NC14 rebuilding target. SC15 noted that if lower than average recruitment persists over the near future the probability of rebuilding the stock would be low, noting that there has been a long-term decline in recruitment since the 1990s. Under the F_{MSY} scenario with short-term recruitment assumptions, the probability of achieving $20\%SB_0$ in 2027 is $<0.5\%$.

SC15 noted the following conservation advice from ISC:

> The status of the WCNPO striped marlin stock shows evidence of substantial depletion of spawning potential (SSB_{2017} is 62% below SSB_{MSY}), however fishing mortality has fluctuated around F_{MSY} in the last four years. The WCNPO striped marlin stock has produced average annual yields of around 2,100 t per year since 2012, or about 40% of the MSY catch amount. However, the majority of the catch are likely immature fish. All of the projections show an increasing trend in spawning stock biomass during the 2018-2020 period, with the exception of the high F scenario under the short-term recruitment scenario. This increasing trend in SSB is due to the 2017 year class, which is estimated from the stock-recruitment curve and is more than twice as large as recent average recruitment.
>
> Based on these findings, the following conservation information is provided:
>
> **1.** Projection results under the long-term recruitment scenario show that the stock has at least a 60% probability of rebuilding to $20\%SSB_0$, the rebuilding target specified by NC14, by 2022 for all harvest scenarios, with the exception of the highest F scenario (Average F 1975-1977);
>
> **2.** However, if the stock continues to experience recruitment consistent with the short-term recruitment scenario (2012-2016), catches must be reduced to 60% of the WCPFC catch quota from CMM 2010-01 (3,397 t) to 1,359 t in order to achieve a

60% probability of rebuilding to 20%SSB_0=3,610 t1 by 2022. This corresponds to a reduction of roughly 37% from the recent average yield of 2,151 t;

3. For the constant catch projection scenarios that were tested, it was notable that all of the projections under the long-term recruitment scenario would be expected to achieve the spawning biomass target by 2020 with probabilities ranging from 61% to 73% and corresponding catch quotas ranging from 3,397 to 1,359 t (Table NMLS-03).

It was also noted that retrospective analyses show that the assessment model appears to overestimate spawning potential in recent years, which may mean the projection results are ecologically optimistic.

Special Comments

The WG achieved a base-case model using the best available data and biological information. However, the WG recognized uncertainty in some assessment inputs including drift gillnet catches and initial catch amounts, life history parameters such as maturation and growth, and stock structure.

Overall, the base case model diagnostics and sensitivity runs show that there are some conflicts in the data (ISC/19/ANNEX/11). When developing a conservation and management measure to rebuild the resource, it is recommended that these issues be recognized and carefully considered, because they affect the perceived stock status and the probabilities and time frame for rebuilding of the WCNPO striped marlin stock.

Research Needs

To improve the stock assessment, the WG recommends continuing model development work, to reduce data conflicts and modeling uncertainties, and reevaluating and improving input assessment data.

Existing genetic studies suggest regional spawning subgroups of striped marlin throughout the entire Pacific. More research is needed to improve upon knowledge of regional stock structure and regional mixing for incorporation into the stock assessment.

Table NMLS-01. Reported catch (t) used in the stock assessment along with annual estimates of population biomass (age-1 and older, t), female spawning biomass (t), relative female spawning biomass (*SSB/SSB_{MSY}*), recruitment (thousands of age-0 fish), fishing mortality (average F, ages-

Year	2011	2012	2013	2014	2015	2016	2017[2]	Mean[1]	Min[1]	Max[1]
Reported Catch	2,690	2,757	2,534	1,879	2,072	1,892	2,487	5,643	1,879	10,862
Population Biomass	5,874	6,057	4,937	6,241	5,745	5,832	6,196	12,153	4,509	22,303
Spawning Biomass	618	809	743	864	1,073	1,185	981	1,765	618	3,999
Relative Spawning Biomass	0.24	0.31	0.29	0.33	0.41	0.46	0.38	0.68	0.24	1.54
Recruitment (age 0)	196,590	87,956	330,550	77,274	185,438	195,069	354,391	396,218	77,274	1,049,460
Fishing Mortality	1.11	1.06	0.86	0.63	0.62	0.51	0.80	1.06	0.51	1.71
Relative Fishing Mortality	1.85	1.76	1.42	1.05	1.03	0.85	1.33	1.76	0.85	2.85
Spawning Potential Ratio	9%	11%	11%	16%	17%	20%	14%	12%	20%	6%

[1] During 1975-2017

[2] Recruitment in 2017 is estimated from the stock recruitment curve.

3 – 12), relative fishing mortality (F/F_{MSY}), and spawning potential ratio of WCNPO striped marlin.

Table NMLS-02. Estimates of biological reference points along with estimates of fishing mortality (F), spawning stock biomass (SSB), recent average yield (C), and spawning potential ratio (SPR) of WCNPO MLS, derived from the base case model assessment model, where

Reference Point	Estimate
F_{MSY} (age 3-12)	0.60
F_{2017} (age 3-12)	0.80
$F_{20\%SSB(F=0)}$	0.47
SSB_{MSY}	2,604 t
SSB_{2017}	981 t
$20\%SSB_0$	3,610 t
MSY	4,946 t
$C_{2015\text{-}2017}$	2,151 t
SPR_{MSY}	18%
SPR_{2017}	14%
$SPR_{20\%SSB(F=0)}$	23%

"MSY" indicates reference points based on maximum sustainable yield.

Table NMLS-03. Projected median values of WCNPO striped marlin spawning stock biomass (SSB, t), catch (t), and probability of reaching 20%SSB0 under five constant fishing mortality rate (F) and ten constant catch scenarios during 2018-2037. For scenarios which have a 60% probability of reaching the target of $20\%SSB_{F=0}$, the year in which this occurs is provided; NA indicates projections that did not meet this criterion. Note that $20\%SSB_{F=0}$ is 3,610 t and SSB_{MSY} is 2,604 t.

Year	2018	2019	2020	2021	2022	2027	2037	Year when target achieved with 60% probability
Scenario 1: $F_{status\ quo}$; Long-Term Recruitment								
SSB	1931.3	2605.3	3591	4288.3	4639.4	4893.4	4884.4	
Catch	2229.8	3089.8	3911.6	4412.8	4644.9	4797.2	4790.9	
Probability of reaching 20% SSB	0%	4%	44%	70%	79%	84%	84%	2021
Scenario 2: $F_{status\ quo}$; Short-Term Recruitment								
SSB	1932.4	2556.5	3080	2786.9	2422.3	2071.4	2072.1	
Catch	2224.6	2827	2871.7	2535.9	2260.7	2029.6	2030.4	
Probability of reaching 20% SSB	0%	4%	21%	9%	2%	<0.5%	<0.5%	NA
Scenario 3: FMSY; Long-Term Recruitment								
SSB	1935.1	2611.8	3650.5	4444	4860.6	5158.9	5203.5	
Catch	2228.1	3092.7	3705.2	4241.6	4498.9	4666.4	4711.5	
Probability of reaching 20% SSB	0%	4%	47%	75%	83%	89%	89%	2021
Scenario 4: FMSY; Short-Term Recruitment								
SSB	1932.9	2557.7	3126.3	2895.5	2552.2	2207	2197	
Catch	2230.8	2829.6	2724.6	2450.7	2209.9	1994.1	1984.9	
Probability of reaching 20% SSB	0%	4%	23%	12%	4%	<0.5%	<0.5%	NA
Scenario 5: F 20%$SSB_{F=0}$; Long-Term Recruitment								
SSB	1933.7	2611.9	3813.4	4943.7	5631	6358.1	6348.5	
Catch	2227.6	3091.3	2996.4	3588.7	3933.2	4271.7	4266.7	
Probability of reaching 20% SSB	0%	4%	55%	85%	93%	97%	98%	2021
Scenario 6: F 20%$SSB_{F=0}$; Short-Term Recruitment								
SSB	1934	2560.5	3276.3	3274.8	3030.2	2697	2690.2	
Catch	2224.9	2828.8	2211.6	2115.4	1969.7	1809.1	1804.7	
Probability of reaching 20% SSB	0%	4%	29%	28%	17%	6%	7%	NA
Scenario 7: Highest F (Average F 1975-1977); Long-Term Recruitment								
SSB	1932.8	2611.8	2739.8	2299.1	2102	2028.4	2036.2	
Catch	2226.4	3088.5	7520.7	6557.5	6184.4	6058	6084.1	

Table NMLS-03. (Continued)

Year	2018	2019	2020	2021	2022	2027	2037	Year when target achieved with 60% probability
Probability of reaching 20% SSB	0%	4%	9%	4%	2%	1%	1%	NA
Scenario 8: Highest F (Average F 1975-1977); Short-Term Recruitment								
SSB	1933.5	2559.4	2289.2	1330.7	968.3	858.7	859.2	
Catch	2225.9	2827.6	5362.9	3399.3	2751.6	2564.6	2570.9	
Probability of reaching 20% SSB	0%	3%	2%	<0.5%	0%	0%	0%	NA
Scenario 9: Low F ($F_{30\%}$); Long-Term Recruitment								
SSB	1933.6	2612.5	4009.5	5603.2	6742.4	8287.5	8353	
Catch	2228.6	3093.5	2117.6	2693.6	3075	3558.2	3577.8	
Probability of reaching 20% SSB	0%	4%	63%	93%	98%	>99.5%	>99.5%	2020
Scenario 10: Low F ($F_{30\%}$); Short-Term Recruitment								
SSB	1932.5	2555.6	3453.8	3788.4	3747.4	3537.4	3525.3	
Catch	2228.4	2832	1572.9	1623.8	1589	1515.8	1511.6	
Probability of reaching 20% SSB	0%	4%	37%	54%	54%	44%	42%	NA
Scenario 11: Current Quota; Long-Term Recruitment								
SSB	1946.7	2823	4141.1	5220.9	6074.7	8147.5	8715.3	
Catch	2150.6	2150.6	3396.8	3396.7	3396.3	3396.1	3396.8	
Probability of reaching 20% SSB	<0.5%	17%	61%	76%	83%	93%	95%	2020
Scenario 12: Current Quota; Short-Term Recruitment								
SSB	1948.8	2737.1	3279.8	2592.9	1781.9	524.2	436.7	
Catch	2150.6	2150.6	3393.7	3377.1	3319.7	2954.7	2903	
Probability of reaching 20% SSB	<0.5%	15%	36%	20%	7%	<0.5%	<0.5%	NA
Scenario 13: 10% Reduction; Long-Term Recruitment								
SSB	1947.9	2826.1	4225.3	5467.3	6492.5	9096.5	9798.7	
Catch	2150.6	2150.6	3057.1	3057.1	3056.8	3057.1	3057.1	
Probability of reaching 20% SSB	<0.5%	17%	63%	81%	87%	96%	97%	2020
Scenario 14: 10% Reduction; Short-Term Recruitment								
SSB	1948.6	2738	3390.9	2886.8	2162.9	763	587	
Catch	2150.6	2150.6	3054.6	3052.8	3032.5	2846.7	2780.1	
Probability of reaching 20% SSB	<0.5%	15%	40%	26%	12%	<0.5%	<0.5%	NA
Scenario 15: 20% Reduction; Long-Term Recruitment								
SSB	1949.9	2829.1	4317.7	5750.4	6954.1	9928.4	10806.2	
Catch	2150.6	2150.6	2717.4	2717.4	2717.4	2717.4	2717.4	
Probability of reaching 20% SSB	<0.5%	18%	65%	84%	90%	98%	99%	2020
Scenario 16: 20% Reduction; Short-Term Recruitment								
SSB	1949.3	2739.2	3495.1	3176.4	2570.8	1175.5	883.3	
Catch	2150.6	2150.6	2716.8	2714.3	2710.8	2648.8	2610.7	
Probability of reaching 20% SSB	<0.5%	15%	43%	34%	19%	1%	<0.5%	NA

Table NMLS-03. (Continued)

Year	2018	2019	2020	2021	2022	2027	2037	Year when target achieved with 60% probability
Scenario 17: 30% Reduction; Long-Term Recruitment								
SSB	1947.6	2824.5	4381.5	5981.7	7356.2	10856.1	11783.5	
Catch	2150.6	2150.6	2377.8	2377.8	2377.8	2377.8	2377.8	
Probability of reaching 20% SSB	<0.5%	17%	67%	87%	94%	99%	>99.5%	2020
Scenario 18: 30% Reduction; Short-Term Recruitment								
SSB	1947.4	2733.8	3594	3479.2	3018.1	1736.6	1383.5	
Catch	2150.6	2150.6	2377.8	2377.1	2377.1	2365.6	2355.3	
Probability of reaching 20% SSB	<0.5%	15%	45%	42%	29%	5%	2%	NA
Scenario 19: 40% Reduction; Long-Term Recruitment								
SSB	1949.2	2831.8	4486.8	6295.8	7868.9	11749.2	12851.3	
Catch	2150.6	2150.6	2038.1	2038.1	2038.1	2038.1	2038.1	
Probability of reaching 20% SSB	<0.5%	18%	70%	90%	95%	>99.5%	>99.5%	2020
Scenario 20: 40% Reduction; Short-Term Recruitment								
SSB	1949.9	2737.3	3689.5	3756	3445.9	2444.2	2124.2	
Catch	2150.6	2150.6	2038.1	2038.1	2037.9	2037.6	2036.4	
Probability of reaching 20% SSB	<0.5%	15%	48%	49%	41%	16%	10%	NA
Scenario 21: 50% Reduction; Long-Term Recruitment								
SSB	1950.4	2829.7	4548.9	6512.1	8259.1	12654	13799.3	
Catch	2150.6	2150.6	1698.4	1698.4	1698.4	1698.4	1698.4	
Probability of reaching 20% SSB	<0.5%	17%	71%	92%	97%	>99.5%	>99.5%	2020
Scenario 22: 50% Reduction; Short-Term Recruitment								
SSB	1949.1	2737.4	3791.4	4065.7	3916.3	3214.4	3021.3	
Catch	2150.6	2150.6	1698.4	1698.4	1698.4	1698.4	1698.4	
Probability of reaching 20% SSB	<0.5%	15%	51%	57%	53%	35%	29%	NA
Scenario 23: 60% Reduction; Long-Term Recruitment								
SSB	1949.9	2829.1	4631.3	6798.1	8741.1	13605.2	14857.1	
Catch	2150.6	2150.6	1358.7	1358.7	1358.7	1358.7	1358.7	
Probability of reaching 20% SSB	<0.5%	18%	73%	94%	98%	>99.5%	>99.5%	2020
Scenario 24: 60% Reduction; Short-Term Recruitment								
SSB	1948.6	2737.7	3888.1	4364.3	4396.6	4110.1	3970.5	
Catch	2150.6	2150.6	1358.7	1358.7	1358.7	1358.7	1358.7	
Probability of reaching 20% SSB	<0.5%	15%	53%	65%	67%	63%	59%	2021*
Scenario 25: 70% Reduction; Short-Term Recruitment								
SSB	1948.7	2736.4	3979.8	4667.7	4886	4960.9	4977	
Catch	2150.6	2150.6	1019	1019	1019	1019	1019	
Probability of reaching 20% SSB	<0.5%	15%	56%	72%	78%	85%	86%	2021

Table NMLS-03. (Continued)

Year	2018	2019	2020	2021	2022	2027	2037	Year when target achieved with 60% probability
Scenario 26: 80% Reduction; Short-Term Recruitment								
SSB	1948.7	2736.2	4071.1	4971.3	5380.3	5909.1	5977.5	
Catch	2150.6	2150.6	679.4	679.4	679.4	679.4	679.4	
Probability of reaching 20% SSB	<0.5%	15%	58%	79%	88%	97%	97%	2021
Scenario 27: 90% Reduction; Short-Term Recruitment								
SSB	1950.6	2740.5	4170.3	5284.1	5881.7	6836.7	7009.4	
Catch	2150.6	2150.6	339.7	339.7	339.7	339.7	339.7	
Probability of reaching 20% SSB	<0.5%	15%	61%	85%	94%	>99.5%	>99.5%	2020

* This scenario has a 60% probability of being at or above 20%$SSB_{F=0}$ in 2020 but drops slightly below 60% starting in 2035.

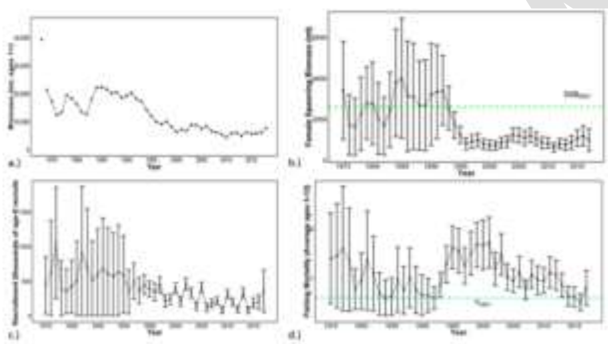


Figure NMLS-01. Time series of estimates of (a) population biomass (age 1+), (b) spawning biomass, (c) recruitment (age-0 fish), and (d) instantaneous fishing mortality (average for age 3-12, year^{-1}) for WCNPO striped marlin (derived from the 2019 stock assessment. The circles represent the maximum likelihood estimates by year for each quantity and the error bars represent the uncertainty of the estimates (95% confidence intervals), green dashed lines indicate SSB_{MSY} and F_{MSY}.

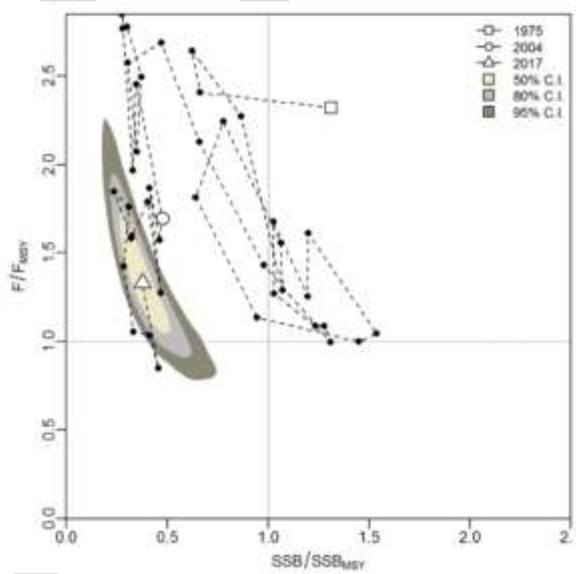


Figure NMLS-02. Kobe plot of the time series of estimates of relative fishing mortality (average of age 3-12) and relative spawning stock biomass of WCNPO striped marlin during 1975-2017. The white square denotes the first year (1975) of the assessment, the white circle denotes 2004, and the white triangle denotes the last year (2017) of the assessment.

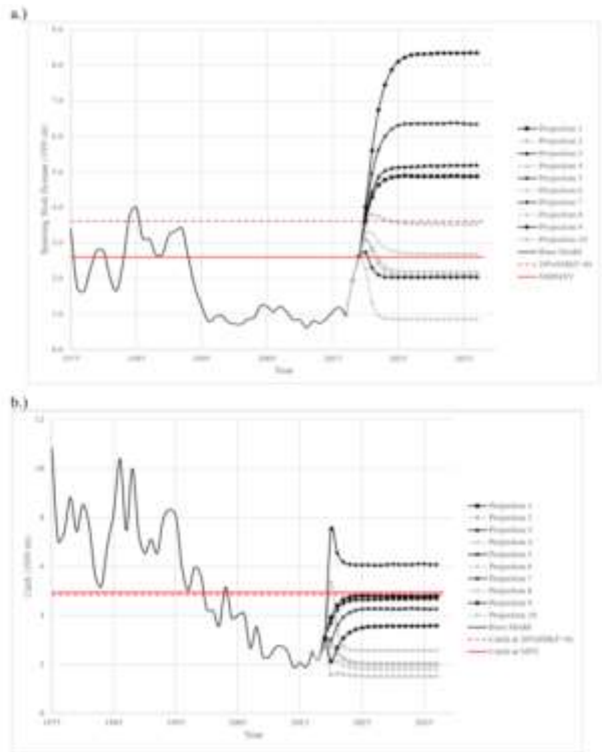


Figure NMLS-03. Historical and projected trajectories of spawning biomass and total catch from the WCNPO striped marlin base case model based upon F scenarios (projection 1-10): (a) projected spawning biomass and (b) projected catch.

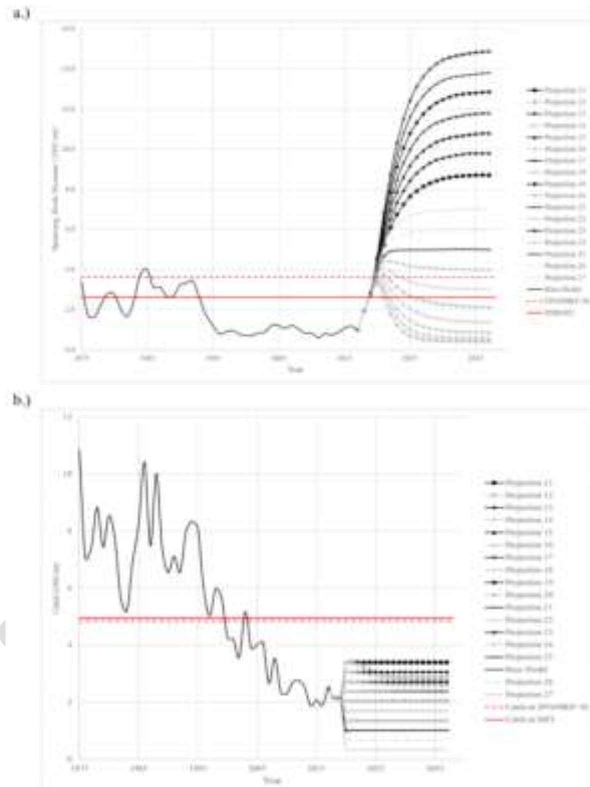


Figure NMLS-04. Historical and projected trajectories of spawning biomass and total catch from the WCNPO striped marlin base case model based upon constant catch scenarios (projections 11-15): (a) projected spawning biomass; and (b) projected catch.

Note on Figure NMLS-3 and Figure NMLS-4: Black lines are the long-term recruitment scenario results; grey lines show the short-term recruitment scenario results. The red dashed line shows the catch or spawning stock biomass at 20%$SSB_{F=0}$ and the solid red line is the catch or spawning stock biomass at SSB_{MSY}. The list of projection scenarios can be found in Table NMLS-03.

2.6.7.4 EASTERN PACIFIC OCEAN BIGEYE TUNA

Stock indicator report: Xu et al. 2019.

Stock status from Executive summary

Several uncertainties have been identified in the update assessment of bigeye tuna conducted in 2018, and its usefulness for management has been questioned. While the workplan to improve the bigeye stock assessment is being implemented (SAC-10-11), the staff will monitor a suite of stock status indicators (SSIs) for bigeye, which have been developed based on the methods used to compute stock status indicators for skipjack tuna. All bigeye indicators, except for catch, show strong trends over time indicating increasing fishing mortality and reduced abundance, and are at, or above, their reference levels. Additional analyses suggest that the method currently used to calculate the number of days fished on floating objects is biased towards an increasing trend in days fished, which also will bias the catch-per-day-fished (CPDF). Nonetheless, the increasing number of floating-object sets, particularly those on fish-aggregating devices (FADs), and the decreasing mean weight of the bigeye in the catch still indicate that the bigeye stock in the eastern Pacific Ocean (EPO) may be under increasing fishing pressure, and measures additional to the current seasonal closures, such as limits on the number of floating-object sets, are required. The staff has initiated research into the increase in the number of floating-object sets, per day and per vessel (SAC-10 INF-D), which is probably due to both the vessels' increased efficiency in finding FADs with tuna, due to the increased number of FADs and the increased use of satellite-linked fish-detecting sonar buoys, and the increased number of floating-object sets by vessels with Dolphin Mortality Limit (DMLs) that historically have made a mixture of floating object and dolphin-associated sets. However, further research is needed.

2.6.7.5 EASTERN PACIFIC OCEAN YELLOWFIN TUNA

Stock assessment: Minte-Vera et al. 2019.

Stock status from Executive summary

The model currently used for the stock assessment of yellowfin tuna in the eastern Pacific Ocean is unable to reconcile data that apparently carry contradictory signals about the status of the stock. The low values for recent years estimated for three CPUE-based indicators (CPUE for two dolphin-associated (DEL) fisheries, standardized using spatiotemporal methods, and for the southern longline (LL-S) fishery) suggest low abundance of the population, but this is inconsistent with the increased average size of the fish in the catch of these fisheries. It is therefore not clear from the indicators whether yellowfin abundance is in fact reduced, or changes have occurred in the fisheries.

Research is planned to revise the model and several of its assumptions in preparation for the benchmark assessment in 2020. Meanwhile, data-based indicators have been developed for the yellowfin stock, similar to those for the skipjack and bigeye tuna stocks.

Table 6. Estimates of stock status in relation to overfishing and overfished reference points for WPRFMC PMUS

Stock	Overfishing reference point	Is overfishing occurring?	Approaching Overfishing (2 yr)	Overfished reference point	Is the stock overfished?	Approaching Overfished (2 yr)	Assessment results[1]	Natural mortality[2]	MSST
Skipjack Tuna (WCPO)	F/F_{MSY}=0.45	No	No	SB_{2018}/SB_{MSY}=2.38, $SB_{2018}/SB_{F=0}$=0.41	No	No	Vincent et al. (2019), SC15 report	>0.5 yr^{-1}	0.5 SB_{MSY}
Skipjack Tuna (EPO)	NA	NA	NA	NA	NA	NA	Maunder (2018)	NA	NA
Yellowfin Tuna (WCPO)	F/F_{MSY}=0.74	No	No	SB_{2015}/SB_{MSY}=1.39, $SB_{2015}/SB_{F=0}$=0.34	No	No	Tremblay-Boyer et al. 2017, SC13 report	0.8-1.6 yr^{-1}	0.5 SB_{MSY}
Yellowfin Tuna (EPO)	F/F_{MSY}=1.01	Yes, because F>MFMT	Not applicable	$SB_{2015\text{-}2017}/SB_{MSY}$=1.08, $B_{2015\text{-}2017}/B_{MSY}$=1.35	No	No	Minte-Vera et al. (2018)	0.2-0.7 yr^{-1}	0.5 B_{MSY}
Albacore (S. Pacific)	$F_{2012\text{-}2014}/F_{MSY}$=0.20	No	No	SB_{2015}/SB_{MSY}=3.42, $SB_{2015}/SB_{F=0}$=0.52	No	No	Tremblay-Boyer et al. (2018)	0.4 yr^{-1}	0.6 SB_{MSY}
Albacore (N. Pacific)	F/F_{MSY}=0.61	No	No	$SB_{2015}/SB_{F=0}$=0.40	No	No	ISC (2017)	0.4 yr^{-1}	0.6 B_{MSY}
Bigeye Tuna (WCPO)	$F_{2011\text{-}2014}/F_{MSY}$=0.77	No	No	SB_{2015}/SB_{MSY}=1.62, $SB_{22015}/SB_{F=0}$=0.42	No, because SSB>MSST	No	Vincent et al. (2018), SC14 Report	0.4 yr^{-1}	0.6 SB_{MSY}
Bigeye Tuna (EPO)	$F_{2015\text{-}2017}/F_{MSY}$=1.15	Yes, because F>MFMT	Not applicable	$SB_{2015\text{-}2017}/SB_{MSY}$=1.02, $B_{2012\text{-}2015}/B_{MSY}$=0.91	No, because SSB>MSST	Not applicable	Aires-da-Silva et al (2018)	0.1-0.25 yr^{-1}	~0.75 B_{MSY}
Pacific Bluefin Tuna	$F20\%_{2015\text{-}2016}$ =1.15	Yes, because F>MFMT	Not applicable	$SB_{2016}/SB_{F=0}$=0.033	Yes, because SSB<MSST	Not applicable	ISC (2018)	0.25-1.6 yr^{-1}	~0.75 B_{MSY}
Blue Marlin (Pacific)	$F_{2012\text{-}2014}/F_{MSY}$=0.88	No	Unknown	$SB_{2012\text{-}2014}/SB_{MSY}$=1.25	No	Unknown	ISC (2016)	0.22-0.42 yr^{-1}	~0.7 SB_{MSY}
Swordfish (WCNPO)	$F_{2013\text{-}2015}/F_{MSY}$=0.45	No	Unknown	SB_{2016}/SB_{MSY}=1.87	No	Unknown	ISC (2018)	0.3 yr^{-1}	0.7 B_{MSY}
Swordfish (EPO)	F_{2012}/F_{MSY} = 1.11	Yes, because F > MFMT	Not applicable	SB_{2012}/SB_{MSY} =1.87	No	Unknown	ISC (2014)	0.35 yr^{-1}	0.65 B_{MSY}
Striped Marlin WC (N. Pacific)	$F_{2015\text{-}2017}/F_{MSY}$=1.07	Yes, because F>MFMT	Not applicable	$SB_{2015\text{-}2017}/SB_{MSY}$=0.42	Yes, because SSB_{2013}<MSST	Not applicable	ISC (2019)	0.4 yr^{-1}	0.6 SB_{MSY}
Striped Marlin	Not provided in assessment	No	No	$SB_{(2009)}/SB_{MSY}$=1.5	No	Unknown	Hinton and Maunder	0.5 yr^{-1}	0.5 B_{MSY}

Stock	Overfishing reference point	Is overfishing occurring?	Approaching Overfishing (2 yr)	Overfished reference point	Is the stock overfished?	Approaching Overfished (2 yr)	Assessment results[1]	Natural mortality[2]	MSST
(NEPO)							(2011)		
Blue Shark (N. Pacific)	$F_{2012-2014}/F_{MSY}=0.38$	No	Unknown	$SB_{2015}/SB_{MSY}=1.69$	No	Unknown	ISC (2017), BSIA	0.145-0.785 yr^{-1}	~0.8 SB_{MSY}
Oceanic white-tip shark (WCPO)[3]	$F_{2016}/F_{MSY}=3.30$	Yes	Not applicable	$SB_{2016}/SB_{MSY}=0.09$	Yes	Not applicable	Tremblay-Boyer et al. (2019), SC15 Report	0.18 yr^{-1}	0.82 B_{MSY}
Silky shark (WCPO)[3]	$F_{2016}/F_{MSY}=1.61$	Yes	Not applicable	$SB_{2016}/SB_{MSY}=1.18$	No	Unknown	Clarke et al. (2018), SC14 Report	0.18 yr^{-1}	0.82 B_{MSY}
Silky Shark (EPO)[3]	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Lennert-Cody et al. (2018)	Unknown	Unknown
Longfin mako shark (N. Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Shortfin mako shark (N. Pacific)	$F_{2013-2015}/F_{MSY}=0.62$	No	Unknown	$SB_{2016}/SB_{MSY}=1.36$	No	Unknown	ISC (2018)	0.128 yr^{-1}	0.872 B_{MSY}
Common thresher shark (N. Pacific)	$F/F_{MSY}=0.21$	No	Unknown	$SB/SB_{MSY}=1.3$	No	Unknown	Teo et al. (2018)	0.04 yr^{-1}	0.96 B_{MSY}
Bigeye thresher shark (N. Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Pelagic thresher shark (N. Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Salmon shark (N. Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Mahimahi (Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Wahoo (Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Opah (Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Pomfret (family	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Stock	Overfishing reference point	Is overfishing occurring?	Approaching Overfishing (2 yr)	Overfished reference point	Is the stock overfished?	Approaching Overfished (2 yr)	Assessment results[1]	Natural mortality[2]	MSST
Bramidae, W. Pacific)									
Black marlin (Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Shortbill spearfish (Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Sailfish (Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Kawakawa (Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Oilfish (family Gempylidae, Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Other tuna relatives (*Auxis* spp., *Allothunnus* spp., and *Scomber* spp, Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Squids (Pacific)	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

[1]For some WCPO stocks, the Scientific Committee of the WCPFC may adjust the weighting of the structural uncertainty grid, based on scientific uncertainty, used to derive median limit reference points. For these stocks, the reference to the SC meeting report at which the weighting decision was made is provided in addition to the stock assessment report reference.
[2]Estimates based on Boggs et al. (2000) or assumed in the assessments.
[3]As of this publication, NMFS has not yet determined that this stock assessment is the best scientific information available for the purposes of stock status determination.

2.6.8 U.S. LONGLINE LANDINGS REPORTED TO WCPFC AND IATTC FOR 2018

The tables of this section show the catches of pelagic MUS by U.S. longline (Hawaii and California-based) and U.S. territorial longline fisheries in the WCPFC Convention Area from 2014-2018, as reported to the WCPFC (NMFS 2019). The catches for 2018 are preliminary.

Table 7. U.S. and Territorial longline catch (mt) by species in the WCPFC Statistical Area, 2014–2018

	U.S. in North Pacific Ocean					CNMI in North Pacific Ocean					Guam in North Pacific Ocean					American Samoa in North Pacific Ocean					American Samoa in South Pacific Ocean					Total				
	2018	2017	2016	2015	2014	2018	2017	2016	2015	2014	2018	2017	2016	2015	2014	2018	2017	2016	2015	2014	2018	2017	2016	2015	2014	2018	2017	2016	2015	2014
Vessels	136	136	133	135	140	121	119	117	117	109			118	112		113	118	23	22	17	13	15	20	21	23	150	150	151	156	162
Species																														
Albacore, NPO	59	74	208	197	178											11	17	34	19							70	90	243	217	186
Albacore, SPO				0																	1,416	1,411	1,517	1,855	1,430	1,416	1,411	1,517	1,855	1,430
Bigeye tuna	3,392	2,948	3,747	3,427		993	999	879	999	1,000			932	856		798	1,346	586	441		47	65	72	116	82	5,230	5,357	6,216	5,840	5,141
Pacific bluefin tuna	0	1	0													0	0				1	2	0	6	3	1	2	1	6	3
Skipjack tuna	105	156	186	176	167											15	36	26	11	9	67	64	94	67	116	187	255	306	254	291
Yellowfin tuna	1,868	1,750	1,093	681	567											209	312	175	105	30	246	538	386	255	424	2,324	2,600	1,654	1,041	1,021
Other tuna			0	0														0										0	0	0
TOTAL TUNA	5,424	4,928	5,234	4,482	4,734	993	999	879	999	1,000			932	856		1,034	1,710	821	577	283	1,776	2,079	2,069	2,299	2,055	9,227	9,717	9,936	9,214	8,072
Black marlin		0	1	0	1												0		0	0		0					1	1	0	1
Blue marlin	529	485	419	445	428											38	87	57	55	31	32	39	30	25	28	598	612	506	525	486
Sailfish	9	9	15	11	15											1	2	2	2	0	1	1	2	2	2	11	12	19	15	17
Spearfish	171	205	251	188	163											15	27	28	15	11	1	2	2	1	1	187	234	281	204	175
Striped marlin, NPO	332	280	280	378	343											44	50	48	36	14						375	330	327	414	357
Striped marlin, SPO																					1	2	2	3	7	0	2	2	3	7
Other marlins	1	1	1	1													0		0							1	1	1	1	0
Swordfish, NPO	590	918	596	665	865											41	49	43	24	15						631	967	639	690	880
Swordfish, SPO																					6	6	6	8	10	6	6	6	8	10
TOTAL BILLFISH	1,631	1,899	1,562	1,688	1,813											138	215	179	133	72	41	50	41	40	47	1,810	2,164	1,782	1,861	1,932
Blue shark																		0			3	1	1	1	1	3	1	1	1	1
Mako shark	36	30	37	35	35											5	5	9	4	2	0	0	0			42	36	46	39	37
Thresher	2	2	3	5	5												0	0	1	1	1	2	0			2	5	4	6	6
Other sharks		0	0																			0	0				0	0		
Oceanic whitetip shark																							0							
Silky shark		0																			0					0				
Hammerhead shark			0																									0		
Tiger shark																														
Porbeagle																														
TOTAL SHARKS	38	32	40	40	40											5	6	10	5	2	4	3	1	1	1	47	42	51	45	43
Mahimahi	155	143	202	199	236											14	23	28	21	15	2	14	4	6	12	172	180	234	226	263
Moonfish	390	257	304	279	385											58	63	74	55	22	1	1	2	2	1	449	322	380	336	408
Oilfish	98	94	160	165	169											14	22	29	20	13	0	0	2	0	0	112	116	191	185	182
Pomfret	265	260	339	380	373											32	40	46	39	18	0	0	0	0	0	298	300	386	419	392
Wahoo	264	217	309	256	243											34	37	47	27	18	16	49	47	58	75	314	304	403	340	336
Other fish	4	2	7	7	6											0	0	1	1	0	0	0	1	1	0	4	3	9	9	6
TOTAL OTHER	1,178	975	1,322	1,285	1,411											153	185	224	164	87	19	66	55	66	89	1,349	1,225	1,602	1,515	1,587
GEAR TOTAL	8,271	7,834	8,158	7,495	7,999	993	999	879	999	1,000			932	856	0	1,330	2,116	1,235	878	445	1,840	2,198	2,167	2,405	2,192	12,433	13,147	13,371	12,634	11,635

Table 8. U.S. longline catch (mt) by species in the North Pacific Ocean, 2014-2018

	U.S. (ISC)				
	2018	**2017**	**2016**	**2015**	**2014**
Vessels	**145**	**145**	**141**	**143**	**141**
Species					
Albacore, North Pacific	86	95	248	243	208
Albacore, South Pacific					
Bigeye tuna	7,572	7,993	8,229	8,774	7,131
Pacific bluefin tuna	1	1	0	0	0
Skipjack tuna	149	221	240	212	187
Yellowfin tuna	2,496	2,593	1,512	921	658
Other tuna	0	0	0	0	0
TOTAL TUNA	**10,304**	**10,903**	**10,230**	**10,150**	**8,185**
Black marlin	0	1	1	0	1
Blue marlin	663	687	554	631	535
Sailfish	13	15	19	15	19
Spearfish	219	303	340	263	218
Striped marlin, North Pacific	465	406	390	493	426
Striped marlin, South Pacific					
Other marlins	1	1	1	2	
Swordfish, North Pacific	1,053	1,618	1,092	1,516	1,665
Swordfish, South Pacific					
TOTAL BILLFISH	**2,413**	**3,032**	**2,397**	**2,919**	**2,864**
Blue shark			0		
Mako shark	60	71	70	59	53
Thresher	2	4	4	7	7
Other sharks			0		
Oceanic whitetip shark					
Silky shark					
Hammerhead shark					
Tiger shark					
Porbeagle					
TOTAL SHARKS	**62**	**74**	**74**	**66**	**60**
Mahimahi	174	256	296	328	389
Moonfish	449	1,039	982	1,207	1,043
Oilfish	112	153	218	239	235
Pomfret	298	403	471	564	509
Wahoo	331	357	418	354	313
Other fish	5	3	9	8	6
TOTAL OTHER	**1,369**	**2,211**	**2,394**	**2,700**	**2,495**
GEAR TOTAL	**14,149**	**16,220**	**15,094**	**15,835**	**13,603**

Table 9. U.S. longline catch (mt) by species in the Eastern Pacific Ocean, 2014-2018

	All U.S. vessels					**U.S. vessels ≥ 24 m**					**U.S. vessels ≤ 24 m**				
	2018	**2017**	**2016**	**2015**	**2014**	**2018**	**2017**	**2016**	**2015**	**2014**	**2018**	**2017**	**2016**	**2015**	**2014**
Vessels	128	131	123	131	126	30	29	24	30	34	91	102	99	101	92
Albacore, North Pacific	16	5	6	26	23	2	2	2	19	17	13	3	4	7	6
Albacore, South Pacific	0	0	0	0							0				
Bigeye tuna	2,389	2,700	2,084	3,050	2,073	517	491	306	553	508	1,872	2,209	1,778	2,497	1,564
Pacific bluefin tuna	0	1	0	0	0		1			0	0			0	
Skipjack tuna	30	29	29	25	11	9	5	5	5	2	21	25	23	20	9
Yellowfin tuna	419	531	244	134	61	98	85	33	38	18	320	446	211	96	43
Other tuna	0	0	0	0	0						0				
TOTAL TUNA	**2,853**	**3,266**	**2,362**	**3,234**	**2,168**	**626**	**584**	**346**	**615**	**545**	**2,227**	**2,682**	**2,016**	**2,620**	**1,622**
Black marlin	0	0	0	0	0						0	0	0		
Blue marlin	97	115	78	131	76	11	15	7	9	17	86	100	70	123	59
Sailfish	3	4	2	2	4	1	0	0	0	1	2	4	2	2	2
Spearfish	32	71	60	59	44	7	10	7	6	9	25	61	53	53	35
Striped marlin, North Pacific	90	76	62	79	69	15	10	11	9	13	74	66	51	70	55
Striped marlin, South Pacific	0		0	0	0	0									
Other marlins	0	0	0	1	0	0	0		0				0	1	
Swordfish, North Pacific	422	651	453	826	786	215	391	253	347	388	207	260	200	479	397
Swordfish, South Pacific	0	0	0	0	0	0									
TOTAL BILLFISH	**644**	**917**	**656**	**1,099**	**978**	**249**	**427**	**279**	**371**	**429**	**395**	**490**	**377**	**728**	**549**
Blue shark			0										0		
Mako shark	19	35	24	20	16	11	21	10	9	10	8	14	14	10	6
Thresher		1	0	2	1		0	0	0			1	0	1	1
Other sharks			0										0		
Oceanic whitetip shark															
Silky shark															
Hammerhead shark															
Tiger shark															
Porbeagle															
TOTAL SHARKS	**19**	**36**	**25**	**21**	**17**	**11**	**21**	**10**	**10**	**10**	**8**	**15**	**14**	**12**	**7**

	All U.S. vessels					U.S. vessels ≥ 24 m					U.S. vessels ≤ 24 m				
	2018	**2017**	**2016**	**2015**	**2014**	**2018**	**2017**	**2016**	**2015**	**2014**	**2018**	**2017**	**2016**	**2015**	**2014**
Mahimahi	57	90	65	108	138	11	11	10	9	35	46	79	56	98	103
Moonfish	930	719	604	872	637	251	162	99	156	165	679	557	506	717	472
Oilfish	30	37	29	54	53	9	7	6	11	16	21	30	23	44	37
Pomfret	91	103	86	145	117	30	24	10	22	30	61	79	76	123	87
Wahoo	91	103	62	72	51	22	17	12	14	12	69	85	50	58	39
Other fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL OTHER	**1,200**	**1,051**	**847**	**1,252**	**997**	**324**	**221**	**136**	**212**	**258**	**876**	**830**	**710**	**1,040**	**739**
GEAR TOTAL	**4,715**	**5,271**	**3,889**	**5,606**	**4,160**	**1,210**	**1,253**	**772**	**1,207**	**1,243**	**3,505**	**4,018**	**3,117**	**4,399**	**2,917**

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